Structure in Language

A Dynamic Perspective

Thomas Berg

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For Johannes Wiermann,
the second most important non-academic teacher
to have had a profound influence
on my attitude towards life

Preface

This monograph presents a synthesis of a good portion of the research I have conducted over the past ten years or so. Although this body of work is quite diverse, ranging from historical syntax to phonological disorders, it was clear to me from the outset that a common thread ran through it all. The task I set myself in this book was therefore to string the various pieces together and to develop a unified theory that is broad enough to embrace the disparate phenomena under consideration. Viewed from a slightly different perspective, this book represents an attempt to work out the ramifications of a psycholinguistic model sketched in Berg and Abd-El-Jawad (1996) that may be seen as the embryonic form of the present monograph. The multitude of ramifications has led to the wide scope of the book with a concomitant vulnerability on all fronts. However, this was an inevitable consequence of the desire to assess the generality of the theory. This appeared all the more desirable as the fractionalization of the field makes it increasingly difficult to see the overall picture.

This brief account of the origin of the book explains (at least in part) why I had to sacrifice one of my holiest publication strategies, which is "if you end up duplicating your own work, you'd better not start publishing" (even though I am ready to acknowledge that monographs follow a somewhat different logic from journal articles). Because it was my overall aim to bring together the various strands of research under the umbrella of a single theory, I could not help quoting my previous publications. In particular, section 2.4.1 is a modified version of Berg (2003b), section 4.2.1 follows Berg (2002b) closely, section 8.2.2 summarizes Berg (2006) and section 9.2 relies on Berg (2002a) as well as Berg (1997). The relevant parts are reproduced by kind permission of Cambridge University Press, Elsevier, and Peter Lang. Some of the ideas contained in this book were first submitted to audiences in Freiburg, Paderborn, Berlin (all in 2001), Boston, MA in 2005, and Bremen in 2006.

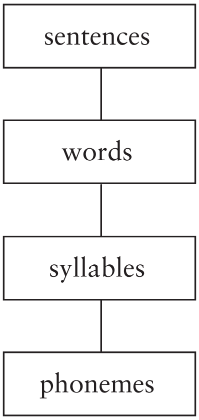
Numerous people have contributed in one way of another to this monograph. I was fortunate to receive comments on the text from Winfried Boeder, Florian Dolberg, Ulrich Schade, and Peter Siemund and above all from the anonymous Routledge readers. Nigel Isle has been my faithful companion on the long road to linguistic correctness. Kath Baker shared her native-speaker intuition with me more than once. The book's long gestation period has seen quite a few student assistants and some others who were of invaluable help in the data collection process, to wit Beata Zaide, Andreas Sohr, Sabine Helmer, Christian Koops, and Anatol Stefanowitsch, or who were immensely serviceable in turning the manuscript into its final shape, viz. Ole Christiansen, Sandra Lund, Marion Neubauer, and Maren Schiefke. The experiment reported in Chapter 10 (and its mute forerunner) would not have been possible without the help of Rik Eshuis, Magdalene Emmelius, Trevor Harley, and Beth Wilson. I could always count on Stefan Gries's expertise in statistical matters. My heartfelt thanks go to all of them.

1 A Structural Model of Language Production

1.1 THE DOUBLE HIERARCHY

One of the incontrovertible facts of language is its hierarchical organization. Although the number of levels and their relationship to one another may be a matter of dispute, there is general consensus that linguistic units are amenable to a ranking by size, as illustrated in (1).

(1) The hierarchical organization of some major linguistic units



It is equally uncontroversial, although not widely acknowledged, that the units in (1) differ in their psycholinguistic status. Whereas some units are "there," like books on a shelf, waiting to be taken and used, others are not "there" and therefore have to be constructed.

Monomorphemic words and phonemes are clear instances of the former category. A speaker must have a repository of lexical items and these items must provide permanent access to their phonological representation, which includes information about the nature of the constituent phonemes and their order. A successful use of language thus requires that monomorphemic words and phonemes be part of the long-term memory representation of the ordinary speaker.

The case of sentences is different. It is obviously true that the infinite number of different sentences, whether actually attested or potentially constructible in compliance with the rules of the language, stands in the way of committing them to memory.[1] We must therefore take it as an established fact that sentences cannot normally be retrieved as holistic units but have to be built up during the preparation to speak.[2]

The case of syllables is different again. We know that the number of syllables in a language is finite and considerably lower than that of words (Schiller, Meyer, Baayen, & Levelt, 1996). The arguments of creativity and limited storage space that apply to syntax thus cannot be extended to phonology. However, this does not mean that syllables have the same status as words and phonemes. The major linguistic criterion that is employed in this connection is that of redundancy. If a particular unit is redundant (i.e., predictable from some other source of information) it need not be stored in the lexicon. Given that syllable boundaries are not normally distinctive,[3] there is no motivation for including syllables in the long-term memory representation. Consequently, syllables would have to be actively put together much like sentences, though for very different reasons.

We thus arrive at an initial division of linguistic units into two classes—those that can be taken off the shelf ready-made ("prefabs") and those that have to be created in an ad hoc manner ("assemblemes"), as shown in (2).

(2) Two sets of linguistic units

Ready-made units	Ad hoc units
monomorphemic words	sentences
phonemes	syllables

These two sets of linguistic elements make up two different hierarchies that must be systematically related to each other to ensure the smooth production of language. (This aspect is not expressed in (2).) The ready-made elements will be termed *content units* and the ad hoc elements *structural units*. It is the purpose of this book to work out the implications of this distinction for a general theory of language—general in the sense that it aims at covering major aspects of language structure, change, acquisition, and loss. The focus of this enterprise will be on the structural side of the coin, which will be systematically explored. We begin by motivating the terms *content* and *structure* and setting them off against other prevalent uses in the relevant literature. This is followed by an assignment of linguistic units to either the content or the structural domain.

1.2 CONTENT VERSUS STRUCTURAL UNITS

Content units have just been defined as being available in a speaker's long-term store, unlike structural units that have to be made up on the spot. This definition of structure is certainly not standard. In fact, it represents quite a radical departure from previous notions of structure. At least three different concepts are discernible in the linguistic literature. The first originates with the structuralists of the first half of the last century (e.g., Hill, 1958) and is still current today. This notion by and large equates structure with hierarchy. In this view, every linguistic element is of the structural kind so long as it is part of a larger chunk. As language is hierarchically organized, the implication is that all linguistic elements are structural in nature. The following statement from Coates (1999, p. 2) is entirely typical: ". . . lots of words . . . do evidently consist of smaller pieces—they have STRUCTURE" (emphasis his). By "smaller pieces," Coates means morphemes and by "structure," he means internal structure. He therefore regards morphemes as structural units. In a very similar vein, Greenberg (1957, p. 81) sees phonemes as "substructures." It goes without saying that this view of structure is incompatible with the distinction between content and structural units.

On the second reading, structure is short-hand for syntactic structure. This equation of structure with syntactic structure probably stems from the fact that syntax is widely recognized as the structural domain par excellence. Whereas the first definition of structure is too general in the light of the content–structure distinction, this one is too narrow in that it assigns syntax a uniqueness it may not have.

The third perspective on structure defines it in opposition to meaning. A pertinent example is the concept of boundary, in particular the distinction between word boundaries (#) and morpheme boundaries (+) introduced by Chomsky and Halle (1968). As Aronoff (1976, p. 121) puts it, ". . . boundaries are structural entities. . . . Like all structural entities, they have no phonological substance in themselves, nor meanings in the conventional sense . . .". It is obvious from this quotation that structure is something invisible or inaudible, a type of unit that lacks both signifier and signified. This view, then, stands in maximum contrast to the first conception of structure. Whereas all of the traditional linguistic units are regarded as structural on the first reading, none of them possesses this status on the last reading because they all have either a signifier or both a signifier and a signified. This third definition of structure contrasts sharply with the idea of sentences and syllables as structural units and leaves no room for the content–structure distinction more generally.

In view of the wide array of meanings attributed to the term *structure*, it may seem unwise to use it in yet another sense. However, what motivates the use of this term in the present context is its etymology, which conveys precisely the idea that puts us on the right track (even though, as will be seen below, it requires considerable elaboration). The term *structure* derives from the Latin noun *structura*, which in turn comes from the verb *struere*, whose original meaning was largely confined to the construction of buildings. Such work involves the assembly of smaller parts to create larger ones, and in fact, this notion is clearly embodied in the term *structure* in both its ordinary use (e.g., a six-story concrete structure) and its scientific use (compare e.g., Hartmann, 1964; Wunderlich, 1971).

The term *content* poses less of a problem because it conflicts less with other uses around. A major way in which this term is understood is in contrast to the notion of frame. Azuma (1993), for example, works with a model that provides for a syntactic frame into which linguistic elements (i.e., words) are inserted. Janssen, Roelofs, and Levelt (2002, 2004) argue for morphological frames and MacNeilage (1998) for phonological frames. These slots are filled with linguistic units such as morphemes and words. We will define here that all elements that are inserted into a frame are content units.

Another important sense in which the term *content* is used in the linguistic literature is in opposition to function. The distinction between content and function elements holds at the lexical level and is built on the semanticity–syntacticity contrast (among other criteria). Content words (e.g., nouns) are characterized by a high degree of semanticity, whereas function words (e.g., the infinitival particle *to*) are syntactically motivated. In this sense, then, content is synonymous with lexical meaning.

The way in which the term *content* is used here is much more congenial to the former than to the latter usage. The latter definition is too narrow and does not capture some fundamental similarities between units with a signified and those without. By contrast, the former definition has essentially (albeit not completely) the same extension as the one proposed below, even though the underlying motivations are quite disparate. The state of having an entry in the mental lexicon is definitely not the same as the quality of being inserted into a frame. It is mainly this considerable overlap in the extensions of the two definitions that justifies the use of the term *content* in the ensuing analysis.

1.3 COHESIVENESS AS THE LITMUS TEST

The first challenge is to divide linguistic elements into either content or structural units. The critical question is this: Which elements are stored in long-term memory and which are not? It should be made quite clear at the outset that both types of unit are eventually "there," only their psycholinguistic history is different. Let us take as an example the units *word* and *sentence*, the former of which was provisionally assigned to the content set and the latter to the structural set in section 1.1. Clearly, both words and sentences are produced in the act of speaking. So, as products, they are both "there." However, while the content units exist from the beginning, the structural units have to be brought into existence. Of central importance is the claim that this generating takes time (i.e., it is a real-time process that begins with the absence of structure and ends with the presence of structural units; see Berg & Abd-El-Jawad, 1996, and Bertinetto, 2001a).[4] In between these limits, structural representations are gradually erected. Theoretically, this erection process continues until a structural unit has been built up completely. What does it mean for a unit to be completed? If a structural element has been created to the fullest, it acquires the status of a unit in the sense that it perfectly unites the elements it is composed of. Differently put, it has reached a maximum degree of cohesion. Cohesiveness thus becomes the foremost index of the gradual build-up of structural information. In the early phases of this process, little cohesiveness is expected, whereas later stages predictably generate more cohesiveness.

Unless the unlikely assumption is made that the head start of the content units is lost to the structural units, the former will display a greater degree of cohesion than the latter at any moment in the process of preparing to speak. Degree of cohesiveness thus turns out to be the major criterion for distinguishing between content and structural units. This leads us to the following identification procedure. An element that behaves cohesively is identified as a content unit while an element that exhibits a less than cohesive behaviour is identified as a structural unit. Note that the degree of cohesiveness is variable both across different elements and within one and the same element. Due to their inherent differences in size, make-up, and function, different structural units may differ in the time they take to reach a certain level of cohesiveness. Assuming a threshold at which the erection process is stopped and articulation begins, different structural units may attain different degrees of cohesion. Moreover, one and the same unit need not always be equally cohesive. If it can be "caught" at different moments in the erection process, it will evince different degrees of cohesion. By averaging across all relevant data points, we may derive a general measure of the cohesiveness of a particular unit. Since we are talking about degrees of cohesiveness, a sharp dividing line can be expected neither between content and structural units nor between structural units and no units at all. It is theoretically possible for a structural unit to be fairly cohesive and thereby approximate to the behaviour of content units. Similarly, if a structural element is highly incohesive, it behaves almost as if it was not there and accordingly may be difficult to make out.

In the following discussion, a wide range of linguistic units will be examined in terms of their membership of the content or structural group. Although the distinction between content and structural units is assumed to be universal, the analysis will be performed using data mainly from English. The list of units is not meant to be exhaustive, although the lower levels are covered more extensively than the higher ones. To determine the cohesiveness of these units, empirical data are necessary that highlight certain parts of an utterance against the background of the utterance as a whole and that may arise at different moments in time in the language-planning process. These two requirements are perfectly met by speech errors (i.e., inadvertent deviations from the speaker's intention). A further great advantage of this data type is that it is uncontaminated by speakers' preconceptions and experimenters' instructions among other potential distortions. Speech errors are local phenomena, that is, they pick out individual units from their surrounding context and leave the remainder untouched. In addition, the least contentious hypothesis holds that slips of the tongue may occur anytime in the language generation process because there is no reason to assume that some stage in the production process is immune to malfunction while another is not. In point of fact, empirical evidence in support of the claim that errors may arise at various temporally defined points in the generation process has been accumulating over the years (e.g., Stemberger & Lewis, 1986, Berg, 1992a; Berg & Abd-El-Jawad, 1996).

The order in which the data will be presented is from larger to smaller units. One of the notable discoveries of speech error research is that the largest units are rather small. Indeed, the largest units involve no more than two words simultaneously. Two such cases are documented next in (3) and (4). All utterances appear in the sequence in which they were produced (i.e., the erroneous utterance precedes the target utterance, either actually produced by the perpetrator or reconstructed by the error collector). The error units are italicized for ease of identification.

(3) If you'll *meet him* you'll *stick around*. for: If you'll stick around you'll meet him. (from Fromkin, 1973)

(4) I'd like to speak to *this matter* about *you*. for: I'd like to speak to you about this matter. (from Fromkin, 1973)

Case (3) involves a reversal of two VP's, and (4) a reversal of two NP's. The fact that one of the interacting units in (3) is a phrasal verb is certainly not coincidental, as phrasal verbs are characterized by a high degree of idiomatization. This aspect implies a high degree of cohesiveness at the semantic level, which is unlikely to be completely lost during the translation process from a semantic to a syntactic representation. It is also not surprising to observe some cohesion between *this* and *matter* in (4) because the determiner modifies the noun. It might be fitting to add the obvious fact that the two-word units misordered in (3) and (4) are adjacent. The first conclusion to be drawn is that the units involved in two-word errors are semantically and syntactically well-defined.

However, much more important in the present connection is the uncommonness of these two-word errors. Whatever the syntactic relationship a word may have contracted, it most usually is affected individually, as in (5) which in a sense is the counterpart to (4).

(5) a small body of *instruments* written for these *compositions*.
for: a small body of *compositions* written for these *instruments*.
(from Fromkin, 1973)

In (5), the NP *these compositions* is broken up. Since this is the typical case, it may be concluded that complex NPs generally display a low degree of cohesiveness. Generalizing, we may go so far as to claim that all syntactic phrases consisting of at least two words rank fairly low on the cohesiveness scale. This result allows us to confirm what was claimed earlier for sentences. On the cohesiveness criterion, both sentences and syntactic constituents (above the single-word level) are structural units.

For expository reasons, the next unit to be investigated is the monomorphemic word, even though polymorphemic words are obviously larger in size. By word we understand a free-standing unit in contrast to a morpheme, which is defined here as bound in order to avoid the classificational ambiguity of items such as *brick*, which are generally viewed both as a word and as a morpheme. Monomorphemic words display a very clear pattern. They are one of the most frequent error units (i.e., they act holistically in the error process). A standard example is provided here.

(6) Although *murder* is a form of *suicide*. for: Although suicide is a form of murder. (from Garrett, 1975)

Case (6) exemplifies the reversal of two words that are misplaced as wholes. Because this example is entirely typical, the cohesiveness of monomorphemic words is beyond doubt. They are accordingly assigned to the category of content units.

An entirely parallel behaviour can be observed with morphemes, no matter whether they are lexical or grammatical, stems or affixes, prefixes or suffixes. Whenever they are involved in a malfunction, they act as units, as in (7).

(7) You want the potatoes *slice*ly *thin*ned? for: thinly sliced? (from Stemberger, 1985)

This is a typical morpheme error in which the lexical morphemes *thin* and *slice* exchange places. Although the morphemes are part of larger units, they themselves do not disintegrate in the error process, thereby testifying to their cohesiveness. By implication, they will be treated as content units.

Error (7) leads us to a consideration of polymorphemic words. As this slip shows, the words *thinly* and *sliced* are split, and their morphemes are individually affected. Thus, they are less than cohesive. How representative is this example? When examining the cohesiveness of morphologically complex words, it is useful to follow the standard practice of distinguishing between inflected and derived words as well as compounds.

Let us begin with inflected words. The following two examples illustrate the basic decision that the processor has to make in dealing with morphologically complex words.

(8) Well you can cut *rain* in the *trees*. for: trees in the rain. (from Garrett, 1982)

(9) He doesn't have any *closet*s in his *skeleton*. for: skeletons in his closet. (from Stemberger, 1985)

The two slips display a massive parallelism of sentence structure. They exemplify a sequencing problem between a singular and a plural noun. There are two options. Either the plural marker accompanies its misordered host or it stays behind and attaches to its new host. The former alternative is documented in (8), the latter in (9). It is quite evident from Stemberger's (1985) database that (8) is the exception and (9) the rule. He has 135 pertinent errors in his corpus of which 120 (= 88.9%) leave the inflection behind and 15 (= 11.1%) take it with them. This low degree of cohesiveness leaves no doubt that inflected words are not normally stored in the mental lexicon (Stemberger & MacWhinney, 1988). They are structural units. It might be added that the percentage of whole-word errors varies with the type of inflection and that it is even lower for most other inflections than for the plural. We thus have to reckon with slightly different degrees of cohesiveness for different inflections.

The next step leads us to consider compounds. As these are less common in English than in German and as quantitative information on English compound errors is not available, I will dip into my own collection of German slips of the tongue. Compounds may be implicated in errors in three different ways. A compound may interact with another compound, a compound may substitute for a noncompound, or vice versa. The first case is illustrated by the following examples, which are augmented by interlinear glosses and translations.

(10) Gestern hat die chemische Industrie auf der *Pressekonferenz*—auf der *Hannovermesse* eine Pressekonferenz gegeben.
yesterday has the chemical industry at the press conference—at the Hanover Fair a press conference given
'Yesterday the chemical industry held a press conference at the Hanover Fair.'

(11) Wir haben morgen Elternabend vom Kinder*abend*—vom Kinder*garten*.
we have tomorrow parents evening of the children evening—of the kindergarten
'Tomorrow we will have a parents' meeting of the kindergarten.'

Again, the parallelism of the two slips allows us to study the basic problem that the processor faces. Either the (bilexemic) compound is replaced in full or only one lexeme is replaced while the other stays put. The former happened in (10), the latter in (11). The compound *Pressekonferenz* (press conference) is anticipated to replace *Hannovermesse* (Hanover Fair) in (10) while the lexeme *Abend* (evening) from the compound *Elternabend* (parents' evening) perseverates to replace the lexeme *Garten* (garden) from the compound *Kindergarten* (kindergarten).

After the exclusion of all ambiguous cases, a total of 46 relevant errors were found in the German database. Of these, 37 (= 80.4%) underwent splitting (as in (11)) and 9 (= 19.6%) were of the holistic type (as in (10)). This asymmetry holds equally for all three subsets of compound errors just mentioned. These figures invite the conclusion that compounds exhibit a rather low degree of cohesiveness (see also Blanken, 2000, for German, Badecker, & Caramazza, 1998, and Badecker, 2001, for English compounds). They are therefore best viewed as structural units. In other words, this approach stresses the compositional nature of compounds.

The same procedure was applied to derived words. The opposite ways of treating this set of morphologically complex words are shown below.

(12) Is there a cigarette *building* in this *machine*? for: a cigarette machine in this building. (from Garrett, 1980)

(13) Can I have a full *nud*al *front*ity? for: a full frontal nudity. (from Stemberger, 1985)

The bimorphemic word *building* interacts in toto with the monomorphemic word *machine* in (12). However, the derivational suffixes *–al* and *–ity* remain in their original location and attach to their new lexemes in (13). In stark contrast to what was found for inflected words and compounds, Stemberger (1985) observes that the majority of derived words in English act in unison. There are 12 relevant slips in his sample of which 9 (= 75%) leave the complex word intact and 3 (= 25%) break it up. Despite the low number of mistakes, it may safely be concluded that derived words rank much higher on the cohesiveness scale than inflected words and compounds.

Translating the 75% cohesiveness index into the binary opposition of content and structural units turns out to be a difficult undertaking. As was pointed out towards the beginning of this section, the general approach adopted here does not lead one to expect a clear-cut distinction between the two types of units. Although one might easily be fooled into believing in the dichotomous nature of linguistic units—they are either stored in, or missing from, long-term memory—it appears much more appropriate to envision a complementary relationship between content and structural units. We could either say that a derived word is basically a content unit that is backed up by structural information or that it is a structural unit that is strongly backed up by content information. Although the first option is bolstered by the fact that the majority of derived words exhibit a cohesive behaviour, preference will, however, be given to the second option. Because content units were defined as being generally cohesive, any element that fails to reach this criterion cannot be assigned to the same group. A 25% break-up rate thus seems reason enough to identify derived words as structural (i.e., compositional rather than holistic) units. This classification takes account of the differential behaviour of monomorphemic and polymorphemic words. Furthermore, it assigns all polymorphemic words, whether inflectional or derivational, to the same category and thereby emphasizes the fundamental similarity between them, without, however, negating their differences. These may be attributed to the varying impact of long-term memory on the production of morphologically complex words. Other factors such as function and frequency also have to be considered in this context.

We now proceed to the levels below the word. The largest element below the word level is what Berg (1989a) termed the *superrime*. It consists of a rime plus a full (unstressed) syllable. Consider (14).

(14) str*unction* and f*ucture*. for: structure and function. (from Garrett, 1975)

Number (14) involves an exchange of two disyllabic words minus their initial consonants. It thus evidences a break point between the initial consonant(s) and the remainder of the word, viz. the superrime. It is a fact that superrime slips are uncommon. The by far more common error type is the whole-word slip as the closest alternative. The low cohesiveness of superrimes makes it quite clear that they belong to the category of structural units.

The constituents of the superrime lead us directly to the analysis of the syllable. We owe to Shattuck (1975) the baffling discovery that syllables are only very rarely implicated in slips of the tongue. One of the few uncontroversial cases is in (15).

(15) guitune my tar. for: tune my guitar. (from Shattuck-Hufnagel, 1979)

This slip exemplifies a leftward shift of the syllable /gi:/, which docks onto the word *tune* to produce *guitune*. The rarity of (syntagmatic) syllable errors shows that the cohesiveness of syllables is very low. Therefore, they are unhesitatingly classed as structural units. It is worth noting that the cohesiveness argument gives exactly the same result as the redundancy argument resorted to in section 1.1.

We now leave the syllable for its constituents, in particular the rime that encompasses everything from the vowel to the coda consonant(s). Refer to (16).

(16) The juice is still on the table. Is that en*uice*? for: en*ough*. (from Garrett, 1980)

This error shows a perseveration of the rime in *juice*, which intrudes on the rime of the stressed syllable in *enough* to yield *enuice*. Rime errors are relatively infrequent, and certainly less frequent than single-phoneme slips, which testifies to the low degree of cohesiveness of rimes. Like syllables, they unequivocally qualify as structural units.

Rimes represent a combination of minimally a vowel and a consonant. The combination of two consonants, that is consonant clusters, will be examined next. There are two types of clusters—tautosyllabic and heterosyllabic. We focus on the former type as it befits the notion of a hierarchy to study elements within elements, not across elements. Clusters come in different subsets depending on the nature (and number) of adjacent consonants. A typical representative of the cluster category is the obstruent + liquid set on the basis of which the contrast between a holistic and an analytic treatment will be illustrated.

(17) *c*oat *thr*utting. for: throat cutting. (from Fromkin, 1973)

(18) *th*eep *d*roat. for: deep throat. (from Shattuck-Hufnagel, 1983)

Examples (17) and (18) present a rare pair of errors in which one and the same word undergoes a differential treatment. The cluster /θr/ in the word *throat* acts as a unit in (17) but splits in (18). Note that there are no phonotactic reasons for this divergent behaviour. The cluster /θr/ interacts with /k/ in (17) and /d/ in (18). Both these consonants can readily be followed by a rhotic, the phoneme sequence that would have resulted if the initial consonant alone had been dislocated (as in (18)).

Berg (1994a) provides a quantitative analysis of the cohesiveness of initial stop + sonorant clusters in English. Of 109 pertinent slips, 85 (= 78.0%) break the cluster up (as in (18)) while 24 (= 22.0%) leave it unscathed. There is hardly any difference in cohesiveness between the various cluster subsets such as /Cl-/ and /Cr-/, apart from the fact that /tr/ and /dr/ prove to be more cohesive than the other stop + rhotic clusters. However, the inverted-sonority type /s/ + stop behaves quite differently. Berg (1994a) reports that clusters like /st/ for example, stick together in 69% of the relevant slips. It may be inferred from these results that the cohesiveness of a cluster depends on the phonological class it belongs to. While /s/ + stop clusters are fairly cohesive, obstruent + sonorant clusters usually fall apart in the error process. Despite these differences in cohesiveness, it may be submitted that clusters in general are structural units. This hypothesis is rather uncontroversial in the case of obstruents + sonorant clusters. The assumption that it also holds for /s/ + stop clusters allows us to account for the (relatively few) incohesive cases. The cohesiveness of these clusters requires a different explanation, presumably one in terms of sonority relationships among their constituents. It might be worth mentioning as an afterthought that heterosyllabic clusters are even less cohesive than tautosyllabic ones.

We have now reached the level of the single segment. It has just been shown that phonemes as parts of clusters tend to migrate individually rather than in conjunction with other consonants. Do phonemes also outstrip their smaller competitors (i.e., features)? The two levels at which speech errors may occur are exemplified in (19) and (20).

(19) Syllable re*s*er*v*als do occur. for: syllable reversals. (from Trevor Harley, unpublished)

(20) *z*eek *f*erification. for: seek verification. (from Fromkin, 1973)

Both (19) and (20) document a problem of ordering the two phonemes /s/ and /v/. In (19), their integrity is preserved during misordering. In (20), by contrast, the intended fricatives /s/ and /v/ turn up as /z/ and /f/, respectively. That is, this reversal took place at the feature level. In particular, the voice feature was exchanged such that /s/ adopted the [voiced] value from /v/ and /v/ the [voiceless] value from /s/. In the latter case, then, the integrity of the interacting phonemes was destroyed.

There is a good deal of agreement in the speech error literature that phonemes are cohesive units, even though it is true that many phoneme slips look ambiguous on the surface. Take (19) as an example. Theoretically, it may be construed not only as a whole-segment slip but also as a feature slip in which the place-of-articulation values of /s/ and /v/ (i.e. [alveolar] and [labial]) traded places whereas the other feature dimensions (i.e., voice and manner of articulation) were left untouched. This interpretation can be shown to be fallacious on a number of empirical and theoretical grounds, the details of which need not concern us here. The main point is that unambiguous feature errors are truly exceptional (e.g., Shattuck-Hufnagel, 1983). On this argument alone, it is justified to contend that phonemes are highly cohesive in character. Implicationally, they form a subset of the content units.

We are thus left with the phonological features themselves. As these constitute the smallest elements in the linguistic hierarchy, they by definition cannot disintegrate. They must therefore be content units.

This completes our *tour d'horizon* of the linguistic units that may be involved in English (and German) slips of the tongue. It will not have escaped the reader's notice that two phonological units have not been mentioned—the foot and the mora. The reason is simply that foot and mora errors do not seem to occur. This is certainly not unexpected in the case of feet. In the light of the fact that syllable errors are so uncommon, it comes as no surprise that sequences of two or more syllables resist misordering. All that can be said at this point is that the foregoing analysis did not yield any evidence in favour of feet.

There are a handful of slips of the tongue that might be mistaken for mora errors. Look at (21).

(21) *ca*ssy *pu*t. for: pussy cat. (from Fromkin, 1971)

At the descriptive level, (21) involves the permutation of the phoneme sequences /pʊ/ and /kæ/. On one version of moraic theory, which is espoused by, for example, Hyman (1985), the syllable-initial consonant and the following vowel are dominated by the same mora node whereas the syllable-final consonant is dominated by a separate mora node. Hence, the link between the prevocalic consonant and the vowel is stronger than that between the vowel and the postvocalic consonant. Assuming that moras form a level of representation that is called on during the language production process, the prediction would be that CV errors occur more frequently than VC errors. However, the opposite is true (see Stemberger, 1983a and Chapter Two, this volume). This version of moraic theory should therefore be rejected and the error in (21) not be categorized as a moraic one.

The other version of moraic theory (Hayes, 1989) adjoins the prevocalic consonant to the syllable rather than the mora node. The vowel and the postvocalic consonant are moraic as in the other version. A characteristic trait of this theory is that moras do not branch. This implies that the structure of the syllable is essentially flat and therefore differences in cohesiveness between adjacent phonemes are not predicted. However, as just noted, CV and VC sequences are unequal in their cohesiveness. Consequently, this version of moraic theory also fails. The conclusion to be drawn from this is that the speech error evidence argues against the reality of a moraic level of representation.

Also missing from this discussion are other units of the prosodic hierarchy, in particular phonological words and phrases (Nespor & Vogel, 1986). The reason for this absence is not that these groupings do not exist but rather that the evidence for them is more indirect than the speech-error argument that has been made in this discussion. As the units involved in malfunctions hardly ever go beyond the single-word level (see earlier discussion), there is no way of arguing the case of larger prosodic groupings within the framework of the preceding analysis. It is clear, however, that if phonological words and phrases are real, they must be structural units. The same goes for moras and feet. If other lines of evidence should find them necessary components of the language production process, their absence in speech errors would certainly militate against their assignment to the category of content units.

A final omission is the issue of segment structure. The basic assumption is that the feature dimensions that are constitutive of a phoneme (e.g., place and manner of articulation and voice in the case of consonants) do not form a linear, unordered set but are hierarchically organized into various levels (e.g., Clements, 1985; Odden, 1991). In a nutshell, phonemes are claimed to have constituent structure not unlike that of sentences. Although it is not my intention to take issue with the theoretical phonologists' proposals as *linguistic* constructs, there is a psycholinguistic sense in which sentence structure and segment structure are fundamentally different. As will be argued in section 1.5, structure is intimately tied to the serialization of language. It helps in the fluent production of a sequence of smaller units within a larger unit. There is a major disparity between sentence and segment structure in terms of serialization. Whereas the words within a sentence have to be put into a certain order, the features within a segment must be simultaneously available. For the production of a segment, all its features must be accessed in parallel. A serial relationship among them would be fatal. It follows from this that structure in the sense used here is not only unnecessary but even detrimental at the subsegmental level. It is consequently maintained that segment structure as a psycholinguistically relevant notion does not exist.[5]

It is time to take stock of what we have discussed up to now. The concept of cohesiveness has been utilized as a diagnostic of whether a linguistic element belongs to the class of content units or to that of structural units. The results of this investigation are summarized in (22).

(22) The inventory of content and structural units

Content units	Structural units
monomorphemic words	sentences
morphemes	syntactic phrases
phonemes	compounds
features	derived words
	inflected words
	superrimes
	syllables
	rimes
	clusters

1.4 TWO TYPES OF STRUCTURAL UNITS

The study of speech errors reveals another class of units that are needed in an adequate description of the language production process. Consider the exchange in (23).

(23) Hel*f*, hel*f*, the wol*p* is after me! for: Help, help, the wolf is after me! (from Garrett, 1980)

It was Shattuck-Hufnagel (1979, p. 303ff) who was the first to ask exactly the right question: How does the /p/ that was driven out of position by the /f/ find the position that was originally inhabited by the /f/? If the /f/ had left no trace of its original position, the /p/ would have been hard put to end up in the position it actually does. Shattuck-Hufnagel's solution was to argue that the /p/, on being dislocated, left a vacant slot behind that could then be filled by the /f/. She thus postulated a two-level representation consisting of slots and fillers that have to be associated with each other in the production process. This separation of representational levels roughly corresponds to the distinction between the skeleton and the melody tier in theoretical phonology (Clements & Keyser, 1983). The melodic tier makes available a set of segments, whereas the skeleton tier generates the place-holders for consonants (C) and vowels (V) that accommodate the segments. The association between fillers and slots is usually one-to-one, but it can also be many-to-one and one-to-many. An example of all three types of association is given in (24) for the word *peach*.

(24)	skeleton tier	C	V	V	C	
		|	\	/	/	\
	melody tier	p	i:		t	ʃ

As a general rule, all consonants including affricates are linked to a single C-slot, short vowels to a single V-slot and long vowels and diphthongs to a double V-slot. (In languages with distinctive consonant length, short consonants are adjoined to a single C-slot and long consonants to a double C-slot.) These departures from the principle of one-to-one association add a new dimension to the CV tier. Although it functions merely as a set of lined-up positions in a model that allows only one-to-one associations, the introduction of one-to-many associations makes the CV tier code quantitative information about segments. This amounts to a representational split whereby the qualitative properties of a segment are coded at the melodic and the quantitative properties at the skeleton tier.

This representational segregation generates an interesting prediction about the behaviour of quantitative and qualitative aspects of phonemes. As the two are represented at different levels and as each level may be reasonably assumed to be affected individually in the error process, one would expect quantitative information to be separated from qualitative information in slips of the tongue. Precisely this happened in (25), an example from German, a language with a consistent vowel length contrast.

(25) M*i*ll- Melanie.
[mil mɛlani:]

This error shows an interaction between the long vowel /i:/ and the short vowel /ɛ/. As can be seen, the word-final /i:/ is "oblivious" to its length specification and surfaces as /i/, that is, it adopts the length of the vowel it replaces (/ɛ/). This metamorphosis is readily explained on the assumption that this slip occurred at the melodic tier and ignored the skeleton tier. The fact that such dissociations between quantity and quality are the rule provides strong support for the dual-representation hypothesis in (24).

What is the status of the CV tier? To be more specific, is it stored in long-term memory? Roelofs & Meyer (1998) deny that the CV structure is included in the permanent representation of lexical items because this level failed to make an impact in their priming experiments. However, Meijer (1996) obtained facilitatory effects due to similarity at the skeleton tier (see also Ferrand & Segui, 1998; Costa & Sebastian-Gallés, 1998; and Berent, Bouissa, & Tuller, 2001) and consequently took his data to mean that the CV structure is stored with each lexical item. In a similar vein, Prunet, Béland, and Idrissi (2000) argued that the representation at the skeleton tier is memorized because the linking between the skeleton and the melody codes serial-order information that cannot be computed by rule.

There are problems with the latter view. It does not seem defensible to delegate serial-order information to the CV tier or to the associative links between the skeleton and the melody tier. This information must be included in the melody tier as the speaker's task is not to put a series of C and V units into proper order but a series of individual phonemes. The links also cannot be held responsible for serial ordering because, without prior knowledge about the correct order, the association process cannot operate smoothly.

The real problem with the CV tier is that it is implicitly assumed to fulfil several functions simultaneously. In order to determine the psycholinguistic status of the CV tier, it is necessary to keep these functions apart. It is certain that the skeleton's function of coding quantitative information is part of a word's permanent representation. The length of a given segment or the number of times it must be produced is an idiosyncratic property of lexical items. It is as unpredictable as the quality of a phoneme. The best proof for this claim is the distinctive nature of quantitative information. For example, vowel length is the distinguishing phonological trait in the German minimal pair *Miete* [mi:tə] 'rent' versus *Mitte* [mitə] 'middle.'

By contrast, the skeleton's function of providing for place-holders need not be included in long-term memory. If each segment is assigned one slot, the CV structure is entirely redundant. That is, there would be no need to clutter up one's memory with it.[6] The same is true of the skeleton's final function of coding major-class information (i.e., the distinction between consonants and vowels). Because this information is predictable from the phonemes themselves, there is no reason to have a CV tier on which it is permanently represented.

The conclusion seems inevitable that the provision for slots and the coding of quantitative information are functions of the skeleton tier that should be kept representationally distinct. It is necessary therefore to create an additional representational level and assign these two functions to distinct levels. Specifically, the function of providing slots will be reserved to what will henceforth be called the *slot level* whereas the function of coding quantitative information will be reserved to what we will dub the *quantity level*. For reasons of terminological consistency, the melody tier will be renamed the *quality level*. Of course, it makes no sense to represent the consonant–vowel distinction at the quantity level. This information is therefore located at the slot level.

The units at the three levels change their names according to their new definitions. The quantity level knows only the numbers 1 and 2 (i.e., indications of how often a unit at the quality tier is to be produced). This way, doubling information is no longer represented by associating a geminate unit with two positions at the CV tier, as in other models, but rather by associating it with a doubling marker that has no other function but to code quantity. This suggestion is quite similar in spirit to an idea briefly expressed in Miceli, Benvegnú, Capasso, & Caramazza (1995). The slot level is endowed with icons symbolizing containers (∪). No changes are necessary at the qualitative level.

As regards the organization of the three levels, the quality level takes the place between the quantity and the slot level. It is obvious that the quantity and the quality level must be adjacent. It is also clear that the slot level links up with the quality rather than the quantity level because the former, though not the latter, provides the fillers that go into the slots. Note that there is a consistent one-to-one correspondence both between the elements at the quality and the slot level and those at the quality and the quantity level.

Diagram (24) can now be expanded into (26).

(26) A three-tiered representation of the word *peach*

quantity level	1	2	1
	|	|	|
quality level	p	i	tʃ
	|	|	|
slot level	∪	∪	∪

This three-tiered model preserves the strengths of the former two-tiered model but has the additional advantages of separating functions that are logically independent and of distinguishing levels that have a different psycholinguistic status.[7] As explained earlier, the quantity tier must be part of an item's long-term memory representation. However, the slot level is denied a place in long-term memory. By the definition set out in the first section, slots belong to the set of structural units.

It is worth noting that the three-tiered representation in (26) is mainly confined to the phonological component because quantity is largely a non-issue in other domains. In syntax, the problem does not arise as there are no lexical representations for sentences or parts thereof (see section 1.1). An ADJP such as *very, very useful* is therefore generated by accessing the lexical node for the intensifier twice. Morphological complexes may have a (weak) lexical representation (see section 1.3), but they are not normally distinguished by a difference in the number of identical morphemes. For example, there is no lexical opposition between *childhood* and **childhood-hood*. The only exception appears to be morpheme-based reduplication. Two types have to be distinguished. The reduplicated form may consist of units that do not exist on their own such as *wakey-wakey*. Because the morphemic status of these units is uncertain, it is not clear whether the reduplicative process belongs in the morphology rather than the phonology. In any event, these cases are rather uncommon. More frequent are reduplications in which a true morpheme or word is needed twice, such as *hush-hush* and *buddy-buddy*. Here, the quantitative information is distinctive much as vowel length in the aforementioned pair *Miete* and *Mitte*. Therefore, the following representation appears justified.

(27)					
	quantity level	1	'hush'	2	'hush-hush'
		|		|	
	quality level	hush		hush	

It is entirely reasonable to assume that the quantity level remains unspecified in all cases where a given morpheme or word is only needed once. Naturally, this option is also available at the phonological level.

Having identified the ∪ units as structural in nature, we may address the question of whether they fit in the pool of structural units that have been uncovered so far or whether they form a structural category of their own. The latter is the case. The slot level creates a sequence of ∪ units. The relationship among these units is entirely linear, no other form of organization, in particular no hierarchical one, is provided for. In contrast, the structural units discussed in the preceding section are quite different in kind. Take a VP as an example. When it is part of a larger structure (S), we have two structural levels with one structural unit subordinated to another. Such a multilevel organization is lacking at the slot level. We will therefore distinguish between two structural types—linear and multilevel structural units.

Phonemes are not the only fillers that require slots. In point of fact, all content units (with one exception) require them. We thus posit word slots, morpheme slots, and phoneme slots. However, there are no feature slots. This is for the aforementioned reason that features are not serialized in the production process. A more accurate description would consequently hold that all serializable content units require slots. This claim furnishes the explanation for why there are slots. As structural units, they are built up in the process of transforming a timeless lexical representation into a temporal representation that enables the sequential output of content units. Thus, slots as a set of lined-up positions are needed whenever the production process engages in serialization. It is worthwhile to add that this function should not be confused with the task of imposing a particular serial order, as is required for the generation of content units. In a sense, slots function as a prerequisite for serial-ordering processes, nothing more and nothing less.

This characterization makes slots an indispensable aspect of the language production process. Any model that purports to do without them should therefore be treated with scepticism. One such model was developed by Dell, Juliano, & Govindjee (1993) who assert that structural units are not necessary to account for certain speech error effects that have been regarded by many as being structurally motivated. Their model appears to successfully account for four error phenomena, but as the authors concede themselves, it is unable to generate the most important class of tongue slips, namely contextual errors. It is customary in speech error research to draw a distinction between contextual (syntagmatic) and noncontextual (paradigmatic) slips. Unlike the latter, the former are instigated by the context in which the error unit is embedded. Berg (2003a) reports for his German data that as many as 96.3% of all phonological slips, the error category that is at the heart of Dell et al.'s article, are contextually determined, whereas only 3.7% are not. This means that the Dell et al. model is seriously undermined by its inability to generate 26 out of 27 errors! Its failure to deal with contextual slips is certainly not coincidental. As argued earlier, the job of slots is to support a sequential representation. If no provision is made for slots, a model may produce nonsequential errors but must fail on the sequential ones. Precisely this happened in Dell et al.'s case.

Another model that manages without the slot-filler distinction is that of Vousden, Brown, & Harley (2000). It uses an oscillatory mechanism to control the serial order of phonemes and replaces the linear slots (or equivalently, frames) with what we may call temporal slots. The selection of phonemes occurs at certain prespecified moments in time. This model successfully accounts for a number of speech error effects including the parallel syllable structure constraint whereby segments preferentially interact with segments from similar structurally defined positions (see section 5.4.1.1 and beyond). Vousden et al. assume that structurally similar frames are selected at structurally similar times (metaphorically speaking) for example, at each full hour.

There are at least three empirical effects that prove difficult to capture. One is that it is unclear how this model handles addition and omission errors.[8] These word-shape errors inevitably alter the slot structure of the target word. Take the case of an addition error. It cannot help but desynchronize the system in that a segment that is intended to be produced at, let us say, 7 o'clock (e.g., a syllable-initial consonant), will be produced at 7:20 if it occurs after the addition error. That is, it would no longer be syllable-initial according to the logic of the model. However, the parallel syllable structure constraint is not banned from addition errors because the production system selects a different frame in the case of an addition error. It is hard to see how a frameless model can produce the requisite flexibility for this output variability.

The second problem is also one of lack of flexibility. As Berg & Abd-El-Jawad (1996) showed, languages may differ quite radically in the extent to which they obey the parallel syllable structure constraint. Unfortunately, Vousden et al. made no attempt to incorporate this variability into their model and in fact, it is hard to see how it could be incorporated, given that the lapsing of time is conceived of as a structured process. By implication, different notions of time would have to be invoked for different languages, which is hardly an attractive solution.

Finally, as will be argued immediately in the following discussion, slots are not neutral entities but may code certain types of information. This, of course, is utterly impossible in a model without slots. In view of these problems, it may be concluded that the Vousden et al. model does not seem to be able to supersede the slots-and-fillers approach, even though it has certain appealing properties.

So far, slots have been characterized as linearly arranged place holders that accommodate content units. The next issue is whether slots (at a particular level) accept all fillers or whether they are more "choosy." Choosiness is ordinarily conceived of as a specification on the slot that restricts the possible interactions between slots and fillers. Basically, three types of specification are conceivable. Slots may be completely unspecified, minimally specified, or maximally specified. An unspecified slot obviously accepts any filler whatsoever, a minimally specified slot imposes coarse-grained restrictions, and a maximally specified slot fine-grained restrictions on the nature of acceptable fillers. It is notable that the middle position has the most to recommend it. Unspecified slots make the prediction that, contrary to fact, anything goes. A prefix, for example, does not substitute for a stem in slips of the tongue. What we do find is that prefixes are replaced with other prefixes. This is a quite strong indication that this slot is geared to prefixes and nothing but. Information pertaining to the general class of an item may be viewed as a minimal specification. A maximal specification not only restricts the set of possible fillers to prefixes in general but to particular prefixes, for example, all disyllabic or reversative ones. Evidence for such maximal specification has been conspicuously lacking, whereas evidence for minimal specification is quite strong. In addition to the like-with-like constraint, some aspects of errors cannot be easily explained without taking recourse to slots. This can be illustrated on the basis of (28), a tongue slip from German.

(28) Welche *Erwartung*— welche Reaktion hast Du denn erwartet?
which expectation which reaction have you then expected
'Which reaction did you expect?'

Number (28) involves the anticipation of the lexeme *erwart(en)* 'to expect'. The remarkable feature of this slip is the occurrence of the suffix *–ung* in the error word *Erwartung* 'expectation,' which cannot be motivated by the source element because the latter has a verbal suffix. However, *-ung* is a nominal suffix. How else can we account for the emergence of *-ung* unless by assuming that it was retrieved on the basis of the information that a noun is to be produced? This information can only be extracted from the target slot for the noun *Reaktion* 'reaction.' This slot must therefore be specified for nominal.

Parallel cases occur in phonology. The boundary between consonants and vowels may occasionally be crossed, as in (29).

(29) Berkeley b*r*us. for: Berkeley bus. (from Stemberger, 1983b)

The curious aspect about (29) is the appearance of the postinitial rhotic in *brus*. Stemberger (1983b) argues that it stems from the syllabic /r/ in *Berkeley*. In this view, a phoneme that was associated with a V slot perseverated into a newly created C slot. This re-association induced a change in the phonetic nature of the misordered segment. Specifically, it took on a more consonantal quality. This can only be explained if the postinitial slot is specified as consonantal.

Comparable cases have not been found in the area of morphology. In all likelihood, the reason for this lack is the absence of a link between the different classes of units. At the lexical level, a link is created between nouns and verbs in virtue of their using the same morphological base (compare *erwart+en* and *Erwart+ung* in [28]). At the phonological level, the versatility of some segments forges a link between consonants and vowels (witness the rhotic in [29]). At the morphological level, however, there does not seem to be any such factor that could establish some common ground between prefixes and suffixes. As a consequence, interactions between them have not been observed.[9]

As an interim summary, it may be conjectured that slots are specified for the following major-class features, depending on the linguistic level they belong to.

(30)	Word slots:	noun, verb, adjective, etc.
	Morpheme slots:	prefix, suffix, stem
	Phoneme slots:	consonant, vowel.

In addition to these general properties, slots may code somewhat more specific information such as person on verbs, case on pronouns, and number on nouns. The logic of the argument is highly similar to the one made in connection with the major-class features. Certain aspects of tongue slips cannot be explained unless the malfunction is allowed access to information that is not inherent in the misordered unit but imposed on it by the slot in which it appears. The following example is again from German because this language has elaborate enough morphophonological paradigms to bring home the following point.

(31) daß sie die Augen*schüsse*— die Augenzeugen einfach niedergeschossen haben.
that they the eye-shots the eye witnesses simply down-shot have
'that they simply shot (down) the eye witnesses.'

Case (31) is not unlike (28) in that a verbal source ends up as a nominal intruder. What is particularly intriguing about (31) is the occurrence of the <ü> (= /y/) in the error word *Augenschüsse*. Whereas the verbal paradigm of the misordered element knows only /iː/ and /ɔ/ as stem vowels, the nominal paradigm knows /u/ and /y/. The claim that the slot of the error word was specified for nominal thus accounts for the vowel change as such, but it fails to arbitrate between /u/ and /y/. Note that the back vowel is appropriate for the singular (*Schuß* 'shot') whereas the front vowel is appropriate for the plural (*Schüsse* 'shots'). The explanation for the appearance of the /y/ lies in the hypothesis that this slot is not only specified for nominal but also for plural.

An exhaustive examination of the types of information for which slots may be specified would detract us from the main line of reasoning. Suffice it to say that slots may be specified for both major-class features and grammatical categories such as case and number. However, slot specification does not appear to go any further.

The function of slot specification is relatively easy to ascertain. It serves to facilitate the association process between slots and fillers. Slot specification considerably narrows down the range of potential candidates for selection. For example, knowing that a verb is needed for a particular slot eliminates no less than four fifths of the entire vocabulary. Hence, a minimum slot specification reaps good benefit. However, would this not imply that a maximum slot specification would be maximally efficient to the point of making the selection process immune to error? Although this may be so, the real question is not which level of detail should be, but *can* be attained. On account of their generality, the major-class features are the easiest to access and therefore available at an early point in processing to specify the slots yet to be filled (Berg, 1992a). More detailed pieces of information would become available only later when a lexical unit has been located. But then there would be no point in specifying a slot for an element that has already been retrieved.

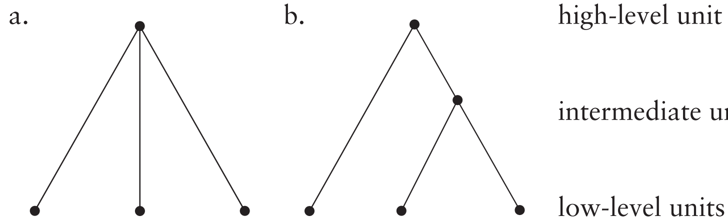
The underlying assumption here is that slots derive their information from the content units that they accommodate. Slot specification for major-class features is possible because this information is available prior to the more specific information and can thus be used to aid the retrieval of particular items. It may well be that a similar mechanism accounts for the other types of slot specification mentioned earlier. However, it is doubtful that all these types are processed alike because they fall on a continuum from more lexical to more syntactic. The general rule appears to be that the greater the syntacticity of an information type, the greater the likelihood of its acting as a slot specifier. For instance, as case is more syntactic than number on nouns, one might expect more case than number accommodations.

Summing up, a case has been made for distinguishing between two types of structural units—multilevel and linear ones. The focus in this section has been on the latter. Slots are structural units because they are not part of the long-term memory representation but are constructed in the process of language production. They have been argued to be an essential part of the serialization process even though they are not responsible for generating a certain serial order. In the production process, they are specified for major-class features and for grammatical-category information. Slot specification is understood here as alleviating the problem of lexical retrieval. In the following, the multilevel units will be paid closer attention.

1.5 THE WHYS AND WHEREFORES OF MULTILEVEL STRUCTURAL UNITS

At first sight, the reason that structure is required appears obvious enough. As argued previously, the function of structure is the gluing together of small units to form larger ones. An illustrative analogy might be the concrete that is used to build houses from bricks. This function seems evidently true in the case of syntax, given the fact that words are essentially the largest long-term memory units and that, by implication, sentences have to be created *de novo*. However, this cannot be the whole story. If it were, structure would only be needed above the word level. It would be superfluous below the word level because it makes no sense to create smaller structures (e.g., rimes) from larger content elements (e.g., monosyllabic words). Why, then, does a simple model consisting of content units but lacking structural units not suffice at the phonological level? The answer is that even in the face of important differences between syntax and phonology, both levels have very similar problems to solve. As all content units (save features) have to be serialized, the processor faces the same task in linearizing the phonemes in a word as in linearizing the words in a sentence. This is so irrespective of where the information that is fed into the serialization mechanism comes from. As argued in the preceding section, the need for serialization is the *raison d'être* of slots. Serialization thus explains the existence of phoneme slots, though not the existence of multilevel structural units. To appreciate the function of the latter, it is expedient to compare the two diagrams depicted in (32).

(32)



What is the advantage in having an intermediate node rather than none? Note at the outset that this node is *not* necessary for generating the correct serial order of the low-level units. Both the more complex structure (32b) and the less complex structure (32a) are suited to this task. The fundamental difference between (32a) and (32b) is the difference in advance planning that they afford of the linguistic material to be outputted. The flat structure affords no advance planning at all. The three low-level units are processed in strict succession, with no temporal overlap between them. When the first unit is selected, the production system leaves upcoming elements unattended to. The same is true of the second unit. All the system does after the selection of the preceding unit is pick the next unit to be produced until the final element has been reached. Thus, the representation in (32a) affords no possibility of looking ahead. It should be emphasized that although this is a disadvantage in certain respects (to be specified later in the book), it by no means disables the production system.

Representation (32b) has different implications. Its major strength is that it supports parallel processing. While the first unit is being processed, the system can concurrently access the intermediate node. No interference is expected between these two simultaneous processes because the one is directed at selecting a terminal node for output, whereas the other is directed at raising the activation level of a structural node. The great advantage of having an intermediate node available is that it provides the system with information about the number and (partly) the nature of the imminent elements. Assuming that an intermediate node is always branching, the system knows that at least two low-level units are in the offing and that, in the case of a rime node, the first is a vowel and the last a consonant. This knowledge allows the system to plan ahead reliably. In this way, it gains access to information about upcoming material at a very early moment in time. This information may be beneficial when decisions have to be quickly made that cannot be based on local considerations alone.

Three phenomena may suffice to illuminate this point. First, knowledge of the phonological make-up of the upcoming word serves as input to the choice of the appropriate allomorph. For example, the English indefinite article has the two variants *a* and *an*, the selection of which depends on whether the following word begins with a consonant or a vowel. This is an instance of advance planning that requires little look-ahead but the availability of fairly specific phonological information. The second example concerns rhythm. In a stress-timed language like English, knowledge of the number and stress value of the upcoming syllables is necessary for programming the duration of each syllable (see e.g., Nooteboom, 1995). This task requires look-ahead at least up to the next stressed syllable as well as access to the phonological level even though the quantity tier need not be called up. The third example is intonation. To compute a smooth intonation contour, advance knowledge spanning a tone unit is indispensible. Because tone units can be quite long, this presupposes a good deal of syntactic planning. And because the intonation contour depends on the tonic syllable, some phonological processing is also required. As these three examples show, advance planning is necessary to cope with the exigencies of the linguistic system because it permits the processor to make well-reasoned decisions. This look-ahead capacity is the major reason for the emergence of multilevel structural units.

The metaphor that will henceforth be used to denote the degree of advance planning is the *planning window*. Structural units may be said to open the planning window.[10] The degree of opening varies with the hierarchical position of the structural unit. The higher the unit is in the hierarchy, the greater the size of the window. A corollary of this is that the lower the level of linguistic analysis, the smaller the window size and the more local the factors that influence a particular decision.

The planning window is intentionally defined in linguistic terms (i.e., in terms of the nature of the structural unit). Alternatively, it might be construed as a temporal notion and termed a time window. These two notions correlate to a certain extent. A larger unit takes more time to be produced. A larger structural unit is therefore capable of opening the window for a longer time. However, the correlation is not perfect as the length of time for which a given unit is available may vary (depending on speech rate for example). Thus, the concept of a temporal window is more difficult to handle than that of a planning window. In view of the emphasis on structure, the idea of a planning window proves to be more consonant with the aims of this study and will therefore be preferred.

What light does this account shed on the assumed function of structural elements to create units that exceed the size of those that are stored in long-term memory? A somewhat surprising implication of the preceding analysis is that this function is of limited importance. If it were the main reason for the emergence of structure, we would not expect to find it at the phonological level. The observation that structure manifests itself in exactly the same way in syntax and phonology allows us to argue that the function of increasing the size of linguistic units is something of a side effect of planning the linearization of language. Of course, this side effect is highly welcome and even essential for the creative use of language, but the planning process would be basically the same if sentences were stored in long-term memory and retrieved in the same way as words.

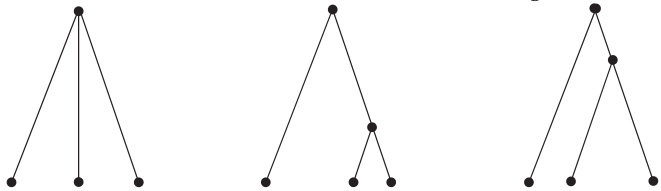
1.6 IMPLEMENTING STRUCTURE

In the foregoing, the building blocks of language and the function they perform have been examined. The next step is to probe into the mechanisms by which multilevel structural units are implemented. A spreading activation framework (e.g., Anderson, 1983) is optimally suited to this purpose. Returning to the diagrams in (32), we may ask what influence an intermediate node has on the activation spread in a network. There are basically three effects. The first is that an intermediate node slows down the activation process. Activation has to be built up on a node and this process takes time (Ratcliff & McKoon, 1981). As a result, the second and third low-level nodes are activated later than the first. The second effect is what may be called the equalizing power of nodes. A(n intermediate) node simultaneously passes on essentially the same quanta of energy to its subordinate nodes. Third, the further down we move in the linguistic hierarchy, the greater the degree of coactivation of units that are dominated by the same node. This is mainly a frequency effect because lower units are used more often than higher units (given their part–whole relationship). Hence, the degree of coactivation of the second and third low-level nodes is higher in (32b) than in (32a).

This notion of coactivation is of crucial importance in that it determines the cohesiveness of linguistic units (Berg, 1989b). The higher their degree of coactivation, the stronger their cohesiveness. This principle follows from the way linguistic units are selected. Selection is generally held to be a function of activation levels. The unit that is most strongly activated at a certain point in time is selected for production (e.g., MacKay, 1987). When two units are strongly activated at the same time and slots are available for each of them, they stand a good chance of being selected together. This, of course, is what has been referred to as cohesiveness in the earlier analysis of slips of the tongue.

A real asset of the spreading activation framework is its ability to deal with gradience, and this is particularly true in the case of cohesiveness. As shown in section 1.3, linguistic units display widely differing degrees of cohesion. These can be nicely modelled by postulating variable activation levels for structural units. An intermediate node as in (32b) with a relatively low activation level engenders a low degree of cohesiveness of its subordinate nodes (and vice versa). Thus, it is the activation level of structural units that determines the cohesiveness of sequences of content units.[11] This gradualness may be graphically represented by the "snapshots" in (33). Cohesiveness is expressed on paper by the vertical position of the intermediate node between the superordinate and subordinate nodes. The higher its position, the more activation it is assumed to have.

(33) a. no cohesiveness b. low cohesiveness c. high cohesiveness



There are two principal factors that influence the activation levels of structural units. The first was introduced in section 1.3. Because activation takes time to build up, a later stage in the production process will see higher activation levels (and hence more cohesiveness) than an earlier one will. In a word, more time, more structure, more cohesiveness.[12] Furthermore, the level of activation may be a function of linguistic orthodoxy. Basically, this concept reflects the frequency with which content units are put together to form larger structures. For example, the plural–singular ratio of *children–child* is higher than that of *snows–snow*. The plural form *children* may therefore be assumed to reach a higher activation level than the plural form *snows*. This difference brings us back to the two slips of the tongue (8) and (9), which are reproduced here as (34) and (35) for convenience.

(34) Well you can cut *rain* in the *trees*. for: trees in the rain. (from Garrett, 1982)

(35) He doesn't have any *closet*s in his *skeleton*. for: skeletons in his closet. (from Stemberger, 1985)

Why is the plural word cohesive in (34) but incohesive in (35)? For one thing, *trees* is a "good" plural word, for another *rains* is a "bad" plural word. Both these arguments conspire to impart cohesiveness to a structure (i.e., an inflected word) that is typically not cohesive (see section 1.3). The default case in (35) therefore needs less motivation than the untypical case (34). In fact, the two interacting nouns in (34) are less susceptible to pluralization than *trees* but do not repel pluralization as does *rain*. Thus, the reason for cohesiveness in (35) and lack thereof in (34) is the linguistic orthodoxy of the outcome. If cohesiveness leads to a "better" error, it may outweigh the more common alternative of breaking up inflected words.

There is no need to assume a competitive relationship between the time hypothesis and the orthodoxy hypothesis. Both influence activation levels in the same way—more time, more activation, and more orthodoxy, more activation. Both are of similar generality. The time hypothesis holds that any activation process, in particular in the case of structural units, takes time. The orthodoxy hypothesis claims that a more frequent unit will amass more activation in the same time than a less frequent one. Many of the slips of the tongue are compatible with both hypotheses. The errors in (34) and (35) can be explained by the orthodoxy hypothesis as was done previously as well as by the time hypothesis by simply assuming that (34) occurred at a later temporal stage than (35). Whether the two hypotheses jointly produce the difference between (34) and (35) or whether one of them plays a larger role in this process than the other is an open issue. In any event, the main point of the preceding discussion is unaffected by the ultimate answer. The cohesiveness of two content units is determined by their degree of coactivation, which in turn is determined by the activation level of the superordinate structural unit.

1.7 REVIEW AND PREVIEW

The structural model of language production that has been sketched out in this introductory chapter is firmly rooted in psychology. It stands or falls on the assumption that not all units that are standardly considered relevant in linguistics are part of a speaker's long-term store. As a consequence, some units have to be created during the preparation to speak whereas others can be retrieved ready-made from long-term memory. This fundamental difference underlies the distinction between content and structural units. The latter can be subdivided into slots and multilevel elements. Slots are reserved for serializable content units and are linearly concatenated. Their task is to enable the linearization of language. Multilevel structural units function to increase the planning span for an utterance.[13] The larger these structural units are, the further ahead the speaker can plan. Thus, the present model recognizes the distinction between hierarchical and linear representations that is variously made in both the linguistic and the psycholinguistic literature (Martin, 1972; Falk, 1983; Vigliocco & Nicol, 1998; Kathol, 1999; Hartsuiker, Kolk, & Huiskamp, 1999). A noteworthy property of the model is its gradience (see also Bolinger, 1961 from the linguistic and Yantis & Meyer, 1988 from the psychological perspective).[14] Because of the model's reliance on the activation metaphor, structural units are not either present or absent but more or less strongly activated. The variable levels of activation entail differences in the model's output.

The processing roots of the model imply that all linguistic units posited are claimed to be psychologically real. This is particularly true of structural nodes. In fact, Bock & Loebell (1990) were able to show that (syntactic) constituent structure can be primed by constituent structure, thereby demonstrating its psychological reality.

The relationship between content and structural units is depicted in Figure 1.1 (see opposite page).

The various aspects of information flow in Figure 1.1 may be depicted thus. First, the vertical connections between the content units make sure that all serializable elements are correctly "interpreted." If, let us say, the /t/ cannot be used to access the feature [alveolar], the production system will degrade into muteness. Second, the content units are responsible for the creation of slots. The activation flow from fillers to slots is a natural consequence of the claim that content units are stored in long-term memory, whereas structural units are not. Clearly, the former can assist in the creation of the latter, though not vice versa. Once a slot has been created it can be specified, and thereby constrain lexical, morphological, and phonological access. Third, the slots are the terminal elements on the basis of which multilevel structural units can be erected in bottom-up fashion. Finally, there might be direct links between the structural units from different levels (not depicted in Figure 1.1). Although such links are not necessitated by any theoretical argument, empirical data in support of them will be adduced in

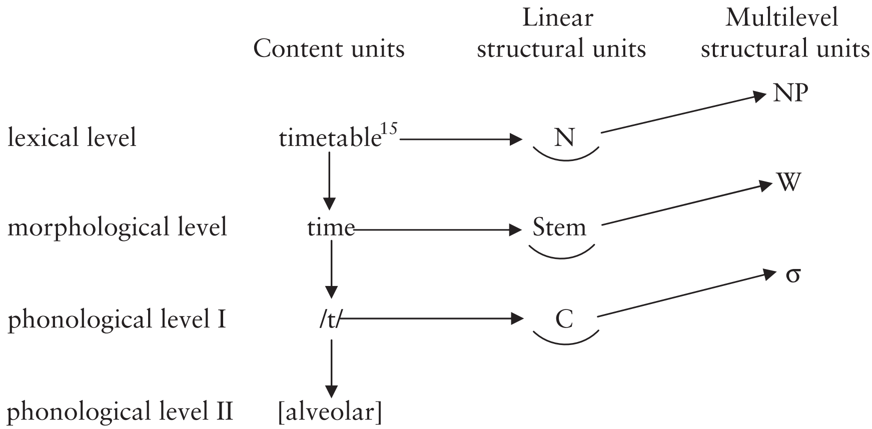


Figure 1.1 A content-and-structure model of language production (illustrated on the basis of the word *timetable*).

sections 8.4 and 10.3.2. Note finally that the arrows indicate the main direction of information flow. Feedback effects are not shown in this diagram.

This is the time for a brief comparison of this model with the three most important psycholinguistic theories of language production as well as two more linguistically oriented proposals. MacKay's (1987) model does not draw a distinction between content and structural units at all. In his approach all linguistic units, ranging from syntactic phrases to syllables to phonemes, are treated alike. They are all called content units and integrated into the same hierarchical network (see also MacKay, Burke, & Stewart, 1998 and Santiago, MacKay, Palma, & Rho, 2000). It is obvious that such a model fails to account for the differences in cohesiveness that were reported in section 1.3.

Also Dell's (1986) model does not make a clear separation between content and structural units although it does distinguish between linguistic elements and "tactic frames," which encompass both slots and hierarchical structural units. At first sight, then, this model bears a certain resemblance to the one presented here. However, Dell's classification of linguistic units does not tally with the one proposed earlier. Consonant clusters, for example, are part of the network of content units in his model. Besides, the status of syllables is less than clear. In Dell's simulation model, the distinction between content and structural units has been given up. All units are integrated into the same network. This decision likens Dell's model to MacKay's. Thus, the criticisms are the same as those put forward before.

Levelt, Roelofs, and Meyer's (1999) model makes a distinction between fillers and slots, at least in the phonological domain. They assume that the retrieval of words involves the parallel access of segments and structural frames. These frames accommodate words, not segments, and are specified for a word's number of syllables and stress pattern. A unique feature of this model is that syllables, which are not part of the lexical network, are retrieved from a separate store after phonological processing has been completed. One motivation for this "post-phonological" status of syllables is the role they play during late stages of the production process. The model developed here also predicts late syllable effects without a separate syllable store but accounts for them quite differently. Because syllables are structural units, their activation is delayed so that they can produce only late effects. The rarity of syllable errors (see section 1.3) presents a particular challenge to Levelt et al.'s concept of a mental syllabary. It must be assumed that the syllable store is organized along principles that are fundamentally different from those of the lexical network and prevent the occurrence of errors. Why the syllable store, though not the lexical network, should be endowed with this quality is totally unclear. A further problem is that the extraordinary status attributed to the syllable does not capture the parallels that exist between syllables and consonant clusters or other structural units in terms of cohesiveness. Rather than assigning a special role to syllables, it seems preferable to emphasize the commonalities between syllables and certain other elements by grouping them in the same category of structural units. From this perspective, there is no need for a mental syllabary.

There are two linguistic models that show important similarities and differences with the one developed here. One is Langacker's (1997) cognitive grammar. Although Langacker does not categorically reject the notion of constituent structure in syntax, he regards it as an epiphenomenon of asymmetrical relationships in the conceptual system. Whether two linguistic units enter a close or not-so-close relationship is determined by their conceptual contiguity and similarity. This dependency of syntactic structure on conceptual structure denies that the former has any independent function to fulfil, be it a syntactic or any other one. In support of his view, Langacker claims that constituency effects may be volatile and inconsistent.

There is a notable parallel between Langacker's model and the one sketched in the present chapter. In contradistinction to most other approaches, both models repudiate the either/or conception of syntactic structure in favour of a more gradient one that allows strong as well as weak effects to show up. Related to this is the emergent nature of structure that Langacker stresses. Linguistic structure emerges in both models, though in somewhat different senses. In Langacker's framework, structure emerges as a result of the moulding of conceptual information into linguistic form whereas in the model developed in the previous pages, structure emerges as a result of activating structural nodes. However, here is also the root for major disparities between the two models. In the structural model, hierarchical structure is necessary to the extent that advance planning is necessary. Unlike Langacker's model, it accords structural units an autonomous syntactic status and grants structure a psycholinguistic motivation. On the other hand, it tallies with Langacker's (as well as Kathol's [2000]) in not taking hierarchical structure for granted (see especially the later chapters of this book).

The other linguistic framework that invites a comparison with the one developed previously is Bybee's (2002) usage-based model. She distinguishes between co-occurrence patterns (i.e., linearly ordered sequences of elements) and the bonds that hold these elements together. The former are argued to be determined by semantic and pragmatic factors, the latter by co-occurrence frequency. Importantly, it is through this string frequency that constituency is claimed to arise. In this sense, constituent structure is an emergent property in that it derives from the sequential organization of language. Thus, sequentiality is more basic than hierarchy.

In many ways, Bybee's model is close in spirit to the one outlined here. Chief among the commonalities are the notions of gradience (even though she remains rather inexplicit about its theoretical consequences) and that of emergence. The two models agree in viewing constituency as a result of the confluence of certain facilitators. However, the two models differ quite radically in the sets of facilitators that they propose. In particular, the role of frequency is not the same (see section 2.5.1.10). Besides, the underlying motivation for constituency is different. Whereas the present model grounds constituency in the language planning process, Bybee sees it as a quasi-automatic spin-off of co-occurrence preferences. It is not unlikely, however, that these two views are compatible to a certain extent.

The remainder of this monograph will be devoted to fleshing out, refining, and testing the model that has been set forth in this chapter. The general approach will be to examine the variability that the model predicts, both within language and between languages. Our point of departure is the motivation underlying the distinction between content and structural units. That which is unavailable in long-term memory is more subject to variation and more difficult to process than that which is permanently stored. As the general working hypothesis of this monograph, we would therefore expect structural units to present a special challenge to the users of language, a challenge that may be responded to in different ways and that may thereby induce considerable variability, both synchronically and diachronically. In actual fact, this explains the focus of this book on the structural aspects of language (as defined earlier).

To be more specific, the multilevel structural units will be investigated in detail across the various descriptive levels in Chapter 2. An attempt will be made to determine their nature and their strength. The results of this chapter serve as a background against which the diachronic analyses can be compared. Chapter 4 looks into the historical development of the structural units and asks whether they or their strength have changed over time. From the perspective of the structural model, such a change would not come unexpected. Chapter 3 compares the strength of structural effects across the various levels of the linguistic hierarchy. In particular, it will be examined whether the degree of hierarchicalness is determined by the hierarchical position of a given level. The model also makes predictions for language acquisition and breakdown. The assumed nature of structural units would lead us to expect that children experience particular difficulty in mastering them. The prediction would accordingly be that the strength of structural units is reduced in language acquisition. This prediction holds for both first and second language acquisition. Almost the same claims can be made for language breakdown. Structural units are predicted to be particularly disrupted in aphasia. Language acquisition and breakdown are the topics of Chapters 7 and 8, respectively.

All of the aforementioned analyses are mainly about English. Two further chapters represent extensions to other languages. Chapter 5 adopts the perspective of contrastive linguistics and provides an in-depth analysis of structural differences between individual languages. Naturally, the focus here is on the range of structural variation that is predicted by the model and observed 'out there.' Chapter 6 is more typologically oriented in that a (severely limited) survey is given of the patterns of structural variation that are found in the languages of the world.

All of the chapters mentioned up to this point assume that language is a homogeneous object and can be examined in modality-neutral fashion. Chapter 9 transcends this parochialism and distinguishes between speaking, writing, and typing as the three major productive skills. The guiding question here is whether these three modalities differ in their reliance on structure, in other words, whether what has been discovered in the other chapters is true of language in general or modality-specific. All of these analyses pave the way for the final chapter in which the overall role of structure in the linguistic system is assessed. In so doing, this study will provide the background for an evaluation of what is considered by many to be one of the most important and most unique design features of language—its structure-sensitivity (compare Chomsky, 1972, 1988).

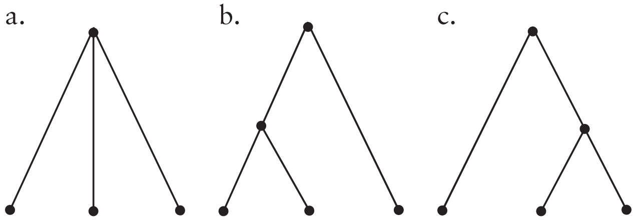
2 Constituent Structure and Branching Direction in English

2.1 INTRODUCTION

All of the ensuing analyses start out from the conviction that nothing (in terms of structure) should be taken as given a priori. In particular, assumptions in generative linguistics about the innateness and thus givenness of certain notions such as the universality of VPs (e.g., Culicover & Jackendoff, 2005, p. 40) and N's (e.g., Lidz, Waxman, & Freedman, 2003) will not be followed here. Deducing the existence of linguistic units and rules from theory-internal considerations is no alternative to demonstrating their existence empirically. This puts the burden of proof on myself and makes the investigation a more challenging task than when the existence of some structural units is taken for granted. At first sight, the nativist approach even has certain advantages. As will be seen in Chapter 6, if the VP is assumed to be universal and hence cannot be used as an argument for branching direction, some inconsistencies within languages disappear. However, this putative advantage is bought at the unacceptable expense of erecting one's analysis on a highly speculative component that is quite removed from the empirical facts. For instance, claiming that all languages are underlyingly SVO, as Kayne (1994) does, requires a powerful patch-up mechanism for languages with an alternative basic word order and furthermore implies that word orders other than SVO cannot have the same theoretical status as the SVO order. Both postulates appear to me to be entirely unfounded. I therefore prefer to keep my options open by starting out from as few theoretical biases as possible and taking the empirical data as my point of departure. This attitude allows me to seek a closer correspondence between data and theory and to take linguistic variation seriously. Let us consider an example. When a VP node is regarded as part of universal grammar, the VP must by definition come out as identical across languages. In other words, the possibility of between-language variation is aprioristically ruled out. However, until a comprehensive cross-linguistic study of VPs has been conducted, there is no way of knowing whether or not there is between-language variation. It will be seen throughout this monograph that once we free ourselves from such preconceptions, quite a few effects await their discovery.

This chapter will in the main be concerned with the organization of structural units in English (i.e., with the representational support that enables advance planning). As explained in the preceding chapter, the look-ahead assumption is necessitated by the mutual dependencies between linguistic units such as agreement and sandhi phenomena (among other reasons). As advance planning can only be assumed with some certainty for shorter distances, attention will be focused on combinations of a minimum number of elements. Although there appears to be little variability in the geometry of two-element sequences (but see below),[1] three-element sequences offer an opportunity of variable internal constituency. Specifically, these sequences allow for a basic choice among the following three representations.

(1) a. b. c.



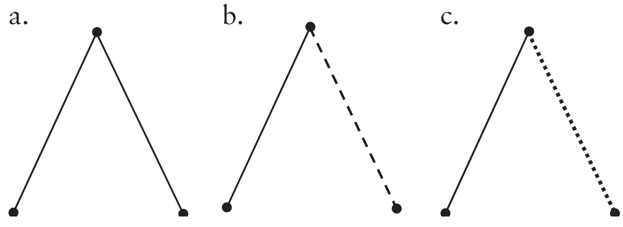
These representations are known as the flat model (1a), the left-branching hierarchical model (1b) and the right-branching hierarchical model (1c), respectively. The three models make quite different assumptions about the planning process. The flat model assumes that the low-level nodes receive about the same amount of activation at the same time (see section 1.6). Clearly, this is a less than optimal processing strategy as planning requires differential activation, that is to say, much activation on the element about to be selected (also called the *current* unit) and less activation on the upcoming elements. In addition, due to concurrent activation, there is an enhanced risk of interference between the low-level units. What we have here is a psycholinguistic argument against flat structures. We would accordingly expect entirely flat structures to be a marked option (i.e., they should occur only if there are powerful reasons that militate against a hierarchical organization).

By dint of an intermediate node, representation (1b) provides for an internal grouping of the first two low-level units. This strategy has two effects, one facilitating efficient planning and the other hindering it. The undesirable effect is that a left-hand intermediate node slows down activation of the first element to be outputted (relative to the third, though not to the second), which is of course counterproductive. The desirable effect is that the second low-level unit has reached a higher activation level than the third at the moment in time at which the selection of the first is imminent. It is certainly advantageous to have the level of activation on upcoming units correlate with the order in which they are to appear. This analysis suggests that the left-branching hierarchical model does not optimally fit the requirements of language planning. On the other hand, it is appreciably better than the flat model because it relies on the principle of differential activation; in other words, it distinguishes between current and upcoming elements. It thus provides representational support for the strategy of planning ahead.

The right-branching hierarchical model introduces an intermediate node that establishes a closer connection between the final two than the initial two low-level units. This representation only has advantages. It guarantees fastest access to the first element to be produced (on account of the absence of an intervening node) and it slows down the activation of the upcoming units (due to the right-hand intermediate node). It thereby ideally satisfies the conflicting requirements of planning and selection in that earlier elements are automatically more strongly activated than later ones. As a side effect, the risk of interference between current and upcoming units is minimized. The right-branching model thus qualifies as the optimal strategy for language planning and may on psycholinguistic grounds be predicted to predominate in language structure.[2]

Within the processing framework espoused here, variability can be observed not only in three-element, but also in two-element combinations. Although there is no room for intermediate branching nodes (and hence no question of branching direction), these sequences allow for variable activation levels on the upcoming element. That is, whereas the superordinate node ensures advance planning in general, upcoming elements may differ in their strength of pre-planning. This variability may be graphically represented as follows.

(2)



Representation (2a) claims that the two subordinate nodes are activated to the same degree. Naturally, this equal strength has to be changed when it comes to selecting the subordinate units in a particular order. The broken line in (2b) represents a reduced activation flow toward the upcoming units as compared to the current one. This asymmetry is more extreme in (2c) where the dotted line denotes an even lower activation level of the upcoming element. Of course, these are highly simplified diagrams that fail to capture both the gradience in the concept of activation and the changes in time to which activation levels are subject in the production process.

There is empirical evidence for this variability in two-element sequences. Although relevant data can be found at all descriptive levels, our focus will be on phonology and syntax. The rationale was explained in the preceding chapter: The higher the degree of coactivation of two units, the higher the degree of their cohesiveness. As a matter of fact, in phonology we find differing degrees of cohesiveness (in decreasing order): /ai/ > /ar/ > /al/ > /an/ > /at/ (e.g., Stemberger, 1983b; Treiman, 1984; Berg, 1989b). The general rule is that the smaller the sonority difference between the two phonemes, the greater their cohesiveness. This variability may be understood as varying degrees of coactivation that are brought about by varying degrees of sonority between any two adjacent phonemes.

The cohesiveness of syntactic units may also vary. A paradigm case of syntactic variation in English is the so-called particle movement. Transitive phrasal verbs generally permit two alternative constructions, one in which the verb and the particle are placed next to each other and the other in which the two words are broken up by the object. Gries (2003) demonstrates that one of the many factors influencing the cohesiveness of phrasal verbs is their idiomaticity. The more idiomatic their meaning is, the more likely their component parts are to resist splitting. The natural explanation here is that a more idiomatic (i.e., holistic) meaning coactivates the verb and the particle more strongly than a less idiomatic meaning, thereby increasing their cohesiveness and decreasing the probability of their being intercalated by an object.

To summarize, linguistic items that are intended to be outputted but are not yet in current position are put in a state of readiness. The element that immediately follows the current unit may be activated to differing degrees, depending on a variety of factors. For two-element sequences, this is basically the only type of variability (see [2]). However, three-element sequences know another type of variability, which is of a representational nature (see [1]). It is to this latter type that the present chapter addresses itself.

2.2 PREVIOUS WORK IN LINGUISTICS AND ITS SHORTCOMINGS

Before the various arguments pertaining to branching direction are drawn together, it is useful to examine the theoretical status that has been assigned to the notion of structure in many previous analyses. As is perhaps inevitable, linguists have customarily understood structure, and especially syntactic structure, as a *linguistic* concept (i.e., as a notion that exists as ink skillfully spread on paper independent of its mental underpinnings). In short, structure is understood as a cultural product rather than a psychological process. A major point of this section is to argue that the linguistic notion of structure is fundamentally misconceived and that this misconception is to blame for several dead ends and wrong conclusions that have been reached in linguistics. As argued in Chapter 1, structure exists to open the planning window. I submit that only by starting from this psychological function and by placing structure in a psychological context can we hope to gain an adequate understanding of structure in particular and of language more generally.

Let us begin with a concrete example. A traditional syntactic representation of a moderately complex sentence is given in (3) on the next page. We are not concerned here with the specifics of this particular analysis, let alone with the wider issues of whether nodes must branch (and if so, how often they may) and whether empty positions are allowed. Alternative analyses are clearly conceivable. Representation (3) is offered mainly as one possible structural description.

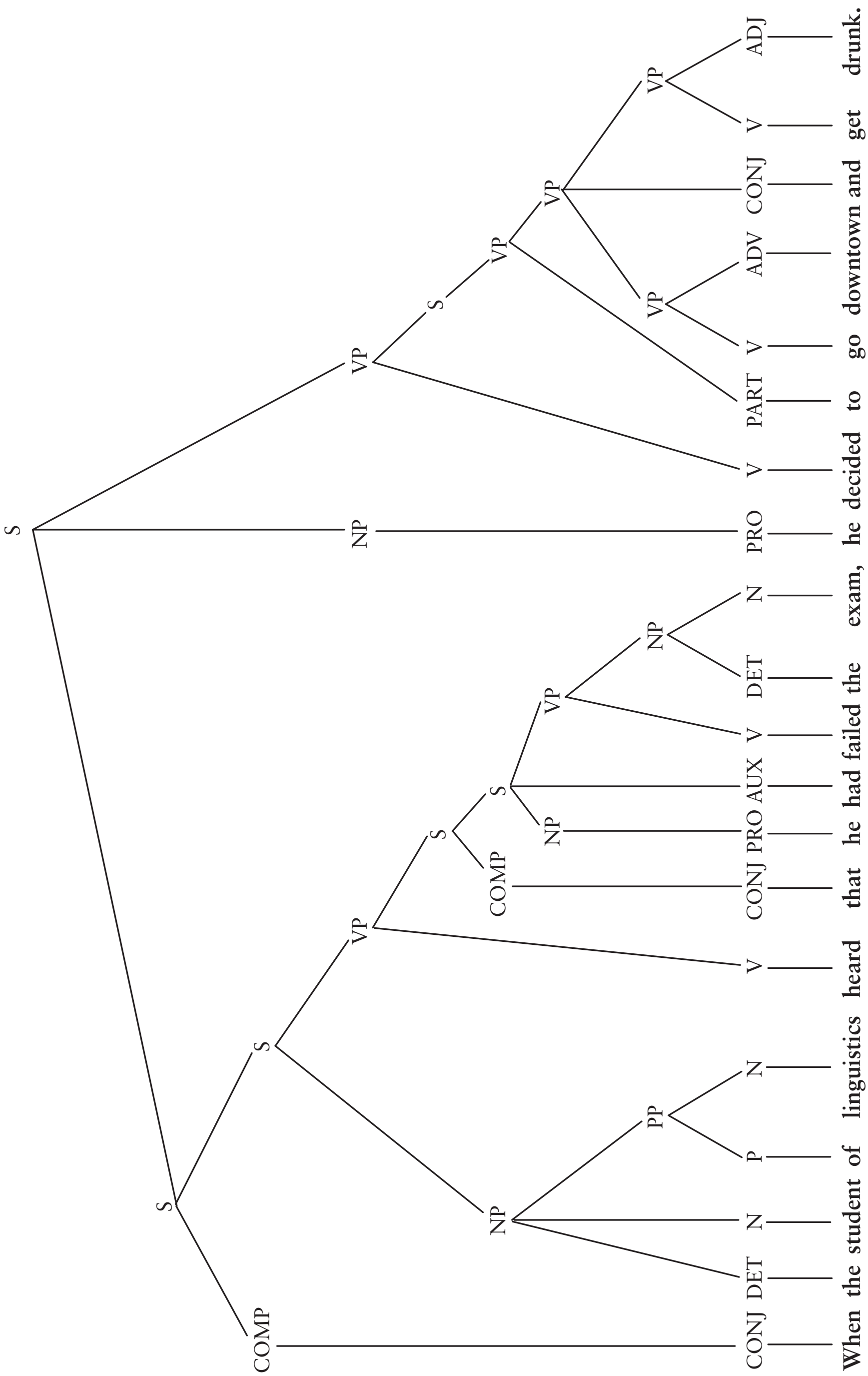
A critical property of diagrams such as (3) is their atemporal nature. The graphic representation is clearly seductive here. Because it is put on paper and because paper is durable and can represent many things at the same time, one is easily fooled into believing that the properties that are insinuated by the graphic representation are in fact the properties of the linguistic representation or even the mental representation. However, this is not the case. As Coleman & Local (1991) warn, diagrams must not be confused with linguistic representations. Indeed, the contrast between the two can hardly be more pronounced. The diagram in (3) tacitly assumes that all nodes are simultaneously available. From the psychological perspective, however, this is hardly a realistic assumption to make. Any such sentence by far exceeds the typical planning capacity of an ordinary language user. What speakers actually do is plan in piecemeal fashion, starting with an outline and activating further content and structural units as the sentence unfolds. In any event, the mental representation changes continually as speakers "walk through" their utterances unit by unit. Concisely put, psychological representations are dynamic, whereas diagrams are static. The nasty conclusion is that diagrams breathe life into representations that do not exist anywhere but on paper.

The second problem is related to the first. Nodes on paper are either there or not there. Thus, diagrams introduce a bias toward construing the syntactic world in binary terms. However, as argued in the preceding chapter, structural nodes are activated in scalar fashion and may have reached any point on this scale at the moment of selecting content units. This paper-induced binary thinking has prevented progress in our understanding of language, which is made possible by the gradient approach.

The diagrams are not the only trouble-makers. Equally serious is the fact that linguists have failed to agree on the criteria that lead us to the correct structural description. Some linguists have simply ignored this methodological issue. In those cases where criteria have been proffered, these were often found to be controversial. In any case, the logic underlying the criteria, when and why they are applicable or inapplicable, has not been clearly spelled out. This is a state of affairs that is of considerable theoretical significance and that needs careful consideration.

Beginning with the first point, it is highly baffling to a dispassionate onlooker that although many linguistic textbooks draw phrase markers,

(3)


S
S NP VP
COMP S PRO V S
NP VP VP
DET N PP V S PART VP
P N COMP S VP CONJ VP
NP AUX VP V ADV V ADJ
PRO V NP
DET N
CONJ DET N P N V CONJ PRO AUX V DET N PRO V PART V ADV CONJ V ADJ
When the student of linguistics heard that he had failed the exam, he decided to go downtown and get drunk.

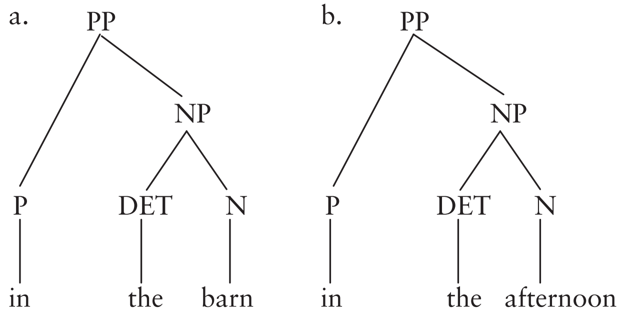
they beg the question of why a given structural description is or is not the correct one. They stipulate that English has the rule S → NP + VP but make no attempt to justify it. This is true not only of older (e.g., Bloomfield, 1933; Hockett, 1958) but also of more recent publications (e.g., Lyons, 1981; Yule, 1996[3]; Hudson, 2000). This may be regarded as a pardonable omission at Bloomfield's time when immediate constituent analysis was in its infancy (see Percival, 1976 for a historical account), but it can hardly be forgiven in a modern book for first-year students of linguistics who are confronted with diagrams but are not told why these look the way they do. Although this assessment pertains to the criteria for syntactic analysis, it is equally true of the morphological and phonological domains. It will be seen in Chapter 6 that many descriptions of the phonologies of diverse languages simply take the right-branching structure of the syllable for granted (e.g., Kaye, 1985). As will be shown later in this chapter, the reasons for branching direction are given even shorter shrift in morphology than in syntax and phonology.

We can only speculate on the reasons why so many linguists have eschewed this fundamental question. It is certainly unsatisfactory to say that the answers are intuitively obvious. Anybody who has ever ventured to draw such diagrams as (3) is profoundly convinced that this is not so. Another speculative reason is that some linguists might feel unsure of the validity or the reliability of the criteria. If there was a grain of truth in this supposition, it would explain the said state of affairs though certainly not justify it. A final suspicion is that some linguists might consider the whole issue of constituent structure of minor importance and therefore give short shrift to its underpinnings. This view is untenable because of the inroads constituent analysis provides not only into the anatomy of language but also into the strategies of advance planning employed by speakers in ordinary language use. Whatever the ultimate reason for this neglect, it is very clear that this methodological issue is an important one and deserves to be looked into and upgraded.

It is similarly surprising that the difficulties besetting the linguistic tests for constituency have often been downplayed or even ignored. A good case in point is Radford (1988) who hails the tests as reliable instruments for determining sentence structure. Although he concedes that they are not "foolproof," he considers the tests as such to be impeccable. When problems arise (i.e., when a test gives an undesired result), it is not the test that is to blame but interferential effects from elsewhere that may occasionally render it inapplicable. A less contentious and more sceptical attitude is adopted by Payne (2006), Grewendorf (1988), and von Stechow & Sternefeld (1988). These authors regard constituency tests as heuristic principles that provide some clues to sentence structure but are of limited reliability in that they may produce contradictory or patently false results. Von Stechow & Sternefeld (1988, p. 110) point out quite explicitly that the tests, taken individually or together, do no allow one to identify the constituent structure of sentences.

Let us quasi-randomly select a few problem areas to illustrate the difficulties and their causes. First consider the parallel structures in (4).

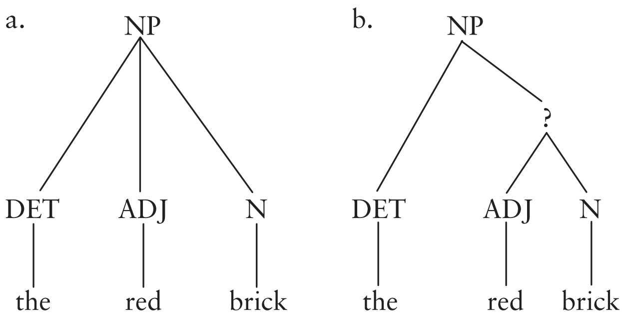
(4) a. b.



There seems to be general agreement that the two PPs in (4) have the same internal structure. However, their motivation is not the same. One criterion for constituency is the pronominalization test, which is widely held to rank among the most reliable ones. This test clearly identifies *the barn* as an NP but fails on *the afternoon*, which cannot be replaced by *it* in this context. Does this mean that the representation in (4b) should be flat? Most linguists would deny this and argue that this restriction on pronominalization is of a semantic or pragmatic, not a syntactic nature. But this is precisely the point! If this is true, then the test as such is invalid because it is designed as a means of tapping into syntax while the conditions on pronominalization are not (entirely) syntactic, and it is not a priori clear when they are syntactic or nonsyntactic. Thus, an adequate use of the pronominalization test requires a detailed theory of pronominalization.

The second problem concerns the status of syntactic categories. It is received wisdom that a string of elements that succeeds on the constituency tests is assigned phrasal status whereas one that fails on them is denied it. This principle has proved problematic in the analysis of NPs consisting of an article, an adjective, and a noun, as in (5).

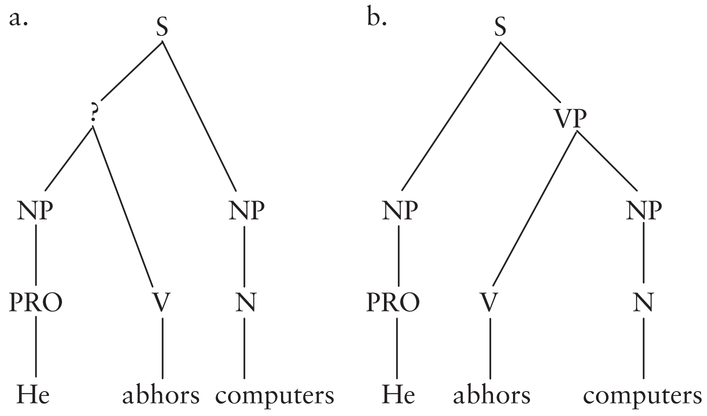
(5) a. b.



Because the pronominalization test, like others, fails to isolate the adjective and the noun, the flat structure as in (5a) has often been assumed. However, this decision is contradicted by the argument from dependency grammar that the adjective modifies the noun, not the article. As is well-known, problems like this one find a ready solution in X′-theory (Jackendoff, 1977) in which the question mark in (5b) would be replaced by N′. However, this innovation blurs the distinction between lexical and phrasal categories. N′ is certainly not lexical but clearly less phrasal than NP. Why is this a problem? It is completely unclear what the mental correlates of the two types of phrasal categories are. Psycholinguistically, there are nothing but nodes and their activation levels. Different types of nodes with distinct behaviours are not known. What is more in the present connection, recourse to X′ categories seriously undermines the logic of constituency tests as a discovery procedure. If a syntactic category can be established even though the standard tests fail, the tests lose their significance. The implication of this is highly uncomfortable: Either the tests or X′-theory must be abolished (or thoroughly modified).

As a third example, different tests may yield different, if not incompatible results. In anticipation of the next section, contradictory evidence for branching direction is produced by subject–verb agreement and the pronominalization test. Refer to the following diagrams in (6).

(6)



The left-branching structure in (6a) is supported by subject–verb agreement, which argues for a closer link between the verb and the subject NP than between the verb and the object NP. By contrast, the right-branching structure in (6b) is bolstered by the pronominalization test, which is positive on the verb–object NP sequence but negative on the subject NP–verb combination. Linguists have often tried to sidestep this dilemma by simply passing over the agreement problem, believing that it is somehow irrelevant to the analysis of sentence structure. In the absence of a specific theory of when a potential test must be ignored, this is hardly a satisfactory strategy. What is needed is a principled way of dealing with inconsistencies, for example a theory in which the individual tests are assigned a certain weight. This would make it possible to arrive at a motivated decision.

The fourth and final example is similar to the third although its emphasis is slightly different. Some tests may generate obviously wrong results. The deletion test, admittedly one of the more controversial ones, holds that a sequence of words that can be deleted is a phrase and inversely that which cannot be deleted is not. Wöllstein-Leisten, Heilmann, Stepan, & Vikner (1997) state that there is an asymmetry in the heuristic value of constituency tests. A successful test can identify a constituent whereas an unsuccessful test cannot be used to deny constituent status. This claim does not follow from any independently established fact. Significantly, Wöllstein-Leisten et al. do not provide an explanation why this should be true. And indeed, it is not. Some tests positively identify groups of words as fake constituents. Grewendorf (1988) presents a particularly devastating example from German, given here as (7).

(7) Weil ihn die Sache interessiert, aber [ihn die Sache] nicht
because him the issue interests but him the issue not
unmittelbar betrifft.
immediately concerns
'because the issue is of interest to him, though not of immediate relevance to him.'

What we have in (7) is a case of ellipsis. The material in square brackets can easily be deleted to prevent its repetition. Because (7) in its elliptical form is a perfectly grammatical utterance, *ihn die Sache* must be a constituent. However, *ihn* is the direct object NP and *die Sache* the subject NP. Hence, the object and the subject NP would form a constituent. Needless to say, this conclusion flies in the face of one of the most uncontroversial insights into syntax, namely that these two NPs are not dominated by the same node.

It may appear from the preceding discussion that some tests are better than others. If this is so, a theory would be called for that leads us to expect such differences in the quality of individual tests. However, no such theory is in the offing (but see Phillips, 2003). There would appear to be no a priori reasons why some tests are more useful than others. Another type of difference in the power of constituency tests is introduced by Radford (1988). He states that unlike other tests the ellipsis test can only serve to identify VPs but no other constituents. Again, one would be eager to know why this should be so. In the absence of a general theory that would shed some light on this issue, Radford's restriction appears to be entirely ad hoc.

In any event, it does not seem to be the case that some constituency tests are better than others. All of them suffer from one drawback or the other. This deplorable state of affairs invites one or both of the following two conclusions. There is something wrong about the constituency tests as heuristics of sentence structure, and/or there is something wrong about the assumption that sentence structure is hierarchical rather than flat. (This is of course the point that constituency tests are designed to prove.) If sentence structure is less hierarchical than is generally assumed, it would not be surprising that the picture created by the constituency tests is such a messy one.

The final important point regarding the nature of constituency tests is their rationale. It is astonishing that linguists have not spent much thought on why a given constituency test should be an appropriate method of uncovering linguistic structure. This question may appear to many to receive a self-evident answer and therefore not worth raising, but this is almost certainly a delusion. Take the interrogation test as an example. Why should we expect that which can be questioned to be a constituent? There is not necessarily a close link between the two. People ask questions to satisfy their curiosity (i.e., about isolable things they want to have some or more information about). Whether the names for these things do or do not form a syntactic phrase is a very different kettle of fish. Questions are posed for pragmatic reasons and there is no cogent reason why pragmatic and syntactic categories must be totally congruent. A similar argument can be developed for the pronominalization test. What can or cannot be pronominalized depends on text-linguistic and stylistic (in addition to pragmatic) factors that are categorically distinct from syntactic factors and therefore need not contract a one-to-one correspondence with these. We will spare ourselves the exercise of performing the same critical analysis on the other constituency tests. Rather, the point is sufficiently clear that it is not surprising at all that the constituency tests have failed to provide unequivocal evidence for syntactic patterns. Because syntax and pragmatics are categorically distinct, we can hardly expect an argument from the one area to settle an issue in the other.

To anticipate a possible misunderstanding, the claim that is advanced here is that there is something wrong with the constituency tests, with an emphasis on *something*. That is to say, they are not completely wrong because syntax and the other levels of linguistic analysis form part of one and the same system in which there are systematic mappings among its subsystems. If each component tries to preserve the content of its neighbour, it is to be expected that extraneous arguments may shed *some* light on what happens at a particular level. However, this evidence is of necessity indirect and hence of limited reliability.

The foregoing analysis of the nature of constituency tests has looked on sentence structure as a linguistic construct. However, a case was made in the preceding chapter for construing structure as a psychological notion (see also Derwing, 1973). I submit that this divergence is also responsible for the inconsistencies that have been observed among certain constituency tests. A process cannot be assumed to be faithfully reflected by the product. Therefore, these tests cannot help but furnish rather indirect evidence for structure.

Phillips (2003) developed an alternative account of the limited power of constituency tests. His starting point is a dynamic view of the generation of syntax as a multiple-stage process. The representations that are built up at each stage change from one stage to another. With these changing representations, the constituent structures also change. Phillips's major claim is that the different constituency tests apply at different stages, and because of the disparate representations of the latter, the former yield disparate results.

It is not entirely clear whether Phillips relies on a "competence" or a "performance model" of sentence generation. Although his analysis is couched in a linguistic framework, he invokes notions, in particular that of time, which are germane to language production and comprehension. However, he is not seriously committed to a psycholinguistic perspective and does not provide any psycholinguistic evidence for transient representations that replace one constituent structure for another in language processing. In fact, there is evidence to the contrary. Pickering, Branigan, & McLean (2002) and Haskell & MacDonald (2005) argue that only one representational stage is generated in language production. To the extent, then, that Phillips's model is intended as a psycholinguistic one, it fails. If it is understood as a wholly linguistic one, it has recourse to a notion of structure which is incompatible with the one endorsed here.

By way of summary, it has been argued that the standard strategy of uncovering syntactic structure is seriously, but not irredeemably flawed. It has created a mess in which arguments can be found for all three possible divisions of a simple SVO sentence. The VO unit is supported by the interrogation test, the SV unit by agreement, and the SO unit by ellipsis, even though the support for the three analyses is not equally compelling. The difficulty from the linguistic perspective is that syntactic problems cannot be unambiguously resolved by adducing evidence from constituency tests that are partly nonsyntactic in nature. The difficulty from the psychological perspective is that a psychological construct cannot be satisfactorily penetrated by adducing evidence from constituency tests that are basically nonpsychological in nature. This is not to say that the tests in general are not viable. Rather, the above analysis should be understood as an exhortation not to rely on a single data type but rather to broaden one's database. In particular, it seems advisable to draw on psycholinguistic and phonetic data that are more germane within a theoretical framework in which structure is regarded as a psychological phenomenon. If the various types of evidence go in the same direction, a relatively strong case can be made for a given constituent structure; if not, a stance will have to be taken on the relative importance of the different data types.

The preceding discussion has been almost completely confined to the criteria employed in the analysis of syntactic structure. This is for two reasons. For one thing, syntax is generally considered the archetypal structural domain. For another, the work on constituent structure in morphology and phonology has progressed far less than in syntax. The tests in these two domains have a relatively short history, are selected in rather haphazard fashion, and not generally agreed on. In particular, a systematic list of relevant tests has never been compiled. This will be done for all three domains in the following sections.[4]

2.3 CONSTITUENT STRUCTURE AND BRANCHING DIRECTION IN SYNTAX

The focus of the ensuing analyses will be on the major constituents of simple sentences, NPs, VPs and PPs. These are the structures for which the most information is available and which lend themselves well to an examination in terms of branching direction. As noted, more complex sentences such as (3) are unlikely to be planned in one pass and therefore inappropriate objects to study in the present context. This leaves us basically with the following three-element structures:

a) SVO sentences (with V representing a finite verb)
b) NPs consisting of DET, ADJ, and N
c) VPs consisting of V and two NPs (i.e., ditransitive verb structures)
d) PPs consisting of PREP, DET, and N.

The criteria that will be employed below fall into two broad categories—the linguistic and the psycholinguistic. Both of these categories are rather heterogeneous and may be divided into several subsets. The set of linguistic criteria comprises among others the aforementioned constituency tests whereas the set of behavioural criteria includes arguments from psycholinguistics in the narrow sense, code-switching, phonetics, and neurolinguistics. The relevance of the criteria to the issue of constituent structure will be explained as the individual arguments are introduced. An effort was made to select criteria that are to the greatest possible extent independent of any particular theory. The following list (sections 2.3.1.1.–2.3.1.10) is not meant to be exhaustive (see Givón, 1995, p. 182 for further criteria).

2.3.1 Linguistic Arguments

Let us begin with a brief review of a selection of constituency tests, some of which were mentioned in passing in the preceding section.

2.3.1.1 Pronominalization

The pronominalization test states that material that can be pronominalized is a constituent. Accordingly, the VP in SVO sentences and the NP in PPs function as such. On the negative side, the two objects of a ditransitive verb and the adjective–noun portion in NPs do not form constituents. The motivation for this test lies in the assumption that material that can be pronominalized owes this property to the fact that it respects syntactic boundaries because the pronominalized version leaves the overall sentence pattern largely untouched. However, there is no compelling reason why languages should have developed a pro-form for all syntactic constituents. This may be taken to imply that the pronominalization test underdetermines the structure of a sentence. Overall, however, this is a relatively reliable test.

Pronominalization is the more rigorous version of the substitution test that identifies constituents on the basis of their identical distribution (i.e., that which can appear in the same position is a constituent). This test seriously overgenerates structure because it cannot distinguish between real and fake constituents. Identical position and context are lax criteria that underdetermine paradigmatic choice. This can even be seen in phonology where the freedom of combining elements is much more rigid. A pertinent example is *many* [meni] versus *mend* [mend], which differ only in their final phoneme. Application of the substitution test would suggest that the /i/ and the /d/ belong to the same paradigm, which unjustly undermines the distinction between consonants and vowels.

2.3.1.2 Interrogation

The interrogation test assigns constituent status to all combinations of elements that can be questioned. This test produces positive results for the VP within S and the NP within PP but negative results for the NP within VP and the N′ within NP. It is thus entirely parallel to the pronominalization test in its yield. This test takes for granted that speakers always question constituents. As pointed out earlier, there is no necessary reason why they should. It is entirely conceivable that they question less than a constituent. This makes the test potentially not very reliable. The fact that it performs very much like the pronominalization test can be put down to a similarity between question words and pro-forms. Both act as syntactic place-holders for information to be sought or to be replaced.

2.3.1.3 Shift

The shift test accords constituent status to material that can be moved around in sentences. The VP can be dislocated within S, even though this is quite uncommon. The other three test cases turn out to be negative. Because English has a fairly rigid word order, it is not surprising that this test produces hardly any positive results concerning constituency. The logic of the test is quite straightforward. Assuming that dislocation is a process that is actively performed by speakers, it is reasonable to shift material that is between syntactic boundaries rather than material that crosses them. The test, then, is relatively reliable but hardly applicable in languages with rigid word order.

2.3.1.4 Coordination

This test holds that elements that can be coordinated qualify as constituents. VPs within Ss and NPs within PPs can be coordinated, whereas pairs of NPs within VPs and Ns within NPs cannot. Although this test produces the same results as tests Nos. 1 and 2, it is less reliable than the others because it overgenerates structure. Subjects and verbs can be coordinated as in (8).

(8) He walked and she drove past the barn.

This overgeneration emanates from the claim that coordination is subject to constraints that may have, but need not have, a syntactic origin. This test should therefore be treated with caution.

2.3.1.5 Deletion

The deletion test says that whatever can be deleted is a constituent. This test yields nothing but negative results for all of the four test cases under investigation. Obviously, the VP cannot be dropped from a sentence. This is for the simple reason that the test cases each involve at least two obligatory elements. It is therefore impossible for two elements, which might form a constituent, to be simultaneously deleted. It transpires that the deletion test cannot really speak on the issue of constituency.

This ends our brief review of some classic constituency tests. It is notable that they point in the same direction in assigning flat structure to ditransitive verbs with their objects and to NPs consisting of DET, ADJ, and N but hierarchical structure to Ss and PPs. This consistency may be taken as suggesting that, despite their indirect status as evidence for constituent structure, they are not entirely on the wrong track. The tests to be introduced next are also linguistic in nature but do not belong to the classic constituency tests.

2.3.1.6 Intercalation

The intercalation test is predicated on the assumption that a word whose positioning is fairly unrestrained can be placed more easily between two words that are separated by a syntactic boundary than between words that are part of the same constituent (Schwartz, 1972). The higher the boundary in the linguistic hierarchy, the more receptive it is supposed to be. The possibilities of placement can thus be used as a test for constituent structure (Zwicky, 1978). On account of their positional versatility, adverbs illustrate this point quite nicely. In a simple SVO sentence, adverbs can appear sentence-internally as in (9a) though not as in (9b).

(9) a. She dearly loves her teacher.
b. *She loves dearly her teacher.

One explanation for this asymmetry is the hypothesis that the syntactic boundary between subject and verb is different from that between verb and object. Specifically, the bond between verb and object is strong enough to prevent intercalation whereas the bond between subject and verb is weak enough to allow intercalation. This is tantamount to positing that verb and object form a unit whereas subject and verb do not, in other words, this is evidence for the VP. Given the nature of this test, it is limited to higher-order constituents. The further one goes down the linguistic hierarchy, the more tightly knit the constituents and hence the greater their resistance to intercalation. A further restriction is imposed by the fact that the test is only applicable to words that are syntactically rather unconstrained. On the other hand, the underlying assumption of the intercalation test is eminently plausible. Syntactic rules such as adverb placement are sensitive to the nature of syntactic boundaries.

2.3.1.7 Subcategorization

This test is by definition restricted to identifying the immediate constituents of Ss. Verbs determine whether they are followed (or preceded) by objects, and if so, by which type of object. These properties of verbs have been known as subcategorization rules since Chomsky (1965). The verb has no comparable power over the subject, which is a general syntactic requirement independent of any particular verb. This asymmetry makes perfect sense in a structure that links the verb to the object and thereby allows the two to interact in a way that is impossible for the subject and the verb to do.

2.3.1.8 Agreement

Perhaps the greatest surprise in the area of constituent structure analysis is that linguists have turned a blind eye to agreement. It is fairly obvious why they have done so—it produces undesirable results—but there is no justification for ignoring phenomena that are, on the face of it, immediately relevant. They can only be ignored if their relevance has been demonstrated to be spurious. It is a cross-linguistic fact that verbs more often agree with subjects than with objects (e.g., Keenan, 1976). This is exactly the opposite of what would be expected under the VP analysis. Subject–verb agreement implies a stronger link between subject and verb than between verb and object. It therefore counts as an argument against right-branching in SVO sentences. The applicability of agreement is restricted to SVO patterns in English.

2.3.1.9 Information Structure

It has been known since the Prague School of Linguists that sentences can be divided into a part that anchors them in the preceding discourse ("old information") and a part that conveys new information to the listener. This communicative principle may be put to good use in the analysis of sentence structure by taking the boundary between old and new information as a clue to identifying a syntactic boundary. In fact, a typical SVO sentence such as *Sue has a boyfriend* can be broken down into the subject, which codes the given information, and the remainder of the sentence, which provides the new information. The old–new distinction thus serves to identify the VP constituent in SVO sentences. Theoretically, the distribution of information is a criterion that can also be applied to smaller units, but it is less successful there because the distinction between given and new is not so easy to draw. For example, the NP within PPs may be argued to code new information and this is certainly true in some contexts. In others, however, the preposition may be equally new. Apart from this limitation, it should be noted that information structure is ultimately a pragmatic criterion that need not have a direct bearing on syntactic issues. It is thus equally indirect evidence as are most classic constituency tests and less direct than agreement, which is clearly a syntactic phenomenon.

2.3.1.10 Idiomatization

The final linguistic criterion is a semantic one. It turns on the closeness of the syntactic link between the verb on the one hand and the subject or the object on the other. A reasonable way of gauging semantic closeness is to examine the proneness to idiomatization of two adjacent constituents (Steenbergen, 1989). If idioms are based more frequently on verb–object than on subject–verb sequences, we would have evidence supporting a VP constituent. Precisely this holds good for English. McCawley's (1972) unpublished collection of idioms as cited in Tomlin (1986) reveals an overwhelming majority of verb–object idiomatizations. Out of a total of 313 cases, 310 (= 99.0%) have a VO structure (e.g., *to know the ropes*). True instances of subject–verb idioms are extremely rare and may rather be viewed as collocations (e.g., *The sun sets*; see also Zwicky, 1978). There is little doubt, then, that the semantic analysis corroborates the postulation of a VP node. As with previous criteria, the idiomatization test applies well to higher-level constituents but does not easily carry over to others. For example, it makes no sense in the analysis of the internal structure of PPs.

2.3.1.11 Conclusion

To summarize, there are many diverse lines of linguistic evidence to support the hypothesis that English has a VP. This claim is contradicted only by agreement, a genuinely syntactic process that does not square with any of the other syntactic and nonsyntactic phenomena. Although it is not entirely clear how to weigh the counterevidence, it seems reasonable to plead that agreement be assigned an exceptional status and not be allowed to undermine the VP hypothesis.

Whereas there is also strong support for the NP within PPs, the evidence for hierarchical structure within VPs and DET-ADJ-N combinations is weak. All of the linguistic tests are either inapplicable or assign them a flat structure. Given the nature of these tests, it cannot be excluded that there is some hierarchical organization that the tests are unable to pick up. For instance, Kayne (1984) claims that the internal structure of VPs with ditransitive verbs is right-branching because the flat analysis fails to capture the governing status of V and the governed status of the two NPs. Even though Kayne's hypothesis would fit in nicely with the general claims made here, it has to be dismissed. It introduces a notion into constituency analysis that is alien to it, viz. dependency. This is an issue that constituency analysis has nothing to say about. Constituency analysis has always been concerned with whether two units form, or do not form, a constituent, nothing more and nothing less. Kayne does not provide any convincing argument for treating the two NPs as a single unit (which he labels S on the basis of a dubious analogy with complex transitive verbs). Thus, the flat-structure assumption remains unchallenged by his proposal (see also Czepluch,1992 for an analysis of more complex VPs).

The linguistic tests have failed to single out the ADJ-N portion in DET-ADJ-N sequences. However, this does not imply that the ADJ-N part cannot act as a planning unit in sentence generation. This potential mismatch between the linguistic nature of the above tests and the psychological conception of structure makes it advisable to consider the linguistic evidence as preliminary and give due consideration to the psychological evidence. This will be done in the next section.

2.3.2 Psycholinguistic Arguments

In the halcyon days of psycholinguistics, a large body of research addressed itself to testing the psychological reality of linguistic constructs including phrase structure. The following logic was widely applied. If syntactic structure is psychologically real (i.e., computed during speaking and listening), it should manifest itself in behavioural terms. That syntax has a general effect on subjects' performance was established over and over again. Johnson (1968) demonstrated a higher learning rate for sentence fragments that have phrasal status (e.g., VPs) than for those that do not. Similarly, subjects' difficulty in completing fragmented sentences increased with the number of constituents deleted (Forster, 1967). More recently, Ferreira (1991) showed that the time to initiate an utterance varies with its syntactic complexity (i.e., number of syntactic nodes).

In addition to recognizing the general role of syntax in processing, many studies produced more specific results that helped to identify particular constituents and to arbitrate between rival models. Ferreira (1991) also looked at the position and duration of pauses in language production. If the VP constituent exists, pauses should occur before rather than after the verb in SVO sentences. This is precisely what she found. Pauses were more likely and of longer duration at the subject–verb boundary than at the verb–object boundary. Further evidence for the VP comes from a task in which subjects had to judge the degree of relatedness of all pairs of words in a sentence. Levelt (1969) argued that these judgements were based on perceived structural relations. He found that these relationships were in good agreement with the hierarchies set up in linguistics. A similar result was obtained in an intelligibility test in which parts of sentences were overlaid with white noise (Levelt, 1970). Subjects comprehended material better within than across syntactic boundaries. Strong evidence was found for major constituents (i.e., the subject–verb boundary) while minor constituents had less of an effect. In a learning experiment, Johnson (1965) probed into phrase structure by examining to what extent memorized chunks correspond to syntactically defined units. His findings confirmed the reality of the VP but also shed some light on the internal structure of DET-ADJ-N sequences. Johnson analysed these as hierarchical right-branching structures and found that this model provided a good fit to his data. To be specific, the probability of a memory error to interfere was lower between the adjective and the noun than between the determiner and the adjective. This finding may be taken as psycholinguistic support for the N′ node.

Johnson's study is relevant in another respect. He observed a very low error probability between the auxiliary and the main verb in the progressive aspect (e.g., *are cooking*). This rate was about as low as that between determiner and noun and considerably lower than would be expected if AUX was an immediate constituent of S. Thus, these behavioural data support the view that AUX and V are dominated by the same node, contrary to what is assumed in (3) shown earlier.

Another line of pertinent work capitalizes on the interactions of syntax and phonology or phonetics. The general idea is that if phonological/phonetic rules are sensitive to syntactic variables, they provide insight into the nature of syntactic representations. Cooper, Lapointe, & Paccia's (1977) study is a case in point. These authors focused on the phonetic rule of stressed syllable shortening that applies when the stressed syllable is followed by an unstressed one. The central question they addressed was whether and which syntactic boundaries intervening between the stressed and unstressed syllable would prevent this rule from applying. Cooper et al. argued for an interaction between the position of the boundary in the syntactic tree and the probability of rule blocking. The lower its position is, the greater the probability of syllable shortening. Cooper et al.'s data lend support to the VP node. They also provide some indirect evidence for the flat analysis of V-NP_1-NP_2 structures. Both the V-NP_1 and the NP_1-NP_2 boundaries are weak in the sense that they fail to prevent rule blocking. This finding might be taken to mean that these boundaries have a similar status, which would only be possible under a flat analysis (for further phonetic evidence for syntactic representations, see Cooper & Paccia-Cooper, 1980).

Like phonetic rules, phonological speech errors may be examined for their sensitivity to syntax. If the (psycho)linguistic system allows for an interaction between syntax and phonology, phonological error patterns can be used as evidence for syntactic representations. The general expectation would be that major syntactic boundaries discourage the occurrence of error more than minor ones. Since phonological slips "like" to cross word boundaries, they serve this purpose quite well. Motley (1973) performed an analysis of the words that accommodate the interacting phonemes in a corpus of 200 spoonerisms. He found that the majority of slips occurred between adjectives and nouns but only a minority between nouns and verbs. The interpretation of the former finding is as follows. Such a high number of errors makes sense when the two words are immediate constituents of the same phrase. That is to say, these slips argue for an intermediate N′ node in DET-ADJ-N structures. The latter finding is slightly more difficult to interpret because not every sequence of noun and verb need be a subject–verb combination. Nevertheless, the small number of such slips finds a ready explanation if error probability is assumed to be lowered by the strong syntactic boundary between subject and verb.

The next body of data comes from the area of code-switching. The logic is clear enough. Psycholinguistic evidence for constituent structure would be obtained if code-switching was sensitive to syntactic boundaries. The general expectation would be that the likelihood of code-switching decreases as branching depth increases. In point of fact, this principle holds. In a study of English-Spanish bilinguals, Woolford (1983) reports that the most frequent intrasentential switch point is at a major syntactic boundary, as in (10) where the switch occurs between the subject NP and the verb.

(10) Todos los Mexicanos were riled up. (from Pfaff, 1979)
'All of the Mexicans . . .'

The status of the subject–verb boundary as a major syntactic break point was further confirmed in a perception experiment by Wakefield, Bradley, Yom, & Doughtie (1975).

The code-switching studies can also be used to address the internal structure of NPs consisting of DET-ADJ-N. In a flat model, break points would be expected to occur equally often at the DET-ADJ boundary and the ADJ-N boundary. By contrast, a hierarchical model predicts a higher number of switches at the former than the latter boundary. Although they do not provide precise quantitative information, both Ewing (1984) and Woolford (1983) argue for the N′ analysis for these NPs. Woolford's argument is erected on the observation that switching does not occur between a noun and a following adjective, a word order that is possible in Spanish but (almost) impossible in English. This nonoccurrence is explained by the hypothesis that the two languages have different recodings for N′, which presupposes the existence of N′.

The final source of data is of a neurolinguistic nature. In the present context, neurolinguistics may be regarded as a branch of psycholinguistics as it is concerned with behavioural evidence. Again, the focus is on the VP constituent. If SVO sentences are right-branching, language-disordered subjects may be predicted to have more difficulty with the production of subject–verb than with verb–object sequences. The underlying assumption here is that major syntactic boundaries present a special challenge to aphasics. Therefore, these people are more at ease with producing syntactic units. Both Goodglass, Gleason, Bernholtz, & Hyde (1972) and Berko Gleason, Goodglass, Green, Ackerman, & Hyde (1975) present evidence in favour of the VP node. In a task that required subjects to provide answers to specific questions, they found that subject–verb sequences created great difficulty while verb–object sequences were comparatively easy to produce. This difference applied not only to the number of errors made but also to the number of productions. Unfortunately, these studies do not shed any light on the internal structure of other linguistic units.

2.3.3 Conclusion

The agreement between the linguistic and the psycholinguistic data is encouraging though not perfect. The major area of disagreement is the structure of complex NPs. Whereas the constituency tests unanimously argue for a flat structure, there is some psycholinguistic evidence, in particular from code-switching and speech errors, for a hierarchical structure. At this juncture, a decision has to be taken regarding the relative weight of the two data types. All in all, there are three arguments that lead us to attach more importance to the psycholinguistic evidence. In view of the fact that structure has been attributed a psychological meaning, psycholinguistic data by their very nature are more relevant than linguistic materials. Second, the linguistic evidence bearing on the internal structure of complex NPs is equivocal. Although constituency tests speak against an intermediate node, dependency supports it. It is not clear which of the two arguments should be given priority. Finally, however standard they may be in linguistics, the nature of constituency tests is rather problematic. Because they throw only an indirect light on constituent structure, they should not be too strongly relied on, in particular when they provide *no* evidence for a particular constituent. Our conclusion consequently is that the N′ in DET-ADJ-N sequences is real (i.e., that these sequences are hierarchical right-branching). As noted earlier, this analysis renders the distinction between nominals and NPs superfluous. All that counts is whether any two or more lexical units form a syntactic constituent. There is only one undifferentiated type of syntactic constituent. Different node labels are not necessary. It seems natural to extend this analysis to other cases and hypothesize that the difference between VPs and VGs (verb groups) is also a spurious one.

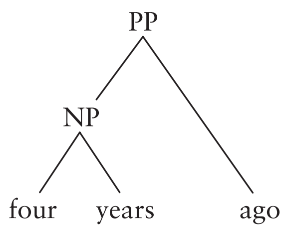
The evidence for the VP node appears incontrovertible. No other node has received as much support from so many different kinds of data. The match between the linguistic and psycholinguistic data is close to perfect. The only fly in the ointment is agreement, and it is unclear at present how it can be reconciled with the asymmetry introduced by the VP analysis. Although less of a research issue, the analysis of PPs with P and NP as their immediate constituents appears equally uncontroversial. Structures with ditransitive verbs as heads have also been largely neglected. The little evidence that is available from both linguistics and psycholinguistics suggests that the two object NPs do not form a constituent (i.e., that V+NP_1+NP_2 combinations have a flat structure).

A look at all three-element sequences under investigation reveals that both flat and hierarchical structures can be found, with the latter predominating. One reason for the predominance of hierarchical organization in syntax might be semantic in nature. The asymmetry in SVO sentences arguably emanates from a semantic asymmetry. The object NP is more strongly affected by the verb than is the subject NP. In Keenan's (1976) words, the subject exhibits a greater independence from the verb than does the object.

Although the semantic hypothesis has a certain appeal, it does not fully explain branching direction in syntax. A comprehensive explanation should include an account of how the assumed semantic bias permeates the syntactic system. It is reasonable to assume that if the syntax was not happy with right-branching, it would not develop it. What is more, the semantic hypothesis cannot account for structural asymmetries in phonology (see section 2.5 to follow). Therefore, it seems likely that semantic as well as processing factors jointly produce a predilection for hierarchical structuring. As explained before, more hierarchy implies more advance planning. Flat structures should therefore be the exception rather than the rule. This prediction meshes well with the above results. There are three hierarchical cases as against one flat structure.

It is a notable fact that all of the three hierarchical structures are right-branching. Again, this is in line with the processing account developed at the beginning of this chapter. However, right-branching is not a deterministic property of English. Let us single out three areas where left-branching is generally assumed, even though it should be added that they have not apparently been addressed from the psycholinguistic perspective. The first area relates to the internal structure of PPs. Exactly the same arguments that lead to the right-branching analysis for PPs with prepositions bolster the left-branching analysis for PPs with postpositions, as in (11).

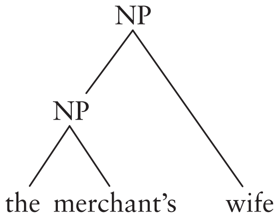
(11)



The important point is that postpositions like *ago* for example have a very low type frequency. The adposition *notwithstanding* may precede or follow the NP and is of low token frequency. Both postpositions and adpositions clearly have an exceptional status in English.

The second area is the Saxon genitive, as illustrated in (12).

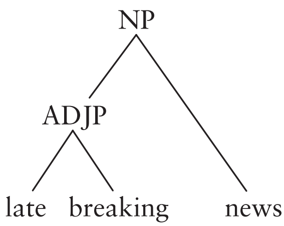
(12)



Since the determiner modifies *merchant* rather than *wife*, possessive NPs must be left-branching. If the possessive marker is regarded as a terminal element, there will even be two levels of left-branching.

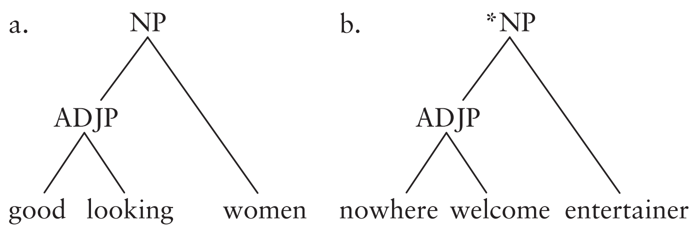
The third area is adverbs that modify adjectives. As these adverbs precede their heads and as adjectives do likewise, the resulting structure is left-branching, as shown in (13).

(13)



The general impression is that such NPs are rather uncommon in English. The more frequent alternative is to use the relative-clause construction, which appears to be particularly preferred when adverb and adjective are maximally independent of each other. However, when the degree of lexicalization increases, so does the probability of premodification. This principle might explain why (14a) is acceptable whereas (14b) is not, according to the native-speaker judgements reported in Matthews (1997).

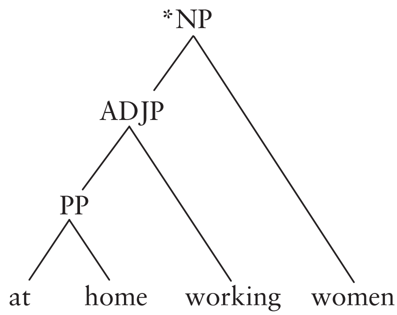
(14)



The critical point in the present context is that the higher the degree of lexicalization, the lower the syntactic independence of the individual items and the lesser the need to create a syntactic phrase that imposes a particular ordering relationship between them. Simply put, if *good-looking* is treated by the syntax as one word, the need for left-branching disappears.[5]

The same principle accounts for the ungrammaticality of (15) in which the complexity of premodification is further increased.

(15)



The noun *home* clearly links up with the preposition to create a PP and consequently cannot form a lexical unit together with the adjective, as is the case in (14a). Note that acceptability is a matter of degree, not of kind. Such structures as exemplified in (15) are not therefore categorically ruled out. The claim here is that the greater the syntacticity of the premodified material (i.e., the greater the left-branching bias), the lesser the acceptability of the phrase.

To conclude, although left-branching is clearly an option, it is an undesired one. Its dispreferred status can be gauged from the low type and token frequency of most relevant units. This bias against left-branching may be accounted for in a system that is heavily geared toward right-branching but is also flexible enough to accommodate countervailing forces. This system is probabilistic rather than deterministic in nature. The next section carries out a similar analysis at the morphological level.

2.4 CONSTITUENT STRUCTURE AND BRANCHING DIRECTION IN MORPHOLOGY

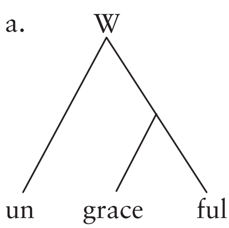
The organization of this section is quite different from that of the preceding one. As morphology is more restricted than syntax in the structures that it permits, it is possible to present an exhaustive investigation of all three-member units in word-formation. Therefore, the different classes of units will provide the organizing framework for this section.

Before we get down to investigating the internal structure of the various morphological types, a brief look at the state-of-the-art in "criteria research" is in order. Remarkably, there is nothing even remotely resembling the classic set of constituency tests in syntax. This may be partly due to the fact that morphology has been less extensively studied than syntax. Another part of the explanation may lie in the fact that three-member sequences are not among the commonest ones in a language like English with a basically analytic structure. At any rate, this state of affairs should not be construed to mean that constituent structure in morphology is a non-issue.

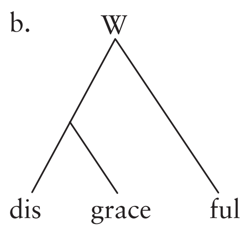
A glance at both older and more recent introductions to morphology leads to some surprising discoveries. Some authors (e.g., Coates, 1999) ignore constituent structure completely. Others (e.g., Katamba, 1993) assume morphological structure but fail to give any criteria at all for how to determine it. When criteria are provided, they differ quite radically, sometimes with hardly any overlap between them (compare, for example, Adams [1973] to Jensen [1990]). Other morphologists such as Spencer (1991) and Anderson (1992) are dismissive of hierarchical structure in morphology, without, however, taking the trouble to go over all available tests to prove their point. None of the authors mentioned makes an attempt to explain the underlying logic of the criteria and their relevance to constituency. There thus is considerably less scholarly foundation to rely on than in syntax, both from the linguistic and the psycholinguistic angle.

It is noteworthy that a predominant branching direction has not been proposed in the morphological literature. What we usually encounter in textbooks is the analysis of individual examples, sometimes from a contrastive perspective. Here are four illustrative examples covering most of the morphological territory that will be dealt with in this chapter. The first is the prefix-stem-suffix type in (16) from Bolinger & Sears (1981, p. 79), the second the stem-stem-stem type in (17) from Szymanek (1998, p. 48), the third the stem-stem-suffix type in (18) from Kastovsky (1995, p. 105) and the fourth the stem-suffix-suffix type in (19) from Scalise (1988, pp. 576–577). The (a) panel represents right-branching, the (b) panel left-branching. Note that example (19a) is from Italian because English lacks comparable cases.

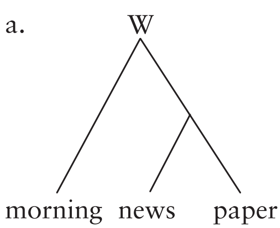
(16) a.



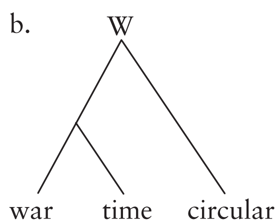
b.



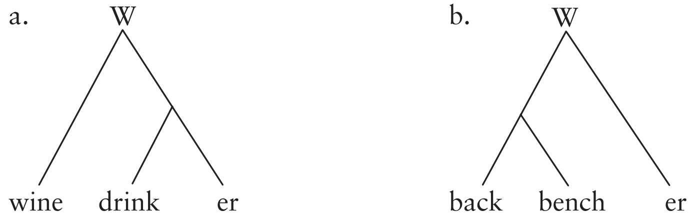
(17) a.



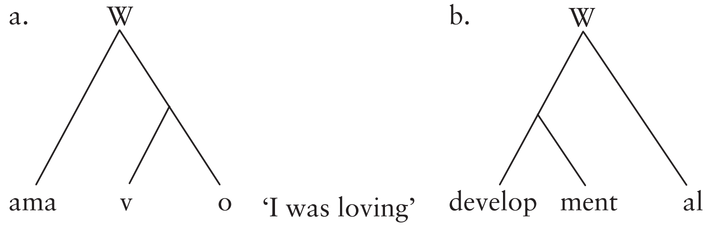
b.



(18)



(19)



The impression one gains from examples (16)–(19) is that English morphology is characterized by both left- and right-branching, as the case may be. To be more specific, these examples might even suggest that branching direction is an idiosyncratic property of individual lexical items. The authors from whom these patterns are taken do surprisingly little in the way of justifying their analyses. Bolinger & Sears (1981) claim that *ungraceful* in (16a) is right-branching because *grace* is “together with” *-ful*, not with *un-*. This is purely tautological. Szymanek (1998) gives no motivation at all for (17). Kastovsky (1995) states that the tree structure in (18) reflects the stepwise composition of the morphologically complex items. Again, this comes close to a tautological redescription of the morphological facts, not an explanation. Unlike the aforementioned scholars, Scalise (1988) does not relate supramorphemic structure to individual items but rather to morphologically defined classes. As he sees it, words with two inflectional suffixes are right-branching as in (19a) whereas words with two derivational suffixes are left-branching as in (19b). It is not quite clear whether Scalise considers this statement to be cross-linguistically valid. At least his explanation for right-branching in morpheme sequences with two inflectional suffixes is language-particular in nature. He notes in support of his analysis that the first inflectional suffix does not go together with the stem to form an independent word (as in the case of derived words). The sequence *ama-v* is nonexistent in Italian. It is not clear how Scalise would treat items in which these morphemes create a real word. If this were the case, they would resemble derived words that he assigned a left-branching structure.

The structural variability displayed in (16)–(18) is puzzling. One of the fundamental features of a structural representation is its basic independence from the linguistic units with which it is associated (Lashley, 1951). As argued earlier, an English SVO sentence is right-branching, irrespective of the lexical items of which it is made up. This independence follows from the function structural representations perform in the linguistic system. Recall that their task is to build up larger chunks from the basic building blocks of language. It would clearly be more congenial to the idea of structure (i.e., the mortar is almost nothing to do with the *individual* bricks) and also more parsimonious to have a small number of these construction routines subserving all content units rather than one construction routine for each constellation of content units. Thus, the ultimate reason for the relative independence between content and structure is one of economy in production and of the general principles underlying the process of their association.

There is an additional problem if the structural variability in (16)–(18) is genuine. If so, the relationship between content and structure would be level-specific. Whereas syntax and (as will be shown later) phonology exhibit a considerable independence between structure and content, morphology would evince a strong dependence of the former on the latter. There is reason to be sceptical of claims about the idiosyncratic nature of morphological structure.

This critical review has a number of important implications. An investigation seeking to explore the notion of a general branching direction preference requires one to take the following four points into consideration. First, analyses of individual items have to be replaced with quantitative probes of larger data sets. In the ideal case, the entire lexicon is subjected to examination. Of course, this is not generally possible in morphology where productivity belies the idea of construing lexical items as a closed class. When a lexicon-wide analysis is impossible, it is imperative to collect a representative sample on which statistical claims can be erected. In addition, it might also be instructive to look at type as well as token frequency. Second, selectivity in the choice of criteria is to be avoided by all means. All the criteria that have a bearing on branching direction have to be taken into account. On top of that, all these criteria have to be applied to all words (within the limits of applicability, of course). Third, it has to be made explicit how (and why) each criterion bears on the issue of hierarchical structure. This requires an analysis of the logic that underlies the use of each criterion for the purpose at hand. Fourth, a stand has to be taken on how to deal with potential conflicts between criteria. It is conceivable, if not to be expected, that different criteria produce conflicting results. In such cases, tactics of reconciliation, such as the differential weighing of individual criteria, will be called for.

The criteria themselves have to meet two general requirements. The first is that they should be grounded in a clearly spelt out rationale rather than merely stipulated. As an example of the latter type, one may cite Jensen's (1990, p. 34) guideline to the effect that branching should as a rule be binary, not ternary. The second requirement is that the criteria should not be too closely tied to a particular theory. A case in point is Lieber (1981) who draws on Siegel's (1979) model of level ordering that assigns certain morphological processes to an earlier level and certain others to a later level.

This level-ordering principle has obvious implications for constituent structure. If, let us say, a given prefix is attached prior to a certain suffix, only the prefix and the stem can contract a privileged relationship (i.e., the word in question must be left-branching). The problem with this criterion is that it stands or falls with the particular theory on which it is based. If the concept of a strict temporal relationship between representational levels founders (as argued by Aronoff & Sridhar, 1983), the criterion will lose all its force. It is advisable therefore to base one's analysis on criteria that are to the greatest possible extent independent of any particular background assumptions.

Finally, one major limitation has to be pointed out. The ensuing analysis will be restricted to word formation. No attention will be paid to inflectional morphology because it is commonly assumed to arise outside the lexicon proper (e.g., Zwicky, 1985) and therefore does not provide direct insight into the structure of lexical items. Recall in this connection from Chapter 1 that inflected words show a relatively small lexical influence. This criterion excludes three-member words of the types Stem-Stem-Inflectional-Suffix (e.g., *beachhuts*) and Stem-Suffix-Inflectional-Suffix (e.g., *neighbourhoods*). Stem-Prefix-Stem structures are not attested (see Table 4.1 of Chapter 4). Given that combinations of prefixes are illicit and that prefixed compounds are not normally lexicalized in English, we are left with the following five types: (a) Prefix-Stem-Suffix, (b) Stem-Stem-Suffix, (c) Stem-Suffix-Stem, (d) Stem-Suffix-Suffix, (e) Stem-Stem-Stem. One section will be devoted to each of these sets. Most of the criteria for constituency will be introduced in the next section, and the remaining ones as they apply to individual sets.

2.4.1 Prefix-Stem-Suffix Structures

We begin with a highly frequent three-member combination—prefix-stem-suffix structures. Nothing appears to inhere in these words that would prejudge the issue of flatness versus hierarchicalness as well as that of left- versus right-branching. The suffix might just as well contract a privileged relationship with the stem as the prefix might, or else the affixes might not differ in their affinity with the stem. This openness makes prefix-stem-suffix sequences an ideal test case for determining constituent structure and branching direction in morphology.

2.4.1.1 Criteria for Determining Constituent Structure

Two sets of criteria will prove relevant in the analysis of prefix-stem-suffix combinations—the linguistic and the psycholinguistic. The total number of linguistic criteria is six. They cover most linguistic domains including semantics, lexicon, morphology, and phonology. The first three domains contribute one criterion each whereas phonology contributes as many as three. Whereas the non-phonological criteria are commonly used in the morphological literature, the phonological ones are generally left out of consideration. However, this bias against phonology is unjustified. Phonology is the level that is directly fed by morphology and, as such, a prime reflector of morphological structure.

The first phonological criterion deals with *resyllabification*. When two morphemes are concatenated, the phonology may interpret them in one of two ways. The two morphemes may be treated as either two isolated elements or one single prosodic unit. In the latter case, it is to be expected that the same syllabification rules will be applied that are ordinarily applied in monomorphemic words. To be more specific, the concatenation of a consonant-final prefix and a vowel-initial stem expectedly leads to re-association of the consonant with the stem following a general tendency to avoid so-called "empty onsets." Such a resyllabification process is evidence of an interaction that would be impossible if the interacting elements were not simultaneously available to the phonological system. Whether or not these elements are co-present is not, however, decided on by the phonology but is arguably determined by the morphological representation. When it is left-branching, resyllabification is expected to occur between the prefix and the stem, though not between the stem and the suffix.

The second phonological criterion is termed the *segmental* one. It refers to the effect an affixation process may have on the segmental makeup of a stem (see Hall, 1988). If, for instance, a prefix, though not a suffix, is capable of altering the phoneme structure of the stem, we would have evidence of a closer interaction between prefix and stem than between suffix and stem. Such an interaction would be expected between morphemes that are dominated by the same superordinate node (i.e., which form a unit at an intermediate level of representation). The segmental criterion would accordingly attribute a left-branching structure to the example under discussion. The underlying assumption of this criterion is that the dominance by the same node leads to the (near-) simultaneous availability of the subordinate nodes (i.e., the individual morphemes, which are therefore free to influence each other). (The direction of influence is of no concern in the present connection.) Conversely, if the terminal elements are dominated by different nodes, they are not simultaneously available and therefore reluctant to interact. Note that this difference is a gradual, not an absolute one. Because in this example the stem and the suffix are indirectly dominated by the same node (i.e., the word node), there is also a potential for interaction. However, this should be lesser than in the case of immediate dominance.

The third phonological criterion is called the *suprasegmental* one. It refers to the effect that a morphological process may have on the stress pattern of a stem (Chomsky & Halle, 1968). If, for example, suffixing though not prefixing induces an alteration of the rhythmic structure of the stem, the suffix may be claimed to be more closely associated with the stem than the prefix. The logic is entirely parallel to the segmental criterion. An asymmetrical interaction is indicative of an asymmetrical structure, in this case a right-branching configuration.

The fourth criterion is the *morphological* one. It is employed by Strauss (1982), Bauer (1988), and Carstairs-McCarthy (1992), among others. The basic insight is that affixes are sensitive to the word class of the stem to which they attach. Such subcategorization rules may be capitalized on in an attempt to uncover the constituent structure of morphologically complex words. Let us pick out the case of an adjective consisting of a prefix + verb stem + suffix (e.g., *uncontentious*). If the prefix can be epoxied to an adjective but not to a verb, there is no way in which the prefix and the stem can form a unit. The prefix can only attach to the verb stem after it has been transformed into an adjective through suffixing. This logic would constitute an argument for right-branching. The underlying assumption here is that constituent structure epitomizes the derivational history of a complex word. The term *derivational history* has two readings. From a diachronic perspective, the assumption would be that the stem and the suffix existed as a complex word some time before the trimorphemic word was created. From the synchronic angle, the prefix-stem-suffix sequence would be assumed to be built up step by step—first suffixing, then prefixing.

The fifth criterion is the *lexical* one. It is used by Adams (1973), Selkirk (1982b), and Scalise (1986), among others. This criterion addresses the lexical status of any pair of adjacent morphemes in a complex word. If in a trimorphemic item the first two constituents form a lexical unit whereas the last two do not, we have an asymmetry that may be interpreted in structural terms. Specifically, it would suggest that the first two morphemes are dominated by the same node and the last two morphemes by different nodes. This is, of course, a left-branching structure. The underlying logic is not unlike that of the morphological criterion. Two constituent morphemes that do not make a real word should not be grouped together, in much the same way as two adjacent morphemes that could not even make a potential word should not form a structural unit.

The sixth and final criterion is the *semantic* one. It is resorted to by, for example, Bauer (1988), Jensen (1990), and Libben (1993). This criterion demands that the constituent structure reflect the meaning of the complex word. Prefixes and suffixes may differ in their semantic scope. If the prefix has scope over both the stem and the suffix in a trimorphemic word whereas the suffix has scope only over the stem, the word may be argued to be semantically asymmetrical. This asymmetry can be construed as an argument for a right-branching structure. The general idea is borrowed from syntax. The syntactic structure is sensitive to the meaning of a sentence, and so is the morphological structure to the meaning of a word. The principle at the heart of this connection is that the erection of structure is guided by semantic information. In this view, semantic differences iconically generate structural differences.

These six diverse criteria have been introduced on the assumption that they are all independent. However, this is largely, though not completely true. There are some dependencies in the sense that one decision may entail another. Let us briefly look at two examples. The segmental and the suprasegmental criteria are independent only to the extent that phonemes and stress are independent. This is generally but not always so. A well-known exception is schwa, which occurs only in unstressed syllables. If, for instance, suffixing induces a stress shift onto a syllable containing a schwa, the vowel is necessarily altered, witness the change from /ə/ to /æ/ in *moral* + *ity* → *morality*. Here, the vowel shift cannot be said to be independent of the stress shift. The second example deals with the interaction of the semantic and the lexical criteria. Applying the semantic criterion presupposes the lexical status of the morpheme sequences under investigation. If two adjacent morphemes within a complex word do not form a lexical unit, there is no point in enquiring about their semantics. The inapplicability of the lexical criterion thus leads to the inapplicability of the semantic criterion.

It is important to stress that this limited dependence in no way undermines the integrity of the six criteria. These were chosen with the intention of performing a maximum number of different tests from different domains in order to gauge the strength of the support for a particular constituent structure. Each criterion has an individual contribution to make and therefore serves its purpose even in the face of restricted nonindependence.

The psycholinguistic criterion is that of cohesiveness. This criterion measures the degree to which two adjacent morphemes stick together in behavioural data such as slips of the tongue (see Chapter 1). The different structural possibilities make different predictions for the cohesiveness of adjacent morphemes in trimorphemic words. The flat model predicts the same degree of cohesion between prefix and stem as between stem and suffix. The left-branching hierarchical model predicts a higher degree of cohesion between prefix and stem than between stem and suffix. The opposite prediction holds for the right-branching hierarchical model. The underlying logic was explained in section 1.6. As the first two morphemes are dominated by the same node in a left-branching structure, and as this dominating node spreads a similar amount of activation to its subordinate nodes, they tend to be simultaneously active and are therefore likely to act in unison.

2.4.1.2 Materials

Consonant with the objective of carrying out a lexicon-wide analysis, all prefix-stem-suffix sequences in the English lexicon were examined on the basis of the six linguistic criteria. To this end, the CELEX database, an electronic version of the COBUILD dictionary, was tapped. It is based on almost 18 million word tokens from both spoken and written language and from both British and American sources (see Burnage, 1990 for further information). The first step involved extracting all trimorphemic lemmas of which the first and the last were affixes (labelled AFA and ASA in the database). After the elimination of all the words that were for one reason or another unsuitable (see Berg, 2003b for details), we were left with the sizeable number of 1056 items.

2.4.1.3 Coding and Exemplification

For each criterion, each of the 1056 items was assigned to one of the following four categories. Category 1 suggests left-branching, category 2 right-branching, category 3 both left- and right-branching, and category 4 neither. Whereas the former two categories argue for hierarchical structuring, the latter two are compatible with the flat-structure assumption. This is self-explanatory in category 4, which evidences a symmetrical relationship between the first two and the last two morphemes. Category 3 is the only one to require further comment. As left- and right-branching are mutually exclusive options (at one and the same representational stage), there is no way in which a given lexical item can be suggestive of both. One reasonable way of interpreting category 3 items is to argue that they imply a flat structure, thereby highlighting their symmetrical nature (i.e., both the prefix and the suffix have the same or a similar effect on the stem).

Generally speaking, the assignment to the four categories on the basis of the six criteria proved uncontroversial. There is little dispute over the segmental structure, the stress pattern and the syllabification of a word (in a particular dialect). The dialect that serves as input to the classifications is educated British English (Received Pronunciation) as codified in Wells (1990). This means in particular that word-final <r>'s are not pronounced. It is usually clear which affix may attach to which word class although there are borderline cases, such as the prefix *un-*, which typically combines with verbs and adjectives. In exceptional cases, *un-* may also join a noun. However, because words like *unbelief* and *unbeliever*, for example, have a very low type frequency, a morphological rule that combines *un-* with nouns was assumed to be nonexistent. In general, reliance was placed on Marchand (1969) who gives a detailed survey of the combinatorial possibilities of affixes and word classes. There were a few uncertainties in applying the lexical criterion because the line between potential and actual words, as well as that between obsolete and obsolescent words, is difficult to draw and because dictionaries differ in their coverage. As a practical strategy, a given pair of morphemes was regarded as lexicalized when it figured in the standard medium-sized dictionaries.

The example of *inflammation* may serve to illustrate the four options. The resyllabification criterion introduces the first asymmetry. The suffix begins with the final part of the stem, hence resyllabification at the end, not at the beginning of the word. This asymmetry argues for right-branching. The segmental criterion leads to the same result as the resyllabification criterion. The item *inflammation* is assigned to category 2 because the suffixing, though not the prefixing, induces a phonemic change on the stem, namely monophthongization. The suprasegmental criterion also argues for right-branching because suffixing but not prefixing entails a stress shift. By contrast, the morphological criterion favours left-branching because the prefix attaches to nouns (*in* + *flame*) whereas the suffix does not (**flame* + *ation*). The stem is quite clearly not a verb here. The same asymmetry emerges on the lexical criterion. The portion *inflame* is a real word whereas **flammation* is not. This justifies assigning *inflammation* to category 1.

The semantic criterion was somewhat more difficult to deal with because it is not always easy to describe the semantic scope of an affix. No problem arises when the lexicon suggests a particular branching direction, as in the case of *inflammation*. Even without lexical support, the majority of items can be afforded an unambiguous interpretation. Such is the case with the verb *immobilize*, which means [cause [become [not [mobile]]]], though not [not [cause [become [mobile]]]]. By implication, the prefix has scope over the stem and the suffix over the prefix and the stem, thus yielding a left-branching structure. Other cases, however, are not that clear. The noun *mismanagement*, for instance, can be paraphrased as "the condition of mismanaging" or as "inept management." The former paraphrase would suggest left-branching, the latter right-branching. In such cases, a conservative strategy was adopted and the items were assigned to category 3. This helped to prevent a bias in favour of one or the other branching direction on the basis of uncertain examples.

2.4.1.4 Results

There are two ways of treating the data. As has been shown in the preceding section, the six linguistic criteria do not necessarily point in the same direction. Therefore, a method has to be devised to deal with conflicting results. It was decided to give each criterion equal weight and apply a simple majority rule. Six classes were set up: Class A items are predominantly left-branching; Class B items are exclusively left-branching; Class C items are predominantly right-branching; Class D items are exclusively right-branching; Class E items have an equal number of arguments for left-and right-branching; and Class F items lack arguments for either branching direction. Because of their branching direction neutrality, assignments to categories 3 and 4 were left out of account. To return to the example given earlier, there are three arguments for left-branching and three arguments for right-branching in the case of *inflammation*. It was therefore assigned to class E.

This method yields the following results. Of the 1056 items, 553 (52.4%) are exclusively right-branching, 147 (13.9%) are predominantly right-branching, 124 (11.7%) are exclusively left-branching, 84 (8.0%) are predominantly left-branching, 107 (10.1%) are balanced and 41 (4.0%) neutral in terms of branching direction. Pooling the predominant and exclusive categories, we obtain 700 (66.3%) right-branching as against 208 (19.7%) left-branching cases. There thus is a clear majority of right-branching items in this part of the English lexicon.

The disadvantage of this method is that it remains silent on the individual contributions of the six criteria. To rectify this, a second way of scoring was resorted to. The classes A to F were ignored and branching direction was determined on the basis of the six criteria alone for all items. The results are displayed in Table 2.1.

Table 2.1 Morphological Structure in Trimorphemic Words (N = 1056)

	Categories			
Criteria	*Left-Branching (1)*	*Right-Branching (2)*	*Both (3)*	*Neither (4)*
Resyllabification	0 (0.0%)	671 (63.5%)	4 (0.4%)	381 (36.1%)
Segmental	6 (0.6%)	482 (45.6%)	18 (1.7%)	550 (52.0%)
Suprasegmental	48 (4.5%)	205 (19.4%)	6 (0.6%)	797 (75.5%)
Morphological	63 (6.0%)	290 (27.5%)	696 (65.9%)	7 (0.7%)
Lexical	176 (16.7%)	397 (37.6%)	428 (40.5%)	55 (5.2%)
Semantic	422 (40.0%)	437 (41.4%)	151 (14.3%)	46 (4.4%)

The most important finding to emerge from Table 2.1 is that on all six criteria without exception, right-branching data points outnumber left-branching ones. Comparing all instances of right-branching (N = 2482) with all instances of left-branching (N = 715) yields a ratio of 4.5:1. Again, there is strong support for the hypothesis that right-branching is the preferred branching direction in English morphology.

Notably, not all criteria are equally inclined toward right-branching. The basic distinction to be made is that between the semantic and the non-semantic criteria. Whereas the semantic criterion divides the left- and right-branching cases into two almost equal halves, the other criteria show a strong predominance of right-branching. This predominance is strongest on the resyllabification and the segmental criteria where left-branching is hardly an alternative, fairly strong on the suprasegmental and the morphological criteria with a ratio of 5:1, and somewhat less strong on the lexical criterion with a ratio of 3.3:1. A first inference to be drawn from these data is that the "lower" levels appear to be more predisposed toward right-branching than the "higher" ones.

We can be more specific here. There is a hierarchy even within the phonological component. As argued by Levelt, Roelofs, & Meyer (1999) and Cholin, Schiller, & Levelt (2004), syllabification (and consequently also resyllabification) occurs late in the language production process and may accordingly be claimed to be the furthest away from the semantic level. As the term implies, the suprasegmental level is "above" the segmental one and therefore closer to the semantic level. This leads us to postulate the following hierarchy within the phonological system (from top to bottom): suprasegmental > segmental > resyllabification. An inspection of Table 2.1 reveals that this hierarchy correlates exactly with the bias for right-branching. The previous claim can now be made more specific. The lower the position of a criterion in the linguistic system is, the stronger its proclivity for right-branching.

By definition, the preference for right-branching implies a preference for hierarchical over flat structure. The hierarchical-structure hypothesis would be cemented if it could be shown that (a) the decisive categories 1 and 2 outnumber the neutral categories 3 and 4, or that (b) a numerical predominance of categories 3 and 4 can be motivated on independent grounds. We may leave out of consideration the two outermost criteria, which play special roles. As noted earlier, there is no clear branching-direction preference on the semantic criterion. The resyllabification criterion is the only one to produce an absolute majority of right-branching responses. It thus fulfils requirement (a).

As Table 2.1 makes plain, the neutral categories 3 and 4 constitute the majority pattern on the remaining four criteria. Category 3 predominates on the morphological and lexical criteria whereas category 4 predominates on the segmental and suprasegmental criteria. These findings should not, however, be taken as an argument for flat structure. Indeed, they are entirely expected in the light of very powerful principles of linguistic structure. A morphological expansion is all the more favoured, the higher its transparency (Cutler, 1980), that is, the lower the number of attendant phonological processes. The ideal case, then, is no phonological change at all—exactly the situation embodied by category 4. The fact that all the phonological criteria assign so many items to category 4 thus follows from the desire to preserve the integrity of the individual morphemes in complex words. Remarkably, not all phonological criteria seem to be equally important in this preservation process. Resyllabification appears to be least disruptive to the integrity of the morphological parts of complex words, as revealed through a higher number of resyllabified cases as compared to non-resyllabified ones.

The preponderance of category 3 items on the morphological criterion results from the very essence of morphology. Morphology serves its creative purpose all the better, the more widely its rules can be applied. It is thus to the obvious advantage of the system to allow prefixes and suffixes to attach to the same stem. As a consequence of this tendency toward generality, two thirds of the items are compatible with both branching directions. The morphological criterion thereby shows itself to have limited discriminative power. This might appear surprising in view of the fact that we are dealing with a morphological issue for which morphological arguments would seem to constitute prima facie evidence.

The high rate of items assigned to category 3 by the lexical criterion partly arises from the nature of morphological rules as was just discussed.

The more general the morphological rules, the higher the number not only of potential but also of actual words. A further reason for the predominance of category 3 items lies in the way in which the words were categorized. The lexical criterion was interpreted as a test of whether a given affix-stem sequence formed part of the English lexicon, irrespective of the closeness of the semantic link of the affix-stem and the prefix-stem-suffix structure. If more weight had been given to semantic influences at the lexical level, the number of category 3 items would have been lower. However, this was not deemed desirable lest the criteria be mixed.

We observe that the number of category 3 items decreases as we move from the morphological to the lexical to the semantic level. This pattern receives a natural explanation when the linguistic hierarchy is taken into account. Not all of the potential offered by the morphology is lexically realized, and not all of the potential offered by the lexicon is semantically realized.

By way of internal summary, the analysis of the category 3 and 4 columns in Table 2.1 disclosed a quasi-mirror-image pattern. Both the frequency of category 3 items on the phonological criteria and the frequency of category 4 items on the non-phonological criteria are largely negligible. The rarity of these subsets of data argues against a flat structure underlying morphologically complex words. By contrast, category 3 items on the non-phonological criteria, as well as category 4 items on the phonological criteria, are moderately to highly frequent. These data only seemingly argue for flat structure. Their frequency is attributable to independent principles of linguistic structure that are powerful enough to prevent excessive phonological alternations in morphological processes and to create a high number of (potential and real) lexical items in the interest of morphological creativity. Note that even if the frequency of category 3 and 4 items was taken as support for the flat-structure hypothesis, the differential frequency of category 1 and 2 items would remain unaccounted for.

The major conclusions are as follows. A strong case can be made for hierarchical, and against flat, morphological structure. An equally strong case can be made for right-branching and against left-branching. The lower the position of the individual criteria in the linguistic system is, the stronger the dominance of right-branching. At the highest level, the semantic criterion is neutral with respect to branching direction. One way of rationalizing this neutrality is to argue that branching direction is a property of nonsemantic levels of representation. This claim is entirely compatible with the model of language production outlined in Chapter 1. Assuming that the semantic level codes prelinguistic, conceptual information, there would be no need for any branching-direction preference. This follows from the nature of hierarchization and the function of nonsemantic levels. Hierarchization was argued to be a consequence of advance planning in the process of transforming thought into language. As the function of the nonsemantic levels is precisely to effect this translation process, it stands to reason that these exhibit a branching-direction preference. The same is not necessary in the case of the semantic level, which is, strictly speaking, not part of the process of linguistic encoding.

Within this model, it can also be explained why the predominance of right-branching increases with the distance from the semantic level. All that has to be assumed is that the influence of one level on another is a function of their distance to one another. The information flow is direct (i.e., stronger) between adjacent levels but indirect (i.e., weaker) between nonadjacent ones. Hence, the semantic level has a strong impact on the lexical level but this impact progressively diminishes at the lower levels. "Impact" in this case means "branching-direction neutrality." As this impact lessens with an increasing distance from the semantic level, the lower levels may show a progressively unrestrained predilection for right-branching.

Before we turn to the psycholinguistic evidence, one extension of the linguistic analysis will be considered. Phonological rules may operate across morphological boundaries, or be blocked by them. A case in point is the resyllabification rule discussed earlier. Another rule is what may be called the "identity constraint." As extensively documented by Menn and MacWhinney (1984), languages display a remarkable resistance to the repetition of identical phonological material. Morphemes that normally would occur next to each other are produced only once if they have the same phonological form, compare the plural possessive of *wives'* to that of *women's*. Partial identity between the neighbouring morphemes suffices for the identity constraint to operate, as long as the identical material is adjacent. This principle can be shown to operate in *linen*, which cannot be turned into the adjective **linen-en* on the model of *wool*, which can be turned in *wool-en* (examples from Dressler, 1977). Similarly, **complet-ity* and **appeal-al* are disallowed whereas *obes-ity* and *approv-al* are fine (see Raffelsiefen, 1998).

The right-branching hypothesis about prefix-stem-suffix sequences entails the following prediction. Given that the stem and the suffix are claimed to be more closely associated to each other than the prefix and the stem, the identity constraint should operate more forcefully in the former than in the latter case. This prediction follows from the hypothesis that the same superordinate node increases the degree of coactivation of the subordinate nodes. The higher the level of their coactivation is, the greater the potential interference (i.e., the higher the likelihood of the identity constraint taking effect).

This prediction appears to be borne out even though an in-depth analysis of English is lacking. On the basis of individual examples, Dressler (1977) claims that the identity constraint applies to suffixation, though not to prefixation. Note that Dressler states his hypothesis in absolute terms, whereas the aforementioned prediction claims a quantitative difference between stem-suffix and prefix-stem structures. Specifically, contra Dressler, the identity constraint may be expected to also hold for prefixation, if less strongly than for suffixation. In this weaker form, the identity constraint with its variable strength receives initial support. The examples given in Dressler (1977) show a certain freedom in combining relevant prefixes and stems (e.g., *un-understandable*) accompanied by a greater restriction on combining relevant stems and suffixes (e.g., **fish-ish* but *ap-ish* and **grief-ful* but *sorrowful*). Other examples from English include the avoidance of regular plural marking on nouns ending in /s/ (e.g., *biceps*) and the unacceptability of regular adverb formation with adjectives ending in *-ly* (e.g., **likelily*; from Menn & MacWhinney, 1984). There is also anecdotal evidence for the operation of the identity constraint in the prefix-stem domain. When the Latin word *in-intelligibilis* entered the English language, the prefix *in-* was dissimilated to *un-* in *un-intelligible*. Despite the limited nature of the data, there is some evidence to back up the prediction from the asymmetrical structure of prefix-stem-suffix sequences. This may be taken as additional support for the right-branching analysis proffered earlier.

It is now time to consider the speech error evidence. The predictions of the three models of word structure are very clear. According to the flat model, prefixes should be involved in errors as often as suffixes. By contrast, on the right-branching model, one would expect prefix slips to be more common than suffix slips because the prefix is structurally “free” (i.e., directly dominated by the word node) whereas the suffix is more deeply embedded and therefore cannot break loose that easily. The opposite prediction holds for the left-branching model.

These predictions will be tested against speech error data from German. English is not the ideal language to examine because it has a relatively impoverished morphology and because the status of quite a few potential prefixes is uncertain. For example, Stemberger (1985) classifies (20) as a prefix error.

(20) We have 25 *de*dollars *de*ductible. for: dollars.

It is doubtful whether *deductible* is prefixed in the same way as *demotivate* is. As *duct* does not exist as a verb (unlike *motivate*), a monomorphemic analysis of *deduct* cannot be lightly dismissed. Whether the *de-* in *deduct* and that in *demotivate* are treated alike by the processing system is not known. Pending further work, it seems wise to concentrate on data whose morphological status is less problematic. This criterion is fulfilled by the German errors summarized in Table 2.2 below. Note that recourse to the German materials is had on the understanding that the internal structure of prefix-stem-suffix combinations is essentially the same in German and English.

Two pertinent slips follow. A prefix error is given in (21), a suffix error in (22).

(21) die erste, die *Ver*achtung *ver*dient. for: Beachtung.
the first who contempt merits attention
‘the first to merit contempt.’ for: ‘attention’

Table 2.2 Frequency of Affix Slips in German

	Anticipation		*Completed Anticipation*		*Perseveration*		*Anticipation/ Perseveration*			*Non-Contextual*				
Affix	*Sub*	*Add*	*Sub*	*Add*	*Sub*	*Add*	*Sub*	*Add*	*Contextual Omission*	*Sub*	*Add*	*Omi*	*Total*	%
Prefix	35	23	8	47	20	7	1	2	15	25	0	55	238	83.5%
Suffix	18	7	2	1	12	0	0	0	2	1	1	3	47	16.5%

(Note: Sub = Substitution; Add = Addition; Omi = Omission)

(22) Das war für meine Begriff*ung* schon eine unheimliche
that was for my consideration already a tremendous
Schwäch*ung*. for: Begriff*e*.
weakening
'In my consideration, that was a tremendous weakening.'

Both errors exemplify a completed anticipation resulting in a substitution of one affix for another. In (21), the prefix *ver-* replaces the prefix *be-* and thereby creates an entirely different word (*Be#achtung* 'attention' → *Ver#achtung* 'contempt'). In (22), the replacement of the plural suffix *-e* by the nominal suffix *-ung* leads to the nonce word *Begriffung*.

It is immediately obvious from Table 2.2 that prefix slips outnumber suffix slips by a factor of more than 5 on an average. This is true of all error categories both at the descriptive (substitution, addition, omission) and the explanatory level (anticipation, perseveration, etc.). A probable account of this pattern would be that suffixes cannot easily break free during the error process because they form a tightly knit structure with their stems. This is the essence of the right-branching hierarchical model.

A final line of speech error evidence needs to be discussed. A special error class, viz. blends, involves the competition of two items for the same slot with a concomitant break-up and recombination of their parts. When these items are morphologically complex, it may be determined at which morphological boundary the split preferentially occurs. To repeat, the right-branching model predicts that the prefix-stem boundary is the ideal breakpoint. This is in fact the case. Almost all blends (46 out of 47) in the German error corpus evidence a break at the prefix-stem boundary. The only exceptional slip is ambiguous in that either of the two morphological boundaries might be implicated. It is plain, then, that the prefix-stem boundary is the seam at which morphologically complex items preferentially come apart. In line with the other speech error data, blends lend support to the right-branching hypothesis.

In conclusion, there is perfect harmony between the linguistic and psycholinguistic evidence. The two types of data agree in arguing for a right-branching preference in prefix-stem-suffix sequences. Stress should be laid on the term *preference* in this context. The issue of branching direction is not a matter of either/or but of more or less. That is to say, we find suffix errors as psycholinguistic evidence for left-branching as well as lexical items as linguistic evidence for left-branching. This is entirely expected in a system that introduces probabilistic biases instead of imposing a categorical ban on certain output types. Clearly, the evidence for left-branching also requires an explanation. The limited number of suffix errors arises in a representational system (i.e., a right-branching structure), which grants suffixes as separate morphemes a certain independence even though this independence is restrained by their degree of embeddedness. There are (at least) two forces that counteract the right-branching tendency. One is the branching-direction neutrality of the semantic level, which, as argued previously, prevents the right-branching bias from instantly unfolding its full strength. The other force applies when the prefix of a morphologically complex item becomes unproductive and the prefix-stem boundary is blurred. As a result of this process, the prefix and the stem begin to merge on semantic and/or formal criteria and thereby increase the left-branching potential of the lexical item. In this view, left-branching is understood as a concomitant of demorphologization (for a more detailed account, see Berg, 2003b). The main point, however, is that the evidence for right-branching as a probabilistic tendency in prefix-stem-suffix combinations is overwhelming.

2.4.2 Stem-Stem-Suffix Structures

Unlike the preceding type, stem-stem-suffix structures are inherently asymmetrical. They involve two disparate morphological boundaries, the stem-stem and the stem-suffix boundary. It is to be expected that this disparity makes a strong impact on branching direction. Because suffixes are by definition bound morphemes and stems free morphemes, the stem-suffix association would appear to be inherently stronger than the stem-stem association (see also Dressler, 1988). In other words, the right-branching structure of stem-stem-suffix combinations seems to be a foregone conclusion. However, it is also possible for the two stems to form a closely knit structure that is expanded by the suffix. This uncertainty can only be eliminated by applying the relevant criteria.

As a matter of fact, the morphological literature has not been unanimous in ascertaining the branching direction of the structures at hand. Lieber (1983) argued that stem-stem-*er* combinations are generally left-branching because a right-branching structure violates her "argument-linking principle." This principle states that the argument structure within a compound is only satisfied if the verb and its argument are immediate constituents. As the argument and the verb appear in the left-hand portion of the word, a left-branching structure is appropriate (e.g., ((*truckdriv*)*er*). Lieber's line of reasoning appears somewhat doubtful. It is predicated on the assumption that functional representations such as verb-argument structures in syntax carry over without any modification to morphology. However, this is an unproven point. The switch from syntax to morphology may even be accompanied by radical changes, as for example in word order (contrast *someone (who) drives trucks* → *truckdriver*). The question here simply is how much of the syntax is preserved in morphology and consequently to what extent an argument from syntax can serve as a criterion for determining morphological constituency.

Booij (1988) uncovered another weakness in Lieber's claim. He argued that a left-branching structure would lead us to expect that the verb and its argument are lexicalized, given that they are dominated by the same node and this superordinate node is the one that is expanded by the agent morpheme. However, **to truckdrive* does not exist in English. As is evident, Booij employs the lexical criterion here. On the basis of this argument, he proposes a right-branching representation for this word type. This analysis was seconded by Williams (1981) and Selkirk (1982b) and later adopted by Lieber (1992) herself.

It has also been argued that the correct branching direction cannot be determined once for all for stem-stem-suffix sequences but only for subsets or even only for individual items. Recall in this context the contrast between *winedrinker* and *backbencher* (example [17] from section 2.4.1). Adams (1973) asserts that *book-binding* is right-branching, whereas *broken-hearted* is left-branching. The suffix, she claims, "belongs to" the second free morpheme in the former example but to the two free morphemes in the latter. Adams does not give any reasons for her decisions, but we may surmise that she invoked the lexical-semantic criterion. *Hearted* does not exist whereas *binding* does. Similarly, Bauer (1988) proposes left-branching in *skate boarder* but right-branching in *job security*, without, however, giving detailed justification. Adams (1973) goes on to state that some words, like *water skiing* for example, admit alternative analyses (i.e., they can be left- or right-branching). However, she does not explain how and why it is possible for one item to allow two branching directions. Adams also does not consider the possibility that the ambiguity might not inhere in the data but be an artifact of her methodology. She appears to have relied on intuition, and because intuition failed her in the case of *water skiing*, she claimed that the branching structure of this word is ambiguous.

Clearly, the issue of branching direction cannot be addressed in such a casual manner. One cannot rely on a single criterion, ignore all others, and if this one turns out to be inapplicable, make sweeping statements that call the entire notion of branching direction into question. As in the analysis of prefix-stem-suffix combinations, it is indispensible to take all relevant criteria into account and go beyond anecdotal evidence.

We begin with a discussion of the criteria that may be brought to bear on the branching-direction controversy. The first was touched on in the opening paragraph of this section and will be termed *Wells's criterion*. In an attempt to lay the foundations for immediate constituent analysis in syntax, Wells (1947, §18) formulated what he considered "the fundamental aim of IC-analysis": The division into smaller parts should proceed such that the resulting units are "maximally independent" in formal (e.g., morphological), semantic, and distributional terms. The practical consequence of this principle is that boundaries that rank higher in the linguistic hierarchy should be broken up prior to boundaries that have a lower rank. Wells's criterion makes perfect sense from the psycholinguistic perspective. As will be discussed in greater detail in Chapter 3, cohesiveness is a function of the hierarchical position of linguistic levels. Units at lower levels are generally more cohesive than those at higher ones. Naturally, the immediate constituency analysis should respect differences in cohesiveness. To be more specific, less cohesive units should be broken up before more cohesive ones. This principle makes a very clear claim about the patterns under investigation. Any stem-stem-suffix structure, no matter what morphemes it may be composed of, has its major cut at the stem-stem boundary and its minor cut at the stem-suffix boundary (i.e., it is right-branching).

We will now apply the six linguistic criteria which were used to examine the structure of prefix-stem-suffix sequences to the stem-stem-suffix combinations. The three phonological criteria will start us off. The resyllabification criterion applies without any difficulty to the pattern under discussion, provided the structural conditions are met (i.e., the prior morpheme ends in a consonant and the subsequent one begins with a vowel). The segmental criterion is also generally applicable even though the elements of compounds are known to preserve their integrity to a maximum degree. Cases like the vowel changes in *vineyard* [vɪnjəd] are exceptional to the point that their status as compounds is in jeopardy. Although applicable in principle, the suprasegmental criterion is marred by a general rule whereby compounds are normally initially stressed. Thus, the noninitial parts lose primary stress irrespective of whether they consist of a single morpheme (as in *teapot*) or of two morphemes (as in *gravedigger*). This makes it hard to decide whether *dig* or *digger* lost its primary stress on being associated with *grave*. Only if this question is answered will it be possible to decide on branching direction.

The morphological criterion is of limited help in the present context. Given that we are dealing with a single morphological type with only a few subtypes, there are hardly any morphological restrictions to reckon with. A case in point is the suffix *–ed*, which is originally verbal in nature (e.g., *well-informed*). However, *-ed* also attaches to morphemes that are clearly not verbal (e.g., *well-mannered*). Word-class variation also occurs in initial positions. The first morpheme is a noun in *snow-capped* but an adjective in *slow-witted*. Verbs are categorically ruled out in this position. Hence, the data are not diverse enough for the morphological criterion to have any effect.

The application of the lexical criterion is straightforward. It simply has to be determined whether the stem-stem portion and the stem-suffix portion form separate words. It is no problem assessing whether *mannered* in *ill-mannered* can be used on its own. It can, even though its meaning is slightly different. How about *hearted* in *tender-hearted*? The answer is in the negative because *hearted* as an independent lexical unit is nonexistent although it enters into many other combinations, such as *broken-hearted* and *light-hearted*. The stem-stem portion was already mentioned previously. The verb *to truckdrive* does not exist separately from *truckdriver*. Note that verbs with this morphological structure are not categorically ruled out in English (e.g., *to sleepwalk* and *to spoon-feed*).

The application of the semantic criterion creates little difficulty when both the stem-stem and the stem-suffix portion are real words. If one or both of them is/are non-extant, it has to be decided whether or not their portions are semantically interpretable. Only if this is the case will it be possible to put the semantic criterion to good use.

A final criterion needs to be introduced, if only to discredit it. Let us name it the *syntactic criterion*. It is commonplace in morphology to analyse and classify complex words according to the underlying syntactic structure that they purportedly represent. For instance, *truckdriver* may be paraphrased as *someone (who) drives trucks*. The paraphrase thus is an SVO sentence in which the stem-stem portion of the complex word corresponds to a VP. Because the VP is a more tightly knit unit than the subject–verb combination, it might be argued that the same material forms a similar structural unit at the morphological level. As *truckdrive* appears on the left-hand side, this would constitute an argument for left-branching.

This argument is based on an analogy between morphology and syntax, and as I am inclined to believe, on a false one. As noted before, there is a certain mismatch between the morphological and the syntactic level. Whereas *holidaymaker* is impeccable, **to make holidays* is not. Constraints that apply at the morphological level need not apply at the syntactic one (and vice versa). Therefore, doubts may be raised about whether conditions that obtain at the syntactic level can be construed as arguments for morphological representations. Specifically, there is no sense in which a full sentence such as *someone (who) drives trucks* can be said "to give rise" to the synthetic compound *truckdriver*. It may be possible to use the syntactic counterpart as an aid in classifying the compound as well as in deriving its meaning. However, this analytical procedure should not fool one into thinking that the syntactic paraphrase is a psychologically real level of representation that is built up at the beginning stages of compound retrieval and that serves as input to the morphological level.[6] Only if such an influence was real would it be justified to utilize the syntactic criterion in the analysis of morphological structure. But clearly, there is no evidence for a psychologically real syntactic level that underlies the generation of morphologically complex words.

Unfortunately, the psycholinguistic criterion cannot be applied to stem-stem-suffix sequences even though the different models of word structure make very clear empirical predictions. For example, the right-branching model predicts that the stem-suffix part should be treated as a unit in speech errors more often than the stem-stem part. However, critical evidence is at a premium. Slips of the tongue do not normally involve combinations of two morphemes, which themselves are embedded in trimorphemic words.

The foregoing review leads us to conclude that stem-stem-suffix combinations lend themselves less well to an examination in terms of branching direction than the prefix-stem-suffix type. Some criteria are inapplicable or of doubtful value. Nevertheless, other criteria may be put to good use and these will suffice to permit a strong commitment to a particular branching-direction preference.

The data to which the above criteria will be applied should meet the same requirement as the prefix-stem-suffix sequences: They must be lexicalized.

This is the best guarantee that the analysis captures the core of words that is shared by the majority of speakers and may therefore be regarded as typical of the language. Lexicalization was operationalized simply as being recorded in a standard dictionary. This is certainly not a foolproof method but by and large adequate in the case of the *Longman Dictionary of Contemporary English* (DCE), which is corpus-based and may therefore be said to reflect actual usage of the language quite faithfully. The DCE, which comprises more than 80,000 entries, was searched for all stem-stem-suffix structures. Only main entries were taken into consideration. A major difficulty that cropped up in the process of data collection was the fuzzy boundary between words and syntactic groups (Bauer, 1998). Any morphological analysis presupposes a definition of the word. As the formal (i.e., structural) side is more important than the semantic side in the present connection, it was deemed reasonable to give more weight to formal properties. In particular, recourse was had to a unit's stress pattern. We know from Cutler & Norris's (1988) research that stressed syllables tend to initiate lexical access in English. Thus, a word can be prosodically defined as a unit with the main stress on the initial syllable and no other main stress. Two main stresses would be indicative of two prosodic units (i.e., a syntactic group). This criterion led to the inclusion of all initially stressed structures and the exclusion of all noninitially stressed structures, such as *heavy breather* and *passive smoking*. Although it is true that these cases have undergone a certain degree of idiomatization, which would be a semantic argument for treating them as one unit, the formal side seems to be lagging behind and to suggest that they have not yet reached single-word status.[7]

The stem-stem-suffix combinations were classified according to the nature of the suffix. A good number of derivational suffix types were found, including among others *-ant* (e.g., *heat-resistant*), *-ment* (e.g., *law enforcement*), *-ance* (e.g., *life insurance*), *-able* (e.g., *machine-readable*), *-ness* (e.g., *snow blindness*), *-ess* (e.g., *cocktail waitress*) and *-y* (e.g., *trustworthy*). However, all of these suffixes have a fairly low token frequency, that is, there are not many compound words in which they occur. Attention was focused therefore on the more frequent cases, to wit: *-er*, *-ing*, and *-ed*, including the allomorph *-en* of the irregular verbs. Pertinent examples are *eye opener*, *childbearing*, *deep-seated*, and *crestfallen*. The typical structure of compounds ending in *–er* and *–ing* is N-V-suffix, with very few exceptions such as *weekender* and *smooth-talking*. The structure of compounds ending in *-ed*/*-en* is more varied. We find ADJ-N-suffix (e.g., *cold-blooded*), ADV-V-suffix (e.g., *well-behaved*), N-N-suffix (e.g., *dog-eared*) and less often N-V-suffix (e.g., *tax-deferred*).

The next step involves applying the criteria to the data. Wells's criterion has already been discussed and will not be reiterated here. The resyllabification criterion allows us to make a very general claim because all suffixes in question begin with a vowel. In all cases where the suffix is syllabic, resyllabification occurs at the stem-suffix boundary (e.g., *heartwarming*, with a change of the bilabial nasal from coda to onset position). In stark contrast, the same phonological constellation never induces resyllabification at the stem-stem boundary, witness *man-eater* in which the alveolar nasal remains in coda position. This is not due to the fact that resyllabification would be conducive to a phonotactically anomalous structure (/mæ/ is impossible as a stressed syllable). There are other examples like *landowner* and *wage-earner*, in which resyllabification of the final consonant in the first morpheme would not lead to a phonotactic anomaly but fails to happen nonetheless. Thus, the resyllabification criterion argues without reservation for a right-branching structure.

As noted before, alterations of the segmental make-up are rare in compounding. They are equally uncommon in words expanded by any of the suffixes under examination. This is because most of these suffixes are originally inflectional in nature and inflections are known to exert less of an influence on the phonological structure of the stem than derivations (e.g., Dressler, 1989). There is only one process that operates in the formation of the morphological structures in question, viz. linking /r/. According to the by now familiar logic, this process would be expected to apply more often at the stem-suffix than at the stem-stem boundary in a right-branching model. All relevant suffixes, on account of their vowel-initialness, give rise to linking /r/, compare *shatter* [ʃætə] → *earth-shattering* [ʃætərɪŋ]. However, /r/-epenthesis also occurs between the two stems. These cases are extremely rare because they require a combination of two stems of which the first ends in a latent /r/ and the second begins with a vowel. There are only three such cases in my data, all of which illustrate the linking /r/ (e.g., *never-ending* and *fire-eater*). Generalizing from these examples, we may argue that whenever the structural conditions are met, the linking /r/ rule applies.

Taken at face value, this rule suggests a symmetry between the stem-stem portion and the stem-suffix portion, which would seem to best fit the flat model of word structure. However, it may be hypothesized that the linking /r/ rule is not sensitive enough (or too sensitive, if you will) to pick up the difference between the two morpheme boundaries in these trimorphemic words because of its general applicability. All that it requires is the adjacency of a prior morpheme terminating in a latent /r/ and a subsequent morpheme that begins with a vowel.[8] It therefore lacks the potential to distinguish between different kinds of morphological boundaries whose reality it consequently cannot call into question. It is not therefore incompatible with other criteria arguing for hierarchical right-branching (or left-branching, for that matter).

The suprasegmental criterion cannot be used because all four suffixes are stress-neutral and because compounds, as operationally defined here, are always subject to the initial-stress rule. As explained previously, the morphological criterion is also inapplicable.

By contrast, the lexical criterion works well. It just has to be determined whether a given morpheme exists in a particular word class. As our focus is on lexicalized units, this was settled with the aid of the DCE. The only difficulty that arose was the role of semantics in ascertaining lexical status. As a general rule, it was decided to ignore semantics, as was done in the analysis of prefix-stem-suffix structures. Therefore, the stem-suffix portion was classed as lexicalized even if this did not do justice to the meaning of the stem-stem-suffix sequence. For example, *open-eyed* may be paraphrased as "having open eyes." The lexeme *eye* also exists as a verb, though not with exactly the same meaning as in *open-eyed*. This semantic difference notwithstanding, *eyed* was treated as a lexicalized subunit of *open-eyed*. An example of the opposite decision is *faint-hearted*. As the lexeme *heart* is nonexistent as a verb, *hearted* cannot have lexical status. Analogous decisions were taken for the left-hand portions of the morphologically complex words. For instance, the stem-stem part in *cold-hearted* was considered lexicalized whereas that in *bloodletting* was not because there is no such unit as *bloodlet* (even though *to let blood* is certainly fine).

The data were divided into four descriptive categories. The first comprises cases in which both the left-hand and the right-hand parts are lexicalized, the second cases in which neither is, and the third in which the left-hand part is but the right-hand part is not. The fourth category is the mirror image of the third. The third category suggests left-branching and the fourth right-branching. Categories 1 and 2 do not tend toward a particular branching direction. The results of the lexical analysis are summarized in Table 2.3.

As can be gleaned from Table 2.3, the left no/right yes category forms the absolute majority with all three suffixes. Right-branching is thus overwhelming. This asymmetry is strongest with *-ing* words, which are closely followed by *-er* words, and least strong with *-ed* words. Typical cases include *breath-taking*, *belly dancer*, and *jet-propelled*, all of which have a non-lexicalized stem-stem but a lexicalized stem-suffix portion. Although the other three categories are largely negligible for *-er* and *-ing* words, the relatively large number of left yes/right yes and left yes/right no items in

Table 2.3 Frequency of Lexicalization of Left- and Right-Hand Portions in Stem-Stem-Suffix Sequences

	Lexicalization			
Suffix	*Left Yes/ Right Yes*	*Left No/ Right No*	*Left Yes/ Right No*	*Left No/ Right Yes*
-er	22 (5.6%)	11 (2.8%)	10 (2.5%)	353 (89.1%)
-ing	9 (3.6%)	0 (0.0%)	3 (1.2%)	239 (95.2%)
-ed/-en	82 (23.8%)	8 (2.3%)	73 (21.2%)	182 (52.8%)

(Yes = Lexicalized; No = Non-Lexicalized) the *-ed/-en* set requires explaining. The former type results from the fact that the stem-stem part often corresponds in syntactic paraphrase to an NP consisting of ADJ and N, as in *big-hearted*. As these NPs are usually fine, the percentage of left yes scorings is rather high. Of course, this account is also valid for the left yes part in the left yes/right no category. The particularity of this category is the right yes part. Given that these trimorphemic items end in a verbal suffix, the second stem may be expected to be a verb. In fact, this is true in the majority of cases. Needless to say, the expansion of a verb by a verbal affix leads to a lexicalized outcome. However, there is a sizeable number of items in which the second stem is not a verb. For example, the morpheme *speck* is a noun even though it is augmented by a verbal suffix in *fly-specked*. Here, semantic considerations appear to override morpholexical constraints. The desire to express the quality of having certain specks in condensed form is more important than the clash between a nominal stem and a verbal suffix. The lexical versatility of English lexemes undoubtedly contributes to weakening the factors that might inhibit such a clash. In conclusion, the lexical criterion clearly argues for right-branching in stem-stem-suffix sequences.

Semantically, the stem-stem-suffix combinations fall into two broad classes. The *-er* items refer to someone or something that does something (e.g., *hairdresser*). The *-ing* and *-ed* items denote a quality or act of doing, being, or having something (e.g., *hair-raising* and *narrow-minded*). We proceed from the assumption that even if a part of the morphologically complex word is not lexicalized, it may be semantically interpretable. For instance, even though *to truckdrive* is not a real word, its meaning is obvious. This allows us to examine the meaning not only of the left yes/right yes items but basically of all items in Table 2.3. Taking for granted the syntactic paraphrase as a means of deriving the meaning of a word, there is good reason to view the two stems as a unit. The word *good-hearted* means "having a good heart." The first stem undoubtedly modifies the second. In other words, the scope of *good* ends at the stem-suffix boundary. In contrast, the scope of the suffix extends across the two stems. The suffix designates the quality of (having) something, and this something is represented by the two stems. This semantic analysis appears to hold for the vast majority, if not all of the items listed in Table 2.3. It may therefore be concluded that the semantic criterion favours left-branching in stem-stem-suffix structures.

In summary, the semantic criterion has yielded a result that is at variance with the outcome of the formal criteria. In all likelihood, there is no point in attempting to reconcile this conflict because the psycholinguistic system itself experiences no conflict. It seems to be flexible enough to allow for a discrepancy between the semantic and the non-semantic levels. The probable reason for this flexibility is that the boundary between the semantic and the non-semantic levels is the major divide in the psycholinguistic system (Levelt, 1993) and that consequently quite disparate conditions may prevail on either side of the line. As was argued in section 2.4.1, the semantic domain is not really within the purview of the theory adumbrated at the beginning of this chapter. Its basic tenet is to account for the encoding of semantic content into linguistic form. Therefore, a deviation at the semantic level does not undermine a theory of the encoding stage.

Restricting ourselves to the formal levels, we may conclude that right-branching is supported by those criteria that have a substantial contribution to make. There are three of them—Wells's criterion, resyllabification, and lexicalization. The segmental, suprasegmental, and morphological criteria are neutral in their implications for branching direction and thus not incompatible with the right-branching preference suggested by the other criteria.

2.4.3 Stem-Suffix-Stem Structures

The next area to investigate is stem-suffix-stem sequences. In a sense, these are the opposites of stem-stem-suffix combinations in that the suffix by definition is attached to the first rather than the second stem. At first glance, it would seem that exactly the mirror-image conditions hold in these two types of words. To be specific, the very same arguments that have led to the right-branching hypothesis in the case of stem-stem-suffix combinations argue for left-branching in the case of stem-suffix-stem structures. This is true of Wells's criterion, which unequivocally divides the three morphemes into a stem-suffix and a stem part. Resyllabification can often be observed at the stem-suffix boundary (contrast *sleep* with a final /p/ and its derived form *sleeping bag* with a /p/ in initial position). Resyllabification at the suffix-stem boundary requires a consonant-final suffix and a vowel-initial stem. In fact, the few relevant cases resist resyllabification. In *postal order*, for instance, the liquid does not resyllabify across the morpheme boundary. The resyllabification criterion thus argues for left-branching.

The lexical criterion goes in the same direction. Of necessity, it tends toward left-branching because the suffix-stem portion in stem-suffix-stem sequences by definition cannot form a lexical unit. In contrast, the stem-suffix part is always lexicalized. There is not a single item in the data in which the suffixed form does not exist independently of the compound. Differently put, suffixation is not part of the compounding process. For example, *drinking* in *drinking water* exists on its own.

If the assumed mirror-image relationship is correct, the semantic criterion may be expected to argue for right-branching in stem-suffix-stem combinations because it argued for left-branching in stem-stem-suffix sequences. This, however, is not so. Not only morphologically but also semantically, the suffix modifies the preceding stem, not the entire compound. A typical case is *driving license* in which the attachment of a suffix leads to a nominalization that expresses a purpose or a quality. The limited scope of the suffix renders stem-suffix-stem complexes left-branching at the semantic level. Thus, the mirror-image relationship between stem-stem-suffix and stem-suffix-stem combinations breaks down at this point.

All of these arguments agree in assigning stem-suffix-stem sequences a left-branching structure. If right-branching is the preferred branching direction in English morphology, the following prediction regarding the frequency of different morphological patterns may be derived. Given that stem-stem-suffix structures were found to exhibit right-branching, they should occur more frequently than stem-suffix-stem sequences in the English language. This prediction was tested by extracting all pertinent examples from the DCE. To ensure comparability, only compounds with the suffixes *-er*, *-ing*, and *-ed/-en* were considered. Exactly the same criteria of data selection were employed as in the preceding section. In particular, the main stress had to be on the first morpheme. So, for example, *flying squad* was included whereas *flying saucer* was excluded. In general, the correlation between form and meaning was relatively high. The more idiomatized the meaning of a compound, the greater the probability of its being initially stressed (contrast *laughing gnóme* with *láughing gas*; the latter is clearly more idiomatic than the former). However, this correlation is not perfect. As a consequence, the initial-stress criterion also rules out a certain number of items with a moderate degree of idiomatization (e.g., *masked ball*). The results of the frequency analysis are reported in Table 2.4.

As can be seen, the prediction from the right-branching preference hypothesis is fulfilled. Taken together, stem-stem-suffix structures are almost three times more common than stem-suffix-stem structures. When the data are examined by suffix type, one exception emerges. Stem-*ing*-stem combinations have a higher frequency than stem-stem-*ing* complexes. That is, left-branching cases like *frying pan* are favoured over right-branching cases like *housekeeping*.

Why the frequency of the stem-*ing*-stem patterns is so high is not yet fully understood, even though it is possible to identify some of the factors that facilitate their emergence. As is well-known, the inflectional suffix *–ing* is quite common in English (e.g., *he is swimming*). These inflected words can easily be turned into derived forms such as adjectives and nouns (e.g., *swimming pool*). The ease with which word class changes can be effected contributes to the frequency of stem-*ing*-stem sequences. Another reason lies in the supposition that English compounds are not very cohesive units.

Table 2.4 Frequency of Stem-Stem-Suffix and Stem-Suffix-Stem Structures (Based on DCE)

	Suffix			
Type	*-er*	*-ing*	*-ed/-en*	*total*
stem-stem-suffix	396	251	355	1002
stem-suffix-stem	35	321	3	359

Therefore, they are prepared to accommodate bound material between the free morphemes in spite of the fact that bound inflectional morphemes are usually missing in compounds. For example, an *apple tree* is not called an *apples tree* even though it bears more than one apple. This reluctance gives rise to morpholexical variation as illustrated by *frying pan* versus *frypan*. Gold (1969) suspects that the former type is gradually giving way to the latter.

These and doubtless other factors are powerful enough to override the general right-branching bias and cause an elevated rate of left-branching patterns in this area of English morphology.

2.4.4 Stem-Suffix-Suffix Structures

Stem-suffix$_1$-suffix$_2$ combinations are quite frequent in English. The CELEX database shows 1473 cases in which the morphological status of both suffixes is uncontroversial. This number is the result of a serious cut-down on the number of items offered by CELEX, in particular the elimination of cases with inflectional suffixes and those that were given questionable or excessively abstract morphological analyses. For example, *abortive* is treated as a trimorphemic word consisting of the stem *abort* and the suffixes *-ion* and *-ive*.

It would seem that the left-branching nature of stem-suffix-suffix sequences is a foregone conclusion for the sole reason that the two suffixes cannot form a morphological constituent. Almost by definition, they depend on the stem more than on each other. However, we recall from example (19) in section 2.4 that this is not necessarily true. The selection of one suffix may be influenced by the other, especially in fusional languages. However unlikely this might be for English, it appears worthwhile to test the stem-suffix-suffix combinations on the criteria that have proved useful in the analysis of the other morphological patterns.

The semantic criterion reveals that the scope of suffix$_2$ is wider than that of suffix$_1$. Take *acceptability* as a typical example. Semantically speaking, *-able* modifies *accept*, as its meaning is "able to be accepted." The suffix *-ity* modifies both *accept* and *-able*, as it can be paraphrased as "the state of being acceptable". Crucially, there is no semantic interaction between the two suffixes. As there are no examples in the corpus that require a radically different analysis, it may be concluded that the semantic criterion suggests left-branching.

The same holds good of the lexical criterion. The stem-suffix$_1$ parts in all items are lexicalized (e.g., *acceptable* in *acceptability*) whereas hardly any of the stem-suffix$_2$ parts are (e.g., **acceptity*). Needless to say, the two suffixes by definition do not create real words.

As it stands, the morphological criterion is not applicable because it rests on the freedom of a suffix to attach to stems of particular word classes. It does not define the possibility of a suffix to attach to another suffix. This is not even necessary as long as suffixes may associate with stems, a provision that is guaranteed by the left-branching analysis.

Both $suffix_1$ and $suffix_2$ may induce stress shift on the stem, as in *óffice* → *offícialdom* and *lócal* → *localizátion*. Let us note as an aside that most usually only one of the two suffixes in these trimorphemic structures is stress-changing (if the stress pattern is changed at all). An exception is *officialese* where both *-ial* and *-ese* advance the main stress. In any case, the two suffixes operate independently in their stress-changing function. $Suffix_1$ operates on the bare stem and $suffix_2$ on the stem + $suffix_1$ portion. Hence, there is no room for interaction between the two suffixes, which comes as expected under a left-branching analysis.

Mutatis mutandis, a similar argument applies with respect to the segmental and resyllabification criteria. $Suffix_1$ and $suffix_2$ alike may induce segmental changes and resyllabification, as in *manage* → *manageress*. They do so on being attached to a stem or a stem-suffix combination. There is no interaction between $suffix_1$ and $suffix_2$ and hence no basis for arguing a right-branching structure.

To conclude, this brief examination confirms that left-branching is the only appropriate analysis for stem-$suffix_1$-$suffix_2$ sequences. To the extent that they are applicable, all criteria converge to give the same result.

2.4.5 Stem-Stem-Stem Structures

As compounding is rather productive in English, it is also possible to find trimorphemic structures consisting of nothing but stems. Because nouns are the most facile word class to contract a compounding relationship, the ensuing analysis will be focused on noun-noun-noun combinations such as *lecture theatre building* and *rubber dust mask*. The first observation to make about these structures is their uncommonness as lexicalized patterns. A search through all the c. 80,000 main entries in the DCE yields a bare 26 items (e.g., *cost-benefit analysis* and *test-tube baby*). Similarly, an electronic search through the CELEX database unearths only 14 clear cases like for example *post office box* and *latchkey child*. In some of these items, two of the stems have undergone a certain degree of idiomatization (e.g., *newspaper* in *newspaper man*), but these were counted in when the individual morphemes could be clearly identified. Geographical terms such as *northnortheast* as well as cases of morphological overanalysis are not included. For instance, it is nonsensical to treat *cocktail* as a bimorphemic item. Cases like *prawn cocktail* were consequently rejected as trimorphemic words.

The rarity of stem-stem-stem sequences as lexicalized items does not imply that these patterns cannot be found in reasonable numbers under any circumstances at all. In actual fact, compounds also exist outside dictionaries in the form of so-called *occasionalisms*, that is words that are made up on the spur of the moment to satisfy a particular need of the speaker but are too situation-specific to meet with general acceptance and accordingly be reserved a place in a dictionary. The process of coining occasionalisms is not unlikely to rely on compounding because this word-formation principle is known for its compactness of expression, which is especially serviceable in the modern scientific world.

When dictionaries are replaced with corpus data, a larger number of stem-stem-stem combinations can actually be observed. Examining the Brown Corpus of American English of 1963, Warren (1978) found a total of 553 three-noun sequences constituting 12.1% of her entire database of compounds. Clearly, this is a sizeable number to start with. Warren divided these 553 compounds into 440 "ordinary" items and 113 items "involving complex units other than non-verbal nexus compounds" (see her Table 3). Unfortunately, neither does Warren give an account of the types that are contained in this latter category, nor does she make the motivation underlying this distinction explicit. The most important result to emerge from her study in the present context is a majority of left-branching cases in her data. In the 553-item set, 320 (= 57.9%) words are left-branching and 233 (= 42.1%) right-branching. Assuming that left- and right-branching have an equal probability of occurrence, the difference between the two options is statistically significant ($\chi^2(1) = 7.0$, $p < 0.01$). This predominance is even more marked in the 440-word set, which divides into 282 (= 64.1%) left-branching and 158 (= 35.9%) right-branching items.

However remarkable this result may be, it is puzzling that Warren made no attempt to detail the reasons that led her to assign a particular branching structure to the items in her corpus. As no list of criteria is provided, it may be suspected that she relied mainly on the semantic criterion. More specifically, she enquired whether there is a compound within a compound. To take the relatively uncontroversial example (16a), *newspaper* in *morning newspaper* clearly is an internal compound, the reason being that *newspaper* is rather strongly idiomatized (see earlier discussion) and certainly more strongly idiomatized than *morning news*. Other criteria that may have played a role in Warren's decisions are not discernible.

Indeed, it is difficult to come up with formal criteria for determining branching direction. Neither resyllabification nor compound-induced change of phonemic make-up is eligible. For obvious reasons, the morphological and Wells's criterion are totally inapplicable. Also, the application of the lexical criterion causes great difficulty because these ad hoc formations are not regularly made up of bilexemic constituents that are so strongly lexicalized as to occur in standard dictionaries. On top of that, the lexical criterion is largely redundant with the semantic one as the degree of lexicalization tends to be gauged in terms of semantic compatibility in the absence of dictionary information. Psycholinguistic evidence bearing on the internal structure of trilexemic compounds is not available, although it would be easy to devise relevant experiments. For example, a memory task might investigate which pairs of nouns are recalled as units and which are separated. The underlying assumption would be that recall is sensitive to the internal structure of the compound.

The only criterion that is left is the suprasegmental one. Considering stem-stem-stem compounds as single lexical units, we would expect them to bear only one main stress. As each of the three stems carries one main stress when taken individually, their concatenation of necessity entails destressing two of the stems. Three stress patterns may occur. The main stress may fall either on the first, the second, or the third lexeme. What implications do these suprasegmental patterns have for morphological structure? We recall from section 2.4.2 Cutler & Norris's (1988) research showing that the main stress marks the beginning of a new prosodic unit. On this logic, second-stem stress would be indicative of right-branching because the second stem would form a unit with the following, though not the preceding stem. By contrast, third-stem stress would be indicative of left-branching. However, initial-stem stress would reveal nothing about the alliance of the second stem with its surrounding elements. Hence, only a majority of middle-stem stresses would constitute an argument for right-branching.

Surprising as it may be, this is exactly what Kvam (1990) found. He ran a small-scale test and asked some 20 native speakers to read a selection of 40 three-part compounds that were embedded in a simple syntactic frame such as *It is*. . . . He observed that for 30 out of the 40 test items, middle-lexeme stress was either the majority or the exclusive option of his subjects. Thus, the suprasegmental criterion lends support to the right-branching hypothesis. As the semantic criterion suggested the opposite, we would seem to have uncovered a major conflict between the semantic and formal levels of representation.

However, this conclusion appears somewhat premature. Kvam does not motivate his choice of test materials. Specifically, he fails precisely to relate branching structure and stress pattern. Although he notes that only 10 of his test items exhibit a correspondence between right-branching for semantic reasons and middle-stem stress and that the remaining data are rather erratic, a full assessment is precluded by a lack of complete quantitative information.

In the light of this uncertainty, it was deemed necessary to build a new corpus of stem-stem-stem compounds. To this end, the British National Corpus (BNC) was tapped. From this vast pool of data, several files from the A, B, and D sections were searched for trinominal compounds by means of the concordancing programme MonoConc. All cases containing proper nouns in any of the three positions were left out of account. A minor problem arose in drawing the dividing line between three- and four-part compounds. Some parts like *playhouse* and *wartime* are internally complex and have been treated by the concordancing programme as single nouns for the sole reason that they are written together. Spelling conventions, however, are a fairly unreliable guide in the determination of morphological complexity. I decided to stay on the safe side and excluded these items from further analysis. Also excluded were some items like *feminist art history*, which was tagged as a noun-noun-noun combination in the BNC but in which *feminist* could equally be regarded as an adjective. As we are concerned with independent words and their relation to one another, there was no reason to discard compounds in which one or more parts were affixed. It might be added in parentheses that almost all of the items come from the written language. The search through the spoken-language files produced a very low yield.

On the basis of the semantic criterion, the data were assigned to the following four categories: category A: left-branching; category B: right-branching; category C: both; category D: unclear. An example of a left-branching structure is *health authority address* whose meaning unquestionably is "address of the health authority," not "authority address for health." A right-branching structure is exemplified by *state disability benefit*, which refers to a disability benefit granted by the state, not to a disabled state. Occasionally, the meaning of the compound is more ambiguous. *Summer holiday season* is a case in point. On the one hand, the reading "season of the summer holidays" is obviously possible. On the other hand, the reading "holiday season in summer" also comes fairly naturally. Such symmetrical cases are grouped in category C. Finally, there are a few unclassifiable items whose meaning is largely impenetrable to an outside observer.

The following results were obtained. Overall, there are 642 stem-stem-stem combinations that distribute as follows across the four categories (see Table 2.5 on the next page).

Let us begin with a look at the stress pattern in isolation. Three-lexeme compounds disprefer final stress. The majority of compounds carry the main stress on the second lexeme (57.2%), with only a minority of initial-stress cases (26.5%). Differently put, main stress is more than twice as likely to fall on the second than the first lexeme in three-member compounds. This result replicates Kvam's findings. It allows us to conclude that the suprasegmental criterion argues for right-branching. As noted earlier, this constitutes a clash between the formal and the semantic criteria.

One of the reasons for the predilection for second-lexeme stress in compounds probably derives from rhythmic constraints. If stress was placed on the first lexeme, a sequence of quite a few unstressed syllables would be created, given that many lexemes consist of more than one syllable. By placing stress on the middle lexeme, the number of unstressed syllables is cut in two more or less equal halves and thereby kept as low as is possible. It can be seen then, that three-lexeme compounds are subject to the principle of rhythmic alternation even though their sheer size permits nothing but non-optimal solutions.

The central question to be asked about Table 2.5 concerns the interaction between the suprasegmental and the semantic criterion. In view of the infrequency of the symmetrical and unclear cases, we may concentrate on the left- and right-branching columns. It is highly remarkable that for both left- and right-branching, second-lexeme stress predominates over first-lexeme stress.

Table 2.5 Branching Direction in Stem-Stem-Stem Combinations

	Semantics				
Stress Position	*Left-Branching*	*Right-Branching*	*Symmetrical*	*Unclear*	*Total*
initial stress	152	13	3	2	170
medial stress	210	126	26	5	367
final stress	82	22	1	0	105
total	441	161	30	7	642

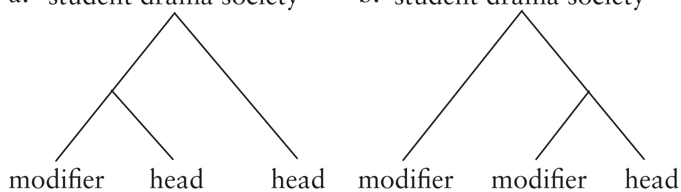
N.B. The semantic criterion is plotted as a function of stress placement.

This result suggests a certain independence of meaning and form. However, this independence is not total. A χ^2 test reveals that right-branching cases are significantly more likely to carry second-lexeme stress than left-branching ones ($\chi^2(1) = 39.0$, $p < 0.001$). There thus is a notable tendency toward matching formal and semantic properties. When the semantics suggests right-branching, the trend toward right-branching in the formal domain is much stronger than when the semantics suggests left-branching.

This analysis leaves us with a seemingly paradoxical result. A case was made for both a match and a clash between the semantic and the suprasegmental criteria. The paradox disappears on the assumption that the linguistic system allows for an interaction between formal and semantic levels but only to a limited extent (i.e., an iconicity effect). In general terms, the semantic level favours left-branching, but the suprasegmental level right-branching. As the semantic information precedes the phonological one in language production (van Turennout, Hagoort, & Brown, 1997), a good part of the left-branching bias at the semantic level penetrates the suprasegmental level and interferes with its right-branching bias. As a result, a relatively high percentage of semantically left-branching items receives first-syllable stress, thereby creating a harmonious branching direction. When no left-branching bias springs from the semantic level (as in semantically right-branching items), the suprasegmental component may unfold its right-branching bias in unimpeded fashion and thereby also creates a harmonious branching direction. However, this two-fold harmony is of a limited nature. As attested by the 223 instances of disharmony in Table 2.5, the semantics and the phonology are too far apart in the linguistic system to attune their decisions to each other in each case.

While it is not too difficult to account for the right-branching preference at the suprasegmental level, given the principle of rhythmic alternation (see previous discussion) and the assumed general right-branching preference in the formal domain, the explanation for the left-branching bias at the semantic level requires a deeper analysis. Kubozono (1988) proposes a link between branching direction and word order, in particular head-modifier order. He appears to suggest a harmony constraint according to which the same head-modifier order should prevail in morphology and syntax. Unfortunately, Kubozono does not work out the details of this proposal. He seems to argue that a right-branching structure is disfavoured because it violates the modifier-head order that is typically found in syntax (e.g., adjective–noun order). However, this is simply not true. Consider the modifer-head structure in the following compound, which is ambiguous between a left- and a right-branching analysis.

(23) a. student drama society b. student drama society



On both readings, the first element *student* is a modifier and the last element *society* is the head of the compound. The difference between (23a) and (23b) lies in the status of the middle element *drama*. In the left-branching structure, it functions as the head of the intermediate node. In the right-branching structure, by contrast, it modifies the final head. The difference between (23a) and (23b) is then that the left-branching structure has two heads but the right-branching structure only one. Importantly, the modifier-head order within a superordinate unit is identical. There is thus no basis for the claim that one branching direction is less compatible with ordering principles in syntax than the other.

The diagrams in (23) pave the way for a better explanation. I submit that (23a) is more frequent than (23b) because the right-branching structure poses a special parsing problem that does not arise in a left-branching structure. We know from psycholinguistic experimentation that listeners continuously interpret the incoming acoustic input. That is, they do not wait until the speaker has completed her utterance. They rather begin working on the input as soon as it becomes available (i.e., from "left" to "right"; Marslen-Wilson & Tyler, 1980). In this process, listeners apply heuristic strategies that are shaped by the experience they have gained in their language, in particular pertaining to the frequency of linguistic patterns. Two-part compounds are by far more frequent than three-part compounds and always follow the modifier-head order. Thus, listeners transfer the decoding strategy that they have developed on the basis of the more frequent pattern to the less frequent pattern as they process the first two lexemes of a three-lexeme compound. In the case of a left-branching structure like (23a) for example, this strategy works fine because the first two lexemes have the same modifier-head relationship as the two parts in a two-lexeme compound. However, right-branching structures like (23b) for example lead listeners down the structural garden path. By applying the aforesaid strategy, listeners misanalyse the modifier-head relationship of the compound and thereby impose a wrong semantic interpretation on it. Once they have perceived the final lexeme, they are forced to abandon this analysis and start anew. It is to the obvious advantage of listeners if such a waste of processing effort is avoided. An ideal way of doing so is to incorporate speakers' and listeners' needs into the language, thereby avoiding such tricky structures. Let it be finally remarked that this listener bias leads to the infrequency, not the abolition, of right-branching in the semantic domain. The reason here is certainly productivity. If right-branching structures were completely eliminated, speakers would be deprived of one way of expressing their intentions. As this is not in their interest, the linguistic system sustains both options, albeit with unequal frequency. Thus, the structure of language proves to be a compromise between speakers' and listeners' needs.

2.4.6 Conclusion

Unlike the analysis of branching direction in syntax, the foregoing investigation of morphological structure is fairly exhaustive. All trimorphemic word-formation patterns that are characteristic of English have been examined. Reviewing the five areas under consideration reveals a heterogeneous picture. A predominance of right-branching is observed for prefix-stem-suffix sequences and somewhat less strongly for stem-stem-suffix sequences. A proclivity for left-branching is seen in stem-suffix-stem combinations as well as stem-suffix-suffix combinations. Stem-stem-stem structures take an intermediate position in that they demonstrate both left- and right-branching characteristics. However, it would be utterly wrong to deduce from this heterogeneity that branching direction in English morphology is erratic and therefore its analysis unilluminating. A proper evaluation of the results needs to take the following three distinctions into account—semantic versus formal criteria, forced versus free branching direction, and high versus low frequency.

It is useful to confine the issue of branching direction to the non-semantic levels, which collectively will be called the formal levels. This restriction follows naturally from the function that structure is assumed to serve. To recap, structural units are required for efficient planning ahead in language production. They therefore arise in the process of transforming a parallel conceptual representation into a linear sequence of linguistic elements. In this view, the question of branching direction arises in the construction of the formal levels of representation. When the semantic level is intentionally left out of account, the three-noun compounds may be reclassified among those patterns showing a predilection for right-branching even though it must be added that there is only one criterion (i.e., the suprasegmental one) to support this claim.

The distinction between forced and free branching direction is of utmost importance in the present connection. By "forced" is meant that the morphemic make-up introduces a certain branching-direction bias whereas nothing is prejudiced in the case of free patterns. As noted in subsection 2.4.4, stem-suffix-suffix sequences are of necessity left-branching because the very nature of suffixes prevents the latter from forming a lexically independent unit. The consequent left-branching is therefore a forced, not a free, decision.[9] Accordingly, less theoretical significance should be attached to stem-suffix-suffix than to prefix-stem-suffix sequences that, as explained in section 2.4.1, are a priori symmetrical in that the morphological make-up does not prejudge what the branching direction will be. Hence, the right-branching proclivity in prefix-stem-suffix combinations weighs more heavily than the left-branching nature of stem-suffix-suffix patterns.

The third point to consider is frequency. The model that is at the heart of this book is of a probabilistic nature and accordingly makes predictions about what is more and what is less frequent, not about existing and nonexisting phenomena. Left-branching thus is tolerated by the model as long as it is significantly less frequent than right-branching. As shown in Table 2.4 of section 2.4.3, stem-stem-suffix structures, which favour right-branching, are almost three times more frequent than stem-suffix-stem structures, which favour left-branching. The claim here is that a general preference for right-branching is one of the reasons for this difference in frequency.

The overall conclusion is that English morphology shows a predilection for right-branching. The primary evidence for this hypothesis comes from prefix-stem-suffix combinations, secondary support from stem-stem-suffix sequences and three-member compounds. However, left-branching is not absent from English word formation. Three aspects are worth mentioning in this respect. Left-branching is (1) a minority option, (2) a property of the semantic level, and (3) instigated by inherent properties of morphological units. Only the last aspect requires elaboration. The left-branching preference in the forced cases suggests that the right-branching preference is less strong than the impact made by the morphological make-up. The right-branching preference may be overridden by certain morphological constellations that give rise to a left-branching trend. However, this left-branching bias is not the result of a free branching decision and should therefore be accorded a limited theoretical significance.

2.5 CONSTITUENT STRUCTURE AND BRANCHING DIRECTION IN PHONOLOGY

The relatively low number of patterns and categories severely reduces the number of areas in which to examine constituent structure in phonology. In point of fact, research over the past 30 years or so has concerned itself mainly with one relevant area—the structure of the syllable, in particular the CVC syllable. This is the most basic three-part sequence in which the major phonological cut can be located. The importance of this structure is comparable to the SVO structure in syntax and the prefix-stem-suffix structure in morphology. The almost exclusive focus on CVC syllables emanates from the fact that the most frequent syllable type cross-linguistically (i.e., CV) does not lend itself to a branching direction analysis and the fact that more complex structures such as CCVCC are comparatively uncommon. However, this restricted perspective has left a serious descriptive gap to fill. This is the no-man's-land above the syllable and below the morpheme level. Because single morphemes may consist of more than one syllable, phonology cannot content itself with the syllable as the main unit for the analysis of constituent structure but has to devote itself to the investigation of multisyllabic morphemes. Furthermore, there are some more minor three-part structures, such as CCC and VCC. Some discussion will be devoted to VCC sequences although three-member onset clusters will be left out of consideration. The reason for this omission is simply that too little relevant evidence is available to argue one way or the other.

2.5.1 CVC Syllables

The phonological literature has produced no unanimity as to the proper characterization of English CVC syllables. All theoretically possible options have been advocated. Some authors argue for a flat structure (e.g., Davis, 1982; Clements & Keyser, 1983; Prinz, 1991), others for a hierarchical left-branching (e.g., Iverson & Wheeler, 1989) and still others for a hierarchical right-branching structure (e.g., MacKay, 1972; Selkirk, 1982a; Treiman,1983; Fudge, 1987).[10] An implicit assumption that is shared by all these scholars is that, of the three models, only one can be correct. This assumption is questioned by Vennemann (1988b) who rejects the dichotomy of flat versus hierarchical organization and argues for a mildly hierarchical flat structure. He resolves this seeming contradiction at a more general level by asserting that all seemingly conflicting claims about the internal organization of the syllable are simultaneously correct. As he sees it, it is possible for different pieces of evidence to invite different conclusions because each piece highlights a different structural aspect of the overall organization. Remarkably, Vennemann likens this phonological issue to an indeterminacy in syntax that purportedly allows both left- and right-branching in simple SVO sentences, and then goes on to liken this alleged indeterminacy in linguistics to the well-known uncertainty in optics of construing light as a continuous wave or as discontinuous particles.[11]

I believe that Vennemann's views are fundamentally mistaken. To make his point convincing, he would have to develop a model in which both left- and right-branching are assigned well-defined and well-motivated roles. This, however, he fails to do. On the methodological side, Vennemann tries to make a case for the data-dependence of theoretical results. Clearly, this data dependence is not a desideratum but, if true, an unfortunate state of affairs that should be overcome by devising methods that yield results that are, to the greatest possible extent, independent of the method by which they have been arrived at. Conclusions that do not extend to data on which they were not originally based are of limited value. Although it is perfectly legitimate to draw attention to methodological pitfalls (something Vennemann does not have in mind), it is counterproductive to hail the data dependence as a methodological asset, as Vennemann does. Furthermore, he does not critically examine the arguments that have been put forward for any of the three models in question. On the substantial side, he makes no attempt to assess the overall weight of the arguments for each model. He implicitly adopts a very idiosyncratic view of the relationship between data and theory without bothering to defend it. A single argument appears sufficient to him to warrant a particular model. This can be most clearly seen in his comparison with syntax. The fact that he considers subject–verb agreement a sufficient reason for postulating left-branching means that he attributes as much weight to this single argument as to the overwhelming majority of arguments in favour of right-branching (see section 2.3). At the bottom of this strategy is, I daresay, a misconception of the nature of structural representations.

A posture similar to Vennemann's can be detected in some advocates of flat structure in CVC syllables. Davis (1982) attacks the right-branching hypothesis by drawing attention to certain onset-coda restrictions. In an English $C_1C_2VC_3$ syllable, for example, C_2 and C_3 cannot be alike (with the possible exception of /t/). Davis argues that when phonotactic constraints (see argument No. 1 to follow) are used to support the right-branching hypothesis, they could just as well be used to support the so-called shell model in which onset and coda are dominated by the same intermediate node. Because both models cannot be correct at the same time, Davis dismisses phonotactic restrictions as an argument for determining the internal structure of the syllable.

Davis makes the same mistake as Vennemann. He appears to believe that the existence of a single constraint, which is not even exceptionless, is strong enough evidence to justify a particular model (even in the face of many arguments to the contrary). That is, he does not acknowledge that, although there may be evidence for both sides, the evidence for the one outweighs that for the other. Why not? I submit that, as in Vennemann's case, the heart of the matter lies in a misunderstanding of the nature of structural representations. In particular, he seems to think that one particular representation can only give rise to one particular linguistic pattern. However plausible it may sound, it is not true. Take a right-branching syllable structure for purposes of illustration. Given its direct link between the nucleus and the coda and the indirect link between the onset and the coda, we would expect a stronger interaction between nucleus and coda than between onset and coda. Importantly, this model does *not* predict an interaction between nucleus and coda but no interaction at all between onset and coda, as Vennemann and Davis believe. To see why, consider again the psycholinguistic consequences of this structural representation. The superordinate nodes relay activation in parallel to the subordinate nodes. Thus the nucleus and coda nodes will have a higher degree of coactivation. However, due to parallel information flow, there is also a reduced amount of coactivation of onset and coda. Hence, the difference between the two pairs of constituents is one of degree, not of kind.

A crucial implication is that the right-branching structure predicts exactly the kind of patterns that Davis believes argue against it. Onset-coda interactions are quite compatible with a right-branching model provided these are much less frequent than nucleus-coda interactions. The mention of individual constraints thus is beside the point. To falsify the right-branching model, Davis would have to demonstrate that there are more constraints in the onset-coda than in the nucleus-coda domain. This, however, he fails to do.

Note that exactly the same argument holds in the onset-nucleus domain. Clements & Keyser (1983) attempt to repudiate the right-branching model by pointing out that there also exist phonotactic restrictions between onset and nucleus in addition to those between nucleus and coda. Again, the question is not whether onset-nucleus restrictions exist—they do. The real issue is the number (and importance) of the restrictions in the various domains. Clements & Keyser (1983, p. 20) state that onset-nucleus constraints appear to be as common as nucleus-coda constraints and, on this basis, defend their claim that the structure of the syllable is flat. Unfortunately, they fail to provide an in-depth comparison of the number of constraints in the two domains. Their claim is thus pure conjecture.

In the following, a fairly complete inventory will be made of the arguments that have been brought to bear on the internal structure of CVC syllables. As in the preceding analyses, the logic underlying each argument will be spelled out and critically examined. The diversity of available arguments is impressive, with roots in phonology, phonetics, poetics, and orthography. As will be seen, it is not necessary to weigh the individual arguments against one another.

2.5.1.1 The Phonotactic Argument

As phonotactic constraints have been repeatedly invoked in previous discussions, it seems appropriate to begin with this argument. Our point of departure is the possibility that phonotactic constraints may be more than just a function of linear distance. If linear distance was the only relevant parameter, they would be expected to be strongest between contiguous segments and lessen as the number of intervening segments increases. This model predicts that the phonotactic constraints holding between any pair of adjacent segments are constant. If this constancy assumption can be shown to be wrong and the constraints to be sensitive to other factors, we may have evidence for hierarchical structure and against flatness.

The flat model predicts that the phonotactic constraints in the onset-nucleus domain are as strong as in the nucleus-coda domain. According to the left-branching hierarchical model, the phonotactic constraints are stronger in the onset-nucleus than in the nucleus-coda domain. Of course, the opposite prediction holds for the right-branching model. The psycholinguistic underpinning of this argument is straightforward. When two subordinate nodes are dominated by the same node, their coactivation, as it were, places them on the same line and allows them to impinge on each other. More specifically, the segments may decide on their neighbour's shape. How does this happen? Note that the access of adjacent segments does not take place independently. Different segments pass on activation to the same feature lexicon. Owing to inhibitory connections in the network, the activation of one feature may lead to the deactivation of another.[12] Thus, the nearly simultaneous access is not equally easy for different pairs of adjacent segments. Segment pairs with low interference potential will accordingly be preferred to those with a high potential. What these problems look like at the nitty-gritty level need not concern us in the present context. The main point is that the mutual influence of segments implies a reduction of the paradigm of one position through the presence of another. This, of course, is what is typically referred to as phonotactic constraints.[13] By contrast, when two subordinate nodes are dominated by different nodes, their low degree of coactivation establishes only a weak communication line between them and thereby limits their opportunity of interaction. Consequently, phonotactic constraints stand a low chance of materializing. To conclude, their clear underlying logic makes phonotactic constraints a powerful argument in the examination of syllable structure.

Before we get down to the actual analysis, it is essential to be clear about the nature of phonotactic restrictions. In the phonological literature, these have mostly been construed in absolute terms. Either a certain restriction is imposed or it is not. However, this is once again the spectre of binarity raising its ugly head. As Kessler & Treiman (1997) forcefully demonstrate, phonotactic constraints exist not only as absolute but also as relative restrictions. That is to say, the traditional conception of phonotactic constraints only marks the end point of a continuum but ignores everything "before" this end point. Negating this probabilistic nature means losing a great deal of valuable information that is every bit as characteristic of language as the absolute constraints. Thus, the major question is not what is possible and what is impossible but rather whether the frequencies of phoneme sequences are significantly different from what may be expected to occur by chance alone.

There is a second amendment to be made concerning phonotactic restrictions. Constraints limit the number of choices that are theoretically conceivable. However, this is only one side of the coin. The parallel access of two adjacent segments may not only have an inhibitory effect, which results in phonotactic constraints as conventionally defined, but also a facilitatory effect. That is, the activation level of a neighbour may be raised through the processing of the current element. If this psycholinguistic principle grinds itself into the permanent structure of the language, we obtain the opposite of phonotactic constraints, viz. phonotactic preferences. Like the phonotactic restrictions, these preferences may be position-specific and thus serve as arguments for hierarchical structure. It is essential therefore also to consider the phoneme sequences that occur more frequently than chance.

The ensuing analysis is divided into two parts. The first deals with weight restrictions within the syllable, the second with so-called qualitative aspects. Phonological weight refers to the slot level, segmental quality to the quality level (compare section 1.4). Weight will be quite simply defined as follows. Long vowels and diphthongs count as heavy (VV) and short vowels as light (V). The weight of consonants is a simple function of the number of consonants per phonological constituent (from zero to CCC). The critical question is the potential interaction between the weight of onset and nucleus and that between nucleus and coda. To investigate this issue, all monosyllabic lemmas have been extracted from the CELEX database. The results are reported in Table 2.6.

Beginning with Table 2.6A, we find a remarkable symmetry in the data. The weight of the onset has virtually no effect on the weight of the nucleus. The percentages are very nearly the same, and the χ^2 test shows this minor difference to be due to chance ($\chi^2(3) = 1.8$, $p > 0.5$). This is all the more surprising as small differences in percentages may easily turn significant in the case of large numbers. There is thus not a shred of evidence for a weight interaction between onsets and nuclei in monosyllabic words.[14]

In stark contrast to Table 2.6A, it is quite obvious from Table 2.6B that there is a strong weight interaction in the nucleus-coda domain. The χ^2 test reveals a highly significant difference ($\chi^2(3) = 710.6$, $p < 0.001$). Light nuclei accept heavier codas more easily than heavy nuclei do, and vice versa. Light vowels without codas are almost nonexistent whereas heavy vowels do without codas quite easily. The VC structure is a case of relative “neutrality” in that a single coda consonant is preceded by light or heavy nuclei almost equally often.[15] As soon as the coda gets heavy, light nuclei outdo heavy nuclei. VCC sequences are more than twice as frequent as VVCC ones, and VCCC combinations are even 10 times more frequent than VVCCC ones.

The qualitative side has been treated in an in-depth study by Kessler & Treiman (1997). These authors restricted their distributional analysis to all the monomorphemic CVC/CVVC words found in the Random House Dictionary (N = 2001). They derived chance values for the occurrence of all pairs of adjacent segments in the onset-nucleus, nucleus-coda as well as onset-coda domains, and calculated which pairs were significantly more, or less, frequent than chance. Kessler and Treiman found that, among the segment pairs having at least 5 tokens in their corpus, 12 pairs differ from chance in the onset-nucleus domain, 53 in the nucleus-coda domain, and 13 in the onset-coda domain. For example, /ruː/, /ʌf/ and /f_n/ are more

Table 2.6 Weight Interaction in English Monosyllabic Words (N = 6757)

	A: Onset-Nucleus		*B: Nucleus-Coda*	
	Light Nucleus	*Heavy Nucleus*	*Light Nucleus*	*Heavy Nucleus*
	V-: 117 (4.0%)	VV-: 166 (4.3%)	-V: 2 (0.0%)	-VV: 559 (14.5%)
	CV-: 1841 (63.3%)	CVV-: 2478 (64.4%)	-VC: 1968 (67.7%)	-VVC: 2767 (71.9%)
	CCV-: 874 (30.0%)	CCVV-: 1101 (28.6%)	-VCC: 871 (29.9%)	-VVCC: 513 (13.3%)
	CCCV-: 77 (2.6%)	CCCVV-: 103 (2.7%)	-VCCC: 68 (2.3%)	-VVCCC: 9 (0.2%)
Total	2909 (99.9%)	3848 (100.0%)	2909 (99.9%)	3848 (99.9%)

frequent, whereas /kiː/, /æz/ and /b_p/ are less frequent than chance. This predominance of nucleus-coda interactions is statistically significant whereas the figures for the other two domains are not.[16] This result constitutes strong support for the right-branching structure of the English syllable.

The issue of phonotactic constraints as evidence for syllable organization can be addressed from another angle. The right-branching model predicts that the token/type ratio is larger in the nucleus-coda than in the onset-nucleus domain. As there are by hypothesis more restrictions in the former domain, the number of different types should be lower and consequently the number of tokens higher than in the latter domain. Relevant data were gathered by Dell, Juliano, & Govindjee (1993) who examined all CVC words (which were also three-letter words) listed in a standard frequency dictionary. In line with the prediction, they found that the token/type ratio for VC sequences was more than twice as high as that for CV sequences. Dell et al. also investigated the effect of word frequency on token/type ratios. They sampled 50 high-frequency and 50 low-frequency items from their corpus and found that the token/type ratio for CV sequences was higher for frequent than for infrequent words. This is a notable finding, which would seem to invite the tentative conclusion that frequent words are more strongly hierarchical right-branching than their infrequent counterparts. Although more data would be needed to put this conclusion on a firm footing, it makes good sense from the psycholinguistic standpoint. As explained in the opening chapter, a hierarchical representation supports more efficient processing than a flat one. It stands to reason that more efficient strategies are employed in those areas in which they can be most easily created and/or in which efficiency is most profitable. One facilitating factor in the activation of the rime node is the knowledge about the phonological make-up of nucleus and coda. The higher the token/type ratio of VC sequences, the higher their redundancy and the knowledge about them. Rime nodes can therefore be activated more easily in high-frequency words. It also makes sense to assume that efficiency is linked to its beneficial effects. It is well-known that frequent words are accessed more rapidly than infrequent ones (Oldfield & Wingfield, 1965). As hierarchicalness increases the planning efficiency and thereby decreases retrieval time, it would be useful to apply this resource-consuming strategy particularly to those areas where the beneficial effects are greatest. This is of course the set of frequent words, which by their very nature make the application of this strategy worthwhile.

To summarize, the phonotactic evidence in its entirety supports the claim that the structure of the English CVC syllable is hierarchical right-branching. The fact that detailed studies of the complete vocabulary have been published since the late 1990s has taken us well beyond the stage of appealing to individual constraints as arguments for diverse models of syllable structure. The question is no longer whether individual arguments for the various models exist—this is undoubtedly the case for each of the models—but rather whether there is a predominance of arguments for one model.

This is so, and indeed this is the only set of results that can reasonably be expected to emerge from a probabilistic output system that explicitly allows for minority patterns.

2.5.1.2 The Suprasegmental Argument

A standard motivation for a particular unit in linguistics is the existence of rules that make reference to it (i.e., that without this unit, generalizations could either be only very awkwardly expressed or not expressed at all). One such generalization pertains to the suprasegmental feature of lexical stress. Main-stress placement was long regarded as rather erratic up to the time Chomsky & Halle (1968) proposed their Main Stress Rule. One of the major theoretical advances of this rule was the claim that stress placement is sensitive to the distinction between heavy and light rimes. A light rime is defined as an open syllable with a short vowel, a heavy rime as either a closed syllable or an open syllable with a long vowel or diphthong. Generally speaking, a heavy rime attracts stress whereas a light rime rebuffs it. This can be most clearly seen in trisyllabic words. If the rime of the final syllable is light and that of the penultimate syllable heavy, stress falls on the penultimate syllable (e.g., *charísma*); if the rimes of both the final and the penultimate syllable are light and the rime of the antepenultimate syllable is heavy, stress falls on the antepenultimate syllable (e.g., *dénsity*).

However, the picture is less neat than is suggested by the preceding description. The rime-weight hypothesis runs into a number of problems. If stress is counted from right to left, as is generally taken for granted, it is predicted to fall on the final syllable if its rime is heavy. Although this is true of some cases (e.g., *cigaréttе*), it is not true of many others (e.g., *mícrophone*). Attempts have been made to remedy this unsatisfactory state of affairs by stipulating that the final syllable be disregarded by stress rules (extrametricality; see Trommelen & Zonneveld [1999] for a survey). However, this solution is not only entirely ad hoc, it is also immediately contradicted by the fact that the final syllable is not exempt from bearing stress (e.g., *magazíne*). It cannot be blind to stress and at the same time be stressed. The rime-weight hypothesis by itself also provides no natural account for words that have two heavy rimes (e.g., *horízon*) as well as for those that have none (e.g., *Cánada*). In some cases, stress may even fall on a light syllable although there are two heavy syllables in the word (e.g., *quárantine*).

Most of these problems disappear when a particular view of syllable structure is adopted. There has been some debate about the proper representation of words like *hammer* for example. Is the intervocalic /m/ part of the first or the second syllable, or does it belong to both, in which case it is called ambisyllabic? The evidence for ambisyllabicity in English is quite strong (e.g., Stemberger, 1983a; Giegerich, 1992). This would imply that the first syllable of *hammer* is closed and therefore heavy. More generally, all (non-final) stressed syllables are heavy under the ambisyllabicity hypothesis.

They are not only heavy when they have a long vowel or a diphthong. They are also heavy when they have a short vowel because ambisyllabicity associates the following consonant with the preceding syllable. In this view, the initially stressed words *Canada* and *quarantine* are no longer exceptional. In *Canada*, the stressed syllable is the only heavy one.[17] In such an analysis, the word *quarantine* now has nothing but heavy syllables, which means that stress placement cannot be solely determined by weight. However, the fact that other factors have to be reckoned with in stress assignment does not undermine the validity of the weight factor.

Most previous analyses of English stress were severely restricted in their empirical coverage. They usually contented themselves with basing their conclusions on individual examples (as can be seen from the previous discussion). We now take an alternative approach and examine the possible interactions of stress and weight on the basis of a representative sample of di- and trisyllabic words. Disyllabic items fall into a maximum of 8 categories: 4 weight patterns (i.e., light–light, light–heavy, heavy–light, heavy–heavy) times 2 stress patterns (i.e., stressed–unstressed, unstressed–stressed). Half of these categories are neutral with respect to the weight hypothesis (e.g., heavy–héavy, líght–light) because the syllables do not differ in weight and so stress placement cannot be influenced by it. Two of the categories (i.e., heavy–light, light–héavy) are encouraged by the weight hypothesis whereas the remaining two (i.e. heavy–líght, líght–heavy) are discouraged by it. The picture is slightly more complex for trisyllabic words. Theoretically, there are 24 categories: 8 weight patterns times 3 stress patterns. As in the disyllabic words, half of the categories are neutral. Neutrality was scored not only for items with consistently weak or strong syllables but also for those in which two syllables are light and one is heavy or vice versa. In patterns like "héavy–light–heavy" for example, it cannot be established with certainty that stress placement is under the sway of the weight principle. The distribution of cases arguing for or against the weight hypothesis is asymmetrical. Only 3 categories (e.g., héavy–light–light) count as evidence for it whereas 9 (e.g., líght–light–heavy) count against it. This analysis rests on the assumption that stress can occur on all syllables in di- and trisyllabic words. Longer words were not considered for two reasons. For one thing, the number of theoretically possible categories increases considerably. For another, these words are so infrequent that they cannot be regarded as typical of the English language. According to Roberts (1965), all words longer than three syllables account for no more than 10% of the entire vocabulary.

A corpus of two- and three-syllable words was set up from all entries that occurred first on each page of the 1668-page Dictionary of Contemporary English. Excluded were abbreviations, letters, bound morphemes, and compounds, as well as syntactic groups. The British English pronunciation as indicated in the dictionary was chosen. Where schwa was given as optional, it was taken into account. Syllable boundaries were determined following the onset maximization principle. The results are summarized in Table 2.7.

Table 2.7 Sensitivity of Main Stress to Rime Weight in a Sample of Di- and Trisyllabic Words

	Sensitivity			
Length	+	–	*Neutral*	*Total*
disyllabic words	121 (27.4%)	63 (14.3%)	257 (58.3%)	441
trisyllabic words	24 (8.9%)	79 (29.2%)	168 (62.0%)	271

A plus sign means that the pattern is predicted by the weight hypothesis, a minus sign that it is not.

Setting aside the fact that the neutral cases predominate in both di- and trisyllabic words, the results are quite heterogeneous. Whereas the plus cases are almost twice as frequent as the minus cases in disyllabic words, the minus cases are more than three times more common than the plus cases in trisyllabic items. The two word types therefore need to be treated separately. Stress in disyllabic words shows a sensitivity to rime weight. The relevant figures are significantly different from chance ($\chi^2(1) = 9.4$, $p < 0.005$). However, this is not true of trisyllabic words. Even if it is taken into consideration that the minus sign has an a priori probability of occurrence that is three times that of the plus sign, there is no chance for a weight effect to emerge. The lion's share of the minus cases is constituted by a single weight pattern, viz. light–light–heavy. As many as 55 items bear stress on the initial syllable (e.g., *cápital*) and 13 are stressed on the middle syllable (e.g., *lacónic*). If extrametricality is adopted, it can explain away most of the minus cases and thereby reduce them to a mere 11. This figure would be less than half the number of the plus cases. On this doubtful proviso, then, a weight sensitivity can also be argued for trisyllabic words.

All in all, there is some evidence for lexical stress to be sensitive to phonological weight, although this evidence is equivocal. If ambisyllabicity is assumed, the effect is clearly present; if ambisyllabicity is rejected, the effect can be demonstrated only for disyllabic words. In trisyllabic words, by contrast, the effect emerges only on the condition that recourse is had to extrametricality, which is a concept of doubtful value. A good part of the putative explanatory power of extrametricality can be assumed by a notion that is less controversial because it is more descriptive and does not require any theoretical background assumptions. This is the pronounced tendency in English toward first-syllable stress. In the sample on which Table 2.7 is based, 84.4% of the disyllabic and 57.9% of the trisyllabic items carry stress on the initial syllable. This tendency comes into conflict with the weight principle whenever the non-initial syllables are heavy. In the light of the preponderance of first-syllable stress, it seems safe to argue that the initialness principle is stronger than the weight principle and that the latter is bounded by the former. All things considered, there is good reason to claim that English stress rules are not totally blind to the rime. The suprasegmental argument thus provides some support to the hierarchical right-branching structure of the syllable.

2.5.1.3 The Orthographic Argument

Invoking spelling as an argument for phonological structure may be in need of justification. This decision is predicated on the assumption that orthography is derived from phonology. This is true for language acquisition to the extent that the learning of a word's orthographic representation is guided by its constituent phonemes. It is also true of adult language in that competent users of the language have at their disposal a set of phoneme-to-grapheme conversion rules (see Goodman & Caramazza, 1986). A phonological representation may therefore impact on the orthographic one.

The opposite direction is also conceivable. If orthography is open to phonology, it may code phonological properties that might manifest themselves in the conversion of letters to sounds. The pronunciation of written words is known to be a challenging task because of the one-to-many relationship between graphemes and phonemes in English. These complex relationships imply a certain freedom of phonemic choice, and it is this freedom that allows for variation that might reflect phonological influences. Let us examine this variation more closely.

Variation is orthogonal to regularity. The critical question is which written units create how much (ir)regularity in pronunciation. The three models of the syllable make different predictions in this regard. The flat model predicts that the body and the rime are equally difficult to pronounce. If the rime is a real unit, as postulated by the right-branching model, it may be expected to function as an "island of stability" and therefore to give rise to more regularity in pronunciation than the body. Conversely, less variation in pronunciation is predicted for the body than the rime by the left-branching hypothesis. The underlying logic is that units that belong to the same superordinate node constrain one another (due to their co-activation) and thereby limit the variation in pronunciation that inheres in them individually as well as that which is created by their being conjoined. This limitation makes their pronunciation more regular than in the case of units which are dominated by different nodes and therefore do not constrain one another.

These predictions were tested in a large-scale study by Treiman, Mullennix, Bijeljac-Babic, & Richmond-Welty (1995). Their analysis was based on all the CVC words that are included in the Merriam-Webster Pocket Dictionary (N = 1329). They calculated the number of different pronunciations for consonant–vowel and vowel–consonant sequences and found that the average number was lower for rimes than for bodies. They also counted the proportion of neighbours of each CVC item with the same pronunciation of body and rime units. This proportion was higher for rimes than for bodies.

Another relevant finding was that the number of orthographic rime types was lower than that of orthographic body types, thereby paralleling Dell, Juliano & Govindjee's (1993) figures for phonological rimes and bodies.

In a follow-up study, Kessler & Treiman (2001) approached the same problem from the opposite side. They asked at which linguistic level spelling rather than pronunciation rules can best be described and came up with essentially the same pattern of results as in the previous analysis. Knowledge of the coda is much more helpful in spelling the vowel correctly than knowledge of the onset. Similarly, knowledge of the vowel facilitates the spelling of the coda to a greater extent than the spelling of the onset.

All these results point in the same direction. Rimes form a more natural unit than bodies. In particular, they serve as domains over which pronunciation rules and spelling can be defined. Put another way, there is more regularity in the grapheme-to-phoneme and phoneme-to-grapheme conversion process when rimes rather than bodies are assumed. This is as predicted by the hierarchical right-branching model of syllable structure.

2.5.1.4 The Phonetic Argument

Like the orthographic argument, the phonetic argument stands or falls on the relationship that holds between phonology and its neighbouring component. For phonetics and phonology, this relationship is assumed to be interactive, perhaps with a stronger effect of the former on the latter than vice versa. The most compelling argument for this impact probably comes from language acquisition. The only clues children may rely on in their construction of phonological categories are of a phonetic nature. This information becomes part and parcel of the adult phonological system, as can be seen from the fact that phonemes behave according to the principle of phonetic similarity. From this perspective, phonetic constraints may serve as explanations for phonological patterns, and indirectly phonetic arguments help to identify phonological structures.

The influence of phonology on phonetics is enshrined in the architecture of the production system. Phonological representations feed the phonetic component and thereby ineluctably impose their properties to an unspecified extent on the representations to be constructed at the next level down. Given this direction of information flow, phonetic constraints may serve as subsidiary arguments for phonological structure. This is particularly true when the phonetic arguments go in the same direction as the phonological ones.

We proceed as before by formulating predictions from the three models of the syllable and testing them against the data. In fact, the predictions are the same as in previous subsections. On whatever phonetic parameter one may choose to investigate, the right-branching structure of the syllable predicts a closer interaction between nucleus and coda than between onset and nucleus. Of course, the opposite prediction holds for the left-branching model. No difference is expected in the flat representation.

The first parameter to be examined is phonetic duration. Undoubtedly, duration is a phonetic parameter as phonemes are devoid of temporal content.[18] Despite the continuous nature of the phonetic signal, it is possible to measure the duration of speech sounds and in particular to compare their duration across categories. Provided that duration is not uniquely determined by inherent properties of a speech sound, one may test for possible interactions between the duration of adjacent elements. Such an analysis was carried out by Peterson & Lehiste (1960). They measured the duration of the vowel in CVC syllables as a function of the preceding and following consonant. Their results were highly consistent. All vowels were affected in their duration by the coda consonant whereas the influence of the onset consonant was negligible. For instance, the vowel was shorter when it was followed by a voiceless consonant than when it was followed by its voiced congener. No comparable effect of voicing on vowel duration was observed of onset consonants. This result is readily understandable if the analogue of the phonological rime, the phonetic rime, is assumed. We may thus posit right-branching in phonetics and take the durational asymmetry as indirect support for the right-branching structure of the phonological syllable.

The reason why voiceless obstruents tend to pair with shorter vowels than voiced ones probably is to do with an interaction of voicing and duration. As has been repeatedly demonstrated, voiced obstruents are considerably shorter than voiceless ones (e.g., Crystal & House, 1988). Peterson & Lehiste's findings may accordingly be interpreted as a negative correlation between the duration of the nucleus and that of the coda. The longer the one component is, the shorter the other. This hypothesis makes sense on the assumption that the phonetic rime acts as a sort of time frame that tends to allocate a certain overall duration to the entire unit but leaves open how this time is distributed across its constituents.

The existence of a phonetic rime as just defined motivates going back to the phonological level. As Donegan & Stampe (1979) and others noted, phonetic facts may bias phonological rules. By tailoring these rules to articulatory constraints, the requirements of the concrete act of speaking are worked into, and anticipated by, the permanent structure of the language. This is to the obvious advantage of the processing system. In particular, phonological patterns that conform to principles of phonetic implementation are easier to use than those that do not. We would therefore expect the inverse relationship between the duration of vowels and that of coda consonants to have phonologized (i.e., to have shaped the phonotactic structure of phonological rimes; Fowler, 1983). This prediction was tested in a study of the rimes of all monosyllabic words as well as second-syllable rimes of all disyllabic words (Berg, 1994b).[19] Phonological rimes show a trend to accommodate vowels and consonants that are at opposite ends of the duration scale. A paradigm case is the voice specification of the coda obstruent. The rate of voiceless obstruents is significantly higher after short monophthongs than after long monophthongs and diphthongs. Even though the effect is not always very strong, a number of further analyses reported in Berg (1994b) confirm the general picture that long vowels tend to pair with short consonants and vice versa. Phonetics "infiltrates" into phonology.

Durational differences may not only be examined between the immediate constituents of rimes but also between onsets and codas. According to the rime hypothesis, onsets form an immediate constituent of the syllable whereas codas must negotiate timing with the preceding vowel. This independence of onsets and dependence of codas leads to the prediction that onsets will be longer than codas (especially if some kind of syllable isochrony is assumed). As the studies of Hoard (1966) and Anderson and Port (1994) show, this is in fact the case. This may be taken as additional support for the right-branching structure of the phonetic syllable.

Another phonetic parameter of relevance here is coarticulation (i.e., the extent to which articulatory gestures for different segments overlap). The variable strength of coarticulation leaves room for diverse influences including syllable structure. On the by-now familiar logic, the right-branching model of the syllable predicts a higher degree of coarticulation between nucleus and coda than between onset and nucleus.[20] And this is exactly the result obtained by several researchers including Lindblom (1983, p. 226), Browman & Goldstein (1995), and Krakow (1999). There is thus a more extensive spread of articulatory movements from the coda to the nucleus than from the onset to the nucleus. Two examples may suffice to illustrate the point. One comes from nasals, the other from the lateral. To produce a nasal, the velum has to be lowered. This movement extends from a coda to a preceding nucleus though not from an onset to a following nucleus (Sproat & Fujimura, 1993). The net effect is nasalization on the vowel due to the following nasal consonant. By contrast, prevocalic nasal consonants do not induce nasalization.

The second example concerns the phonetic quality of the lateral. According to the traditional view, English possesses two allophones of /l/, viz. velar [ɫ] in postvocalic and palatal [l] in prevocalic positions. Sproat & Fujimura (1993) argue against this view and show that the quality of the coda /l/ is determined by the duration of the rime of which it is a part. The lateral is more velar in longer rimes but more palatal in shorter rimes. This difference would be difficult to account for without the concept of a phonetic rime, that is, a right-branching structure.

There is a more general point here. Coda consonants are generally more vocalic than onset consonants. This is not only true of [ɫ], which is more vocalic than [l], but also of stops and fricatives (Umeda & Coker, 1975). Coarticulation provides one account of this difference. Preceding vowels extend their vocalic aspects to coda consonants, thereby reducing the acoustic contrast between them. However, no such overlap occurs between the onset and the nucleus to the effect that the contrast between them is maintained (and even enhanced). The conclusion is always the same. This finding is nicely accommodated by a model that groups nucleus and coda more closely together than onset and nucleus. This is of course provided for in a right-branching structure of the syllable.

It is remarkable that the phonetic rime makes a claim not only about phonetics but also phonology. Because in language production, the phonological representation serves as input to phonetics, the nature of the phonological representation can be inferred from properties of the phonetic structure that may be claimed to reflect those of the phonological structure. The overall conclusion is then that we have another domain where right-branching prevails and another argument for a particular branching direction.

2.5.1.5 The Word Game Argument

Word games represent a linguistic activity that functions to highlight the ludic nature of language (or rather, of its users) and/or to convey secret messages. They therefore require a deliberate distortion of the original phonological form, which has to be recovered by at least one listener. The players of word games thus need a common set of rules that transform an ordinary word into its disguised version, although these rules need be neither consciously learned nor explicitly statable by the players. These rules are of special interest because they raise the question of the nature of the units that are manipulated. For monosyllabic words, the three models of the syllable make the familiar predictions, which need not be reiterated here.

One of the better known word games is Pig Latin (Lashley, 1951; Halle, 1962; Hockett, 1967). It involves shifting the onset of the word to the end and adding /eɪ/ to it. The word *pig* would accordingly be transformed into *igpay*. As is obvious, this game breaks up the word at the onset-rime boundary, the major break point in the right-branching model of the syllable. There are other games in English (e.g., Eggy-Peggy) that also crucially involve the onset-rime boundary but apparently none that divide the word into a body and a coda. Hence, the word game evidence weighs in favour of right-branching.

2.5.1.6 The Speech Error Argument

Phonological slips of the tongue most usually implicate single phonemes. Less often, however, larger chunks such as CV and VC sequences are involved. Two pertinent examples are given in (24) and (25).

(24) the cutting *wi*dge of his *e*t. for: the cutting *e*dge of his *wi*t. (from Shattuck-Hufnagel, 1983)

(25) Our p*atch*-m*ost* tea. for: p*ost*-m*atch* tea. (from Trevor Harley, unpublished)

The units that are transposed in (24) are /wɪ/ and /e/, of which the first is unquestionably a body. By contrast, the two rimes /əʊst/ and /ætʃ/ trade places in (25). In Stemberger's (1983a) database, there are 4 body slips as against 53 rime slips. The same bias emerges in Harley's corpus of English speech errors. A similar observation can be made about blend errors in which the interacting words stand in a paradigmatic rather than a syntagmatic relationship as in the earlier examples of exchanges. Fudge (1987) reports a ratio of 4:1 in favour of onset-rime as opposed to body-coda breaks in Fromkin's error corpus. These results are exactly as predicted by the right-branching model. This conclusion is cemented by another prediction that is borne out. Because coda consonants are more closely tied to the nucleus than onset consonants, the former are less likely to break free and be dislodged than the latter. Onsets would consequently be expected to be more often involved in slips of the tongue than codas. In fact, such an asymmetry has been observed over and over again in speech error research (e.g., Stemberger, 1983a).

There are further speech error effects that have a bearing on the organization of the syllable. A well-documented one is the repeated phoneme effect whereby a phonemic slip is facilitated when the interacting elements are flanked on one side by the same segment. Exchanges such as (26) and (27) illustrate this phenomenon.

(26) I haven't got *m*ery *v*eny pieces left now. for: *v*ery *m*any. (from Trevor Harley, unpublished)

(27) Lots of ga*n*es rai*m*ed off. for: games rai*n*ed off. (from Trevor Harley, unpublished)

Two onset consonants exchange places in (26), two coda consonants in (27). The onset consonants are followed by an identical vowel whereas the coda consonants are preceded by an identical vowel. The three models of the syllable differ in their predictions as to the strength of the repeated phoneme effect. The flat model predicts an equal strength of this effect as it radiates from right to left (as in [26]) or from left to right (as in [27]). On account of the closer link between nucleus and coda, the right-branching model predicts a stronger repetition effect from the nucleus to the coda than from the nucleus to the onset. The opposite prediction is made by the left-branching structure. This issue was addressed by Stemberger (1994) on the basis of his error data. He found that the rate of coda slips was four times higher when the coda was preceded by an identical nucleus than when it was not. However, the rate of onset slips was only twice as high when the onset was followed by an identical nucleus than when it was not. The repeated phoneme effect thus is much stronger in the rime than in the body domain. This is another piece of evidence in favour of the right-branching model.

Finally, attention will be drawn to a sonority effect in slips of the tongue. Berg (1989b, 1994a) observed that the greater the similarity of two adjacent phonemes in terms of their sonority values, the higher their cohesiveness in speech errors. Compare (28) and (29).

(28) thi*ck* sla*ck*. for: thick sla*b*. (from Fromkin, 1973)

(29) You b*ind* while I gr*one* it. for: You b*one* while I gr*ind* it. (from Shattuck-Hufnagel, 1983)

Stops rank lowest while nasals take a middle position on the sonority scale. The fact that only the coda consonant is misordered in (28) may be ascribed to the large sonority difference between /ɪ/ and /k/ in *thick*. By contrast, the fact that the rime is involved in (29) may be attributed to the relatively low sonority difference between /əʊ/ and /n/ in *bone*. Note that sonority is only one factor among others to influence cohesiveness.

As in the case of the repeated phoneme effect, the critical question is whether the strength of the cohesiveness effect is variable and, if so, whether this variability is determined by the structural position that the adjacent elements occupy. Taking this assumption as our starting point, we may expect a stronger sonority effect between segments that are dominated by the same structural unit. The logic is always the same. Because a common superordinate unit provides for good communication between the subordinate elements, any syntagmatic effect should be enhanced. So if a rime exists, sonority should play a greater role between nucleus and coda than between onset and nucleus. This prediction is in fact borne out by the error data, which reveal a difference that is even larger than predicted. Berg (1994a) reported evidence for cohesiveness in the rime domain but did not find any in the body domain. One way of rationalizing these results is to argue that sonority is a structure-dependent effect. It emerges quite clearly in the rime that forms a closely knit structure, but it fails to manifest itself in the body probably because onset and nucleus belong to different structural domains and therefore cannot interact strongly enough for this effect to materialize. Like everything else that has been discussed in this subsection, the sonority effect lends support to the right-branching model of the syllable.

2.5.1.7 The Argument from Experimental Tasks

Whereas the preceding two arguments constitute behavioural evidence of the naturalistic kind, the present argument relies on tasks that subjects were instructed to perform in experimental settings. These tasks involve the deliberate and conscious manipulation of stimuli and thus the results they produce are of a different nature than the naturalistic data discussed earlier. Their common core is, of course, that they are both of the psycholinguistic kind. Even though the tasks that have been employed are quite diverse, they will be presented here under a common heading.

Treiman (1983) compared the ease with which subjects were able to break up monosyllabic words at the onset-rime and body-coda boundaries. Subjects were taught word games in which predefined materials had to be inserted at certain points in the stimuli (which are not unlike the rules used in naturalistic word games). As expected under the right-branching organization of the syllable, subjects made fewer errors on the games that required them to break up the stimuli at the onset-nucleus boundary than on those that required them to insert material between nucleus and coda.

In another experiment, Treiman (1983) aimed at replicating, under more controlled conditions, the results of the naturalistic blend data that were discussed in the preceding subsection. Subjects were asked to blend two nonsense CCVCC syllables into one. The strategy most frequently employed was to combine the onset of the first syllable with the rime of the second, a finding that attests to the naturalness of the onset-rime boundary. In a follow-up study, this result was replicated for real words and for different syllable structures (Treiman, 1986). She also replicated the sonority effect mentioned in the previous subsection.

A different method of studying the same issue was employed by Treiman & Danis (1988b). They resorted to a memory task in which subjects had to recall a sequence of six nonsensical CVC syllables. Assuming that subjects make memory errors in which only part of the target is replaced, the critical question was where in the syllable the discrepancy between target and error arose. Provided that short-term memory builds on structural representations, the right-branching model would lead us to expect nucleus and coda to be replaced in tandem more frequently than onset and nucleus. This turned out to be true of both contextually and noncontextually motivated errors. In both categories, rime substitutions were about three times more frequent than body substitutions.

Two further methods were introduced by Dow & Derwing (1989). One was a segment deletion, the other a segment substitution task. In the first, subjects were given pairs of real words such as *leg–egg* and *beat–bee*, which differed systematically in the presence or absence of the onset or coda consonant(s), and then presented a stimulus word that had to be transformed by analogy with the second word of the sample pair. The dependent variable was the difficulty subjects experienced with the task. Dow & Derwing found that the deletion of the onset turned out to be easier for the subjects than the deletion of the coda. The same result was obtained in the substitution task in which the authors tested both the proportion of correct responses and response latency. Onset substitutions were not only easier but also faster to perform than coda substitutions. Notably, the errors that the subjects made tended toward respecting the integrity of the onset and the rime. All this is excellent support for the right-branching structure of the syllable.

Finally, mention will be made of a method that differs from the previous ones in having subjects evaluate linguistic forms rather than produce them. In one such metalinguistic task devised by Wiebe & Derwing (1994), subjects were to decide which item on a predefined list of four they considered to be the best outcome of the blending of two orally presented words. The proposed blends were constructed by recombinations of onset and rime or body and coda of the stimulus words. As will have been anticipated, subjects preferred blends that respect the onset-rime boundary to those respecting the body-coda boundary. Again, right-branching wins out.

Even though this review of the experimental data is far from exhaustive, we have seen abundant evidence for the claim that English CVC syllables possess an internal organization that is characterized by a closer union between nucleus and coda than between nucleus and onset. Thus, the phonological rime is psychologically real. The fact that there is such enormous agreement among so many different studies using so many different methodologies is quite remarkable. If nothing else, it testifies to the robust nature of the rime from the experimental perspective.

2.5.1.8 The Poetic Argument

The name of the phonological concept of rime was borrowed from an area that plays only a marginal role in linguistic research—poetry. There is a wide-spread belief that rhyming practices are cultural artifacts and therefore either irrelevant or problematic as arguments for linguistic structure (e.g., Primus, 2002). However, this is a misconception. In order to be regarded as natural and aesthetically satisfying by native speakers, poets are well-advised to construct their rhymes in accordance with the rules of the language. More specifically, poetic structures that match phonological representations are preferable to those that do not (Berg, 2001). The question is then, which phonological structure supports a poetic rhyme. The answer is of course well-known. A perfect rhyme requires as its underpinning a phonological rime whereas a body does not form a rhyme. Contrast (30) and (31).

(30) heal ~ feel

(31) heal ~ heed

Clearly, (30) counts as a rhyme whereas (31) does not. Rhymes thus make crucial use of the onset-rime boundary in that everything preceding this boundary must be different and everything that follows it must be identical. This rhyming tradition makes perfect sense on the assumption that the poetic rhyme corresponds to the phonological rime. Hence, the former qualifies as evidence in support of the latter.

2.5.1.9 The Historical Argument

A synchronic investigation may be backed up by historical evidence, provided the following background assumption holds. A synchronic analysis by definition targets the structure of a language at a certain point in time t. The classical argument for a categorical separation of synchrony and diachrony is that a language may have changed from t_{-1} to t and hence a piece of evidence from t_{-1} may be irrelevant to the description of the language at t.

Although the argument is basically correct, the uncertain nature of the antecedent condition needs to be emphasized. There is no necessity of change. If certain basic properties of a language remain stable over time, more superficial changes at t_{-1} may still be regarded as valid evidence for the synchronic state of the language at t.

Let us consider an example. Suppose a given language has a right-branching bias as a diachronically robust feature. Certain historical changes affecting syllable structure will then be interpreted as evidence for right-branching at t_{-1}. Of course, the critical question is, how do we know that this language was right-branching at t_{-1}? The obvious answer is that we know this only through the historical processes taking place at t_{-1}. This circularity makes the historical argument asymmetrical. If the diachronic data argue for right-branching, they may be used as ancillary evidence for the structure of the language at the later stage t because they simultaneously confirm right-branching at t_{-1}. If, however, the diachronic data do not argue for right-branching, they cannot be used as evidence for the structure of the language at t because the antecedent condition of historical constancy is not met. We are thus confronted with a methodological situation in which positive evidence from t_{-1} may support a hypothesis about t whereas negative evidence from t_{-1} cannot be taken to disconfirm a hypothesis about t.

The predictions that the three competing models of syllable structure make about the nature of historical change are straightforward. The right-branching model predicts a predominance of interactions between nuclei and codas, the left-branching model a predominance of onset-nucleus interactions, and the flat model an equal number of both. Interactions are best conceived of in the present context as contextually determined changes, for example a change of the vowel that is facilitated by the prior or subsequent consonant.

A list of such consonant-induced changes in the recent history of English was set up by Wełna (1978). According to Kessler & Treiman (2001), who based their counts on Wełna's work, 22 coda-induced vowel changes are accompanied by 1 onset-induced (as well as 2 both coda- and onset-induced) vowel changes. This marked difference may be interpreted as diachronic evidence for the Modern English slant toward a right-branching syllable structure.

There is a well-known historical process that nicely illustrates this asymmetry. It goes by the name of compensatory lengthening and involves short vowels that are lengthened following the loss of a coda consonant. Consider the Old English example in (32).

(32) mæʒden → mǣden 'maiden'

As can be seen, the loss of the <ʒ> is accompanied by the lengthening of the preceding vowel. The essential point here is the position of the consonant relative to the vowel. Only the loss of the coda consonant induces lengthening, the loss of the onset consonant remains without effect. A typical example from Middle English is given in (33).

(33) hit → it 'it'

The disappearance of /h/ did not affect in any way the following vowel. This differing role of onset and coda consonants is most readily explained under the right-branching hypothesis.

2.5.1.10 The Typological and the Frequency Argument

The final argument, dubbed the typological one, will be introduced for the sole purpose of discrediting it. It was advocated by Iverson & Wheeler (1989) who proposed that the structure of the syllable is left-branching. This proposal is based on the incontrovertible fact that CV is the commonest syllable structure in the languages of the world. The body thus represents the "hard core" of most syllables. Iverson & Wheeler go on to argue that, because of this nested nature, more complex syllable structures are created on the basis of the body. Interpreted from the production perspective, a CVC syllable would be activated by first accessing a CV syllable and subsequently adding a consonant to it. Such a strategy would be supported by a left-branching model that allows the material to be accessed first (i.e., CV) to be accessed as a unit. A right-branching model could definitely not accommodate this strategy in any natural way.

There is a fundamental flaw in Iverson and Wheeler's reasoning. They construct a view of language generation as proceeding from universal to particular aspects. The former are processed first and the latter are added at a later stage. This view is hardly defensible from both the logical and the psycholinguistic perspective. Logically, it makes no sense to attribute speakers knowledge of the universal aspects of language. Naïve speakers do not know, neither consciously nor subconsciously, that the CV syllable is a language universal[21] until they are told. It is not reasonable to argue that this alleged knowledge is part of the genetic endowment of human beings because this knowledge would be practically of no help in acquiring or using a particular language. One might attempt to salvage the hypothesis by reinterpreting universal as simple and language-particular as complex. However, this move is flatly contradicted by the fact that many languages do not have CV as their most frequent syllable pattern. German, for example, has more CVC than CV syllables.

From the psycholinguistic standpoint, it makes no sense to argue that the access of linguistic units proceeds in two separate steps of which the first involves accessing a non-target unit and the second transforms the non-target unit into the target unit. This is not only extremely cumbersome but also unnecessarily complex as it is much easier to access the target unit directly. There is not a shred of psycholinguistic evidence that language users adopt such a questionable strategy in speaking. We therefore reject the hypothesis that a CVC syllable is retrieved through the intermediate step of accessing a CV syllable, and consequently, the claim that English CVC syllables are left-branching.

In essence, the typological argument is an argument about frequency, either cross-linguistically or within a single language. The more frequently two units co-occur, the more likely they are to form a constituent. However intuitively plausible such a hypothesis may be, the available evidence militates against it. As shown in the preceding subsections, all arguments point toward right-branching. The same is true of syntax. In his quantitative analysis of English basic sentence patterns, Ellegård (1978) found a strong asymmetry between the co-occurrence of subjects and verbs on the one hand and verbs and objects on the other. Whereas two thirds of the sentences in his corpus have a subject and a verb, only one fourth has both a verb and a direct object. On this measure, then, we would have to argue for left-branching in English SVO sentences, which is contradicted by (almost) all the evidence adduced in section 2.3. This is a noteworthy conclusion indeed: constituency does not appear to be influenced by frequency.

The reasons for this surprising independence are largely a mystery. It seems almost impossible to categorically rule out frequency effects on constituency in the light of the fact that the human mind is a highly associative system. When two unrelated phenomena, let us say, a particular image and a particular smell, are contiguous, they tend to be associated such that the one may provoke the sensation of the other. Association strength is the greater, the more often the two occur together. There is no reason why this principle should be inapplicable to two adjacent linguistic units. In fact, Bybee & Scheibman (1999) argued that this principle is applicable to language and accounts for phonological reduction phenomena. They observed in a corpus of American English conversation that the weakening of *don't* in constructions such as *I don't know* is a frequency-sensitive process. The higher the string frequency of *don't* and its neighbour(s), the greater the phonological reduction. In particular, Bybee and Scheibman hypothesized that contrary to standard analyses, the auxiliary forms a unit with the subject NP rather than the verb because the subject determines the reduction of *don't* to a greater degree than the verb. They went on to explain that the paradigm of subjects being able to induce reduction is much smaller than that of verbs with the same capacity.

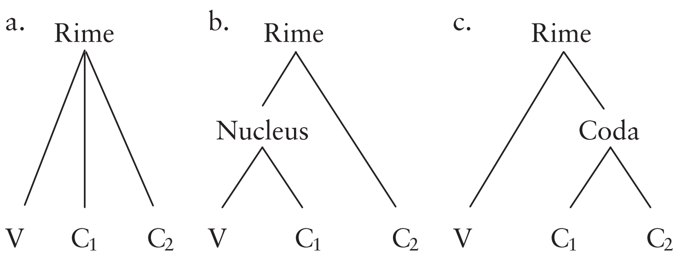
I think that Bybee & Scheibman's case is less strong than they would have it. Although there is no doubt that predictability as an effect of frequency occasions reduction (as forcefully demonstrated long ago by Lieberman [1963]), it is less clear that reduction must be taken as an index of constituency. As Bybee & Scheibman point out themselves, the reduction of the auxiliary is a case of cliticization along roughly the same lines as *I am* → *I'm* and *I will* → *I'll*. Typically, cliticization is a right-to-left process in that the clitic attaches to a host on its left. This is for the very good reason that the head-dependent order is easier to process than the inverse order.[22] The claim being made here is, then, that phonological reduction as an instance of cliticization is not under the sway of constituent structure but follows from a general right-to-left asymmetry in cliticization. In other words, cliticization is a linear rather than a hierarchical phenomenon.

Concluding, for reasons not yet understood, the typological and the frequency argument lacks force in the analysis of constituent structure. A great deal of evidence has been marshalled in support of the view that CVC syllables have a right-branching structure. Not only the diversity of the different data types, but also the near-perfect agreement among them, deserve emphasis. The confidence with which the rime hypothesis can be formulated thus is especially strong.

2.5.2 The Rime

Having established beyond any reasonable doubt the reality of the rime, we may now go on to examine its internal structure. As English allows postvocalic consonant clusters, rimes may consist of three elements. For the ensuing analysis, no distinction will be made between long and short vowels or monophthongs and diphthongs. The three possible ways of organizing the three elements within the rime are diagrammed here.

(34)



The flat model in (34a) is unremarkable. The left-branching model in (34b) creates an intermediate node that groups together the vowel and the immediately following consonant, which is thereby distanced from the final consonant. For convenience, this intermediate node will be called the *nucleus*, although this term tends to be commonly associated only with vocalic elements. The right-branching model in (34c) has at its core a coda node that ties the two consonants together and sets them off from the vowel.

It is a notable fact that proponents for all three models of rime structure can be found in the pertinent literature. The flat model is countenanced by Halle & Vergnaud (1980) and Treiman (1983) who accept the onset-rime distinction but assume no further structure of the syllable. Although there is nobody who has advocated the left-branching structure in (34b) as a general model for the rime, several researchers argue that (34b) is the correct model for vowel-liquid-consonant sequences, though not for others (e.g., Stemberger, 1983b; Shattuck-Hufnagel, 1983; Treiman, 1984; Berg, 1989b). They thus opt for a mixture of left- and right-branching in the rime. Consistent right-branching is propounded by MacKay (1972), Selkirk (1982a), and Vincent (1986).[23]

Empirical evidence for or against any of the models in (34) is much scantier than in the case of the syllable. There are at least three arguments that can be brought to bear on the issue—phonotactic, speech error, and experimental data. Before each of these is examined in turn, a general remark may be in order. VCC sequences are inherently asymmetrical in that they consist of one vowel and two consonants. This fact alone might be taken to prejudge the issue in favour of right-branching because two adjacent consonants arguably form a more natural unit than a vowel–consonant sequence. This reasoning is predicated on the assumption that phonological similarity is a determinant of the structural representation.

As is well-known, the distinction between consonants and vowels is a gradual rather than a categorical one. Consonants may be more or less vowel-like, and vowels may be more or less consonant-like. One parameter that spans both major sound classes is sonority (see section 2.5.1.6). This notion allows us to express similarity relationships at a more fine-grained level and opens up the theoretical possibility that the phonological difference between a consonant and a vowel may be less than that between two consonants because the former pair differs less in sonority than the latter. Consequently, a sonority-based approach might favour left-branching under special circumstances. Most usually, though, it would support right-branching as the sonority difference is generally higher between a consonant and a vowel than between two consonants.

Let us begin with the phonotactic argument. According to familiar logic, the three models of the rime can be differentiated as follows. The flat model predicts that phonotactic restrictions are equally strong (or weak) between V and C_1 as between C_1 and C_2. Stronger restrictions between V and C_1 than between C_1 and C_2 are predicted by the left-branching model whereas the right-branching structure makes the opposite prediction.

To arbitrate among the rival models, recourse was had to the same corpus on which Table 2.6B was based. This is the complete set of monosyllabic words (including homophones) listed in the CELEX database. For each C_1, the number of different vowels to its left as well as the number of different words with this structure were determined. By the same token, the number of different consonants to its right as well as the number of different words with this structure were calculated. The results for each C_1 were added together and averaged and are shown in Table 2.8. In the light of the earlier discussion, special attention was paid to the liquids. The results for the lateral as C_1 are presented separately in Table 2.8. However, no consideration could be given to the rhotic as postvocalic /r/ is not pronounced in Standard British English.

To fully understand Table 2.8, it is necessary to know the maximum number of Vs and C_2s that may flank C_1. For vowels, this number is identical

Table 2.8 Phonotactic Structure in the VC_1 and the C_1C_2 Domains

Number of Words	*Number of Vs*	C_1	*Number of* C_2*s*	*Number of Words*
364	14.2	all	3.6	112
688	20	/l/	13	228

to the total number of vowels as the group of vowels occurring in open syllables is a subset of the group of vowels occurring in closed syllables in English. By contrast, the number of consonants that may take the second position of postvocalic clusters is lower than the total number of consonants. Only about half of the consonants (13 out of 24) may appear as C_2. This is the first piece of evidence to suggest that the phonotactic constraints are generally tighter in the coda than in the nucleus domain (as defined in [36]). As mentioned before, a likely explanation of this difference is the higher degree of similarity between C_1 and C_2 than between V and C_1. There is a wide-spread tendency to the effect that the adjoining of highly similar phonemes is discouraged in language (see Trnka, 1936).

We may now turn to Table 2.8. As can be seen, 14.2 different vowels may precede C_1 whereas only 3.6 different consonants may follow C_1 on an average. This shows that the likelihood of combining two phonemes and hitting on an attested sequence is much higher for V and C_1 than for C_1 and C_2. In other words, C_1 is much more selective in its choice of C_2 than in its choice of V. The token frequency analysis confirms this hypothesis. These results are most naturally accounted for by the right-branching model (34c).

The case of /l/ is remarkable. Table 2.8 demonstrates that it combines with all vowels and all consonants that may occur as C_2. What Table 2.8 does not show is that /l/ is the only consonant to have such a versatility. All other consonants in C_1 position are much more restrictive in terms of the consonants that may follow them. Thus, the phonotactics of /l/ is clearly different from that of the other C_1s. Because the lateral imposes specific restrictions neither to its left nor to its right, it is not justified to assign it to the coda as was done for the other consonants. Instead, the phonotactic argument leads us to conclude that the flat model (34a) is appropriate for vowel-liquid-consonant sequences.

The next analysis is based on naturalistic speech errors. As noted before, single-segment slips by far outnumber segment sequence slips. This appears to be true for all three components of CVV rimes, as exemplified in (35)–(37).

(35) to the s*a*nd of the samba. for: the s*ou*nd. (from Trevor Harley, unpublished)

(36) made out of si*n*k and have a plu*n*ging top. for: out of si*l*k. (from Trevor Harley, unpublished)

(37) on the to*f* shel*p*. for: on the to*p* shel*f*. (from Fromkin, 1973)

The vowel is misordered in (35), C_1 in (36) and C_2 in (37). The ousting of single segments from VCC sequences justifies what might seem an obvious claim: Each of the three constituents of the rime occupies a slot of its own.[24]

Turning to sequence errors, we should note the extreme uncommonness of (final) consonant cluster slips. It is not quite clear how this rarity comes about. It might point to a low degree of cohesion between C_1 and C_2. Alternatively, it might be the joint result of two error types that are uncommon individually. Cluster errors and coda errors are by far less frequent than single-segment slips and onset slips, respectively. The combined effect might lead to the extreme infrequency of coda cluster errors.

VC_1 slips are also not frequent, though they seem to occur more frequently than C_1C_2 slips. The great majority of these involve liquids as C_1. Refer to (38) and (39), both of which are from speakers of American English.

(38) Is the m*er*k b*il*ning? for: Is the milk burning? (from Shattuck-Hufnagel, 1983)

(39) f*ar*t very h*i*de. for: fight very hard. (from Fromkin, 1973)

In (38), the rime in *milk* is split up before C_2, leaving V and C_1 as a unit. The same description applies to (39) in which the vowel and the rhotic are jointly dislodged. Vowel + liquid combinations are quite cohesive not only in various English error samples but also in my German corpus. However, this high degree of cohesion is restricted to vowel-liquid sequences. Vowel-nasal structures are much less cohesive, as suggested by the low number of such errors. Vowel-obstruent combinations rank lowest on the frequency and cohesiveness scale.

Exactly the same result was obtained by Treiman (1984) in several experiments. She had subjects blend two VC_1C_2 structures together and systematically varied the phonological nature of C_1. When C_1 was an obstruent, the breakpoint was twice as likely to occur after the vowel than after the first consonant. When C_1 was a nasal, the two breakpoints were about equiprobable, with a slight but nonsignificant advantage for the V-C_1C_2 split. When C_1 was a liquid, the pattern was reversed. In two (out of four) of her experiments, the liquid associated itself significantly more closely with the preceding vowel than with the following consonant.[25] The same hierarchy of "vowel-stickiness" was obtained by Derwing, Dow, & Nearey (1988).

At first glance, it appears difficult to accommodate all these findings within a single structural pattern. Treiman's results would seem to suggest right-branching for V-obstruent-C_2 sequences, flatness for V-nasal-C_2 sequences, and left-branching for V-liquid-C_2 sequences. However, this proposal is not without its problems. First and foremost, it has at its core a dependency between content and structure in that the phonological nature of C_1 determines the structural representation. Such a dependence is generally undesirable because it increases the complexity, and decreases the productivity, of language. The greater the independence between content and structure, the better the processing system can perform its job. There is a further problem to be noted. If the liquid in the medial position of VCC sequences is associated with the vowel, how should the liquid in a two-member rime such as /æl/ in *pal* be analysed? There is evidence to suggest that the rime-final liquid does *not* belong to the nucleus but to the coda of the syllable. In speech errors, for example, the rime-final /l/ is much more frequently dissociated from the preceding vowel than not, as shown in (40). This is true for both Stemberger's and my own corpus.

(40) bi*ll*—big ba*ll*room. (from Stemberger, 1983b)

If this hypothesis is correct, the association of /l/ with sites in the suprasegmental structure would be context-dependent. The liquid would be assigned to the nucleus in VCC rimes but to the coda in VC rimes. Although there is nothing to rule out this possibility categorically, it conflicts with the assumed independence between content and structure.

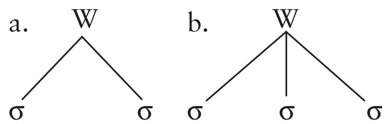
In view of these criticisms, one wonders whether there is an alternative to the proposal just discussed. Thus far, cohesiveness has been assumed to be determined by syllable structure. However, as alluded to in this proposal, it may also be influenced by sonority. The claim is that the smaller the difference in sonority between two adjacent phonemes, the greater their cohesiveness. The varying cohesiveness of C_1 with the preceding vowel or the following consonant may accordingly be attributed to the varying sonority of C_1 and consequently to the varying sonority difference between V and C_1 as well as C_1 and C_2. As liquids are very sonorous, they are tied to the preceding vowel. Inversely, the fact that obstruents have a low sonority value explains why they distance themselves from the preceding vowel and associate themselves with the following consonant. Because nasals have a sonority value between liquids and obstruents, they are indeterminate in their affiliation with the preceding and the following phoneme. The sonority hypothesis thus seems to elegantly account for the variable behaviour of VC_1C_2 sequences. If true, the implication would be that the rime has a flat structure. That is, the flat model is appropriate for all rime types irrespective of the nature of C_1. The difference in cohesiveness is solely brought about by sonority. At the same time, the suprasegmental structure as a general principle is not considered irrelevant. It does exist, but because it is flat in this particular area, it allows sonority to take over and shape both the phonotactic and the error patterns. In this way, all of the data can be accounted for by a single structural option.

To summarize, a case has been made for a flat representation of three-member rimes. The variability that is observed with the differing rime types is ascribable to the influence of sonority that regulates the alliances that the middle phoneme C_1 contracts with its immediate neighbours to the left (V) and right (C_2). Branching direction effects cannot be independently established.

2.5.3 Polysyllabic Words

Whereas the preceding subsections looked at structure below the syllabic level, the following section addresses the same issue above the syllabic level. This domain is important because it takes all words, irrespective of their length, into consideration. Surprisingly, this area has been severely neglected in previous work. Phonologists have either focused their attention on monosyllabic words and thereby eschewed the problem altogether or they have "solved" the problem by assuming a level of syllable nodes and a flat organization above it. In fact, this may justly be regarded as the received view, as found in standard textbooks on phonology (e.g., Hogg & McCully, 1987; Goldsmith, 1990; Spencer, 1996), even though it has never been properly defended. It is diagrammed in (41) for di- and trisyllabic words. To avoid complications introduced by non-initial stress, words are assumed (for the time being) to have first-syllable stress.

(41)



It should be emphasized that two quite strong claims are embodied in (41) although they have hardly ever been made explicit. The first is that at one phonological stage, language is represented as a sequence of syllables. Ignoring the status of these units in terms of the content–structure distinction, this view appears to be adopted as a default solution. That is to say, given that syllables are generally believed to be necessary for the description of language, they are linearly arranged. However, it is anything but clear that such a linear arrangement rightly deserves the status of a default option, considering that it is not even clear whether syllables are needed at this particular level of representation.

The other claim embodied in (41) is that there is no intermediate representational level between the word node and the syllable nodes. Phonologists have introduced the foot mainly in an attempt to deal with stress phenomena. But, as typically defined, this notion denies internal structure in dactyls (i.e., a stressed syllable followed by two unstressed ones), which are quite common in English. Words like *mimicry* for example consist of a single foot and therefore have a flat organization of their constituent syllables. What makes a flat structure open to suspicion is, above all, its exceptional status. The fact that no positive evidence has been adduced in its favour only serves to increase the scepticism toward this option.

What are the alternatives to the flat model in (41)? A radical proposal would be to do without the syllabic level altogether. This would imply the immediate dominance of the syllable constituent nodes by the word node. The disappearance of the syllable level might, or might not, be accompanied by the introduction of new representational levels.

The central issue is the location of the major breakpoint. The flat model in (41) is quite explicit about this. As the syllables are immediate constituents, it predicts that the major breakpoint coincides with a syllable boundary. This is straightforward in the case of disyllabic words where there is only one. For trisyllabic items, two major breakpoints would have to be postulated. If these two breakpoints have the same status, trisyllabic words are expected to be broken up with equal frequency at the first and the second syllable boundary.

Slips of the tongue provide an excellent source of data to test these predictions. In particular, blend errors are ideally suited to determining preferred breakpoints as they involve the recombination of a part of one word with a part of another. Berg (1989a) carried out an in-depth analysis of blends in his German database. He found 80 slips in which the interacting words shared the same number of syllables and were polysyllabic. Astonishingly, there was only a singleton case among the 80 errors in which the break occurred at a syllable boundary. It is given in (42).

(42) Iese (*I*gel/ Ha*se*)
[iːzə iːgɛl haːzə]
'hedgehog/hare'

The simplest description of this tongue slip is that the /iː/ from *Igel* was combined with the /zə/ from *Hase*. As these parts form syllables, the most probable breakpoint is the syllable boundary. Although *Igel* is a vowel-initial word, (42) cannot be treated as a vowel substitution error because this interpretation would leave the disappearance of the glottal fricative unaccounted for.

The main point in the present context is that polysyllabic words are not normally split at the syllable level in malfunctions. This is as true of disyllabic words, which form the clear majority in the corpus, as it is of trisyllabic words. This leads us to a very important conclusion. Syllables are not the immediate constituents of polysyllabic words. The representations in (41) are therefore misconceived. With the disappearance of the syllable level, the issue of the organization of the syllable nodes loses its meaning.

So far, the result has been negative. We know where the breakpoints are not, but not what the immediate constituents of polysyllabic words are. The remaining 79 tongue slips provide an answer to this question. Almost two thirds of these show a break between the word-initial consonant(s) and the remainder of the word, named the superrime (see section 1.3). The German example given in (43) is supplemented by an analogous English one in (44).

(43) Je leiter— weiter der Abend fortschreitet. (*l*änger/w*eiter*)
[laɪtɛr vaɪtɛr lɛŋgɛr/vaɪtɛr]
'The further the evening progresses'

(44) stummy (*st*omach/t*ummy*; from Fromkin, 1973)

Case (43) illustrates the merging of the two competitors *länger* and *weiter* into *leiter*. That is, the onset of the one was combined with the superrime of the other interactant. The same description applies to the English example in (44). An alternative analysis in terms of an addition of the /s/ to *tummy* is extremely unlikely in view of the high degree of cohesion of the consonants within the word-onset cluster in *stomach*.

What about the remaining third? The largest single subcategory is constituted by vowel slips such as (45).

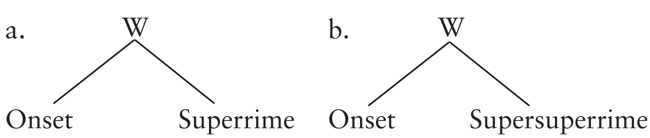
(45) Ich mocker— mecker auch nicht den ganzen Tag
[mɔkɛr mɛkɛr
rum. (meckern/motzen)
mɛkɛrn mɔtsən]
'I don't complain all day long either.'

The fact that the blending of the two verbs *meckern* and *motzen* results in a vowel substitution is not a coincidence. Significantly, the great majority of these vowel substitutions occur in blends whose interactants have the same onset consonants, as in (45). This suggests a causal relationship between identical onsets and the incidence of vowel substitutions. The link is that interactions between identical units are logically impossible in a representational system that is type-based (i.e., in which there is only one bilabial nasal subserving the onsets of both *meckern* and *motzen*; Stemberger, 1985).

The upshot of the preceding discussion is that vowel errors require a special linguistic constellation to arise. They should not be taken as evidence for a specific structural model. The onset-superrime boundary emerges as the default option that is resorted to when the linguistic constellation allows it. If it does not, the onset-superrime boundary may be overridden by other breakpoints that are, however, inherently less likely. Thus, the primacy of the onset-superrime boundary is not called into question by such blends as (45).

We are now in a position to replace the representations in (41) with those in (46).

(46) a. b.



The major claim in (46) is that the structural representation divides polysyllabic items into a consonantal onset and the remainder of the word. To distinguish between the remainder of disyllabic and trisyllabic words, the former are referred to as *superrimes* and the latter as *supersuperrimes*. The internal structure of the superrime cannot be examined in great detail on the basis of the above speech error data because the onset-superrime boundary is so prevalent. We will return to this issue below. Whatever its internal structure, it is clear that the onset-superrime division renders polysyllabic words right-branching. Although the data on which this conclusion is based mostly come from German, there is little reason to suspect that representation (46) is not applicable to English. From what can be gathered from the blends that have been published in the pertinent literature, syllabic breakpoints are also disfavoured in English.

Given that the superrime has been established as a psycholinguistically relevant unit, it is to be expected that it is also required as a descriptive linguistic unit. This is in fact the case. An analysis of all the reduplicated forms listed in the DCE reveals basically three types of reduplications—vowel-alternating, rime-based, and superrime-based. Two examples of each are offered next. This classification ignores the reduplication of full words such as *wee-wee*.

(47) a. zigzag b. wishy-washy

(48) a. nitwit b. hotch-potch

(49) a. nitty-gritty b. namby-pamby

It turns out that the superrime-based cases are in the clear majority. Hence, the superrime emerges as the major descriptive unit on which reduplication is built. Supersuperrimes may also be involved, as in (50), though very rarely so probably because trisyllabic words are much less common than disyllabic ones.

(50) higgledy-piggledy

Thus, the length of the word determines which rime type is chosen. This generalization attests to a major parallelism between rimes and superrimes. Recognizing the rime, as is widely done, entails the recognition of the superrime (as well as the supersuperrime).

A further line of evidence comes from versification. The argument from poetic rhymes that was taken as support for phonological rimes (see section 2.5.1.8) extends naturally to superrimes and supersuperrimes. Whereas monosyllabic words rhyme on the basis of rimes, polysyllabic words rhyme on superrimes and supersuperrimes. These are the so-called feminine rhymes, as illustrated in (51) and (52).

(51) What is glory?—in the s*ocket*
. . .
What is pride? A whizzing r*ocket*. (William Wordsworth, Inscriptions)

(52) Now and then bending towards me a glance of w*istfulness*,
. . .
And in the bearing of each a passive tr*istfulness*. (Thomas Hardy, Night in the Old Home)

The poetic rhyme is co-extensive with a superrime in (51) and a supersuperrime in (52). It is important to stress the typicality of these examples. Poetic rhymes always rely on identical rimes and superrimes. If not, they just do not count as perfect rhymes. It fits in neatly with the previous discussion that rhymes based on syllable identity are disallowed.

Experimental evidence bearing on the internal structure of polysyllabic words was produced by Treiman and co-workers (Fowler, Treiman, & Gross, 1993; Treiman, Fowler, Gross, Berch, & Weatherston, 1995). They employed a phoneme shift task in which subjects were instructed to shift a prespecified phoneme (or phoneme sequence) from the second word to the corresponding position of the first word of nonsense two-word stimuli. Treiman et al. systematically varied the position of the phoneme to be moved and measured reaction time and response accuracy as indicators of the difficulty that the task caused. The underlying assumption was that more deeply embedded phonemes should be harder to dislodge than less deeply embedded ones. The ease with which the task could be performed was thus presumed to reflect syllable and word structure.

Fowler et al. (1993) found that the first phoneme in disyllabic words could be moved out of position more easily than the other consonants, suggesting that the word onset has a special status in disyllabic words, as claimed in (46). Because it is least integrated into the suprasegmental structure, it can be moved quite easily. In subsequent work, Treiman, Mullennix, Bijeljac-Babic, & Richmond-Welty (1995) found an effect of syllable structure in the superrime. The onset of the final syllable was more mobile than the coda of the initial syllable. Also, the rime of the second syllable was manipulated more quickly and more accurately than its body. These findings suggest that the superrime is made up of two rimes and an onset. Remarkably, the data remain neutral as to whether a syllable node is part of the superrime. They thus are compatible with both of the following representations.

(53) a. b.

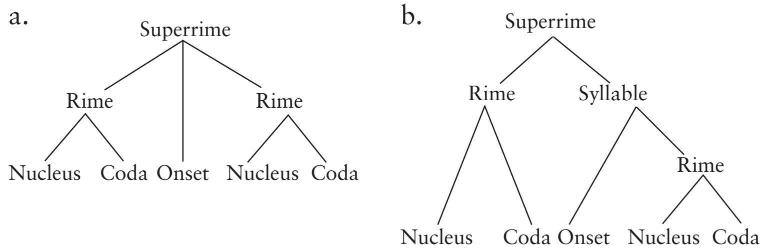


Diagram (53a) postulates a flat structure in that the superrime branches into rime$_1$, onset, and rime$_2$. By contrast, the superrime is more nearly right-branching in (53b) because the syllable node leads to a deeper embedding than the left-hand rime node. It may be argued that (53a) is the more consistent representation as it does without syllables altogether. Diagram (53b) is less consistent in that it assumes a holistic (i.e., syllabic) representation of the second syllable but an analytic (i.e., nonsyllabic) representation of the first syllable in disyllabic words. However, since Treiman et al. did not examine the manipulability of the final syllable, its status can at present neither be proved nor disproved.

In disyllabic words, it is impossible to disentangle word from syllable structure effects because word edges overlap with syllable edges. The clearest case where such a disentanglement is possible is the medial syllable in trisyllabic words, which is unaffected by word edge effects. This is why Fowler et al. (1993) focused on this position in their other experiments. Using the same task, they uncovered an advantage for the onset consonant over the coda consonant as well as an advantage for the rime over the body in the medial CVC syllable of trisyllabic nonwords. This syllable, then, behaves exactly like monosyllabic words and may be claimed to be hierarchically right-branching. This finding was replicated by a different method in a further experiment.

The picture is still sketchy for trisyllabic words. Fowler et al.'s test items all had the stress pattern "unstressed-stressed-unstressed." In view of Cutler & Norris's (1988) hypothesis that the stressed syllable is interpreted as the beginning of a word, this stress pattern likens trisyllabic words to disyllabic ones in that the former are construed as the latter plus a preceding unstressed syllable. This similarity allows us to propose one possible reason for the syllable structure effects that Fowler et al. observed in the medial syllable. These may be linked to the fact that this syllable carries the main stress. A possible implication would be that syllable structure effects are more likely to emerge in stressed than in unstressed syllables. Following up on this similarity, one would expect the final syllable of trisyllabic words to behave like the final syllable of disyllabic items. That is, it should have a right-branching structure and itself be part of the superrime, which has the onset of the stressed medial syllable as its sister constituent. This in turn raises the issue of the status of the node that dominates the onset and the superrime. One possibility would be to identify it as a foot. The internal structure of the unstressed initial syllable is less clear. It is also not known whether trisyllabic finally stressed words know superrimes or even supersuperrimes.

2.5.4 Conclusion

Three phonological tripartite patterns have been investigated from the perspective of their internal structure. Two provided very strong evidence for right-branching whereas the other was compatible with the flat-structure assumption. Why is it that a hierarchical representation is built up in some areas but not in others? One difference among the three patterns is their frequency. Very many polysyllabic words have initial stress and a consonantal beginning, hence, an onset and a superrime as their immediate constituents and very many monosyllabic words have a CVC structure, hence an onset and a rime as their immediate constituents. In stark contrast, few words (or syllables) possess clustered codas. Succinctly put, these higher units occur more frequently than these lower units. From this observation, the following hypothesis may be developed. The unfolding of a structural representation is a frequency-sensitive process. It makes perfect sense that the more efficient strategy is used with the more frequent patterns. However, it is not always used because it is not for free, given that it requires the creation of additional nodes. Less frequent units such as rimes with coda clusters are consequently generated under a flat representation.

Flatness thus appears to be the default production scheme. As it represents the simplest structure, it is always resorted to unless there is reason to reject it. By contrast, hierarchicalness is the more complex strategy that is invoked when the default option proves insufficient. As was noted at the beginning of the present chapter, a hierarchical structure is better able to perform the difficult task of concurrently planning and executing an utterance. There is thus a trade-off between processing efficiency and representational complexity. When less processing efficiency is required, representational simplicity prevails. However, when more processing efficiency is required, the representational complexity has to be increased.

It is now possible to resolve a paradox that was addressed in Berg (1994b). Sonority was found to determine the cohesiveness of rimes (VC) though not of bodies (CV). Taking for granted that sonority is a general principle that influences the nature of phonological representations, it should produce across-the-board effects. So when it is found to apply inconsistently, it loses much of its explanatory value. However, there is no reason to question the importance of sonority. The only claim that has to be made is that sonority is subordinated to syllable structure. There are two senses in which syllable structure constrains sonority. As argued in Berg (1994b), sonority has an effect only when the two adjacent phonemes belong to the same structural unit. This explains the ineffectiveness of sonority in CV syllables (given the right-branching nature of English syllables). The second way in which syllable structure may impinge on sonority is hierarchicalness. When the internal structure of a constituent is hierarchical, a bias is introduced that may work against sonority. However, when the internal structure is flat, sonority may unfold in unrestrained fashion. Two noteworthy predictions of this hypothesis are that sonority effects should emerge in the CV portion whenever the structure of the CVC syllable is flat and that even stronger sonority effects should be found in bodies in left-branching languages.

2.6 CONCLUSION TO CHAPTER TWO

The major result of this chapter can be quickly summarized. English is a predominantly right-branching language in all its major components. These include the syntactic, the morphological, the phonological, and the phonetic level. The postulation of a phonetic rime enlarges the core areas of syntax, morphology and phonology, in which branching direction has so far been investigated, by a fourth area.[26] This is a significant finding in that right-branching can now be argued to be not only a property of linguistic programming but also of phonetic implementation. Clearly, the boundary between these two components is fuzzy, so similar strategies or design principles might not seem surprising. However, this parallelism is quite remarkable in view of the fact that abstract, high-level processing is subject to very different constraints from concrete, low-level processing. Three aspects of the major result of this chapter are worth commenting on: the cross-level consistency, the non-absolute nature of branching direction, and the status of the counterexamples. Let us examine each in turn.

The consistency among the various linguistic levels in terms of branching direction is highly remarkable. An appropriate label for this type of consistency is the *cross-level harmony constraint* (see Berg, 2000). This constraint is reminiscent of Anderson's (1992, 2004) principle of structural analogy (see also Böhm [1993], Völtz [1999], and Carstairs-McCarthy [1999]) and more particularly of Dryer's (1992) branching direction harmony constraint that states that individual languages tend toward a consistent branching direction. While Dryer meant it to refer to different ordering types within the syntactic arena, it is understood here in a considerably wider sense, crossing the individual linguistic levels. Also, cross-level harmony is a stronger claim than branching direction harmony because more variation may naturally be expected between levels than within one and the same level. If each level was assumed to operate in complete isolation, such a result could hardly be predicted by chance. It is much more likely therefore that the individual levels are integrated into a network that facilitates communication between them. The decisions taken at one level seem to be influenced by those taken at another.

The predominance of right-branching does not require much discussion. It is exactly in line with the prediction formulated at the beginning of this chapter. Its explanation is assumed to be rooted in the differential processing ease associated with the two branching directions. Because right-branching provides for a better interlocking of planning and execution, it is preferable to left-branching. The fact that English has gone for right-branching may thus be regarded as a natural choice in that it minimizes processing effort.

This explanation sounds as if right-branching should be the preferred option in every single case. However, this is certainly counterfactual. In both syntax and morphology, there are clear cases of left-branching (e.g., PPs with postpositions in syntax and stem-suffix-stem sequences in morphology). This shows not only that the branching-direction decision is a probabilistic one but also that left-branching is not a totally unattractive option. Although some cases might be explained away as minor exceptions, as with PPs with postpositions, others, such as stem-suffix-stem combinations, are both systematic and frequent. A comprehensive explanation for branching direction must take these facts into account. Three aspects should be considered for a proper evaluation of the left-branching cases. Even though these aspects cannot predict the occurrence of left-branching in every case, they may contribute to identifying some of the factors that appear to play a role in the branching-direction decision.

The first point is that even if a branching-direction preference has established itself, its power remains limited. This can be most clearly seen when it competes with, and loses to, other forces. To illustrate, let us pick out the example of stem-suffix-stem sequences. It is undisputed that these morphological complexes are to the speaker's advantage in that they fulfil the typical criteria that make compounding such a serviceable process (e.g., conciseness). If branching direction was deterministic and the decision in favour of right-branching, such patterns could never arise. It is immediately obvious that such a determinism would cripple the production system. It is counterproductive to have a processing system that prevents speakers from expressing with a minimum of effort what they want to express. Therefore, it is clearly desirable to have a system in which branching direction is subordinated to the freedom of morpheme combination. More generally speaking, the processing system is all the more powerful, the better it is able to preclude branching direction from jeopardizing its flexibility or adaptability to the speaker's needs.

The second point may serve as an explanation for the first. It may be that both right- and left-branching find their place in the same system because the difference in processing difficulty that is entailed by them is not always that large. This claim is not entirely ad hoc. Bach, Brown, & Marslen-Wilson (1986) presented experimental evidence to the effect that various types of branching direction and dependency were equally easy to process at low levels of syntactic complexity. However, at higher degrees of complexity, right-branching turned out to be easier to process than left-branching. The linguistic patterns that were subjected to analysis in the present chapter all have a relatively simple structure. Each pattern consists of only three adjoining parts that form a structure with only one level of embedding. It is therefore entirely expected that these structures principally allow both branching directions. The fact that left-branching is a dispreferred option does suggest, however, that there is a certain gain in processing efficiency for right-branching even at low levels of complexity.

This hypothesis may be substantiated by the third point, which leads us to a comparison of the right- and left-branching patterns. One of the key results of this chapter is that the left- and right-branching cases are not randomly distributed. Earlier on, a distinction was introduced between hierarchically higher and more frequent as opposed to hierarchically lower and less frequent patterns, here referred to as major and minor, respectively. For example, SVO sentences in syntax and prefix-stem-suffix complexes in morphology are treated as major patterns but ditransitive verbs and stem-stem-stem sequences as minor ones. It is well-known that the processing system is highly sensitive to frequency (Hasher & Zacks, 1984). It stands to reason therefore that the processing system implements its biases in those areas where it is of maximum utility. This is of course the high-frequency range. As the low-frequency range matters less, the system's interest in enforcing right-branching is more limited and, as a consequence, left-branching and flatness may play a more important role than in the major patterns.

Summarizing, a fairly strong case can be made for right-branching in English. This branching-direction preference is consistent in that it emerges at various linguistic levels. It is a probabilistic bias that co-exists with several cases of left-branching. It is remarkable that both the predominance of right-branching and the counterexamples occur at all analytical levels, though with one important exception. The lowest level (i.e., the phonological one), provides no clear cases of left-branching. This might suggest that the resistance to the dispreferred branching direction increases as we go down the linguistic hierarchy. This leads us to the possibility that each level may not be equally susceptible of erecting hierarchical representations. This susceptibility will be the topic of the next chapter.

3 Level-Specific Differences in Hierarchicalness

3.1 INTRODUCTION

A key claim of the theory sketched in the opening chapter is that structural representations are gradually erected in the language production process and that this build-up may come to a halt at any point on the activation scale. Thus, structural representations may reach various degrees of hierarchicalness. The major purpose of the present chapter is to examine the potential interaction of degrees of hierarchicalness and position of level in the linguistic hierarchy. Because the constraints operating at the various levels are not identical and because the build-up of structure is a drain on mental resources, it is quite possible that different levels require different degrees of hierarchicalness.

A major disparity between flat and hierarchical representations is the way in which the risk of interference is dealt with. In a typical flat structure, the three subordinate units receive about the same amount of activation from the superordinate unit. Consequently, their high degree of co-activation makes them prone to interference. Specifically, the likelihood of a misordering error is enhanced. By contrast, in a hierarchical structure, activation is spread less evenly to the subordinate units. For example, the degree of co-activation of the upcoming elements at the moment of selecting the current unit is lower in a right-branching than in a flat structure. Thus, error probability is lower on the former than on the latter strategy.

Related to the increase in activation difference in hierarchical systems is a heightened dissimilarity between linguistic units. These are all represented alike in flat structures. Hierarchical organizations, by contrast, distinguish among their low-level elements through variable dominance relationships. This distinction may be expressed by using different structural labels for different units such as onset and coda. Thus, hierarchical structures have the effect of making two units more dissimilar. An onset and a coda consonant are representationally more different from each other than two plain consonants.

The more similarity there is, the more competition in the system. The stronger the competition is, the greater the need for hierarchical representations as a safeguard against malfunction. If the various linguistic levels could be shown to differ in their strength of competition, we would have a rationale for predicting different degrees of hierarchicalness at different linguistic levels.

3.2 LEVEL-SPECIFIC DIFFERENCES IN COMPETITION AND THEIR PROCESSING CONSEQUENCES

Competition is mainly a temporal problem. It arises through the near-simultaneous availability of a set of competitors (i.e., elements competing for the same slot). As is well-known, temporal constraints differ quite radically from level to level. Given a fixed time frame, the number of decisions about unit selection is lowest at the syntactic, higher at the morphological, and highest at the phonological level. This relationship between number of selection decisions and hierarchical position of linguistic level is principally a function of varying unit size. The hierarchically more important units have a longer duration than the less important ones. The phonetic realization of phonemes is between 50 and 200 ms. (Crystal & House, 1988), syllables take about 200 ms. on an average, and words between 100 and 1000 ms. (Deese, 1984). The higher the number of decisions is to be taken within a certain time span, the greater the processing strain. It may accordingly be claimed that the processing strain is greatest at the phonological, smaller at the morphological, and smallest at the syntactic level.

Note that processing decisions are not confined to the selection process. After selection, a unit undergoes self-inhibition and subsequently rebounds for a limited period of time before its eventual return to resting state (MacKay, 1987). All these phases are prone to error and tap the speaker's resources. It stands to reason that the faster these processes have to be executed, the more tightly they have to be organized and controlled.

The variable size of linguistic units does not only have an effect on the number of decisions that have to be taken per time unit but also on the strategies of advance planning.[1] Because the lower-level units have to be produced in quicker succession than the higher-level units, the degree of co-activation of upcoming units is expected to be higher in phonology, lower in morphology and lowest in syntax. Assuming that the build-up of activation on a node takes time, the efficiency of the language production device is enhanced by boosting soon-to-be-outputted units closer to threshold than those that are needed only later. Co-activation is the principle underlying competition. Processing at the phonological level may therefore be argued to be more competitive than at the morphological level, which in turn is more competitive than at the syntactic level.

The varying strength of competition is further increased by general differences in similarity between the elements at different linguistic levels. We adopt the standard definition of similarity in a hierarchical system as involving identity at a lower level. For example, the elements of a given pair of phonemes are similar because they have certain phonological features in common. It is well-known that the number of elements per level correlates with the position of the level in the hierarchy. Low numbers are found at lower levels, high numbers at higher levels. It is a rule of simple logic that the fewer elements there are, the greater the likelihood of their being similar. For instance, given the lower number of phonological than semantic features, any two phonemes will generally be more similar to each other than any two words. Because two similar units have a higher degree of co-activation than two dissimilar ones and because co-activation induces competition, we arrive at the same conclusion as stated before: There is more competition at the phonological, less competition at the morphological, and least competition at the syntactic level.

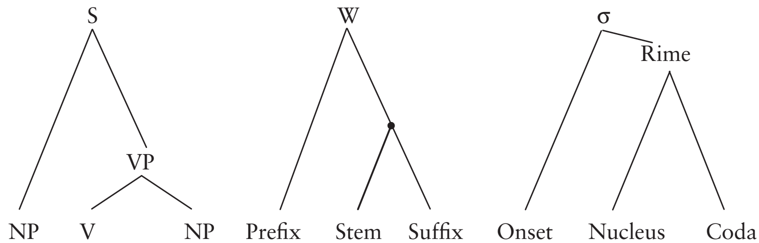
We note as a side effect that a low number of units increases the probability of using the same element again. And indeed, the repetition of phonemes in morphemes or words is much more frequent than the repetition of words in phrases or sentences. Re-using an element within a short period of time is known to strain the processing system (Stemberger & MacWhinney, 1986). This is an additional piece of evidence for the claim that processing is more difficult at the lower than the higher levels of analysis. It might be added that the processing problem is not restricted to identical elements. Also the repetition of similar elements taxes the capacity of the production device. Because, as argued earlier, two phonological units are generally more similar than two lexical units, there is more competition at the former than at the latter level.

It has repeatedly been argued that the production of a linguistic unit has a long-lasting effect on the processing system, however minimal it may be. A standard claim in connectionist theorizing is that the strength of the linkage between any two nodes is increased when they support a particular output. For reasons outlined previously, connections at the lower levels are more frequently used than those at higher levels. To illustrate, the connection between /p/ and [bilabial] is more often needed than that between *philosophy* and /f/. Hence, connection strength is greater in the former than in the latter case. The general claim is then that connection strength decreases with the height of the position of a level in the hierarchy (compare MacKay, Burke, & Stewart, 1998). As connection strength is a determinant of activation levels, this principle further cements the hypothesis that competition is stronger at the lower than at the higher levels.

The processor's reaction to this challenge can be easily predicted. It may be expected to reduce the degree of co-activation at those levels where it is highest, that is, more at the phonological than at the lexical level. As explained earlier, co-activation is diminished by imposing a hierarchical production scheme.

The aforementioned level-specific differences in competition imply that there is a greater need for hierarchical structuring at the phonological than at the morphological and syntactic levels. The consequent prediction is that, generally speaking, phonological structure is more hierarchical than morphological structure, which in turn is more hierarchical than syntactic structure. This prediction is at the core of the present chapter. It is diagrammed in (1), in line with the principles set forth in section 1.6.

(1) a. Syntax b. Morphology c. Phonology



These predictions have been cast in a "language-neutral" mould (i.e., without giving any consideration to the contingencies of individual languages). Of course, competition is not only determined by the position of a given level in the linguistic hierarchy but also by the number of competitors at any one analytical level. Naturally, a language with an impoverished morphology faces less competition at the morphological level than a language with a rich morphology. This leads to the additional prediction that the former type of language will have a flatter morphology than the latter. However, this avenue will not be explored in the present chapter.

3.3 A PRELIMINARY TEST OF THE LEVEL-SPECIFIC-DIFFERENCES HYPOTHESIS

At first sight, the hypothesis that syntactic structure is flatter than phonological structure might meet with scepticism. Isn't the syntactic representation of a sentence such as (3) in the preceding chapter a prime example of the many levels of embedding in syntax and hence of the high degree of hierarchicalness of syntactic representations? From the discussion in section 2.2, we can recall that linguistic diagrams should not be mistaken for mental representations. The high number of levels of embedding is a direct consequence of the initial assumption that all parts of a complex sentence are simultaneously available. This assumption is almost certainly wrong as a hypothesis about the language-generation process that takes place in real time and in a piecemeal fashion. So, the more piecemeal the planning is and the smaller the look-ahead, the less complex the syntactic representation in terms of branching depth. Take as an example the case of complex sentences, in which the main clause typically precedes the subordinate clause

(Diessel, 2005). The decision to generate the subordinate clause need not be taken at the same time as the decision to generate the main clause but rather during (or even after) the articulation of the main clause. As a consequence, there need not be a moment in time in the preparation of utterances where *all* nodes are activated at the same time. In view of this, linguistic diagrams such as that in (3) of the previous chapter are not reliable guides to the degree of hierarchicalness language users actually resort to in real-time speaking situations.

It should be pointed out at the outset that a test of the prediction regarding level-specific differences in hierarchicalness runs up against certain difficulties. This is because the structural representations at the various levels are so difficult to compare. We may safely argue in favour of hierarchical representations at individual levels, but it is exceedingly more difficult to claim that the same degree of hierarchicalness is at two distinct levels. Basically, there are two problems. The first is that it is very hard to determine how much hierarchicalness is needed for a certain effect to come about (which is much more demanding than the standard argument that a certain effect argues for a hierarchical representation). The second problem is that it is very difficult to compare different effects that operate at different levels in terms of their relative degrees of hierarchicalness. A way out of this difficulty is to consider phenomena that occur at more than one level of representation.

There are several types of data that allow a fairly direct comparison of the three linguistic levels under examination. As explained in the opening chapter, an empirically testable prediction of the hierarchicalness hypothesis is the degree of cohesion between two adjacent content units. The more hierarchical a particular structure, the more cohesiveness it imparts to the content units it is associated with. The assumed correlation between hierarchicalness and position of level in the linguistic hierarchy allows us to predict that phonological units are more cohesive than morphological units, which in turn are more cohesive than lexical units. This prediction will now be tested against English and German speech errors.

As shown in Chapter 1, it is extremely uncommon for two lexical units to be simultaneously involved in an error. There are only three such cases in my German database. It is less uncommon for two morphemes to act as a unit in malfunctions. It was reported in the opening chapter that Stemberger (1985) has 15 errors involving a stem morpheme plus an inflectional suffix and 3 errors involving a stem morpheme and a derivational affix. In addition, there are 9 errors involving two stem morphemes in my data collection. Although these numbers are not excessively high, they do back up the claim that two-morpheme slips outnumber two-word slips. The data further attest that two-phoneme slips occur most often. The most frequent category unquestionably is that of consonant clusters. There are 33 cluster slips in Harley's (smaller) English corpus and 55 cluster slips in mine (Berg, 1994b). As regards consonant–vowel combinations, there are 53 VC plus 4 CV slips in Stemberger's sample (see section 2.5.1.6) and 16 VC slips plus 2 CV slips in mine (Berg, 1989b). Even three-phoneme slips involving CCC onsets are attested, albeit at a very low rate. Overall, it can be seen that two-unit slips are much more often encountered at the phonological than at the morphological and lexical level. Thus, the prediction that cohesiveness (as an index of hierarchicalness) is higher at the lower levels is clearly borne out.

Another phenomenon that is observed at several (though not all) levels is coordination. It is generally recognized that coordination is indicative of flat structure whereas subordination is indicative of hierarchical structure (see Chapter 4). The consequent prediction is that the higher we move in the linguistic hierarchy, the more coordination we may expect to find. As coordination is a non-issue at the phonological level, we shift our attention to the higher levels and include the text level for a moment. The general claim is that coordination plays a larger role between sentences than within sentences and also a larger role between clauses than within clauses. This seems to be the case. de Beaugrande & Dressler (1981, p. 50) argue that sentences are fairly independent units and less easily subordinable to one another than clauses within sentences. As one piece of evidence, we may mention conjunctions that usually link clauses rather than sentences and that tend to be more subordinating than coordinating. Especially in spoken language, coordination is the prevalent technique even at the level of clause combining, as demonstrated by Kroll (1977) and Chafe & Danielewicz (1987). By contrast, in the within-clause domain, the subordination of phrases is clearly the predominant pattern.

We may carry this argument one step further and extend the analysis to the morphological level. As morphology is located below syntax in the linguistic hierarchy, we may predict coordination to be even less common in the morphological than in the syntactic domain. A notable test case is compounding, which, in principle, allows both coordinated and subordinated complexes. The latter have a modifier-head structure, and the former consist of two heads on a par with each other. This contrast may be illustrated by *poet-doctor* versus *woman doctor*. Whereas a *poet-doctor* is both at the same time and to the same degree, a *woman doctor* is above all a doctor with the additional attribute of being female (i.e., sex is subordinated to profession).

To determine the subordination/coordination ratio in English compounds, I extracted all two-member compounds beginning with <n> from the Oxford Dictionary of English. The selection of the /n-/ class was entirely arbitrary. Of the 443 compounds found, 433 (97.7%) were of the determinative and 10 (2.3%) of the copulative type. This count of copulative compounds includes reduplicative words such as *never-never* and *no-no*, which also involve coordinated elements. The overwhelming predominance of subordination bears out the aforementioned prediction. The further down we move the linguistic hierarchy, the greater the ban on coordination as an index of flatness.

A further linguistic phenomenon that involves the syntactic and the morphological level though not the phonological one is gapping. Because this process is not attested at the morphological level in English, German allows more insight into possible hierarchical effects. The general prediction is that gapping will be more frequently found at the syntactic level, less frequently at the morphological, and least frequently at the phonological level. This is an immediate consequence of the different degrees of cohesion at the various levels. The higher the level in the linguistic hierarchy and the lower the cohesiveness of the units at this level, the easier it is to delete one of them. Consider the following examples.

(2) Maren spielte Horn und Florian Bass.
'Maren played the horn and Florian the bass.'

(3) be- und entladen
'load and unload'

(4) brüder- und schwesterlich
'brotherly and sisterly'

The syntactic level is involved in (2) and the morphological level is the focus of (3) and (4), with (3) evidencing prefix deletion and (4) suffix deletion. Although there are relatively few restrictions on the gapping of words, bound morphemes are much more reluctant to undergo deletion. Interestingly, there is a clearcut difference between (3) and (4). Prefix deletion is certainly more common and acceptable than suffix deletion. This difference in acceptability follows from the varying degrees of cohesiveness between prefix-stem and stem-suffix sequences and therefore provides additional support for the right-branching analysis of prefix-stem-suffix structures offered in Chapter 2 (though from a different language).

Thus, there is an interaction between the frequency of gapping and the position of the linguistic level at which gapping occurs. The probability of gapping decreases as we move down the linguistic hierarchy. Note that this claim is equally valid for English and German. The only difference between the two languages is that the cut-off point occurs earlier in English than in German (i.e., before the morphological level in English but after it in German).

The final argument is of a more indirect nature and relies on the intricate relationship between hierarchicalness and branching. Flatness by definition allows no branching. Differently put, branching requires a certain degree of hierarchicalness. At high degrees of hierarchicalness, the decision in favour of one branching direction is what we may call a strong one because it changes the patterns of activation spread rather drastically. At low degrees of hierarchicalness, the change in activation spread as a result of a particular branching direction is relatively minor. Therefore, low degrees of hierarchicalness can accommodate alternative branching directions more easily than high degrees of hierarchicalness. From this logic we may derive the prediction that alternative branching directions should be found most often at the syntactic, less often at the morphological, and least often at the phonological level. The time is not yet ripe for a comprehensive test of this prediction. However, the initial evidence is promising. As shown in section 2.5, there is not a single compelling argument for left-branching in the phonological domain. More evidence for left-branching is clearly found at the morphological level. Whether left-branching is more wide-spread in syntax than in morphology cannot as yet be ascertained reliably. More detailed analyses will have to find better ways of measuring and comparing effects at different levels.

3.4 CONCLUSION

Some evidence has been gathered in support of the hypothesis that the hierarchicalness of structural representations increases the further down one moves the linguistic hierarchy. Contrary to what is suggested by the complexity of syntactic tree diagrams, syntactic representations exhibit a relatively low degree of hierarchicalness. Morphological representations exhibit a higher degree and phonological representations the highest degree of hierarchicalness. Although this theoretical result rests on both linguistic and psycholinguistic evidence, it has a somewhat slender empirical basis. However, it makes good sense in the light of the differing psycholinguistic constraints to which the individual analytical levels are subject.

4 Structural Variation Across Time

4.1 INTRODUCTION

In Chapter 2, the internal structure of all major three-element sequences in phonology, morphology, and syntax was established for Modern English. This chapter brings the temporal dimension into the picture and addresses whether and how structure changes across time. The Structural Theory highlights two ways in which historical change might take place. One is a change in branching direction (i.e., from left- to right-branching or from right- to left-branching). The other way is made possible by the scalar nature of the model. As a language is not either totally flat or hierarchical, it is conceivable that it changes along this continuum (i.e., that it moves in the direction of more or less hierarchicalness without, however, changing its overall branching direction) There is an interesting relationship between the two types of change. A given language can only change its branching-direction preference if it is (almost) completely flat. Flatness is, as it were, the gate from one branching direction to the other. A strongly hierarchical language cannot simply change its branching direction. Because branching direction relies on hierarchicalness, the former cannot change without the latter (though not vice versa).

As structural aspects are generally held to belong to the heart of language, they may be presumed to be quite resistant to change. It is remarkable that the Structural Theory makes a different prediction. It explicitly admits structural change across time because structural representations are not laid down in long-term memory but rather created anew in every act of speaking. Although the model cannot predict that such a change must happen over time, it does suggest that looking out for it may not be a futile undertaking. In this spirit, the current chapter presents a systematic analysis of the major structures of Old English and compares these patterns to those of Modern English (as presented in Chapter 2).

Unfortunately, tracing a historical change of hierarchicalness is not a straightforward matter. It presupposes the feasibility of locating individual temporal stages of a language at well-defined points on a scale of hierarchicalness that is normally conceived of in two-dimensional terms. There are two difficulties here. The first is that it is by no means clear how a language can be assigned a point on a scale. Granted, Chapter 2 discussed criteria that can be used to determine whether flatness or hierarchicalness as well as left- or right-branching prevails. However, it is exceedingly more difficult to specify the degree of hierarchicalness of a given representation. The results of a linguistic analysis do not translate in any simple way into a certain point on a scale. However, a more modest aim seems within reach. It may be possible to identify not the absolute but the relative positions that two given temporal stages have to each other. One stage may be further up and the other further down the scale irrespective of where exactly on the scale they are to be positioned. The idea is thus that a comparative analysis can avoid some of the problems that arise in attempting to identify points on a particular scale.

The second difficulty is that languages are not normally homogeneous objects. They may be more hierarchical in one respect but less hierarchical in another. It is well known for instance that languages may be advanced (in whatever sense) in some areas but lagging behind in others without any apparent desire to solve this conflict. With this being so, how are we to pool the leaders and the stragglers? We might assign all the aspects equal weight and go for a simple majority rule. However, this may be unjustified because some aspects may be more weighty than others. The overall problem is that it is certainly inadequate to try to squeeze a multidimensional object such as language into a single point on a two-dimensional scale. In spite of this overarching difficulty, it may be possible to profitably use this method when a relatively homogeneous picture emerges.

The criteria that will be employed in the analysis of the degree of hierarchicalness in Old English are by and large those that were used in the investigation of the modern language. In many cases, exactly the same tests can be performed on the basis of the same criteria. This is possible whenever the historical and the modern data are comparable. In some cases, however, we encounter qualitative differences between the synchronic stages and consequently need to invoke criteria for the analysis of Old English that played no role in the description of Modern English. This enlargement shows both the language-specificity of some of the criteria and the open-endedness of the list.

Synchronically, the issue of structural representations has been attacked on three fronts—the syntactic, the morphological, and the phonological. Let us suppose that a diachronic structural change could be demonstrated. The three descriptive levels could be affected either individually or jointly by it. In the former case, one level might undergo a change from which the other is exempted. This would appear to be an entirely reasonable option in a system that grants a certain autonomy to each level. Alternatively, a situation might arise in which a change at one level moves in a direction that is opposite the direction in which a change at another level moves. Although there is nothing to rule out such a scenario on aprioristic grounds, it appears to be less likely in view of the branching direction consistency observed in Chapter 2. Of course, parallel developments at all analytical levels form the theoretically most interesting perspective. If the development is not only in the same direction but also proceeds at roughly the same pace, it would be hard to escape the conclusion that the changes are causally related, that is, individual manifestations of the same underlying principle. The discovery of such a principle would certainly be a major step forward. It would allow a glimpse into a system that grants its constituent levels only a limited freedom and whose dynamics are subject to the same driving force(s).

Each of the following three sections is devoted to one descriptive level. The focus will always be on comparing Old and Modern English. Middle English will not be given serious consideration mainly because it suffices to put into relief the beginning and end points of the historical development (from today's perspective, of course).

Finally, the customary reservations about historical evidence are in order. The facts that the data are limited to written sources and that the texts that have come down to us fall far short of conveying the full spectrum hardly need mentioning. In addition, it should be remembered that the Old English dialect in which the majority of texts were written is not the direct forerunner of Modern English. All these caveats have to be borne in mind when the historical data are probed.

4.2 SENTENCE STRUCTURE

4.2.1 Tests for Determining Sentence Structure

This section is divided into 10 subsections, each of which deals with one criterion. This separation is not meant to imply that all criteria are independent from one another. In fact, it is even likely that they co-vary to a certain degree. However, because the extent of co-variation is not a priori clear, it is safer to treat the criteria separately. Each subsection will begin by detailing the role the criterion at issue plays in the context of the hierarchicalness issue. The historical data will subsequently be presented as a thumbnail sketch, with no concern for regional or social variation. Both phrasal and clausal units will be considered.

4.2.1.1 Basic Word Order

The problem of word order will be approached from the perspective of the VP. Our starting point is the assumption that the level of activation of a VP node is influenced by the frequency of the adjacency of its immediate constituents. Most usually, the terminal elements are V and N or V and ADJ. The underlying logic is as follows. As outlined in the opening chapter, the function of a structural node such as VP is to prepare for the production of a larger unit whose constituents belong closely enough together to be planned in tandem. The superordinate node thus ensures that dependencies between the constituents can be worked out early on in the process. This is to an obvious advantage in the case of verb and object as a verb determines whether it must be followed (or preceded) by an object (and if so, by what type). When the constituents occur next to each other, their co-activation (by means of a VP node) is clearly advantageous. When, however, the constituents are not adjacent in surface structure, it is less useful to co-activate them because they are needed at different times in the production process. Hence, a VP node is less likely. Note that the order in which the constituents appear is less important than their adjacency.

It should be added that frequency of co-occurrence is not the ultimate reason for the creation of a structural node. Frequency encourages its activation, but without a syntactic or semantic dependency between the constituents these will not be sufficiently co-activated in the first place for frequency to take an effect. In any event, the unmarked case is for conceptually and syntactically dependent elements to stand close to each other (Behaghel's First Law).

The claim that emanates from the preceding analysis is this. If a language has a free word order and in particular allows verb and object to be frequently separated by VP-external elements, it is unlikely to strongly activate a VP node. Its syntactic structure therefore tends to be flat. If, in contrast, word order is fixed and there is a high probability for V and O to be adjacent, a VP node is likely to attain a high activation level. With this perspective, let us turn to the historical evidence.

It is uncontroversial that Old English shows much more word order variation than Modern English. Although the hypothesis of full word order freedom has been rightly dismissed as a myth (Bacquet, 1962), it is a striking fact that all 6 possible orders of S, V, O are attested and that, with the exception of VOS, no order is too infrequent (West, 1973; Kohonen, 1978; Bean, 1983). In particular, Kohonen's (1978) quantitative analysis reveals that verb and object are separated by the subject in main clauses in the oldest texts in 30% of cases. The figure for the two orders OSV and VSO decreases in later texts and declines further in Middle English (Swieczkowski, 1962). Clause type is another source of variation. Kohonen's results also demonstrate that the OV order is preferred in subordinate clauses whereas the VO order is more strongly associated with main clauses. Both orders are fairly frequent. Furthermore, the OV order depends on whether subject and object are nominal or pronominal. Generally speaking, pronominal NPs favour the OV order whereas nominal NPs prefer the VO order. It is clear then, that word order cannot be captured by a single rule and that there is a relatively low transitional probability between verb and object in Old English.

The contrast to Modern English can hardly be more pronounced. As is well-known, SVO is so very predominant that it dwarfs all alternatives (see

Chapter 5, Table 5.1, below). Today's language has very powerful means of maintaining the predominant word order in the face of countervailing forces. For example, yes–no questions may induce inversion (e.g., *Was she ill?*). However, this reordering is prevented by the auxiliary *do* (e.g., *Did he write a farewell letter?*), which therefore functions to keep the frequency of SVO at a high level. This order is independent of clause type and the (pro) nominal status of NPs. Exceptions to the SVO order exist, but they are highly infrequent. The "segregating" orders OSV and VSO do not figure at all in Ellegård's (1978) sample of Modern English texts (ignoring those cases where the object is itself a clause). In a word, Modern English is a most rigid SVO language (Lehmann, 1978).

These drastic disparities between Old and Modern English allow us to conclude that the VP node was less important in Old English than nowadays. This is not to deny the existence of the VP in Old English (in line with Bacquet, 1962; McLaughlin, 1983; and Koopman, 1990), a chunking strategy that is supported by 70% of the main clauses in Kohonen's earliest texts (see earlier discussion). Rather, the claim is that the VP was useful in Old English and has become even more useful ever since. In a more psycholinguistically inspired vein, it may be argued that the VP node normally reaches a higher level of activation today than it did a thousand years ago.

4.2.1.2 Discontinuity within NPs and PPs

Discontinuity refers to the fact that a string of words that belong together at the conceptual level may be separated by extraneous material in surface structure. It is therefore a variation on the word order theme treated in the preceding subsection. The less rigid the word order is, the greater the variation of sentence patterns and the number of factors that influence them. Viewed in this light, the splitting of a VP is only one instance of the more general possibility of breaking up higher-order units. Thus, at issue is a potential parallelism in the behaviour of syntactic phrases (i.e., whether the breaking-up is restricted to particular phrase types or characteristic of phrases in general). Clearly, the possibility of a split in one type of phrase is no guarantee that this is feasible in all phrases. There is thus a possible independence between discontinuity and word order as discussed previously.

The relevance of discontinuous structures to the hierarchicalness issue is the following. A flat representation means little structure. Little structure means a low degree of cohesion. Little cohesiveness in turn means low resistance to intercalation. Therefore, discontinuity can be taken as an index of a less hierarchical structure (compare criterion No. 6 in section 2.3.1).

It is quite obvious that Old English allowed discontinuity in places that may appear bewildering from today's perspective. We focus on discontinuous NPs and PPs. An example of each is provided in (1) and (2). All examples are augmented by a morpheme-by-morpheme gloss as well as an idiomatic translation into Modern English.

(1) God bebēad Abrahame þæt he sceolde and his ofspring his wed healdan (Aelfric, Homilies I, cited from Traugott, 1992, p.179)
God commanded Abraham that he should and his offspring his covenant keep
'God commanded Abraham that he and his offspring should keep his covenant.'

(2) þær him mon tō ne meahte (Anglo Saxon Chronicle, Anno 877, Parker)
there them one to not could
'There they could not get close to them.'

In (1), the conjoined NP *he and his ofspring* is broken up by the modal verb *sculan* while the subject pronoun *mon* is inserted into the PP *him tō* in (2).

Such constructions are completely impossible in Modern English. What we do find nowadays, however, is the interruption of higher-order phrases as illustrated in (3) and (4).

(3) The child . . . shall have the right from birth to a name. (United Nations
Convention of the Rights of the Child, Article 7-1)

(4) They enjoy a different standard of living from us.

There is a marked difference between (2) and (3). Whereas the PP itself was split in (2), the two PPs in (3) exchanged places but themselves remained unscathed. No. (4) involves a reversal of an N and a PP. That is, the intercalation occurred at a hierarchically higher level in (3) and (4) than in (1) and (2). The theoretical claim underlying this analysis is that the higher we move in the hierarchy, the flatter it gets (see Chapter 3) and by implication, the larger the number of possible orderings. This is reminiscent of Ross's (1973) "Penthouse Principle," which holds that a greater number of syntactic processes are possible in main than in subordinate clauses.

In summary, Old English is clearly more permissive of discontinuities than Modern English. Today's language does not rule them out categorically but restricts them to higher levels of representation wheras Old English also allows the split at lower levels. This difference is compatible with the hypothesis that the syntactic units are less tightly knit, implying that the syntactic structure was less hierarchical in Old English than it is nowadays.

4.2.1.3 Discontinuity within VPs

The preceding analysis of NPs and PPs can be straightforwardly extended to VPs. The issue in section 4.2.1 was whether a VP can be split by a subject-NP. In the following, we ask whether VPs can also accommodate adverbs. These two questions are to a certain extent independent of each other because syntactic rules are most usually word-class-sensitive (i.e., they apply to one particular word class but not necessarily to any other). On the other hand, this independence is unlikely to be total. On the logic just outlined, the hierarchicalness of a syntactic structure heightens its resistance to intercalation, irrespective of the nature of the intervening element. It should also be taken into consideration that VPs do not form a homogeneous set. Hence, it cannot be taken for granted that a VP consisting of a verb and a PP carries the same intercalation potential as a VP consisting of a verb and an ADJP.

In Old English as well as Modern English, adverbs display an enormous versatility. As documented by Wülfing (1901) and Schachter (1935), they can appear almost anywhere in Old English sentences. This freedom includes the critical position between verb and direct object, as shown in (5) and (6).

(5) Oncweþ nū þisne cwide. (Judgement Day 114, cited from Visser, 1963, p. 414)
answered (3 Pers. Sg.) now this statement
'Then he replied as follows.'

(6) Dryhten ongiet suīðe swīðe feorran ða hēahmōdnesse. (Alfred's Pastoral Care 299.24–301.1, cited from Brown, 1970, p 66)
Lord perceives very very far the pride
'The Lord perceives pride from afar.'

As can be seen, the temporal adverb *nū* 'now' intervenes between the verb and the direct object in (5). No. (6) exemplifies the splitting of verb and object by means of the locative adverb phrase *suīðe swīðe feorran* 'very very far.'

Remarkably, their large positional freedom notwithstanding, adverbs cannot appear in this very position in Modern English, irrespective of the type of adverb. All variants in (7) are ungrammatical. By contrast, verbs and PPs may be separated by an adverb, as in (8).

(7) *He smashed suddenly/joyfully/yesterday/probably/over there the stained glass window.

(8) She helped her reluctantly with her needlework.

The main point is that Modern English forbids the breaking up of a VP consisting of a verb and an NP by an adverb. The fact that the modern language is more lenient in (8) can be linked to the nature of PPs. Prepositions introduce both a syntactic and a conceptual distance between the verb and the object (Thompson & Koide, 1987). Metaphorically speaking, they drive a wedge between the verb and the object, and the space thereby created can be filled with an adverb.

By way of conclusion, as in the case of PPs and NPs, Old English displays a greater range of possibilities of VP splitting than does the modern language. This difference is supportive of the claim that the Old English VP was less cohesive and therefore less hierarchical than its Modern English counterpart. As a consequence, syntactic rules of word placement are more likely to insert adverbs between the verb and the object-NP in Old than in Modern English.

4.2.1.4 Dislocation

Mainly for reasons of topicalization, constituents may be dissociated from the syntactic core of a sentence and be moved to its outer edges. The gap that is created by this shift may be filled by a so-called *resumptive* pronoun. Dislocation destroys or at least reduces the syntactic cohesiveness of an utterance in that the dislocated element and the remainder of the sentence are less closely tied together than the to-be-dislocated element in its original position and the remainder of the sentence. The relationship in the former case is of a paratactic nature whereas the relationship in the latter case is more hypotactic. Thus, dislocation makes the sentence structure less hierarchical.

The other relevant aspect is the conditions under which dislocation is or is not allowed. The constraint that is most germane in the present context is the syntactic structure of the sentence kernel. When the structure is relatively flat, dislocation is more likely than when the sentence structure is more hierarchical. The by-now familiar logic is that hierarchicalness increases the cohesiveness of a sentence and it is more difficult to cut out a piece from a closely knit structure than from a looser one. The probability of dislocation may therefore be taken as an index of the degree of hierarchicalness.

In Old English, dislocation is not infrequently encountered. Its occurrence is all the more probable, the greater the weight of the to-be-dislocated constituent and by implication, the lesser the penetrability of the sentence structure. The resumptive pronoun thus functions to preserve the original sentence kernel and helps the listener or reader to recover the basic syntactic structure. The following examples illustrate only two of the many classes established by Peltola (1960).

(9) On ǣfentīd Justinus se mæssepreost and Ypolitus, se cristena tūngerēfa, unrōte and wēpende hī byrgdon his līchoman. (Martyrology 142b, cited from Peltola, 1960, p.169)
in evening Justinus the mass-priest and Ypolitus, the Christian town reeve, despondently and weepingly they buried his body
'In the evening, Justinus the mass-priest and Ypolitus the Christian town reeve, despondently and weepingly buried his body.'

(10) þēah Omerus se gōde scēop, þe mid Crēcum sēlest was, se wæs Firgilies lārēow. (Alfred: Boetius 141m, cited from Peltola, 1960, p. 168)
however Homer the good poet who with Greeks best was, he was Virgil's teacher
'However, Homer, the good poet, who knew the Greeks well, was Virgil's teacher.'

Both (9) and (10) have superheavy subjects. No. (9) has two conjoined NPs each of which is augmented by an apposition. The subject-NP in (10) is augmented by an apposition as well as a relative clause. The two subjects are resumed by means of the pronouns *hī* 'they' and *se* 'he' in (9) and (10), respectively.

There can be little doubt that the Modern English renditions of these two sentences go without dislocation and the resumptive pronouns. Although the equivalents of the Old English constructions are not categorically ruled out in the spoken language of today (e.g., Keenan & Schieffelin, 1976), they are definitely an undesired option in the written language, irrespective of the syntactic weight of the constituent to be dislocated (Geluykens, 2001). Pérez-Guerra (1998) advances the general claim that the frequency of (right) dislocations has gone down from Old to Modern English in the written language, even though he provides no supporting data.

In conclusion, Old English appears to be more liberal in the use of dislocations than the modern language. This difference can be explained on the assumption that Old English sentence structure was relatively flat (i.e., only weakly cohesive) and therefore more readily accepted the disintegration of the sentence in the case of dislocation. In contrast, Modern English syntax is more tightly organized. As a result, dislocation is more rarely found. Modern English sentences may thus be argued to possess a more hierarchical structure than those in Old English.

4.2.1.5 Subjectless Sentences: PRO-Drop and Impersonal Constructions

A prerequisite for erecting a syntactic structure is the availability of lexical elements. When these are missing, the syntactic structure is either reduced or generates empty slots. We will assume here a close correspondence between syntax and lexis and exclude the possibility of empty slots. Less lexical material leads to less syntactic structure. So when, let us say, the subject position need not be filled, the subject cannot be reliably defined in structural terms.

Old English knew two different types of subjectless sentences. It allowed the dropping of subject pronouns and had impersonal constructions. Both phenomena are by no means small scale. Though less frequent than in, let us say, Modern Spanish, pronoun deletion is certainly not exceptional in cases where the referent can be unambiguously determined. Impersonal constructions have a high type and token frequency (Visser, 1963). One example of each follows.

(11) and þā on hærfeste ʒefōr se here on Miercna lond and hit ʒedǣldon sum and sum Cēolwulfe saldon. (Anglo Saxon Chronicle, Anno 877, Parker)
and then in autumn retreated the army in Mercian country and it (Acc.) divided (Pl.) some and some Ceolwulf gave (Pl.)
'And then in autumn the army left for Mercia and they divided it (i.e., Mercia) and gave a part of it to Ceolwulf.'

(12) And þā ʒelīcode him eallum mid heora cyninʒe . . . þæt hī Seaxna þēode ofer þām sǣlicum dǣlum him on fultum gecygdon and gelaðeron. (Ecclesiastical History of the English People I. XI.)
and then pleased (3 Pers. Sg.) them (Dat.) all with their king . . . that they Saxons people over the sea parts them in help called and invited
'And then it seemed best to all and also to their king . . . to invite and call in to their aid the people of the Saxons from the parts beyond the sea.'

In (11), the second sentence beginning with *and* lacks an overt subject. The only clue as to the subject is the suffix on the verb form *ʒedǣl-don* (from *ʒedǣl-an*), which codes past tense and plural (in this case, third person plural). The first sentence beginning with *and* cannot provide the subject for the second sentence because its subject is the singular NP *se here* with which the plural verb form *ʒedǣldon* does not agree.

The impersonal construction in (12) also lacks an overt subject. The experiencer *him* 'them' is in the dative and there is no grammatical subject such as the dummy *it*. A third person singular subject is implied by the singular form *ʒelīc-ode* (from *līcian*). A translation that is more faithful to the Old English construction would therefore be something like 'It pleased them.'

This brings us to the situation in Modern English, which is quite clearly not a PRO-drop language. It has reached a stage where subjectless sentences are totally banned. Impersonal constructions have completely dropped out of the language, with a few relics like *methinks* for example being decidedly archaic but still comprehensible. Hence, every sentence requires a grammatical subject, usually *it* or *there*, even when there is no semantic motivation for it. As Kim (1999) argued, the change from impersonal to personal constructions and the emergence of dummy subjects is best understood as a strategy of filling the subject position.[1]

It was claimed in the previous discussion that the availability of a subject is a prerequisite for assigning a standard structural description to a sentence. Subjectless sentences have no branching S node because the only node dominated by S is VP. This renders the distinction between S and VP less clear-cut and in the final analysis even eliminates it because both have the same "extension." By contrast, the distinction between S and VP is absolutely necessary in sentences with subjects because S and VP have different extensions. The change from subjectless sentences to those with compulsory subjects can therefore be seen as a change from less to more structural complexity and hence, from a less to a more hierarchical representation.

4.2.1.6 Pro-VP

It was argued in section 4.2.1.1 that there are differences in the availability of the VP in Old and Modern English that follow from the frequency with which its immediate constituents occur next to each other. Another test, in fact one of the more robust tests of constituency, is pronominalization. Whenever a string of lexical elements can be replaced by a pro-form, it qualifies as a syntactic phrase. If no such pro-form exists, it cannot be conclusively proven that a VP is absent, but at least it can be hypothesized that a VP node has a lower activation level than when a pro-form exists.

This time we will work our way backwards from Modern to Old English. Today's language possesses a means of pronominalizing VPs. Consider (13).

(13) Most people don't like people but I do.

The function of the final *do* is to replace the VP *like people*. It is thus a clear instance of a pro-VP.

Old English had nothing equivalent. Although *dōn* existed, it was normally used as a main verb, as can be seen in (14). However, it could also function as a proverb, as in (15); see Traugott, 1992). The grammatical function of *do* as a pro-VP is a fairly recent development in the history of the language (Visser, 1963, p. 173), much like its other auxiliary functions (Stein, 1990).

(14) Hī on beorg dydon bēg and siglu (Beowolf, line 3163)
they on hill did rings and jewels
'They put rings and jewels on the hill.'

(15) and hit weox swā swā ōðre cild dōð būton synne ānum. (Aelfric, Homilies I, 1 24.33, cited from Traugott, 1992, p. 262)
and it grew so as other children do without sin one
'and it grew as do other children without any sin.'

Thus, the VP pronominalization test turns out to be positive in Modern English but negative in Old English. This means that the Old English VP node was either absent, or weakly present (i.e., not sufficiently strong to have given rise to a pro-form[2]). For the modern language, the strength of the VP is confirmed. To conclude, the pronominalization data are consonant with the hypothesis that Old English sentence structure is less hierarchical than the Modern English one.

4.2.1.7 Modal Auxiliaries

There are two competing proposals for the syntactic analysis of modal auxiliaries. They are regarded either as instantiations of IPs (e.g., Chomsky, 1981) or as parts of VPs (e.g., Burton-Roberts, 1986). We will follow Burton-Roberts in assigning modals to the VP, in particular the verb group (VG). In this view, a modal auxiliary increases the complexity of the VP.

Without the modal, the main verb is directly dominated by the VP whereas the use of a modal necessitates the creation of a VG node whose immediate constituents are the modal and the main verb. The modal thus makes the structure of a sentence more complex as well as more hierarchical (through the addition of an intermediate node). A diachronic rise of modals can therefore be taken as evidence for hierarchization.

The so-called modals had an ambivalent status in Old English. They could function as auxiliaries as well as main verbs. An example of each function is given in (16) and (17), respectively.

(16) hī woldon þā ealle ōðer twēga, līf forlǣtan oððe lēofne gewrecan. (The Battle of Maldon, lines 207-8)
they wanted then all other two life forsake or beloved (N.) avenge
'Then they all wanted to take the lives of the other two or avenge themselves for their beloved ones.'

(17) þā hī tō scipan woldon (Anglo Saxon Chronicle, Anno 1009, Laud)
when they to ships wanted
'when they wanted to go to their ships'

The verb *willan* is used as an auxiliary in (16) but as a main verb in (17). It is followed by an infinitive in (16), as is typical of modals. However, it stands on its own in (17) and consequently must have independent-verb status.

The so-called modals display the following characteristics in Old English. They can take a direct object, a *þǣt*-complement clause or a bare infinitive, they are inflected for tense and mood, they agree with the subject in person and number, and they show only weak traces of epistemic meaning (Traugott, 1992). Apart from the preference for infinitives without *to*, this is a list of properties that typifies main verbs. On the other hand, other pieces of syntactic and semantic evidence point to the auxiliary status of the modals.[3] Thus, the Old English modals were hybrids sharing properties with both main verbs and auxiliaries.

A comparison with Modern English quickly reveals that the verb class under discussion has given up all of its independent-verb traits. The disappearance of the main verb use as illustrated in (17) implies that the simpler syntactic structure has given way to a more complex one. This may be taken as evidence for the claim that a change has taken place from less to more hierarchical structure within the VP.

4.2.1.8 Parataxis versus Hypotaxis

We now leave the domain of the clause and look into the possibilities of clause combining. Basically, three options are conceivable. Two clauses may remain unconnected, or they may be paratactically or hypotactically connected. These three alternatives differ in the extent of hierarchical structure that they implicate. Almost by definition, the least structure is involved in unconnected sentences. More structure is involved in paratactic constructions that require a superordinate S node. Still more structure is involved in hypotactic constructions because the number of levels of embedding is increased. A language with predominant parataxis may accordingly be considered less hierarchical and a language that is more susceptible to hypotaxis, more hierarchical. By the same logic, a language that shifts its ratio of parataxis to hypotaxis in favour of the latter may be said to move up on the hierarchicalness scale.

The paratactic nature of Old English syntax in both poetry and some prose has been commented on by quite a few authors (e.g., Kellner, 1892; Mitchell & Robinson, 1992; Godden, 1992). This is particularly true of the earliest writings. The prevalence of parataxis receives special weight in the light of the fact that all sources document the written language, which is generally more prone to hypotaxis than the spoken language (Kroll, 1977). It stands to reason therefore that parataxis was even more frequent in ordinary conversation.

Traugott (1992) points out that the paratactic effect is created by the prevalence of coordinated and uncoordinated sentences. Many sentences begin with *and*, *þā*, or *and þā*, as in (11) and (12). There are a number of other repetitive devices. In many cases, it is difficult to identify the syntactic (in)dependence of a clause. This difficulty is significant in itself because it may be interpreted to mean that the distinction between main and subordinate clauses was underdeveloped in the time of Old English, a possibility hinted at by Denison (1987). This point will be made more concrete in the following two subsections. Since main clauses are more basic than dependent clauses, we may infer that the existence of the latter, not that of the former, is in doubt, which cements the hypothesis of the paratactic nature of Old English.

The difficulty of clearly separating main from subordinate clauses is one of the reasons for the absence of precise quantitative information with which Modern English data can be compared. However, even without such information, some differences are all too conspicuous to be overlooked. For example, the frequency with which sentences begin with the paratactic conjunction *and* has steeply gone down from Old to Modern English. There is little doubt, then, that the techniques of clause combining have shifted from coordination to subordination. This shift implies that sentence structure has become more hierarchical over time.

4.2.1.9 NP-Dependent Subordination: Relative Clauses

This and the following subsection will probe into two specific means of clause linkage—relative clauses and other subordinate-clause types. Dekeyser (1987) argues that Old English relative clauses come in various types ranging from less to more hypotactic. A more paratactic relative clause is characterized by the use of a personal or a demonstrative pronoun as relative-clause marker, the use of the conjunction *and* and SVO order. The logic behind these criteria is evident. Unlike relative pronouns, personal and demonstrative pronouns are inherently non-subordinating, *and* is a coordinating conjunction, and SVO was the typical word order in main clauses (see section 4.2.1.1). All four aspects of parataxis are illustrated in (18) and (19).

(18) Belēaf þǣr nan būtan an munec hē wæs ge hāten Leofwine lange. (Anglo Saxon Chronicle, Anno 1070, Laud)
remained there none but a monk he was called Leofwine tall
'None remained there except one monk who was called Leofwine the Tall.'

(19) Eac þis land wæs swīþe afylled mid munecan. And þā leofodan heora līf æfter scs Benedictus regule. (Anglo Saxon Chronicle, Anno 1086, Plummer)
also this land was much filled with monks. And who lived their life after St. Benedict's rule.
'This land too was exceedingly full of monks who lived their lives after the rule of St. Benedict.'

These are fine examples of relative clauses *in statu nascendi*. Superficially, they look like two unconnected sentences with SVO in the second (ignoring orthographical issues such as non-capitalization in [18]). However, the second clause clearly modifies the first, as is typical of relative clauses. The relative marker is expressed by the personal pronoun *hē* modifying *munec* in (18) and by the demonstrative pronoun *þā* modifying *munecan* in (19).

Of course, none of the more paratactic types of relative clauses are possible in Modern English. With the exception of *that*, personal and demonstrative pronouns no longer function as relativizers, and the conjunction *and* can no longer precede the relative clause. This clause type is today unambiguously subordinating.

To conclude, the development of relative clauses may be construed as a change from more coordination to more subordination. As subordination involves a larger number of levels of embedding than coordination, this is a change from less to more hierarchical structure.

4.2.1.10 S-Dependent Subordination: Conjunctions

A major strategy of clause linking is the use of conjunctions. Like relative pronouns, conjunctions had an ambiguous status in Old English and consequently contributed to blurring the distinction between parataxis and hypotaxis. In most cases, Old English did not formally distinguish between adverbs and conjunctions (as far as can be told from the written representation). Synchronically speaking, the former may assume the function of the latter; diachronically speaking, the latter were evolving from the former in Old English time. A first example of this ambiguity is *þā*, which functions as an adverb ('then') in (11) but as a conjunction ('when') in (17). The criterion that is ordinarily employed to identify the syntactic status of the item in question is word order, which argues for a paratactic reading in (11) but a hypotactic reading in (17). However, given the relative word order freedom, this is not a hard and fast rule and therefore ambiguities remain, as in the following example from Traugott (1992).

(20) Nū hæbbe wē āwriten þære Asian suþdǣl; nū wille wē fōn tō hire norðdǣle. (Ormulum I 1.14.5)
now have we described the Asia's southern part; now will we turn to its northern part.

If the two clauses are understood as being coordinated, their beginnings might be translated as '(up to) now' and 'next'; if, however, a subordinate structure is intended, an adequate rendition of the first clause might begin with 'now that.' There is a striking similarity between (18), (19) and (20). The subordinate clause appears to be in the initial stages of developing from a principal clause.

It should be noted that the ambiguity between adverbs and conjunctions was not limited to individual cases but occurred on a fairly large scale. Other examples include *þǣr* ('there' vs. 'where'), *þonne* ('then' vs. 'when'), *ǣr* ('formerly' vs. 'before'), *ǣfter* ('afterwards' vs. 'after'), *swā* ('so' vs. 'so that') and *forþon* ('therefore' vs. 'because').

Also this ambiguity has completely disappeared in Modern English. There is a clear-cut formal distinction between adverbs and conjunctions,[4] as can be seen from the translations just shown. The subordinate clause introduced by conjunctions has established itself firmly.

The conclusion that this analysis leads to is the same as in the preceding subsection. English has shifted from less to more subordination and thereby increased the syntactic complexity of sentences. This is reflected in a change from a less to a more hierarchical representation.

4.2.2 Discussion

We have surveyed a number of disparate areas both within and between clauses. The structure of VPs, complex NPs, and PPs was examined in the former domain, and so were various types of clause linking in the latter. Although this treatment is certainly not exhaustive, major aspects of syntactic structure have been covered. It is highly remarkable that each of these areas is productive of the same general result. This is the development from a lower to a higher degree of hierarchicalness in the structural representation from Old to Modern English.

Why has English syntax undergone this process of hierarchization? It is not entirely clear whether there is one answer to this question, but basic word order appears to be a promising area in which to look for an explanation. The reduction of word order freedom was conducive to an elevated predictability of upcoming constituent types in an utterance and thereby opened up the possibility of increased advance planning by means of a VP. Hierarchization is thus conceived of as a concomitant of the shift from free to rigid word order (on the understanding that Behaghel's Law is obeyed).

In a psycholinguistically inspired vein, we may envision this connection between word order and structural representation as follows. As was pointed out in section 4.2.1.1, the more often the sister constituents of a VP immediately follow each other, the higher the activation level of the VP. Because V and O are conceptually close, Behaghel's Law makes the creation of a VP aprioristically probable. The final activation level of the VP is determined by the rate of activation growth, which in turn is influenced by the number and strength of the competitors that the production system has to deal with during the selection of the target unit. If the number of competitors is high and their strength considerable, the target unit has a hard time asserting itself (i.e., its activation process is slowed down; Marslen-Wilson, 1990). One of the chief factors underlying strength is frequency of occurrence.[5]

The competitive nature of the processing system holds the key for comprehending the difference between Old and Modern English. The many different word orders in Old English imply that the decision in favour of one involves the suppression of all alternative options, both frequent and infrequent ones. This outcompeting takes time and slows down the activation of the target unit, let us say, the SVO order. As a consequence, the erection of the VP node is also slowed down to the effect that it attains a relatively low activation level at the moment of selection. Because of this weakness of the structural representation, all structural effects are relatively minor.

The situation is very different in Modern English. Because there is basically only one option (i.e., the SVO pattern), there is no competition and the activation of the SVO order can proceed unhampered. Consequently, the VP node is able to reach full activation. This difference in the strength of the VP in Old and Modern English, not the existence of the VP as such, is what makes the syntactic representation more hierarchical nowadays than it was a millennium ago.

The fact that each of the areas examined in the preceding subsections is productive of the same result is strong indication that the individual changes that took place did not occur independently of one another. The Penthouse Principle referred to earlier predicts that the strong activation of a VP node entails hierarchization elsewhere. On the assumption that lower syntactic levels are more hierarchical than higher ones, the rigidification of word order at upper levels entails a rigidification at deeper levels of embedding. The precise mechanism of how this is accomplished is left open by the Penthouse Principle.

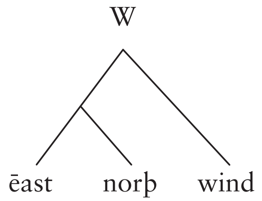
It is even more difficult to explain the connection between the rise of the VP and the emergence of clause subordination. It seems as if the strong activation of intermediate nodes such as VPs facilitates the generation of other intermediate nodes such as S dominated by NP for relative clauses. Apart from this general appeal to analogy, it is not clear how this link should be established.

To conclude, English syntax has been remarkably consistent in its historical development. All of the 10 areas examined point toward an increase in the strength of the structural representation, which is modelled in terms of a general increase in the activation levels of structural nodes. Although there are further areas, not treated here, which lead to the same result, there are, to the best of my knowledge, none that suggest a trend in the opposite direction. Such an impressive consistency may be taken to argue for a high level of organization in the syntactic system. In the next section, the morphological system will be probed. The overall perspective will be to examine whether the changes that took place in this domain parallel the ones that took place in syntax.

4.3 WORD STRUCTURE

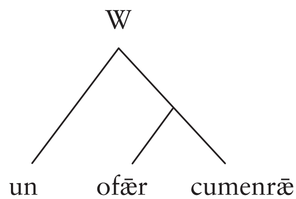
What little previous work there is on the internal structure of polymorphemic words in Modern English is extensive in comparison with work on earlier stages of the language. Sauer (2000) is among the very few scholars who have raised the issue of branching direction in Old English. He points out that both left- and right-branching occur in trimorphemic Old English words and illustrates his claim with the following examples.

(21)



'east-north wind'

(22)



'unsubdued'

Sauer appears to consider the branching direction in (21) and (22) as obvious. This is how we may interpret the fact that he provides no arguments at all for his decisions. It is relatively easy to see that he employed different criteria in (21) and (22). The syntactico-semantic criterion probably led him to postulate left-branching for *ēastnorþwind* because the two directions *east* and *norþ* jointly modify *wind*. By contrast, the morphological criterion was almost certainly resorted to in *unofǣrcumenrǣ* which consists of the two prefixes *un-* 'un-' and *ofǣr-* 'over-' and the stem *cumenrǣ*[6] 'come.' As prefixes by definition attach to stems rather than other prefixes, the two prefixes cannot be dominated by the same node. Further criteria such as the lexical and the semantic one join the morphological one in arguing for right-branching in (22). It should be emphasized that Sauer does not go beyond these individual examples. In particular, he makes no claims as to general or word-type-specific branching direction preferences in Old English.

In view of this unchartered territory, it is necessary to almost start from scratch. The only previous results that could be relied on are methodological in nature. The six criteria that had proven useful in the analysis of Modern English were applied to Old English data. Paralleling the investigation of Modern English word structure in section 2.4, the following analysis will focus on derivation and compounding to the exclusion of inflection.

The aim of the present chapter is two-fold. Its immediate function is to determine a possible branching direction preference and the degree of hierarchicalness in Old English. The completion of this synchronic task is a prerequisite to the more important diachronic task of identifying possible changes in branching direction and hierarchicalness from Old to Modern English. Has English word structure moved from less to more hierarchical, as was observed for English sentence structure? And is right-branching as characteristic of Old English as it is of the modern language, or has branching direction in morphology been susceptible to historical change?

In an effort to address these questions systematically, all three-morphemic words were extracted from Bosworth & Toller (1898), the most comprehensive Old English dictionary in existence. This database was supplemented by several items found in Raith (1965) and Holthausen (l974) but missing in the larger dictionary. The sampling and categorization task was complicated by the following problems. As in any synchronic study, the morphological analysis is not always straightforward. There are a good number of items in which the morphological analysis is clear for one or two of the constituent morphemes but unclear for the other(s). Such is the case with *gesundig* 'prosperous' in which the morphological analysis *ge-sund-ig* yields a stem of unclear status. Although Bosworth & Toller (1898) do not regard this item as an independent word, Holthausen (1974) relates it to the adjective *swīþ* 'strong' (and the verb *swīþan* 'to strengthen'). All items like *gesundig* in which the stem was not clearly recoverable were left out of account. A slightly different problem is exemplified in *gerēfa* 'reeve' in which the morphological boundaries cannot be established with certainty. If this word is assumed to have the individualizing prefix *ge-* and the agens suffix *-a*, we are left with the baffling unit *rēf*, which apparently does not occur on its own. So either *rēf* is a relic of an erstwhile free-standing form that occurs only in conjunction with certain affixes or *-a* is not an agens morpheme in this particular item. In either case, there would be no justification for viewing this word as being made up of three distinct morphemes. Accordingly, all items for which morphological boundaries could not be reliably established were discounted.

Given the focus on word formation, a decision had to be taken on four-morphemic items in which one morpheme was of an inflectional nature. Two subtypes were discernible. The first is exemplified by words such as *unfæderlīce* 'in an unfatherly manner,' which is composed of the three-morphemic adjective *unfæderlic* and the adverbial suffix *-e*. The snag is that the adjective *unfæderlic* is not found in any of the Old English dictionaries even though it is highly likely that the adjective provided the morphological base for the adverb and therefore should have independently existed. Consequently, the inflectional suffix was ignored and all these four-morphemic items were included in the empirical analysis.

The other subtype involves words in which the stem part is augmented by an inflectional morpheme as in *geglengendīc* 'spendid' (from *glengan* 'to adorn'). Also these cases were taken into consideration because the inflectional morpheme does not in any way alter the basic structure of the word. Branching direction is not affected because the derivational affixes modify the stem as such, irrespective of whether it is morphologically simple or complex. On top of that, the inflectional morpheme, which is almost invariably a present or past participle, often has an optional status. Taking up again the previous example, whereas the prefixed form is listed as a four-morphemic word (*ge-gleng-end-īc*), the non-prefixed variant is entered as a bimorphemic word (*gleng-līc*) with virtually the same meaning in Bosworth

& Toller's dictionary. This variability suggests that the inflection does not partake in the basic word-formation processes under investigation and may safely be disregarded.

A further difficulty arose in the categorization procedure. As is well-known from prototype theory, some linguistic units fit a given category better than others. A pertinent problem area is the distinction between stems and affixes. Some affixes have an affixoidal character because, at the historical stage of interest, the grammaticalization process is caught midway (i.e., has not been completed). Let us consider the example *gemægfæst* 'gluttonous' whose meaning derives from the fact that somebody who eats in excess must have a solid stomach (*fæst* 'solid'; *maga* 'stomach'). The morpheme *fæst* occurs both in isolation and in combination with other morphemes with basically the same meaning and apparently the same pronunciation. In the absence of reliable criteria for classifying *gemægfæst* as a compound or a derivative, I followed Quirk & Wrenn (1957) in treating this and kindred items as prefix-stem-suffix structures.

The final issue concerns variation in form. Orthographic variants pose the least problem. Items with variable spelling (e.g., *gegripennis* vs. *gegripenniss* 'a seizing') were invariably counted once. Dialectal differences as in *gehērnes* versus *gehȳrnes* 'a hearing' were given the same treatment. Temporal differences evidently play a limited role in synchronic dictionaries. However, it is clear that some entries are older than others, as can be seen from the cooccurrence of umlauted and non-umlauted forms, as in *brādingpanne* versus *brǣdingpanne* and *brēdingpanne* 'frying pan.' These were also regarded as one lexeme. The same applies to breaking (i.e., the variation between monophthongal and diphthongal forms), as well as to ablaut, as in *anfangenness* versus *anfengnes* 'a receiving' which derive from the class VII verb *fōn* 'to take' with <e> in the past tense and <a> in the past participle. The final type of variation is metathesis as exemplified in *gebrosnung* versus *geborsnung* 'corruption,' which derives from the verb *brosnian* 'to corrupt.' To the extent that all these types of variation could be identified as such, they were eliminated from the corpus.

The discussion of the Modern English data in section 2.4 led to the distinction between forced and free branching direction in morphological complexes. The latter refer to the fact that the morphological make-up of a word determines its internal structure in advance. For instance, a stem-prefix-stem sequence cannot help but be right-branching because prefixes by definition associate themselves with the following rather than the preceding stem. By contrast, the former encompass all those items that leave room for alternative morphological analyses. Such is the case with stem-stem-stem combinations. The theoretical significance of free and forced complexes is clearly different. Whereas the former can be taken as a primary source of evidence for branching direction, the latter cannot. Our focus in the remainder of this section will therefore be on the two free structures. However, a brief look at the forced structures from the diachronic angle may not be out of place here as it helps to put the historical development into a wider perspective.

Old English runs the full gamut of six types of forced trimorphemic complexes, which are illustrated here. As before, the hyphens indicate morpheme boundaries.

(23) Stem-Suffix-Suffix: (e.g., *flǣsc-līc-nes* [flesh-ly-ness] 'incarnation')

(24) Prefix-Prefix-Stem: (e.g., *un-ofer-cumen* [un-over-come] 'unsubdued)'

(25) Stem-Prefix-Stem: (e.g., *gold-ge-weorc* [gold-COLLECTIVE-work] 'gold work')

(26) Stem-Suffix-Stem: (e.g., *hrēow-ig-mōd* [sorrow-ful-mood] 'sad at heart)'

(27) Prefix-Stem-Stem: (e.g., *un-friþ-here* {NOT-peace-army] 'hostile army)'

(28) Stem-Stem-Suffix: (e.g., *cyric-sang-ere* [church-sing-er] 'church singer')

Whereas (23) and (26) are unequivocally left-branching, (24) and (25) are unambiguously right-branching. Cases (27) and (28) require more discussion. Theoretically, the prefix in (27) might modify either the following stem or the following compound. An analogous situation holds for the suffix in (28). In view of the fact that affix-stem boundaries are ranked lower in the linguistic hierarchy than stem-stem boundaries, affixes may be expected to have a limited scope. It is therefore more natural for them to modify single stems rather than sequences of stems (see also Williams, 1981). This theoretical argument is countenanced by the empirical analysis of stem-stem-suffix combinations performed in section 2.4.2. Hence, it is appropriate to group (27) and (28) with the forced morphological complexes and regard (27) as left-branching and (28) as right-branching.

Table 4.1 furnishes information on the frequency of the six forced types in Old and Modern English. The Modern English data are taken from the CELEX corpus and the DCE (see section 2.4). Note that these are complete data sets (to the extent that the dictionaries are exhaustive).

It is immediately apparent from Table 4.1 that major morphological restructurings have taken place in the history of the English language. As the totals are rather similar, we may rely on the absolute numbers in our interpretation of the data. The single most important development is the shift from prefixing to suffixing. Whereas all trimorphemic structures with prefixes have dropped out of the language, those with suffixes have generally

Table 4.1 Frequency of Forced Tripartite Morphological Complexes in Old and Modern English

Type	*Old English*	*Modern English*
Stem-Suffix-Suffix	153	1473
Prefix-Prefix-Stem	306	0
Stem-Prefix-Stem	384	0
Stem-Suffix-Stem	183	364
Prefix-Stem-Stem	267	0
Stem-Stem-Suffix	1261	978
Total	2554	2815

been on the increase.[7] As Lutz (1997) argues, these two changes are related in that separable prefixes that were placed after the verb were reinterpreted as quasi-suffixes. The reason for this change need not concern us here. Suffice it to point out that the issue of branching direction does not seem to have anything to do with it.

We now turn to a detailed examination of the internal structure of the free morphological complexes, to wit prefix-stem-suffix and stem-stem-stem sequences.

4.3.1 Prefix-Stem-Suffix Structures

Let us begin with the observation that prefix-stem-suffix structures were at least as frequent in Old English as they are nowadays. The 1056 Modern English items are outnumbered by 1168 comparable forms in Old English. The commonness of this morphological pattern thus ensures that the analysis of this core area can be based on a relatively large data set.

4.3.1.1 Methodological Issues

In the following, we will take a look at the six criteria worked out in section 2.4 and discuss the problems that arise in applying these criteria to the Old English data. The first criterion to be examined is resyllabification. The issue is whether affixing leads to resyllabification under appropriate circumstances, or more specifically, whether resyllabification occurs more frequently at the prefix-stem than at the stem-suffix boundary or vice versa. The determination of syllabification is a particularly thorny issue in a dead language. Of course, the evidence can only be of an indirect nature. Fortunately, there are certain characteristics of the poetic language that grant an unexpected insight into the principles of syllabification. To see this, it is necessary briefly to review the poetic conventions that prevailed in Old English times. The dominant rhyming principle was alliteration, the repetition of onset consonants in one line. These lines consist of two so-called half-lines. Alliteration must occur across the half-line but it may also occur within half-lines. The alliterating consonants are italicized in the example shown here.

(29) *B*eowulf maþelode *b*earn Ecgþeowes: (Beowulf, line 1384)
Beowulf spoke child Ecgtheow-GEN
'Beowulf, the son of Ecgtheow, said'

Two aspects are crucially important for the analysis of syllable structure. One is that alliteration always involves stressed syllables. If the initial syllable of a word is unstressed, the alliterating consonant may occur word-internally. This property is essential in that it allows us to identify the syllabic position of word-internal consonants. As rhyming is based on alliteration, we know that every alliterating consonant must be syllable-initial. So if the syllable-final consonant of a prefix is involved in rhyming, resyllabification may be claimed to have taken place. The reverse situation also holds: The fact that alliteration spares the syllable-final consonant may be taken as evidence against resyllabification.

The other critical aspect is that alliteration in Old English is not only based on consonants but also on vowels. Interestingly, any vowel alliterates with any other. So if consonantal alliteration can be ruled out and the stem of a prefix-stem sequence begins with a vowel, this vowel may be argued to be alliterating. And if the prefix ends in a consonant, we can be pretty sure that resyllabification did not take place.

It is obvious that the several very specific conditions that have to be fulfilled will make relevant cases hard to come by. In fact, not a single pertinent example was found in *Beowulf*, the longest poetic work of Old English. However, the following line from the poem *Solomon and Saturn* meets all requirements perfectly.

(30) Ne mǣg mon for*i*ldan *ǣ*nige hwīle (Solomon and Saturn, line 395)
not can one delay any while
'We cannot delay for long'

As is evident, consonantal alliteration is absent from (30). The critical word is *forildan* 'to delay,' which consists of the prefix *for-* and the stem *ildan*, which also exists as an independent verb with the same meaning as the prefixed verb. As *for-* is unstressed and as no word in the second half-line begins with <r>, it may safely be concluded that the alliteration is vowel-based and, by implication, that the <r> in *for-* was not resyllabified into the onset of the following syllable. To anticipate the results, no cases of resyllabification at the prefix-stem boundary could be found in the entire poetry corpus, no matter whether the prefix was stressed or unstressed.

Unfortunately, resyllabification across the stem-suffix boundary could not be investigated using the same method because suffixes in Old English were always unstressed and alliteration did not involve segments from unstressed syllables. What other arguments may help to find out whether *edlǣcung* 'repetition' for example (from *edlǣcan* 'to repeat') was syllabified as *edlǣc.ung* or *edlǣ.cung*? The phonotactic argument is inapplicable as both solutions are phonotactically legal in this and all other such cases. There are only two lines of indirect evidence, one specific to Old English and the other of a typological nature. As shown in Table 4.2 below, Old English had a very high percentage of vowel-initial suffix tokens (50.3% in the database). If resyllabification did not take place, we would have a large number of vowel-initial syllables within words. This, however, is highly unlikely as there generally is a structural parallelism between words and syllables in that both or neither tends to begin with consonants. Because Old English words were predominantly consonant-initial, it may be inferred that so were syllables. This parallelism may be taken as support for the hypothesis that resyllabification across the stem-suffix boundary was the rule in Old English.

The typological argument relates to the onset dominance effect, which holds that single intervocalic consonants are onsets rather than codas. That is, in a disyllabic CVCVC structure with initial stress, the intervocalic consonant is associated with the second rather than the first syllable. This is felt to be invariably so if the intervocalic consonant is preceded by a long vowel, as in the previous example. Because the onset dominance principle is generally considered to be crosslinguistically valid (e.g., Clements, 1990) or even universally true (e.g., Spencer, 1996), it may be assumed to also hold for Old English. Therefore, *edlǣ.cung* is assumed to represent the correct syllabification. Generalizing from this example, the claim is that resyllabification took place across the stem-suffix boundary in Old English.

The segmental criterion looks at the effects of affixing on the phonemic make-up of the stem. An alteration of this phonemic structure is interpreted as reflecting an interaction that is facilitated by the sister constituency of the interactants. As is unavoidable in the study of a dead language, the phonological analysis is based on the interpretation of orthographic patterns. The less equivocal the correspondence between graphemes and phonemes, the more reliable the phonological probe. It is widely assumed that all graphemes, in particular all consonantal ones, have a phonetic value (e.g., Mitchell & Robinson, 1992). As a consequence, a change in spelling may be interpreted as reflecting a change in pronunciation.

The analysis of affix-induced changes in the phonological structure of Old English morphemes is hampered by stem-internal variation that is not caused by morphological factors. A good case in point is the vowel grapheme <e>. Not infrequently, we encounter variants of the same lexeme whose only difference lies in the presence or absence of <e>, as in (31).

(31) a. efen ~ efn 'even'
b. dafenian ~ dafnian 'to befit'

The analytical difficulty created by this apparently free variation may be illustrated by the complex word *unefnlīc* 'unequal.' It might be supposed that the loss of <e> is instigated by the addition of the suffix (or prefix, for that matter). This would then serve as an argument for between-morpheme interaction. However, there is no basis for such a supposition as the loss of <e> may be completely unrelated to the affixing process, given the variation in (31a).

Similarly, the variation in *dafenlīc* - *dafnlīc* 'suitable' may be put down to variation in the verb stem, as shown in (31b). It follows from this that the disappearance of <e> can only be argued to result from affixing if stem-internal free variation can be ruled out.

Another problem concerns the proper analysis of degemination, in particular the degemination of two identical consonants followed by a third consonant. Refer to (32).

(32) a. will ~ wil 'will'
b. aworpenness ~ aworpeness 'rejection'
c. gelēafful 'faithful'
d. unwemness 'purity'
e. unstillness ~ unstilness 'disturbance'

Even though consonant length is distinctive in Old English (compare *cwelan* 'to die' vs. *cwellan* 'to kill'), geminated consonants often appear in degeminated form in monomorphemic words, as exemplified in (32a). When the stem ends and the suffix begins with the same consonant, the precondition for degemination across morpheme boundaries is given. In many cases, this situation is conducive to optional degemination, as in (32b), whereas in others it is not, as in (32c).

When three consonants occur in a row, as when the stem ends in a geminate and the suffix begins with a consonant, the stem-final consonant is usually lost. This process is illustrated in (32d). The morphological complex *unwemness* is derived from the verb stem *wemman* 'to spoil' whose consonant doubling disappears following suffixation. The general rule seems to be that degemination occurs before consonant-initial suffixes but not before vowel-initial suffixes: contrast *unwemlīc* 'pure' versus *unwemming* 'incorruption.' It may be suspected that there is a general ban on three-consonant sequences.[8] However, this ban is far from compulsory, as can be seen from example (32e). Both the degeminated form *unstilness* and the geminated form *unstillness* are attested. For the empirical analysis, degemination is treated as an instance of stem-suffix interaction if the main entry of the prefix-stem-suffix sequence in the dictionaries is given in its degeminated form, as for example in (32b).

The suprasegmental criterion enquires into affix-induced changes in the stress pattern of a given stem. To assess the power of an affix to change a stem's stress pattern, it is necessary to determine the stress pattern of morphologically complex words. Again, recourse to Old English poetry proves extremely helpful. As will be recalled, alliterating consonants always come from stressed syllables. If this consonant occurs in the prefix, we know that the prefix was stressed; if, however, the consonant occurs in the stem, we know that the prefix was unstressed. Here are two examples to illustrate the point.

(33) Ne meahten wiþerbrōgan wīge spōwan (The Exeter Book: Christ
not could adversaries in war succeed
A, B, C, line 564)
'His adversaries could not succeed in battle.'

(34) Hī hyne þā ætboron to brimes faroðe (Beowulf, line 28)
they him then carried to sea current
'Then they carried him to the sea.'

The alliterating consonant is <w> in (33) and <b> in (34). It may be inferred from this that the adversative prefix *wiþer-* rather than the stem *brōgan* 'to oppress' carries the main stress in (33). The opposite situation holds in (34) where the main stress falls on the stem *bǣron* 'carried' rather than on the prefix *æt-*.

The analysis of the Old English alliterative poetry reveals that some prefixes (in particular *ge-* and *be-*) are always unstressed whereas all others have both a stressed and an unstressed variant. Which variant is appropriate depends on the word class of the lexical item and the stress pattern of its base form. These criteria were consistently applied in determining the stress pattern of the prefix-stem-suffix sequences because most of these morphological complexes could not be found in the (alliterating portions of) Old English poetic texts.

The remaining three criteria require little discussion as they do not raise any special methodological problems. The morphological criterion capitalizes on the fact that affixes generally attach to some word classes though not to others. Whether or not an affix is incompatible with a certain word class was decided on the basis of attested stem-suffix and prefix-stem combinations (in the absence of a comprehensive treatise of Old English morphology).

The lexical criterion examines the lexical status of the prefix-stem and stem-suffix portions in prefix-stem-suffix complexes. Lexical status was determined with the help of Bosworth & Toller's dictionary. In a number of cases, the phonological relationship between the stem portion in the morphological complex and the base (usually a verbal infinitive) was found to lack full transparency. Of course, lexical status was only accorded if the likely base could be successfully located.

Finally, the semantic criterion assesses the relative strength of the semantic bonds between prefix and stem as well as stem and suffix. This assessment had to rely on the translations that were provided in the pertinent dictionaries, in particular Bosworth & Toller's. This method is certainly not the most reliable one in view of the fact that translations can only be rough guides to meaning and that the semantics of a dead language is even more difficult to penetrate than, let us say, its morphology. However, in the majority of cases, the semantic structure of the prefix-stem-suffix combinations could be determined with a reasonable degree of confidence.

4.3.1.2 Results

The application of the six criteria discussed earlier to the set of 1168 Old English prefix-stem-suffix sequences yields the following results. The logic underlying the assignment of the data to the four categories of branching direction is exactly the same as in the analysis of the Modern English data reported in section 2.4 and will therefore not be reiterated here.

The overall picture that seems to emerge from Table 4.2 is a strikingly inconsistent one. Neither a consistent branching direction nor a consistent degree of hierarchicalness is discernible. Exaggerating only slightly, each criterion has a different story to tell. Let us look at each criterion in turn.

Resyllabification is the only criterion to lead to an absolute difference between left- and right-branching. All relevant items point toward right-branching but never left-branching. This is because syllabification

Table 4.2 Morphological Structure in Old English Prefix-Stem-Suffix Sequences (N = 1168)

	Categories			
Criteria	*Left-Branching*	*Right-Branching*	*Both*	*Neither*
Resyllabification	0 (0.0%)	587 (50.3%)	0 (0.0%)	581 (49.7%)
Segmental	0 (0.0%)	10 (0.9%)	0 (0.0%)	1158 (99.1%)
Suprasegmental	529 (45.3%)	0 (0.0%)	0 (0.0%)	639 (54.7%)
Morphological	1 (0.1%)	0 (0.0%)	1166 (99.8%)	1 (0.1%)
Lexical	419 (35.9%)	195 (16.7%)	455 (39.0%)	99 (8.5%)
Semantic	782 (67.0%)	231 (19.8%)	115 (9.8%)	40 (3.4%)

principles are assumed to apply across the board (i.e., in all words that meet certain structural conditions). Thus resyllabification is hypothesized to apply across the stem-suffix boundary though not across the prefix-stem boundary throughout the lexicon. Given this absolute difference, the actual number of cases in the right-branching category is largely immaterial. This number depends entirely on the frequency with which a vowel-initial suffix is preceded by a consonant-final stem. Still, it is notable that this structural condition is met in more than 50% of cases. Whatever the percentage, it is obvious that the resyllabification criterion argues for right-branching. At the same time, the resyllabification criterion remains silent on the strength of right-branching (i.e., on the issue of hierarchicalness.

At first sight, the segmental criterion appears to invite a different conclusion. In less than 1% of the 1168 items does the addition of an affix entail a modification of the phonemic structure of the stem. This demonstrates that a morphophonology so defined is virtually absent from Old English. There are only two morphophonological processes, to wit degemination and <e> deletion. As explained in the preceding section, neither of these is totally morphophonological as they may also arise without a morphological motivation. That is to say, not even these 10 cases are entirely convincing. It may accordingly be argued that the segmental criterion is compatible with a flat structure of morphologically complex words.

We note that the 10 cases of morphophonological adjustment are not evenly distributed. All of them involve changes in the stem that are brought about by suffixes. No single prefix (token) could be found to change the phonemic structure of the stem. The segmental criterion may thus be argued to favour right-branching. It seems then that the segmental and the resyllabification criteria lead to the same conclusion. Unfortunately, this is far from certain because the right-branching slant that is suggested by the segmental criterion is extremely weak, given that the theoretical possibilities of stem-suffix interaction are almost unlimited. However, hardly any such interaction is observed. It is possible, though difficult to prove, that the resyllabification criterion argues for the same low degree of hierarchicalness. For resyllabification to take place, only a minimum degree of hierarchicalness may be required. On this assumption, the segmental and the resyllabification criteria could be claimed to be in harmony with each other.

The conclusion supported by the suprasegmental criterion appears to be diametrically opposite to what was suggested by the previous criteria. The fact that almost every other prefix token is stressed whereas not a single suffix receives stress seems to constitute irrefutable evidence for left-branching. The high number of stressed prefixes results from the fact that practically all items in the data set are nouns or adjectives and these two word classes generally take initial stress, regardless of whether they are prefixed or not.[9] One would be tempted to close the case here if it was not for the special behaviour of Old English prefixes. In fact, there is reason to reconsider their status and pose the fundamental question: Are these prefixes really prefixes?

What is typically required of a prefix is that it be bound. However, there are three relevant senses in which these prefixes are not bound. In the first place, prefixes and stems were not always written in one word. For all that orthographic evidence is worth, the idea is that a prefix that is separated from its stem loses its status as a prefix in the strict sense and behaves like an adverb or a preposition. Indeed, many Old English prefixes are formally identical to adverbs and prepositions and probably developed from these. In the second place, many prefixed verbs had a variable prefix-stem order, not unlike the situation in Modern German and Dutch. Clearly, a prefix that is placed after its stem does not deserve its name. In the third place, material could be intercalated between the "prefix" and the stem (as well as between the stem and the "suffix"). The following examples illustrate these three properties. They are borrowed from Harrison (1892).

(35) se Godes man wæs ūt gongende of þǣm mynstre. (Bede 362, 18)
the God's man was out going of the monastery
'The man of God was leaving the monastery.'

(36) Se forlǣt ūt ðæt wæter. (Cura Pastoralis 279, 13)
he let out the water
'He let out the water.'

(37) þonne orn þǣr blōd ūt. (Orosius 234, 5)
then ran there blood out
'Then blood ran out there.'

All three examples involve the morpheme *ūt* 'out.' As is immediately obvious, the relationship that *ūt* contracts with the various verbs in (35–37) is a rather loose one. As it behaves largely like an independent word, it cannot be legitimately regarded as a prototypical prefix even in prefix-stem combinations. In the light of their properties of independent words, it comes as no surprise that these "prefixes" attract stress, given the general rule that Old English words are initially stressed.[10]

Viewed in this light, it makes sense to classify these morphemic combinations as (quasi) compounds rather than derivations (see e.g., Campbell, 1959). If this decision is taken to its extreme, we would have to eliminate all prefix-stem-suffix sequences that are initially stressed. The net result would be an identical behaviour of prefixes and suffixes (in being unable to change a stem's stress pattern) and, by implication, the hypothesis that the suprasegmental criterion speaks in favour of a flat structure. However, this conclusion overlooks the fact that not all Old English "prefixes" were separable. Some were clearly inseparable as verbal prefixes but at the same time stress-bearing as non-verbal prefixes. Among these are *and-* 'against,', *ed-* 'back, again' and *un-* 'un.' The existence of such genuine prefixes suggests that prefixes have the power to alter a stem's stress pattern, especially in nouns and adjectives (i.e., the data on which the present analysis is based). Given the fact that suffixes do not have this power at all, the conclusion seems inevitable that the suprasegmental criterion provides an argument for left-branching in prefix-stem-suffix sequences.

With respect to word class, there are virtually no restrictions on which affix may go together with which stem in the 1168 items. There are important similarities both between verbs and nouns and between nouns and adjectives. For example, the prefix *un-* attaches to nouns and adjectives alike, unlike in Modern English. Compare Old English *unþankful* to its Modern English successor *unthankful*. Whereas the Modern English form lends itself to a right-branching analysis because the prefix cannot in general attach to nouns, the Old English form is not subject to any such constraint. It is therefore compatible with both branching directions. This is true of basically all items in the database. The morphological criterion thus proves largely unhelpful in the current debate. However, as it argues neither for a left- nor for a right-branching bias, it may be claimed to be consonant with a flat view of morphologically complex words in Old English.

Yet another conclusion is invited by the lexical criterion. Although the relative majority of items allow for both branching directions, left-branching cases occur more than twice as often as right-branching cases. Hence, the lexical criterion makes a relatively strong case for a left-branching preference. This preference comes out even more strongly when the semantic criterion is applied. Here the left-branching cases constitute the absolute majority and are more than three times more frequent than the right-branching ones.

4.3.1.3 Discussion

Viewing the six criteria together, we find ourselves in an uncomfortable position. Whereas one half of the criteria favours left-branching, the other half favours either right-branching or no branching direction at all. There does not seem to be a single principle under which all these divergent effects can be subsumed. However, the following three conclusions appear to be warranted. One is that right-branching is only weakly developed. There are hardly any segmental interactions between stem and suffix, and as argued earlier, the resyllabification criterion probably provides little evidence for the strength of a particular branching direction. The other conclusion turns on the inconsistency in the data. It might be that this inconsistency itself is of theoretical significance. It is a bold, but perhaps not too bold a claim to turn inconsistency into flatness. If there is consistent evidence neither for left- nor for right-branching, it might be very tentatively argued that the system is relatively flat. It should be emphasized, however, that this is a highly controversial claim to make. The final point concerns the explanation for the observed heterogeneity. Assuming that a change in branching direction has to go through a flat stage, it might be argued that there is an asynchrony among the various criteria. Some simply lag behind others and therefore give rise to conflicting interpretations.

Whereas the synchronic approach discloses a great deal of heterogeneity in the data, the picture looks radically different from the diachronic perspective. In point of fact, when we trace the historical development of branching structure, the heterogeneity gives way to an astonishingly homogeneous situation. As will be seen in the following dicussion, all of the six criteria invite exactly the same conclusion.

As before, we will begin with the resyllabification criterion. Provided that this criterion can be given a quantitative interpretation, right-branching may be argued to have increased over time. A percentage of 63.5% right-branching cases in Modern English as against 50.3% in Old English makes for a significant difference ($\chi^2(1) = 40.1$, $p < 0.001$). A very similar conclusion is invited by the segmental criterion. Both Old and Modern English show a right-branching bias but this bias was extremely weak a thousand years ago but is very strong today. Thus the segmental criterion argues for an increase in hierarchicalness. A most radical change can be observed in the domain of stress. According to the suprasegmental criterion, a change has taken place from left-branching in Old English to right-branching in Modern English. Also the morphological criterion concurs with the previous criteria in confirming a diachronic tendency toward right-branching. Whereas no branching-direction preference is discernible in Old English, right-branching certainly prevails in the modern language. The morphological criterion thus provides clear evidence for a development from flat to hierarchical structure.

Turning to the lexical criterion, we find another reversal during the transition from Old to Modern English. Whereas left-branching cases outnumbered right-branching ones by a factor of more than 2 in Old English, Modern English shows right-branching structures to be more than twice as frequent as left-branching ones. Like the suprasegmental criterion, the lexical criterion argues for a pronounced change from left-branching to right-branching. The semantic criterion suggests likewise. The changes we observe in the transition from Old to Modern English involve an increase in right-branching and a concurrent decrease in left-branching structures (with the other categories remaining relatively constant). While the Modern English data do not display a preponderance of right-branching cases, the historical development is clearly one from less left- to more right-branching.

Concluding, all six criteria are unanimous that the historical development of English morphology is adequately characterized by an increasing importance of right-branching. They agree perfectly on the direction of the diachronic change even though the starting points are not identical. What is the reason for this structural change? It is possible to explain the increasing right-branching bias as an effect that arises within morphology itself. Certain morphological changes would be assumed to have taken place that have repercussions on the internal structure of words. A prime candidate for such a morphological change is the decreasing importance of prefixes coupled with the increasing importance of suffixes, as discussed in section 4.3. Clearly, there is a connection between branching direction and an asymmetry between prefixes and suffixes. The more prefixes and the fewer suffixes there are, the greater the importance of left-branching (and vice versa). This account reflects the situation in Old English. As one example for many others, let us come back to the verbal prefix *ge*-, which was extremely frequent and created a contrast between prefixed and unprefixed verbs with hardly any noticeable difference in meaning (compare *trumian* ~ *getrumian* 'to gain strength'). This state of affairs almost inevitably leads to a left-branching structure from the semantic point of view, whatever the derivational suffix that might be attached. It also heightens the probability of left-branching at the lexical level because the productivity of *ge*- is large enough to surpass that of the derivational suffixes. As a consequence, more items with a prefix-stem than those with a stem-suffix structure are attested. By contrast, Modern English is very different. As prefixing has come to be a disfavoured option, the basis for a left-branching dominance has gone. Hence, the diminished importance of prefixing may be understood as a causal agent in the shift from left- to right-branching in the historical development of prefix-stem-suffix sequences.

However, the fact that a local explanation has been offered of the structural reorientation is not to say that global effects cannot also play a role. In fact, it is quite likely that global effects are nourished by a series of local effects. In this view, several factors may conspire to generate a global effect, which may then strengthen the individual local factors. We will return to this issue in section 4.5 after all the relevant evidence has been presented.

4.3.2 Stem-Stem-Stem Structures

The remarkable frequency of nominal compounding gives rise to a good number of stem-stem-stem complexes, almost all of which have a noun as their head. Two illustrative examples are given here (in addition to (21)).

(38) eafor hēafod segn 'boar head banner'

(39) biscop hēafod līn 'bishop's head ornament'

Both cases involve the same middle constituent *hēafod*. The critical question is whether *hēafod* associates with the preceding noun to form a left-branching structure or with the following noun to create a right-branching structure. Unfortunately, only a minority of criteria are applicable. The combination of independent words represents such a loose structure that there is no basis for phonological processes. Neither resyllabification nor segmental modifications occur. The suprasegmental criterion is inapplicable as there is no stress variation. All compounds receive the main stress on the first constituent in Old English. Also the morphological criterion fails to apply as the great majority of constituents are nouns. By contrast, the lexical criterion is applicable despite the following well-known asymmetry. Whereas the lexical attestation is proof that a word was in use, the fact that a word is not attested in a given dictionary does not necessarily mean that it was not in use. Care must be taken when reviewing the results of applying this criterion. Nourishing this scepticism, none of the four two-member portions in (38) and (39) are listed in Bosworth & Toller (e.g., *eafor hēafod*). To the extent that the meaning of a compound can be accurately determined, the semantic criterion is the most reliable one. According to this criterion, (38) is assigned a left-branching structure because it is a banner with the head of a boar on it. In contrast, (39) is classified as right-branching because its meaning is the head ornament that a bishop wears rather than the ornament of a bishop's head.

A total of 133 three-member compounds were found in Bosworth & Toller's dictionary. All compounds containing proper names (e.g., *Granta-brycg-scir* 'Cambridgeshire') were discarded. When a compound contained a constituent that could not be unambiguously identified as an independent word, it was also eliminated. This left us with 117 items altogether. The results of applying the lexical and the semantic criteria are tabulated in Table 4.3.

The most important result of Table 4.3 is that Old English stem-stem-stem sequences are predominantly left-branching. This conclusion is supported by the lexical and semantic criteria alike. It appears from Table 4.3 that the left-branching bias is stronger on the semantic than on the lexical criterion. This difference makes sense on the assumption that these linguistic patterns exhibit a general preference for left-branching, which may unfold itself in unrestrained fashion at the semantic level but is restrained at the lexical level, and which has to provide for $stem_1$-$stem_2$ as well as $stem_2$-$stem_3$ structures as individual lexical items. This provision automatically introduces some symmetry into the picture.

The predominance of left-branching has remained remarkably constant across time, as the comparison between the stem-stem-stem sequences in

Table 4.3 Morphological Structure in Old English Stem-Stem-Stem Sequences (N = 117)

	Categories			
Criteria	*Left-Branching*	*Right-Branching*	*Both*	*Neither*
Lexical	45 (38.5%)	32 (27.4%)	27 (23.1%)	13 (11.1%)
Semantic	76 (65.0%)	40 (34.2%)	1 (0.9%)	0 (0.0%)

Old and Modern English (see section 2.4.4) reveals. It is not surprising therefore that Middle English is probably no different. According to Sauer (1992, p. 324), it is subject to the same bias even though he does not adduce any quantitative support for his claim.

It is worthwhile to note that even the strength of the left-branching bias has remained unchanged. Let us pick out the semantic criterion. A χ^2 test that contrasts only the left- and right-branching cases yields a non-significant difference between Old and Modern English ($\chi^2(1) = 3.3$, $p > 0.05$). This constancy allows us to make two major claims. One is that whatever historical change may be going on, it is not one that affects all morphological types. At least stem-stem-stem structures are resistant to it. This lends credence to the hypothesis of the local nature of the change, as discussed in the foregoing section. The other claim is that the reasons for the left-branching slant of stem-stem-stem sequences may lie outside the general branching-direction preference of the language. As was argued in section 2.4.4, left-branching three-part compounds are much easier to process for the listener than their right-branching counterparts. It stands to reason that this processing principle is as true of Modern English as it was of Old and Middle English. In other words, there is no reason for it to change even if a structural change in other areas of the language is taking place. And this constancy is precisely what we observe.

4.3.3 Conclusion

Because only two linguistic patterns could be subjected to a detailed analysis, it is inappropriate to draw a general picture of structural change at the morphological level. What is clear is that it is impossible to put down all historical developments to a single structural change. Among all morphological complexes, both free and forced, there are cases of increased left-branching (e.g., stem-suffix-suffix sequences), cases of increased right-branching (e.g., prefix-stem-suffix sequences), cases of decreased left-branching (e.g., prefix-stem-stem sequences) as well as cases of decreased right-branching (e.g., prefix-prefix-stem sequences). This full gamut of possibilities might be taken to suggest that branching-direction analysis is not the most insightful approach to capture the morphological changes that have taken place in the history of English. However, it was argued earlier that not all types of morphological complexes should be assigned the same status. In particular, only free types qualify as valid test cases.

Once this criterion is imposed, we are left with only two types of very different status. The major category is the prefix-stem-suffix combinations, which have both a high type and token frequency. Stem-stem-stem complexes form a minor category because they have both a low type and token frequency. Whereas the latter category does not undergo a historical change, the former consistently developed toward right-branching. Although this structural change is the principal theoretical result of this section, it must be borne in mind that it is based on a single, yet crucial data type.

4.4 SYLLABLE STRUCTURE

The limitations of historical data are nowhere felt as acutely as in the phonological domain. As only written documents are available, the entire underpinning from phonetics breaks off. Needless to say, the same goes for experimentation as well as naturalistic data, such as slips of the tongue. Old English word games are unknown. These restrictions make it difficult to reach reasonably firm conclusions about the structural representations underlying VCC sequences and polysyllabic words. The ensuing analysis will therefore be confined to the CVC syllable for which at least some of the criteria set out in Chapter 2 are applicable.

4.4.1 CVC Syllables

Evidence for the internal structure of CVC syllables in Old English comes from three types of argument—the phonotactic, the suprasegmental, and the poetic. These will be examined in this order.

4.4.1.1 The Phonotactic Argument

The following analysis will provide a separate treatment of the qualitative and the quantitative side of the syllable. It will be recalled from Chapter 1 that the latter side involves changes that have repercussions on the slot tier. The discussion of syllable quantity is divided into two parts. The first presents a list of pertinent diachronic changes whereas the second looks at Old English from a synchronic perspective.

Luick (1964, p. 187) points out a tendency, beginning as early as in West Germanic time, toward equalizing the duration of syllables. Excessive length was eliminated by vowel shortening and excessive shortness by vowel lengthening. To be specific, short vowels in Old English monosyllabic words, in particular in open syllables, were lengthened (e.g., Gothic *nu* = O.E. *nū* 'now'). Vowel lengthening also occurred before homorganic consonant clusters (e.g., O.E. *eald* -> *ēald* 'old'). Heterorganic clusters induced the opposite development. Long vowels underwent shortening before two or more consonants (e.g., O.E. *blīþs* → *bliss* 'bliss'). This differentiation between homorganic and heterorganic clusters is remarkable. It may be suspected that homorganic sequences are shorter than heterorganic ones. If this is so, the two opposite developments may be claimed to be related. Suppose that there is a certain durational threshold for postvocalic clusters below which preceding vowels are lengthened and above which preceding vowels are shortened. If homorganic sequences fall below this threshold but heterorganic clusters above this threshold, we would have a unified explanation for their opposite behaviour.

These principles of quantitative change persisted in Middle English, even though they were largely restricted to disyllabic words (but see Kim, 1993). Generally speaking, vowels in open syllables were lengthened and vowels in closed syllables were shortened. These processes remained in operation throughout the Middle English period and applied whenever another change had created appropriate structural conditions.

It is obvious from the previous discussion that Luick was not talking about isochrony in syllables, but rather in rimes. All phonological changes illustrate the action of postvocalic rather than prevocalic consonants. With this ground-clearing, the interpretation of the quantitative changes is straightforward. Their overall motivation appears to be an increased importance of the rime. The heightened sensitivity to rime weight resulted in a compensatory effect such that heavy nuclei required lighter codas and vice versa. Of course, such a compensatory effect is what one would expect to find in a right-branching structure. The quantitative changes may therefore be interpreted as reflecting a development from a flat to a hierarchical organization of the syllable.

The next step involves examining the distribution of phonemes in Old English CVC syllables. The diachronic approach adopted earlier leads us to expect that Old English CVC syllables should have been relatively symmetrical. Only if the synchronic analysis reveals that there is little interaction between the nucleus and the coda is it justified to argue that a historical change has taken place. Consonant with this expectation, it has often been claimed that coda consonant and vowel length are independently specified in Old English (e.g., Mossé, 1952, p. 16; Pilch, 1970, p. 61; Lass, 1992, p. 70). That is, a long or short vowel may combine with a long or short coda consonant. This statement is correct as a claim about what is possible in Old English. However, the non-interaction that it suggests is potentially spurious because it does not rule out the possibility of distributional asymmetries in the Old English lexicon. Only a frequency analysis can furnish an adequate basis for arguing the independence or otherwise between the weight of the constituents of the rime.

To this end, all monosyllabic words listed as main entries in Raith's (1965) dictionary of Old English were subjected to analysis. As our interest is in phonological patterns, homophones were counted only once. So were spelling variants. Bound morphemes such as *seld-* 'rare' and inflected forms such as *cann* (from *cunnan* 'to know') were excluded. Standard diphthongs were treated as tautosyllabic but nonstandard sequences of vowels as heterosyllabic. Entries like *buan* 'to dwell' for example, were therefore classified as disyllabic and discarded. Hyphenated words such as *and-lēan* 'reward' were counted as one. Words ending in a cluster of which the second consonant is more sonorous than the first (e.g., *ādl* 'disease') were regarded as disyllabic and consequently not taken into account. After these reductions we were left with 945 items.

The orthographic representation in Raith (1965) was converted and coded in the assumed phonological form. This conversion was straightforward at the slot level. Each single consonant was assigned a single C slot because all consonants are generally held to have a certain phonetic value (i.e., there are no mute letters). Geminate consonants were invariably reserved two C slots. Like Modern English, Old English is assumed to have the two affricates /tʃ/ and /dʒ/. These were connected with a single C slot. Short monophthongs and short diphthongs were associated with one V position whereas their long counterparts were linked to two V positions.

For easy comparison, both the Old and the Modern English data are contained in Table 4.4. Table 4.5B from section 2.5.1.1 is reproduced here as Table 4.4B. As no evidence for an onset-nucleus interaction could be found for the modern language (see Table 4.5A), our focus will be on rime-internal effects.

The critical information contained in Table 4.4 is the ratio of short- to long-vowelled rimes. A ratio of 1.0 implies that a given coda type associates itself as frequently with a short as with a long vowel. Such a result would be expected under a flat representation of the syllable. A ratio of significantly less or more than 1.0 indicates an interaction between the nucleus and the coda and is therefore compatible with a hierarchical right-branching structure. Whether the ratio is above or below 1.0 depends on what is considered to be the optimal CV shape of the rime. If we assume that the optimal rime is of medium size, shorter rimes may be expected to have values below 1.0 and longer ones above 1.0. Table 4.4 bears this out. The short/long ratio steadily increases with the weight of the rime in both Old and Modern English.

The comparison between Tables 4.4A and 4.4B would be greatly facilitated if the optimal rime size was identical for Old and Modern English. In fact, Vennemann (1988a) assumes that the optimal rime size can be determined on a universal basis (at least for stress-timed languages). Thus, in stressed syllables the optimal rime has the same number of segmental slots as immediate constituents, that is, two (i.e., VC or equivalently VV). There is an obvious way of operationalizing Vennemann's claim and thereby subject it to an empirical test. If optimality is operationalized in terms of frequency, it may be predicted that non-optimal rimes occur less commonly than optimal ones. This is true neither of Modern English nor of Old English monosyllabic words. While VC and VVC rimes are almost equally frequent in Modern English, Old English displays a pronounced asymmetry even in favour of non-optimal VVC rimes.

This result very clearly argues against the universality of Vennemann's claim. More specifically, it demonstrates that the optimal rime size has to be determined on a language-particular basis. In order to gain a clearer picture of the optimal rime size in Old and Modern English, the data of Table 4.4 have been rearranged according to rime weight in Table 4.5.

Table 4.4 Weight Interactions in the Rimes of Old and Modern English Monosyllabic Words

A: Old English (N = 945)			*B: Modern English (N = 6757)*		
Short Vowel	*Long Vowel*	*Short/Long Ratio*	*Short Vowel*	*Long Vowel*	*Short/Long Ratio*
-V: 6 (1.2%)	-VV: 43 (9.6%)	0.13	-V: 2 (0.1%)	-VV: 559 (14.5%)	0.01
-VC: 138 (27.9%)	-VVC: 375 (83.3%)	0.33	-VC: 1968 (67.7%)	-VVC: 2767 (71.9%)	0.94
-VCC: 337 (68.1%)	-VVCC: 32 (7.1%)	9.6	-VCC: 871 (29.9%)	-VVCC: 513 (13.3%)	2.25
-VCCC: 14 (2.8%)	-VVCCC: 0 (0.0%)	> 28	-VCCC: 68 (2.3%)	-VVCCC: 9 (0.2%)	11.5

Table 4.5 Frequency of Different Types of Rime Weight in Old and Modern English

	Old English	*Modern English*
monomoraic	6 (0.6%)	2 (0.0%)
bimoraic	181 (19.2%)	2527 (37.4%)
trimoraic	712 (75.3%)	3638 (53.8%)
tetramoraic	46 (4.9%)	581 (8.6%)
pentamoraic	0 (0.0%)	9 (0.1%)

As can be seen from Table 4.5, the absolute majority of rimes in both Old and Modern English monosyllabic words are trimoraic. The average rime weight is 2.84 for Old English and 2.71 for Modern English. If the four rime types in Table 4.4 are divided into two subsets, the first comprising the two simpler types (V)V and (V)VC and the second the two more complex types (V)VCC and (V)VCCC, and tested against each other, Old English rime structure turns out to be significantly more complex than that of Modern English ($\chi^2(1) = 163.4$, $p < 0.001$). There thus appears to be a diachronic decrease in the complexity of the rime. This finding suggests that an account of the historical development of nucleus-coda interactions is not an easy task because this development is overlaid with a decrease in rime complexity. Another implication is that we should not expect a short/long vowel ratio of above 1 until the coda cluster stage (third row in Table 4.4).

Before interpreting Table 4.4 from the diachronic perspective, it is helpful to point out the consequences of a possible change from a less to a more hierarchical organization of the syllable. Generally speaking, the asymmetry between short- and long-vowelled rimes will increase with hierarchicalness. To be specific, open syllables will exhibit a lowered ratio whereas closed syllables with coda clusters will exhibit an elevated ratio. The prediction is more difficult for syllables ending in a singleton consonant as the optimum rime size for both Old and Modern English lies between 2 and 3 C/V units. Whatever the accurate prediction for syllables with one coda consonant may be, it is clear that these predictions receive little support from Table 4.4. As indicated by the short/long ratios, it is true that Modern English possesses a better syllable structure for codaless rimes than its predecessor, viewed from the perspective of the right-branching hierarchical model. However, Old English had the better syllable structure than the modern language for complex syllables ending in two or three consonants. It might even be argued that the same is true of syllables with one coda consonant, given the trimoraic nature of the rime. It may be concluded from this that the importance of rime isochrony has not been enhanced in the history of the English language and therefore, this analysis does not provide any evidence in favour of an increase in hierarchicalness from Old to Modern English.

Although this result is disappointing from the overall perspective of hierarchization, it teaches us an important methodological lesson. A non-quantitative analysis that simply states what is permitted by the phonotactic rules of the language may give a highly distorted, if not false picture of the structure of the language in general. What is possible in principle need not be typical. Therefore, it is unjustified to infer from qualitative patterns that there is an independence between nucleus and coda, as so many scholars have done. What we find instead is that Old English phonotactics at the slot level was as sensitive to the rime as it is today. As Table 4.4 amply demonstrates, nucleus and coda were clearly not independent at that time. The greater the weight is of the coda, the greater its reluctance to follow a long vowel.

We now shift our attention from the slot level to the segmental domain. The principal question of the ensuing analysis is whether the number of "phonotactic conspiracies" has changed in the history of the English language. By "phonotactic conspiracies" we mean pairs of adjacent segments whose frequency is not predicted by the combined frequency of its individual parts. Differently put, phonotactic conspiracies are adjacent-segment pairs that occur significantly more (or less) often than expected by chance (see section 2.5.1.1).[11] Subsequent to the identification of these phonotactic conspiracies, it has to be determined whether these pairs occupy the body or the rime portion of the syllable. This will furnish the basis for an assessment of possible diachronic changes that may have taken place in the syllable structure of English. To repeat familiar logic, an equal number of body and rime conspiracies constitute evidence for flat structure whereas a predominance of rime conspiracies argues for right-branching hierarchical structure. By comparing the absolute numbers, we may determine whether hierarchicalness in the domain of the syllable has or has not increased over time.

The data on the basis of which this theoretical issue will be addressed are exactly the same as those that went into the quantitative investigation above. Although our focus is on the internal structure of CVC syllables, all monosyllabic words (from Raith, 1965) were taken into consideration, irrespective of syllable size. It was felt that the nature of the bond between, let us say, a certain vowel and a following consonant can be profitably studied not only in CVC but also in CVCC syllables because if there is a special relationship between these two units, it would not be severely disturbed by the presence of another consonant at the very end of the word. Of course, the decision of relying on all monosyllabic words had the additional advantage of enlarging the database, which is important for the discovery of statistically significant patterns.

Determining the phonetic value of the graphemes turned out to be a slightly more difficult task as there is occasional indeterminacy in the pronunciation rules given in the standard manuals of Old English. The following four handbooks were consulted: Quirk & Wrenn (1957), Blakeley (1964), Mitchell & Robinson (1992), and Pollington (1997).

For the sake of transparency, the more complex decisions are enumerated in the following discussion. The grapheme <h> was given the value [h] in prevocalic sites but the values [x] and [ç] in postvocalic sites. The letter <h> was phonetically realized as [ç] after palatal vowels and as [x] before velar vowels. The coding system treats the two fricatives as distinct segments and therefore ignores the issue of whether they might be considered allophones. The letters <þ> and <ð> were given identical treatment. In the word margins, they invariably represented the voiceless variant. The digraph <sc> was always rendered as [ʃ], <cg> always as [dʒ], <f> as [f] and <s> as [s] in the set of monosyllabic words.

The major problems of Old English pronunciation concern <c> and <g>. The grapheme <c> had two pronunciations. It was given the phonetic value [tʃ] before front vowels word-initially and after front vowels word-finally (e.g., *ic* 'I') as well as in those words where the Modern English outcome has an affricate, as in *ælc* 'each' and *benc* 'bench.' Elsewhere, <c> was interpreted as [k], in particular word-initially before back vowels and before consonants (e.g., *cneo* 'knee'). The same value was assigned to <c> before the front rounded vowel [y] as in *cynn* 'kin.'

Even more complex is the letter <g>, which knows the three pronunciations [g], [j] and [ɣ]. It was rendered as [j] word-initially before palatal vowels and word-finally after palatal vowels. However, it was coded as [g] prevocalically before back vowels and consonants (e.g., *glæd* 'glad'). As in the case of <c>, the front rounded vowel behaved like the back vowels in requiring <g> to be treated as a stop (e.g., *gylt* 'guilt'). The third rendition of <g> was [ɣ], which occurred word-finally after back vowels and liquids (e.g., *dolg* 'wound').

All pairs of vowel and immediately preceding or following consonant were extracted from the set of monosyllabic words. The frequency of the individual phonemes was derived corpus-internally, that is on the basis of the same materials that served to gauge the frequency of phoneme combinations. This method allowed for maximum internal consistency. Whether the difference between the combined frequency of individual adjacent segments and the actual frequency of adjacent-segment pairs is statistically significant was ascertained on the basis of Fisher's exact test, which is a more accurate and more rigorous variant of the chi-square test. The same procedure was applied to the complete set of monosyllabic words in Modern English. The results of the two analyses are summarized in Table 4.6.

One noteworthy result emerging from Table 4.6 is that the distribution of phonotactic conspiracies has been remarkably stable over the past 1300 years or so. The ratio of body to rime conspiracies has remained constant. Out of 5 conspiracies, 4 occur in the rime and only 1 in the body domain in both Old and Modern English. However, the absolute numbers of phonotactic conspiracies have changed quite impressively. Whereas these were

Table 4.6 Frequency of Phonotactic Conspiracies in Old and Modern English as a Function of Syllable Position

	CV			*VC*			*Grand Total*
	>	<	*Total*	>	<	*Total*	
Old English	1	1	2	1	7	8	10
Modern English	11	2	13	24	25	49	62

(N.B. The “>” and “<” signs indicate that a given pair occurred more or less often than expected by chance, respectively.)

rather uncommon in Old English, they are 6 times more frequent in the modern language. Differences in sample size alone cannot account for the diachronic increase in the number of phonotactic conspiracies because Kessler and Treiman (1997) found a very similar number of significant CV and VC combinations in their corpus of CVC syllables, which was less than a third of the size of the present corpus (see section 2.5.1.1). Thus, it seems safe to claim that the number of phonotactic conspiracies has been on the increase since the Old English period. One way of interpreting this finding is to argue that Old English syllable structure underwent a process of hierarchization. In contrast, branching direction did not change. Old English was as right-branching as is the modern language.

A final observation to make about Table 4.6 pertains to a possible interaction between syllable position and the above- or below-chance occurrence of phonotactic conspiracies. The increase in phonotactic conspiracies from Old to Modern English occurs in both the body and the rime domains as well as for the above- and the below-chance occurrences. However, this increase is only minimal in the below-chance conspiracies in the body domain. It is not clear why this is so.

To summarize this subsection, the phonotactic analysis has produced the following results. Right-branching appears to be the appropriate characterization for both historical stages. It is less clear whether syllable structure has become more hierarchical in the history of English. The segmental analysis provided arguments in favour of this view whereas the CV analysis did not. It remains to be seen whether a larger database of Old English could yield less equivocal results than the ones reported here.

4.4.1.2 The Suprasegmental Argument

It was argued in section 2.5.1.2 that lexical-stress placement in Modern English is moderately sensitive to rime weight. Our next task is to enquire whether Old English stress was more or less sensitive to rime weight than today’s language. Diachronically, the former case may be interpreted as an instance of dehierarchization, the latter as an instance of hierarchization.

In the analysis of lexical stress in Old English, it is proper to treat primary and secondary stress separately because different constraints appear to be at work. The overriding rule in Old English is that the main stress falls on the initial syllable of the word. This is true for both monomorphemic items and compounds. The only major exception to this rule is a set of preposed particles that may be unstressed. As Campbell (1959, p. 30) explains, the particle-stem combinations functioned as syntactic groups (i.e., as sequences of independent words) at the time the main stress was fixed on the first syllable of a word. When these particle-stem combinations developed into single-word units, the stem preserved its main stress, and as a result, the word was non-initially stressed (e.g., *wisácan* 'deny'). As noted in section 4.3.1.2, many particles have stressed and unstressed variants, depending on the word class of the stem.

It transpires from this brief account that main-stress assignment in Old English was completely insensitive to rime weight. Stress fell on the initial syllable because it was the initial syllable, not because it had a particular weight. The irrelevance of phonological factors is further demonstrated by the fact that one and the same particle could be either stressed or unstressed. What matters in stress placement is the morphology (Hutton, 1998) and perhaps the lexicon (i.e., whether the first syllable is a particle [or a prefix] or a stem and whether the stem is nominal or verbal). Thus, there is strong indication that phonology in general and rime weight in particular played no role in Old English main-stress assignment. The comparison with Modern English leaves no doubt, then, that the sensitivity to rime weight has increased over the past millennium.

Although the facts of main-stress placement are uncontroversial, there is considerable debate about the factors underlying secondary-stress placement in Old English. Some argue that its major determinant is phonological in nature (e.g., McCully & Hogg, 1990; Dresher & Lahiri, 1991; Idsardi, 1994). Others prefer a morphological account (e.g., Suphi, 1988) and still others see both influences at work, though to varying degrees (e.g., Colman, 1994b; Hutton, 1998). The basic facts according to Campbell (1959) are as follows. The second element in semantically transparent compounds receives secondary stress (e.g., *fȳrgenstrèam* 'mountain stream'). This second element can also receive secondary stress in opaque structures if it is disyllabic or followed by an inflectional syllable (e.g., *fréondscìpe* 'friendship'). Derivational suffixes may acquire secondary stress when they are preceded by a long vowel and followed by an unstressed syllable (e.g., *lúfiènde* 'loving'). Finally, any long syllable is secondarily stressed when it is preceded by another long syllable and followed by an inflectional suffix (e.g., *héngèstes* 'horses').

Two aspects of Campbell's account are worth elaborating. He uses the terms *long* and *short* to classify syllables and *heavy* and *light* to classify suffixes. Although Campbell does not provide precise definitions of these terms, it may be gathered from the examples he gives that the two antonymic pairs are largely synonymous and that by a heavy syllable he means an open syllable with a long vowel or any closed syllable. He thus implicitly relies on rime weight. The other notable aspect is that Campbell not only refers to weight as a property of the syllable, which is assigned secondary stress but also to weight as a property of a syllable, which adjoins the to-be-stressed one. That is to say, secondary-stress placement is determined by the phonological structure of adjacent syllables (see also McCully & Hogg, 1990). To illustrate, the second syllable is secondarily stressed in *tímbròde* 'he built' but not in *bífode* 'he trembled' because the first syllable is heavy in *tímbròde* but light in *bífode*.

We will not comment on the phonetic naturalness of the assumed interaction between neighbouring syllables that creates adjacent (primary and secondary) stresses, although non-adjacent stresses are much more typical in the world's languages. Rather, the main point in the present connection is that rime weight appears to be a factor in the assignment of secondary stress. In Hutton's (1998, p. 872) words, "secondary stress in Old English is incipiently phonological." Hutton further suggests that the sensitivity of stress to phonological factors may have originated in the process of secondary-stress assignment and from there spread to primary-stress assignment in the history of English.

The conclusion that may be derived from the suprasegmental argument is reasonably clear. Whereas Old English stress was largely uninfluenced by phonological weight (only in secondary-, not in primary-stress assignment), Modern English has reached a stage at which primary- (as well as secondary-) stress placement depends to a certain extent on the structure of the rime. The sensitivity to rime weight thus has increased in the historical development of English.[12] This development is naturally explained by the hypothesis that the rime has gained in strength over the centuries. As the rime was insufficiently strong in Old English times, it could not be "seen," and therefore not be incorporated, by the main-stress rules. However, as the rime was not absent, the secondary-stress rules could refer to it (however inconsistently, which might explain the controversy in the pertinent literature). The assumption here would be that secondary-stress rules manage with a lower activation level of the rime node than primary-stress rules. When the activation level of the rime rose in the Middle English period, it reached a point at which the rime became "visible" to the stress rules so that they could refer to it and take its weight into account. Thus, the rime has gained in importance as a structural element in the phonological representation. Recall, however, that the stress assignment in the modern language is not consistently rime-based (see section 2.5.1.2). This may be taken to suggest that the rime's activation level is too high for stress rules to ignore it completely, but not high enough for them to respect it to the full. Clearly, first-syllable stress is still an important characteristic of the language, even if it is less general nowadays than it used to be. Because these two rules, the initial-stress rule and the rime weight rule, stand in a competitive relationship, the strength of the former keeps the latter in check. This relationship helps to explain why the sensitivity to rime weight is still rather limited in the modern language.

4.4.1.3 The Poetic Argument

As mentioned in section 2.5.1.8, the Modern English rhyme is exclusively rime-based (or superrime-based). This was entirely different in Old English. From among the many different ways in which poetic rhyme can be instantiated (see Leech [1969] for a survey), Old English selected alliteration as its principal means (see section 4.3.1.1 and Sievers [1893] whose account is followed here). Alliteration denotes the repetition of the first consonant of a word or stressed syllable. Importantly, only the first consonant needs to be repeated in onset clusters. A difference in the second consonant does not destroy the rhyme. The only exception to this principle is the /s/ + stop clusters, which alliterate only with themselves. The absence of a consonantal onset does not preclude rhyming. In fact, all vowels alliterate, which suggests that the rhyme is built on something like a null onset.[13] It is also worthy of note that alliteration is phonemically, not allophonically based.

The alliterating principle is consistently applied in *Beowulf*. There is no convincing evidence for other rhyme types. Sievers (1893) points out that (super)rime-based rhyme is not completely absent in Old English poetry. But these cases always also involve alliteration. Consider (40).

(40) fylle ʒefǣgon, fǣgere ʒeþǣgon (Beowulf, line 1014)
'they were very happy, truly happy'

Here, both the alliterating /f/ and the superrime <ǣgon> could serve as the phonological basis for the rhyme. However, the rarity of such cases coupled with the fact that these do not occur without alliterative support very strongly suggests that alliteration is the basic poetic device also in (40) and that the identical superrime is a chance product.

It is worth adding that the rime-based rhyme was brought to England from the continent. According to Sievers, a poem written in 1036 is the first to use rime-based rhyme. It thus marks the transition from alliteration to the modern rhyme type, which spread fairly quickly in the Middle English period.

What light do the rhyming traditions and their radical change shed on the issue of the internal structure of the syllable? At first sight, the Old English rhyme looks onset-based. The onset is an immediate constituent of a right-branching syllable and hence a likely candidate for being singled out for rhyming. It would seem therefore that the Old English rhyming patterns, much like the Modern English ones, argue for a right-branching organization. However, as noted earlier, it is not the onset that rhymes but the syllable-initial consonant. Even the special cases /st/, /sp/ and /sk/ need not be complete onsets as they may be followed by a rhotic, which would not partake in rhyming. Old English rhyming thus is not onset-based but largely phoneme-based, or in the terminology of this book, not structure-based but content-based. By implication, Old English rhyming does not provide strong support for any of the models of syllable structure that are here at issue. If anything, the disregard for structure may be argued to favour the flat model as the one with no structural machinery at all. However, the match between the rhyming data and the flat model is far from perfect. The flat model allows the rhyming segment to occur anywhere in the syllable, but precisely this is not true of Old English poetry.

The change from alliteration to end rhyme may now be interpreted as follows. The English rhyming tradition developed from a content-based to a structure-based device. The phonological basis of the rhyme shifted from a single consonant at the beginning of a syllable to a sequence of phonemes corresponding to the rime. Such a development would be hard to understand if it could not rely on the phonological rime as a structural unit. The fact that Old English poets used alliteration may be taken to suggest that the rime node (i.e., the hierarchicalness of the syllable) was not excessively strong so that it could be ignored. The rhyming data are therefore compatible with the hypothesis that the rime has become increasingly important in the history of English, although they do not actually require this view.

4.4.2 Conclusion

The diachronic evidence from phonology is suggestive rather than conclusive. The only certain finding is that like Modern English, Old English had a right-branching syllable structure. It is somewhat more difficult to defend the hypothesis that Old English syllables underwent an increase in hierarchicalness from the beginnings of the language until today. Support for this view comes from an increased sensitivity to the rime as a structural unit in phonotactic conspiracies, stress rules, and rhyming patterns. However, although there is some agreement among the data, none of the three lines of evidence is particularly strong. Although being the strongest in relative terms, the evidence from stress suffers from the fact that the Modern English case for rime-weight-based stress assignment is not entirely convincing. The evidence from rhyming is somewhat weak as it is not known whether the adoption of the end rhyme would have taken place without the Norman Conquest. Finally, the evidence from phonotactics is somewhat undermined by the mismatch between the segmental and the slot level analysis. Thus, it may be concluded that the degree of hierarchicalness within the syllable has increased from Old to Modern English but this claim cannot be enunciated with a high level of confidence.

4.5 CONCLUSION TO CHAPTER FOUR

After the detailed examination of the historical changes in sentence, word, and syllable structure, it is time to take a bird's-eye view and address the issue of whether these changes are related or occurred independently of one another. Our first task is to assess the level of agreement among the diachronic changes. Only if a certain match can be established does it make sense to argue for a relationship among the changes and hence for a common cause or mechanism underlying them.

Let us begin with branching direction. There is positive evidence to suggest that Old English basically was a right-branching language. There is strong support for a rime node in phonology, some support for a VP node in syntax, and not quite consistent evidence for a stem-suffix node in morphology. Whereas the hierarchically lower criteria applied in the morphological analysis argued in favour of right-branching, the higher ones did not. Only on the premise that the lower ones are more weighty than the higher ones is it justified to postulate a right-branching bias in the morphology of Old English. Thus, a case can be made for some cross-level harmony in Old English branching direction, even though this case is not a very strong one. In view of the fact that Modern English is also a right-branching language, it may be concluded that branching direction is a linguistic principle that has remained unchanged in the history of English.

There is also some evidence to back the claim that Old English displayed a limited sensitivity to structural effects (i.e., hierarchicalness). The case is clearest in syntax, but somewhat less clear in morphology and phonology. Old English sentence structure was found to be relatively unconstrained on all the criteria examined. The fact that Old English word structure showed some inconsistency (in addition to the fact that it had only rudimentary morphophonology) may, on a charitable reading, be taken to mean that the stem-affix node had very little strength. Note, however, that this argument is less direct than in the case of syntax. The phonological evidence for reduced structure sensitivity is also not entirely consistent. A number of observations such as the insensitivity of primary stress to rime weight and the low number of phonotactic conspiracies argue for a relatively weak rime node.

However, the rime undeniably shaped the CV patterns in fostering an interaction between the nucleus and the coda. One way of overcoming this inconsistency is to argue that the rime node had an intermediate strength in Old English. This hypothesis stands or falls on the assumption that a weaker activation level suffices to bring about slot-level effects and that a stronger activation level is necessary for bringing about segment-level effects. An implication of this hypothesis is that the rime node may have a higher activation level than the VP node. In fact, as was argued in Chapter 3, cohesiveness has a more important role to play at the lower levels of the linguistic hierarchy. It is therefore only to be expected that the phonological domain reaches a higher degree of hierarchicalness than the syntactic domain.

The net result is that although there is some uncertainty about precisely determining the lowness of the activation levels of structural nodes in Old English, there is considerable evidence to suggest that these activation levels lean toward the lower end of the scale. In view of the solid evidence for strong hierarchicalness mustered in Chapter 2, it is therefore hard to escape the conclusion that there is a general (i.e., cross-level) difference in hierarchicalness between Old and Modern English. To be specific, the development from Old to Modern English may be characterized by an across-the-board increase in hierarchicalness. It seems perfectly possible that this increase varies with the linguistic level under consideration. The increase may have been greater at the syntactic than the phonological level. This is a possible reason for why the analysis was more difficult in the phonological than in the syntactic domain.

The claim that similar changes have taken place at different linguistic levels raises the possibility that these changes did not occur independently of one another but are related. Several scenarios are conceivable. There may be one underlying mechanism that causes a global change (i.e., a typological reorientation of the language). Alternatively, the change may have begun at one level and from there spread to the other levels through the principle of cross-level harmony. It is also possible that the three types of change occurred as a response to the same problem that had to be solved at each of the three levels. Let us consider the three scenarios in turn.

The first mechanism is a kind of central agent that is powerful enough to impose its biases on the individual levels alike. This comes quite close to the notion of parameter setting in generative linguistics. However, a central agent raises more problems than it solves. First and foremost, its ontological status is entirely unclear. What is its nature? What is its purpose? Where is it located? Where does it come from? How does it know what decisions (e.g., regarding branching direction) to take? These are only some of the questions to which there is no obvious answer. On top of that, such a machinery appears to be empirically inadequate as it enforces more uniformity than is actually observed among the levels. This hypothesis should therefore be abandoned.

Much more appealing is the idea that the change started out as a local one and then gradually propagated through the system. A likely starting-point is syntax. As word order became more predictable, structural nodes assumed a more important role. The principal challenge of this scenario is to explain how the incipient hierarchization in syntax reached the lower levels. In other words, what is the underlying mechanism of the cross-level harmony constraint? One psycholinguistic possibility is opened up by the theory of distributed representations, as expounded by Hinton, McClelland, and Rumelhart (1986). The basic claim is that part of the mental representation of structural nodes from different linguistic levels is identical only by virtue of their all being structural in nature. Owing to this representational overlap, if one structural node (let us say, a syntactic one) undergoes a change, other structural nodes will follow suit, at least to a certain extent. These other structural nodes may not only be of the syntactic, but also of the morphological and phonological kind. Note that by changing other syntactic nodes, Ross's Penthouse Principle would be instantiated and by changing non-syntactic nodes, the cross-level harmony constraint would be instantiated. Thus, the hypothesis about local changes with global effects appears worth entertaining.

The third scenario assumes the "blind" concurrence of several changes. It centers around the claim that the various linguistic levels strive for similar solutions because they are subject to similar constraints. This alternative requires hardly any background assumptions. All that has to be presumed is that a more hierarchical representation is generally more efficient and therefore to be preferred at all levels. This increased efficiency is the only instigator of the change. Because the increased efficiency applies to all levels, the change affects the whole system.

At this stage of enquiry, it is not possible to arbitrate between the second and the third scenario. The only point of the preceding discussion has been to show that there are theoretical accounts that may help us understand the commonality of the changes at the various levels of analysis. Clearly, the most important result of this chapter is that roughly parallel developments at different analytical levels have taken place in the history of the English language.

5 Structural Variation Across Languages

5.1 INTRODUCTION

Whereas the previous chapter examined structural differences within one language from the diachronic viewpoint, this chapter presents a synchronic analysis of structural variation across languages. However, the basic approach remains the same as there is no principled difference in the comparison of two synchronic stages of the same language and that of different languages at the same moment in time. The model outlined in the introductory chapter makes clear and testable predictions regarding the range of cross-linguistic variation. Generally speaking, languages are expected to vary to a greater extent in the structural than in the content domain. By virtue of the fact that a great many degrees of freedom are involved in how the elementary building blocks may be put together, structural units may be predicted to exhibit a certain variability across languages. By contrast, no decisions as to the type of content unit (and their strength) have to be taken in preparing to speak. The stock of content units is on speakers' shelves, as it were, and allows them to retrieve items as appropriate. This retrieval process admits of little variation even across languages as everything is "prefabricated." We would therefore expect content units to be relatively invariant across languages.

Before these predictions can be put to the test, it is necessary to elaborate on the issue of variation. Basically, two types of structural variation have to be taken into consideration—qualitative and quantitative variation. One would expect more quantitative than qualitative variation across languages. Qualitative variation is the more extreme type in that it assumes the presence of one particular structural unit in one language and its complete absence in another. Quantitative variation is less categorical in that it assumes that a given unit exists in both languages even though it plays a more important role in the one than in the other. Determining the importance of a unit across languages is not an easy matter. From the psycholinguistic perspective, importance may be construed as the level of activation that a unit usually reaches in the production process. This is precisely the procedure adopted in the preceding chapter where the linguistic effects of structural nodes were argued to be a reflection of their activation levels.

There is little question that the types of content units are fairly constant across languages although their importance is subject to cross-linguistic variation. As far as I am aware, all languages have phonological features and phonemes. Morphemes are also a ubiquitous category. They certainly exist in the vast majority of the world's languages, but they cannot by definition occur in purely isolating languages. However, purely isolating languages are hardly ever found. Even Vietnamese, a language that is generally cited as being isolating, does have compounding (see Dình-Hoà, 1997) and therefore an adequate description of it cannot do without the notion of morphemes. We may conclude that even though there is no necessary reason for languages to possess morphemes, these are a highly likely choice. Monomorphemic words are good candidates for a language universal (see Dixon & Aikhenvald, 2002), although they are clearly untypical of polysynthetic languages. However, even this language type knows monomorphemic islands, as for example in West Greenlandic where certain pronouns and adverbs do not combine with other elements (Fortescue, 1984). Recall in this connection that the theory does not lead us to expect total uniformity of content-unit types across languages. It rather predicts less cross-linguistic variation in the domain of contentful units than in the domain of structural units.

A cursory glance at the structural domain suggests that structural units show relatively large cross-linguistic variation. Phonology is a good field to illustrate this variability. It has been contested that syllables are phonological universals. Hyman (1985), for example, argues that Gokana, a Niger-Kordofanian language, knows no syllables. His claims are based on three arguments—the lack of phonotactic constraints, the absence of rules referring to syllables, and the hypothesis that there are no higher-order units that are necessarily made up of syllables.

Fudge (1999) argues that feet are not phonological universals. Specifically, he advances the claim that stress-timed languages have them whereas syllable-timed languages do not. As syllable-timing appears to be the more common option in the languages of the world (Crystal, 1996), feet would constitute a minority pattern overall.

The mora as a further structural unit apparently does not exist in all languages; at least it does not have the same status in all languages. Although some authors advocate the mora in English (e.g., Hayes, 1989; Pierrehumbert & Nair, 1995), others recognize the tremendous difference between the putative mora in English and the mora in "true" mora languages such as Japanese (e.g., Kubozono, 1990; Beckman, 1995). In Japanese, the mora fulfils very important functions in both language production and comprehension (e.g., Kamio & Terao, 1986; Kubozono, 1995; Otake, Hatano, Cutler, & Mehler, 1993), functions that it clearly does not fulfil in English. For example, Otake et al. show that Japanese listeners segment the incoming speech stream on a moraic basis whereas this is not an option for English listeners. In a similar vein, slips of the tongue implicate moraic units in Japanese though not in English. Finally, Katada (1990) reports on a language game involving moras in Japanese, which has no analogue in English. These and many other pieces of evidence strongly suggest that a unit that performs the job of the mora in Japanese does not exist in many other languages including English. The mora thus presents itself as a language-particular rhythmic unit.

The mora also raises the issue of qualitative versus quantitative differences referred to earlier. It would seem from the production and perception data that the mora is present in Japanese but absent in English (i.e., that there is a qualitative difference between the two languages). However, Beckman (1995) postulates a quantitative difference. She claims that the mora exists in both languages but that it plays a central role in Japanese but a marginal role in English. The problem with Beckman's approach is that it is not clear how to represent marginality. By contrast, the framework of this study presents a natural solution. Moraic nodes might be available in both English and Japanese, though their activation levels are considerably less strong in the former than in the latter language. Unfortunately, the mora node appears to be incompatible with the right-branching structure of the English syllable, which may be considered to be well-established on the basis of section 2.5.1. Wherever the ultimate answer may lie, it is beyond doubt that the mora is a highly variable unit across languages.

The tentative conclusion that this brief discussion leads up to is that structural units in phonology display a cross-linguistic variability unbeknown to content units. This is precisely as predicted by the Structural Theory.

In syntax, where everything is structural, the case for variability is easily made. The most fundamental distinction is that between configurational and non-configurational languages. There is no question that languages differ on the position they occupy on the configurational scale. Free word-order languages are widely regarded as less configurational than fixed word-order languages (e.g., Hale, 1983; Blake, 1983; Heath, 1986). Also, agglutinative languages have been argued to be less configurational than isolating languages (Jelinek, 1984). A core issue in the configurationality debate is the existence or otherwise of a VP. It is generally felt that SOV languages offer less support for a VP node than SVO languages (e.g., Keenan, 1976; Gazdar, Klein, & Pullum, 1983; Andrews, 1988). For quite a few individual languages, the existence of a VP is a matter of controversy: Hungarian: pro: Farkas (1984), contra: Kiss (1981); Japanese: pro: Kuno (1973), contra: Hinds (1974); German: pro: Thiersch (1982), contra: Haider (1989). This short list may suffice to illustrate the variability that can be observed in structural units in syntax. Again, this is the expected result even though a direct comparison with content units is impossible in this area.

It should be noted that there is another type of cross-linguistic variation. It may be that a unit that is classed as structural in one language behaves like a content element in another. The syllable appears to be just such a unit. Whereas it was argued to be structural in English in Chapter 1, it functions like a content unit in Mandarin Chinese (Chen, Chen, & Dell, 2002). This raises the extremely important issue of what factors assign a given unit to the structural or the content domain. Because this question goes beyond the Structural Theory as formulated in the opening chapter, it will not be given any further attention here.

The following sections will present three case studies of structural variation across languages.

5.2 THE VP IN ENGLISH AND GERMAN

5.2.1 Tests for Determining Hierarchicalness

The following comparison between Modern English and Modern German VPs parallels the analysis of the VP in Old and Modern English performed in section 4.2.1.1. This similarity is not coincidental. It results from the aforementioned philosophy that there is neither a categorical distinction between synchrony and diachrony nor a principled difference between a comparison of different historical stages of one language and different languages. The present section contains eight subsections, each of which deals with one argument for the relative strength or weakness of the VP node. Provided that the tests produce consistent results, this procedure allows us to gauge the degree of availability of one and the same node in two disparate languages.

5.2.1.1 Basic Word Order

The logic underlying the theoretical significance of word order freedom or rigidity was detailed in section 4.2.1.1 and will be repeated only briefly. The basic idea is that the unfolding of the VP is facilitated if it incurs a processing advantage. This is the case when the immediate constituents of VPs are adjacent and when their order is fixed. These conditions enhance the predictability of an upcoming item in the presence of a current unit and hence the usefulness of activating the two together by means of a superordinate node. Thus, (relatively) free word order is indicative of a weak VP and (relatively) fixed word order of a strong VP.

It has often been noted but rarely been demonstrated that German word order is more variable than English word order. Hawkins (1986) conducted a metalinguistic test in which subjects were required to judge the grammaticality of the various constituent orders in sentences like the following.

(1) a. English: Peter gave the book to his brother for Christmas.
b. German: Peter schenkte seinem Bruder das Buch zu Weihnachten.

The two sentences are (almost) exact translations of each other. They consist of four constituents—the subject, the direct object, the indirect object, and the adverbial. The maximum number of orderings is 4! = 24. The German native speakers accepted all 24 sentences as grammatical (provided an appropriate context was given) whereas the English native speakers rejected 14 of the 24 possibilities. Hawkins conceded that introspective data are not entirely appropriate for determining word order patterns. However, his results clearly hint at the greater word order freedom in German compared to English.

A complementary, if not better, method of measuring the difference between the two languages is the use of corpus data. Given the focus on basic word order, 2000 clauses containing a subject, a verb and an object were collected, 1000 for each language. Only spoken language was considered. The English data were taken from Svartvik & Quirk (1980, pp. 34–156), the German data from Steger, Engel, & Moser (1971–1975, Vol. 1, pp. 221–253; Vol. 2, pp. 159–237, 315–331, 367–391; Vol. 3, pp. 27–45). The selection of these parts occurred quasi-randomly, being mostly motivated by the subjective interest in the topics talked about.

The following three variables were introduced that were either known to have an impact on word order or whose impact on word order was deemed worthy of investigation: main clause versus subordinate clause, clause function (declarative, interrogative, and exclamative),[1] and adjacency versus non-adjacency of constituents.[2] The latter variable tests for the possible effect of intercalating a certain unit between two constituents. As explained earlier, the erection of a VP is facilitated by the regular adjacency of V and O. Note that a language would clearly be classified as SVO even if the verb and the object were often separated by intervening elements. In this case, however, the processing advantage of the VP node might be reduced because the need to activate the object-NP at the moment in time when the verb is prepared for output is less urgent. In other words, the predictability of what follows the verb is lower. It is therefore important to test for possible cross-linguistic differences in the use of intercalation strategies.

The other two variables are known to affect word order. To echo only two well-known statements, German has VO in main clauses but OV in subordinate clauses. Questions in both languages may break up the adjacency of V and O through the intercalation of S. However, the magnitude of these effects is less well-known and can only be ascertained when a quantitative approach is adopted.

The classification of the clauses was straightforward in the vast majority of cases. A certain difficulty arose in sentences with two verbs, as exemplified in (2).

(2) a. who wants a leaflet designed
    b. they had this fellowship to offer

It is not immediately clear whether these sentences are best treated as SVO or SOV. This decision depends on the syntactic status of the verb. Both *to want* and *to have* are main verbs even though they cannot stand on their own.

Table 5.1 Frequency of Basic Sentence Patterns in English and German

	SVO	*SOV*	*OSV*	*OVS*	*VOS*	*VSO*	*Total*
English	898	0	102	0	0	0	1000
German	324	262	87	103	2	222	1000

Clearly, *designed* and *offer* depend on them, which argues for the primacy of *to want* and *to have*. This analysis is supported by the fact that *designed* is not even governed by the subject *who* in (2a). It was decided therefore to classify these sentences as SVO. As it turned out later, if they had been analysed as SOV, these would have been the only examples in this category. Because there were only seven such cases in the database, they could not make a large impact on the overall results, no matter how they were classified.

The general picture is presented in Table 5.1 from which huge differences between English and German emerge. Competition among alternative word orders is much stronger in German than in English. Whereas all six basic word orders occur in German, only two are attested in English. This outcome is fully in line with the grammaticality judgements reported by Hawkins (1986). It is also no surprise that the SVO pattern is so strongly predominant in English. Its only contender, the OSV order, shows that verb and object are separated in 10% of the clauses. The case of German is vastly different. A rather unexpected result is that five out of the six word orders are relatively frequent, which only serves to increase the competition among them. In 31% of cases, object and verb are separated by the subject. This percentage is three times higher than that for English ($\chi^2(1) = 131.2$, $p < 0.001$). It may therefore be concluded that the VP is more strongly activated in English than in German.

Table 5.2 breaks down the data into main and subordinate clauses.

A first observation to make is that main and subordinate clauses are of almost the same frequency in the two languages (with a ratio of 2:1). The major question that can be addressed on the basis of Table 5.2 is whether

Table 5.2 Frequency of Basic Sentence Patterns in English and German as a Function of Clause Type

	SVO		*SOV*		*OSV*		*OVS*		*VOS*		*VSO*		*Total*	
	MC	*SC*	*MC*	*SC*	*MC*	*SC*	*MC*	*SC*	*MC*	*SC*	*MC*	*SC*	*MC*	*SC*
English	634	264	0	0	29	73	0	0	0	0	0	0	663	337
German	324	0	4	258	1	86	103	0	2	0	219	3	653	347

(MC = Main Clause; SC = Subordinate Clause) the higher degree of separation of the immediate constituents V and O in German than in English is limited to one clause type or characteristic of both. The chi-square test reveals that although this effect is highly significant for main clauses ($\chi^2(1) = 167.3$, $p < 0.001$), it fails to reach significance for subordinate clauses ($\chi^2(1) = 1.7$, $p > 0.1$). Because main clauses are twice as common as subordinate clauses, it may be argued that the cross-linguistic difference holds for the majority of clauses. The main reason for the non-significant effect in subordinate clauses is that both languages make similar use of relative clauses, the major area where the VP-segregating order OSV occurs in subordinate clauses.

It follows from this that the preponderance of SVO over OSV is stronger in main than in subordinate clauses in English ($\chi^2(1) = 44.7$, $p < 0.001$). The opposite is true of German. The splitting of the VP by an S occurs more frequently in main than in subordinate clauses ($\chi^2(1) = 6.7$, $p < 0.01$). This is mainly due to the high frequency of subject–verb inversion in main clauses, which destroys the unity of the VP. Inversion does not occur in subordinate clauses because the triggering conditions are not met.

The final test examines whether the six basic constituent orders are equally open to the possibility of placing material between any two constituents. In addition, it allows us to determine the frequency with which basic constituents are separated in actual language use.

Note first that Table 5.3 distinguishes neither between main and subordinate clauses nor between the non-adjacency of the first and the second or the second and the third constituent. The most important result to emerge from Table 5.3 is the huge difference between English and German in allowing non-adjacency. Whereas English shows a minority of intercalations between basic constituents (18.5%), German constituents are intercalated in almost every other case (46.4%). This finding brings to light a hitherto unnoticed aspect of word order. The rigidity of English word order not only means a lack of alternative orderings but also a strong resistance to inserting material between the constituents. The English SVO pattern thus is a highly cohesive unit in a two-fold sense. This makes it an ideal basis on which to erect a VP. German, by contrast, has not only a choice among all six word orders

Table 5.3 Frequency of Basic Sentence Patterns in English and German as a Function of Adjacency

	SVO		*SOV*		*OSV*		*OVS*		*VOS*		*VSO*		*Total*	
	A	*NA*	*A*	*NA*	*A*	*NA*	*A*	*NA*	*A*	*NA*	*A*	*NA*	*A*	*NA*
English	746	152	0	0	69	33	0	0	0	0	0	0	815	185
German	179	145	96	166	27	60	96	7	2	0	136	86	536	464

(A = Adjacent; NA = Non-Adjacent)

but also prefers to break up these patterns by positioning nonbasic material between their parts. It may be argued that this proclivity to non-adjacency hinders the activation of the VP node in German.

Summarizing, the comparison of basic sentence patterns in English and German brings forth a clear picture. All the evidence points to the conclusion that the conditions for erecting a VP in English are more favourable in English than in German. Not only is there little competition between alternative orders, there is also a high predictability of constituents within these sentence patterns. The opposite is true for German. The argument in this subsection is of special weight because word order is one of the most fundamental properties of a language. Decisions on word order have to be made in almost every sentence. Different decisions may therefore be assumed to have important consequences in other domains.

5.2.1.2 Inversion

In the preceding subsection, word order was examined from the global perspective without paying attention to the individual factors that are responsible for word order variation. To make the general analysis more specific, one of these factors, viz. subject–verb inversion, was singled out for closer scrutiny. This factor is worth looking at as it affects the major constituents of a sentence and contributes in no small measure to the cross-linguistic differences set out in the previous subsection.

Of necessity, subject–verb inversion breaks up the VP in that it interposes the subject between the verb and the object. It may accordingly be predicted that a language with a strong VP will have less inversion than a language with a weak VP. The degree of cohesion thus determines the likelihood of inversion.

As noted earlier, German is generally described as a verb-second language. The first constituent may be the subject-NP or any other phrase. So when a non-subject-NP occurs at the beginning of the sentence, it drives the subject out of position, that is, it induces inversion. This phenomenon occurs with many different types of constituents including ADVPs, PPs as well as Ss. An example of each is provided in (4). The non-inverted main clause is given in (3).

(3) She liebt ihren Mann.
'She loves her husband.'

(4) a. Ganz gewiß liebt sie ihren Mann.
'Certainly she loves her husband.'
b. Trotz seines Verhaltens liebt sie ihren Mann.
'Despite his behaviour she loves her husband.'
c. Wenn es darauf ankommt, liebt sie ihren Mann.
'When it comes to the crunch, she loves her husband.'

These examples illustrate only a small fraction of the many different ways in which inversion can be brought about. This process has a relatively high type and token frequency in German.

A further area where inversion plays a major role is question formation. In both yes–no and Wh-questions, inversion is the rule, as illustrated in (5).

(5) a. Liebt sie ihren Mann?
'Does she love her husband?'
b. Wen liebt sie?
'Whom does she love?'

As the English translations show, the English system is vastly different. While it is also possible to have ADVPs and subordinate clauses precede the sentence kernel, this constellation never entails inversion in English. The situation is slightly more complex with questions. If there is an auxiliary, inversion does occur (*Am I right?*). However, if there is no auxiliary, *do* support is needed whose major aspect in the present connection is that it preserves the canonical SVO order (*Does she love her husband?* see also section 4.2.1). Apart from questions, inversion is required in some other more minor areas such as fronted negative particles and conditional clauses lacking *if* (*Had he made no mistakes, he would have won the race.*). Especially the latter case shows that these are relatively infrequent phenomena that are stylistically marked and therefore of limited applicability.

Even this brief comparison makes abundantly clear that inversion is much more characteristic of German than of English. This is in full harmony with the differences in word order freedom reported earlier. An obvious explanation for this result is that English VPs are more strongly activated, hence more cohesive and hence more resistant to being split by the subject-NP.

5.2.1.3 Discontinuity within VPs

The preceding subsection asked how typical it is for verbs and their objects to be interrupted by subject-NPs. This line of analysis will now be extended by a look at other material that may, or may not, occur between verbs and object-NPs. As pointed out in section 4.2.3, the fact that a given word class or functional category has a certain intercalation potential is no guarantee that other word classes behave likewise. Syntactic rules are usually word-class-sensitive and therefore do not apply indiscriminately to all word classes. At the same time, the cohesiveness of two adjacent syntactic units may be so great that intercalation is generally prohibited, not just for a particular word class. In view of this uncertainty, it is well worth extending the results of the previous section.

The word class to be placed at the centre of the ensuing analysis is adverbs. The reason for their choice is their great variability in positioning. This variability is a prerequisite for the following investigation because it is not very telling for a unit that is generally very choosy not to appear in a certain position. If, however, a very versatile unit prefers not to appear in a certain position, this syntactic restriction is of greater theoretical significance.

In both English and German, the placement of adverbs is highly variable. They may in principle occur sentence-initially, medially, and finally. In German, the slot between verb and object-NP is a common locus of adverb placement. This holds good of all types of adverbs and adverbials such as manner, place, and time adverbs, as illustrated in (6).

(6) Sie bemerkte schnell/von fern/plötzlich die herannahende
she noticed quickly from afar suddenly the approaching
Katastrophe.
disaster
'She quickly/suddenly noticed the approaching disaster/from afar.'

The same rule applies to the negation marker *nicht* 'not,' which may also be regarded as an adverb and may also occur between the verb and the object.

English adverbs are markedly different. As shown in Chapter 4, they are reluctant to be placed in the position that is so much favoured in German, as can be seen from the word-by-word translation in (6). Their favourite position is between the subject-NP and the verb. This is also true of the negation particle *not* (or any other negation marker such as *never* and *seldom*, for that matter) even though there is the additional complication of the prop word *do*. However, the principal point is that verbs and objects cannot be broken up by negation markers in English.

This between-language difference lends itself well to an interpretation in terms of variable degrees of cohesion. The VP is less cohesive in German and can therefore be split up rather easily by all kinds of adverbs. By contrast, the English VP is more cohesive and thus in a position to prevent its being split by adverbs and adverbials. The difference is one of degree, not of kind. English VPs do not categorically resist the insertion of adverbs, as evidenced by the possibility of positioning an adverb between a verb or an auxiliary and a PP (see [8] in section 4.2.3) where VP-internal bonds are relaxed. However, with transitive verbs that display a stronger bond between verb and object-NP, the difference between the languages emerges quite clearly. The explanation that is proposed here to account for this difference is that the VP node is generally weaker in German than in English and therefore allows the intercalation of adverbs in the former though not normally in the latter language. The fact that English places adverbs most naturally outside the VP can now be seen as a direct consequence of the impenetrability of the VP due to its high activation level. Note finally that this account does not deny the relevance of many other factors guiding adverb placement, especially semantic ones.

5.2.1.4 Movement Out of VPs

Most languages allow for deviations from canonical word order. One way of doing so is fronting—the movement of a constituent to the left of the sentential core. Within the VP two constituents can theoretically be moved individually—the verb and the object. It is a straightforward prediction that a language with a strong VP node will be more resistant to the movement of individual constituents than a language with a weak VP node. Let us compare the possibilities of verb fronting in English and German. The following sentences involve modal verbs, so the topicalized verbs are non-finite. The topicalization of finite verb forms involves certain complications, which need not concern us here. Examples (7) and (8), freely adapted from Hudson (1980, p. 184), represent exact translations of each other.

(7) G: a. Vergessen kann ich diese Frau nicht, aber . . .
forget can I this woman not but
b. Diese Frau vergessen kann ich nicht, aber . . .
this woman forget can I not but
'Although I cannot forget this woman . . .'

(8) E: a. *Forget I cannot this woman, but . . .
b. Forget this woman I cannot, but . . .

No. (7) shows that in German the infinitive *vergessen* 'to forget' can be freely fronted while the direct object is left behind. Just this is impossible in English (see [8a]). However, the two languages agree in allowing the fronting of the entire VP (see [7b] and [8b]; and incidentally that of the object-NP). This latter result is readily accounted for on the assumption that both languages possess a VP. The grammaticality difference between (7a) and (8a) naturally follows from the hypothesis that the English VP is more cohesive than its German counterpart. This greater cohesiveness is assumed to be a direct function of the higher availability of the English as compared to the German VP.

5.2.1.5 Discontinuity within Composite Verb Forms

There is another less direct way of examining the status of VPs. Ross's (1973) Penthouse Principle predicts a certain dependence between VPs and their subordinate nodes. One such node is the verb group (VG), which represents verbs that are composed of an auxiliary and a participle, as in present perfect forms. Given that the VG node is hierarchically lower than the VP node, composite verbs should always be more cohesive than verb–object combinations. Hence, a cohesive VG may be taken as an indirect argument for a relatively cohesive VP whereas an incohesive VG is suggestive of a relatively incohesive VP. Cross-linguistic differences at the VG level are therefore indicative of cross-linguistic differences at the VP level.

Syntactically, auxiliaries and participles are independent words, so it is theoretically possible for material to be inserted between the two parts of the VG. Semantically, however, it is plain that the two parts belong together. Consequently, any intercalation involves discontinuity. The logic of the intercalation argument is the same as above. The more strongly the VG node is activated, the more cohesive the VG and by implication, the greater its resistance to intercalation.

There is a pronounced difference between English and German word order in the VG. German not only permits, it even requires the interruption of the VG by object-NPs in main clauses. This rule is blind to the nature of the auxiliary. Both true auxiliaries and modal verbs are separated from the participle and the infinitive, respectively. Following is a simple sentence consisting of a subject-NP, a composite verb, and an object-NP.

(9) G: Ich habe den Film gesehen.
I have the film seen
'I have seen the film.'

Number (9) exemplifies the interposing of the VG *habe gesehen* 'have seen' by the object-NP *den Film*. The continuous word order *habe gesehen den Film* is illicit in German. By contrast, English syntax prescribes the continuous order and banishes discontinuity.

As is evident, English VGs are more cohesive than German VGs. From the perspective of the Penthouse Principle, this difference may be interpreted to mean that the superordinate VP node is relatively more cohesive in the former than in the latter language. This allows us to conclude that the VP is more available in English than in German. A subsidiary result of the foregoing analysis is that the discontinuity in the German VG appears to be related to the discontinuity in the VP treated in the preceding section. Owing to the subordinate nature of the VG to the VP, their relationship is not symmetrical. Although a discontinuity at the VG level entails a discontinuity at the VP level, the reverse implication does not hold. Note also that a discontinuity at the higher level facilitates a discontinuity at the lower level, but does not actually enforce it. Specifically, the claim is that if a VP cannot be broken up, a VG cannot be broken up either.

It might be added as an afterthought that the activation account explains the possibility, though not the compulsion, to split VGs in German. Grammaticalized discontinuity represents a permanent infringement of Behaghel's First Law and a mind-boggling challenge to linguistic theory. In the case at hand, it may be that verb-finality, as found in subordinate clauses, is a relevant factor that increases the consistency of word order in main and subordinate clauses.

5.2.1.6 Dislocation

There are two types of dislocation, depending on whether the dislocated element is shifted to the left or to the right of the sentence kernel. In either case, dislocation creates a two-part structure with a relatively weak syntactic link between the dislocated unit and the remainder of the sentence. For dislocation to be possible, an element has to be isolated and cut out from the sentence kernel. As explained in section 4.2.4, this process may be expected to be all the more likely, the looser the ties are among the elements of the basic sentence. Because we are concerned with the VP, attention will be focused on the dislocation of objects.

Two explanations may be proposed for dislocation—a psycholinguistic and a pragmatic one. The former sees dislocation as a result of a planning problem. In right-dislocation the dislocated element was not fully retrievable at the moment it would have to occur in its original position. The speaker thus fills this position with an easily retrievable element such as a pronoun and thereby gains time to finish processing on the fully specified object. In left-dislocation, planning may have been completed on the dislocated element, though not on the other parts of the sentence. The pragmatic account views dislocations mainly as topicalizations that serve to direct the listener's attention to particular parts of the utterance (Gregory & Michaelis, 2001).

The two explanations make different empirical predictions. On the sensible assumption that speakers of different languages face similar planning problems, the psycholinguistic account leads us to expect dislocation to be equally common cross-linguistically. In contrast, much more between-language variation is predicted by the pragmatic account, given that dislocation is only one of several means of topicalization.

The data bear out the pragmatic account. Dislocation figures more prominently in German than in English conversation. Right-dislocation in German is exemplified in (10), left-dislocation in (11).

(10) Ich hab den nicht gesehen, den gelben Laster.
I have it not seen the yellow lorry
'I haven't seen the yellow lorry.'

(11) Die Katze, die werde ich noch mal umbringen.
the cat it will I one day kill
'I'll kill the cat one of these days.'

No. (10) demonstrates the dislocation of the object-NP *den gelben Laster*, which is anticipated by the pronoun *den*. No. (11) is more complex in that the left-dislocation of the object-NP *die Katze* is accompanied by a deviation from the basic word order. The object in the form of the pronoun *die* moves into the initial position of the sentence kernel and therefore induces subject–verb inversion (see section 5.2.1.2).

The idiomatic English translations of (10) and (11) would do without dislocation. After the elimination of the word order differences, the English sentences with dislocation read as follows.

(10′) I haven't seen it, the yellow lorry.

(11′) The cat, I'll kill it one of these days.

While (10') sounds marginally acceptable, (11') is rather odd. It sounds definitely better without the resumptive pronoun *it*, but it still remains a highly marked option. Thus, both (10') and (11') have nothing of the naturalness that characterizes (10) and (11). Even without a detailed quantitative analysis, it is safe to conclude that dislocation of object-NPs occurs more frequently in spoken German than in spoken English.

The explanation of this result proceeds from the assumption that object-NPs break free less easily in English than in German. This is because the bonds among the members of the VP are tighter in the former than in the latter language. This in turn may be taken as evidence for the stronger activation of the VP node in English than in German.

5.2.1.7 Pro-VP

As mentioned in section 4.2.6, pronominalization is one of the more reliable tests of phrasal status. The existence of a pro-form is a good argument for the high availability of the VP node whereas its absence is an indication of the reduced availability of the VP node.

As is well-known, one of the several functions of *do* is to act as a pro-VP. Consider (12) in which *do* replaces the entire VP *know the answer*.

(12) Who knows the answer?—I do.

Like Old English, Modern German lacks a pro-VP. Whereas the parts of the VP can be individually replaced by a pro-form, the entire VP cannot. This may have to do with the syntactic status of German *tun*, the congener of *to do* in English, which would be the most likely candidate for this function but does not have the same auxiliary status as in English.

The fact that a pro-VP exists in English but is missing in German finds an explanation in the hypothesis that the English VP is more available than its German counterpart. This enhanced availability increases the utility of having a pro-VP. And in the course of its history, the English language has developed this option (see section 4.1.2.6). Apparently, the need to create a pro-VP has been either less acutely felt or less easy to fulfil in German. In essence, then, the structural difference between English and German is claimed to emanate from different degrees of activation that the VP node usually attains in the two languages.

5.2.1.8 Modal Auxiliaries

As in section 4.2.7, it will be taken for granted that modal auxiliaries, like other auxiliaries, are part of the VP. If the group of verbs that is commonly referred to as modal shares certain properties with main verbs, especially the ability of the modal to do without a main verb, the complexity of the VP is kept to a minimum. If, however, the modal cannot stand on its own, the VP is more complex in that it has to accommodate another verb. The higher the degree of complexity there is, the greater the need for hierarchical structure. This is secured by a highly activated VP node that allows the VP to be tightly organized. True modal auxiliaries are therefore indicative of a high activation level of the VP whereas the absence of auxiliaries is compatible with a lower activation level of the VP.

In German, the so-called modals behave like main verbs in several respects. In particular, a main verb is not required to form a grammatical sentence. This is true for all modals. The example of *müssen* 'must' in (13) thus is entirely representative.

(13) Ich muß zum Bahnhof.
I must to-the station
'I must go to the station.'

It might be held that a main verb such as *gehen* 'to go' is somehow implied at the semantic level, but this is beside the point. The real issue is that the absence of a main verb in no way jeopardizes the syntactic naturalness of this utterance.

Unlike their German congeners, none of the English modals can occur without main verbs. As the interlinear gloss in (13) shows, a modal that is not propped by a main verb creates an ungrammatical sentence. The so-called modals thus have acquired full auxiliary status in Modern English.

By hypothesis, this difference is due to a VP node whose variable power enables it to accommodate a greater or smaller number of syntactic units. The VP node is quite powerful in English where VPs are relatively complex. German, in contrast, allows for simpler VPs and therefore makes do with a less powerful VP. It may thus be concluded that the different syntactic behaviour of the modals in English and German serves as an argument for a higher activation level of the VP in the former than in the latter language.

5.2.2 Conclusion

We have reviewed eight syntactic phenomena pertaining to the internal structure of the VP in German and English. In all of these, the English VP was found to impose a tighter structure on its elements than its German counterpart. As a result, word order within the VP is less flexible, movement out of the VP less acceptable, replacement of the entire VP possible, and more complex material more accommodating in English. The claim is then that all these phenomena are reducible to the same principle—the average activation level that the VP node attains in speaking. As this level is generally higher in English than in German, more VP-related effects are observed in the former than in the latter language.

It is useful to repeat that the difference between the two languages is a gradual one. Both languages possess VP nodes, though these differ in terms of their availability. Thus, it is no good asking, as is done in the relevant literature, whether German does, or does not, have a VP. A VP is indubitably part of the syntactic toolkit of German. The real question, probably for any language, is to determine the activation level that the VP reaches in ordinary language use. Although it is certainly difficult to do so in absolute terms, the comparison of activation levels reveals itself as a more tractable research strategy.

The hypothesis that the eight phenomena in question can be subsumed under the same principle might be interpreted as a causal relation among them. However, such a relationship should not be taken to imply that all these phenomena must necessarily co-occur. All linguistic phenomena are multiply determined. Identifying one cause should therefore not be mistaken for their complete penetration. Viewed in this light, the aforementioned result lends itself to the following interpretation. Postulating one common underlying principle for a number of different phenomena implies that the existence of one enhances the relative likelihood of the occurrence of another. This is a prediction that can only be adequately addressed from the typological angle, not on the basis of the analysis of a single language.

It could theoretically be that the several diverse phenomena discussed here vary in importance in the sense that one may contribute more to the raising of the activation level of the VP than another. Indeed, this appears to be a reasonable claim to make. As discussed in section 4.2.1.1, word order is likely to be a prime factor. This hypothesis follows naturally from the properties of structural units as laid out in the opening chapter, in particular their function of supporting advance planning. Of course, the feasibility of advance planning depends on the probability with which two units, which are apt to form a syntactic phrase, are placed next to each other. If this probability is high, the processing system has for example good reason to erect a VP node. Taken as given, then, that a fixed word order motivates a highly activated VP, we may go on to argue that the more prominent VP encourages the emergence of some other phenomena such as the pro-VP function and discourages the occurrence of other phenomena such as dislocation.

This assumed sequence of events makes a testable prediction about the historical development of English. The rigidification of word order is expected to precede the other phenomena discussed earlier. Although a certain temporal overlap must always be allowed, the diachrony of English seems to be in harmony with this prediction. Word order variation began to diminish in Old English and the canonical order SVO emerged in Middle English. By contrast, the function of *do* as a pro-VP developed only at the beginning of the Early Modern English period. The current status of modals is an even more recent phenomenon. In Shakespeare's time, the word-by-word gloss of (13) was still possible (i.e., *I must to the king.*). A detailed diachronic study of dislocation has yet to be performed.

Although the focus of the preceding analysis was on the VP, it makes good sense to extend it to the sentence. Recall that a liberal reading of the Penthouse Principle opens up the possibility of an analogy between VP and S. Given that the VP is more hierarchical in English than in German, it may be that the same holds good of S. Indeed, there is some evidence in support of this view. Let us briefly mention two items. It was argued in section 5.2.1.6 that English is more reluctant than German to dislocate the object-NP of the VP. The same is true of the subject-NP. The analogous explanation for this difference would be that S-internal relationships, in particular that between (subject-)NP and VP, are more tightly organized in English than in German. Consequently, the subject-NP can break loose less easily in the former than in the latter language.

The second relevant phenomenon is subjectless sentences. Like Old English, German permits subjectless sentences, as in (14).

(14) Mir ist kalt.
me (Dative) is cold
'I am cold.'

Although this option is historically receding, cases like (14) for example are fully idiomatic and highly frequent. In stark contrast, English does not by any means license subjectless sentences. This difference may be understood as the consequence of a more restrictive syntactic organization of English sentences, which requires all core elements to be present, but of a more liberal syntactic organization of German sentences, which tolerates the omission of core elements such as the subject-NP. Again the Penthouse Principle leads us to formulate intriguing predictions that are borne out by the data.

To conclude, the preceding investigation has transcended the limitations imposed by an either–or approach and explored the notion of gradualness in some detail. From this perspective, English and German could be shown not to differ in the presence or absence of a VP but in the strength with which this node is activated during speaking. This cross-linguistic difference illustrates a case of structural variability. According to the theory outlined in the opening chapter, variability should be especially common among structural units. Whereas a single case study is of limited use in this respect, it is worth stressing that the VP is a node of major importance in syntax. The discovery of variability in this area is therefore a significant finding and gives reason to expect more variability elsewhere.

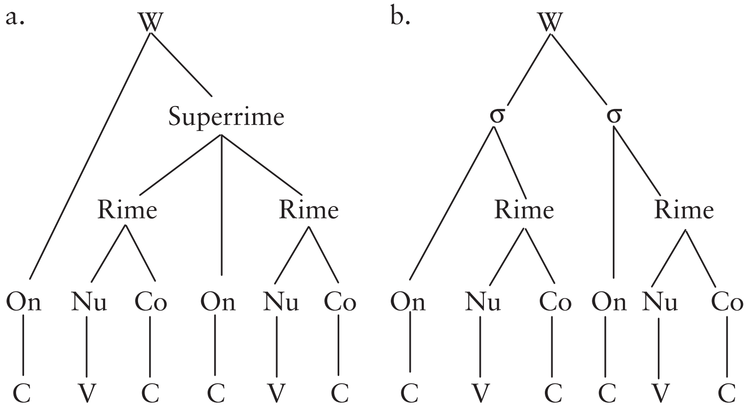
5.3 PHONOLOGICAL-WORD STRUCTURE IN ENGLISH AND GERMAN VERSUS SPANISH AND FRENCH

In this section a look will be taken at the major constituent boundary within monomorphemic polysyllabic words. The central question is whether all languages divide these items in the same way or whether languages differ in the type of structural representation they build up below the word level. As before, the other important issue is whether a possible cross-linguistic difference is qualitative (i.e., involving different structural units) or quantitative (i.e., involving the same nodes but with different levels of activation).

For English and German, the main division in initially stressed polysyllabic words is between the word onset and the remainder (see section 2.5.4). This division is supported, among other arguments, by the very high frequency of word onset errors, the occurrence of superrime errors, and the almost total absence of whole-syllable errors in these languages. This speech-error distribution is not, however, a psycholinguistic universal. Berg (1991) found no trace of a word-onset vulnerability in a large corpus of naturally occurring slips of the tongue in Castilian Spanish. While word-internal, syllable-initial slips were involved in malfunctions more frequently than expected by chance, the word-initial position was particularly immune to error. There is thus a syllable-onset but no word-onset effect.

A first implication of this result is that Spanish word onsets may not have the special status they enjoy in English and German in that they do not form a separate constituent. This would explain the absence of the word-onset effect. To deal with the syllable-onset effect, it is necessary to assign syllable onsets a special representational status. This function is most naturally fulfilled by the right-branching structure of the syllable. However, such a solution entails another decision. Since it is difficult to envision a word-initial syllable onset node without a syllable node, one is led to additionally postulate a level of syllable nodes for all the syllables of a lexical item. This in turn implies the dismissal of the superrime because an exhaustive parsing into syllables would seem to make superrimes superfluous. Recall in this respect that the word-onset/superrime distinction was deliberately introduced as an alternative to a syllabic representation. We thus assume (15b) as a working hypothesis for the structure of a disyllabic word in Spanish (e.g., *también*[3] 'but'). For contrastive reasons, the structure of English words is repeated as (15a).

(15) a. b.



The remainder of the present section will be devoted to testing the working hypothesis in (15b) and contrasting it with (15a). The bulk of the tests will be psycholinguistically oriented, but arguments from language structure and poetic rhyme will also be considered. In addition to the word-onset effect, which has motivated the contrast in (15), six empirical effects will be discussed. For some of them, additional evidence will be adduced from French not only to supplement but also to gauge the generality of the Spanish data.

5.3.1 The Evidence from Speech Errors

The backbone of the superrime analysis in (15a) was the pattern observed in blend errors. It is appropriate therefore to begin with these. The predictions made by representations (15a) and (15b) about breakpoints are quite different. At first sight, representation (15b) seems to suggest that interacting elements should be predominantly split up at syllable boundaries, which constitute the major breakpoints. However, this prediction overlooks an important complicating factor. As argued in the opening chapter, syllables are structural units and as such have a low a priori probability of being implicated in errors. This is especially true of syllables by virtue of their heterogeneous composition. It is essential to take this factor into account when deriving predictions from (15). The aforementioned prediction therefore has to be changed to the effect that syllable boundaries are expected to be significantly more often respected in Spanish than in German blends. A commitment to the absolute number of slips breaking up syllable boundaries is not possible.

This prediction was tested against del Viso, Igoa, and García-Albea's (1987) complete corpus of Spanish slips of the tongue, numbering 3600 items at the time of distribution. Let us begin with some background information to show that blends share some essential properties across languages. Berg (1989a) reported for his German data that 150 (73.2%) blends involved interacting elements with the same number of syllables while 55 (26.8%) involved interacting elements of unequal length. A similar picture emerges from the Spanish data. Out of a total of 107 blends (117 – 10 unclear or inappropriate cases), 70 (65.4%) were of the former and 37 (34.6%) of the latter type. This difference is not statistically significant ($\chi^2(1) = 1.7$, $p > 0.2$), suggesting that both the Spanish and German data are subject to the same similarity constraint.

Among the 37 Spanish blends in which two words of unequal length vied for the same slot, 23 slips (62%) are as long as the longer interactant whereas only 12 (32%) are as long as the shorter interactant. (The remaining two cases are more complex.) There thus is an effect of producing more rather than less material in Spanish. The same tendency is apparent in the English and German data. Fromkin's (1973) published sample, for instance, includes 13 blends of the longer as against 6 of the shorter type. Again, there is no difference between the languages ($p > 0.4$). These and other similarities not mentioned here suggest that blends in Spanish are subject to basically the same constraints as blends in the Germanic languages. This is what makes the ensuing comparison meaningful.

It is not always easy to unequivocally identify the breakpoint in blends as the interacting elements tend to be phonologically similar around the breakpoint (Gries, 2004). Out of the total of 110 errors, only 58 lend themselves to a relatively uncontroversial classification. The exclusion of more than half of the slips is certainly a worrisome problem, but at this stage of enquiry (where little knowledge is available), it is safer to focus on the clear cases and use these for theory construction rather than to make unjustified decisions regarding error classification. Basically, four descriptive classes emerge from the analysis of the breakpoints in blends. The interactants may split up at the syllable boundary, the superrime boundary, the rime boundary or the body boundary. The first three categories are illustrated in (17)–(19). They are preceded by an ambiguous case in (16).

(16) síndromas (síntomas—síndromes)
'symptoms–syndromes'

(17) Si se entera mi prima, me *mala*—me *ma*ta, me pe*la*.
'If my cousin knows about it, she will kill me.'

(18) ¿. . . en cierta *manida*, no han podido predisponer un poco el ambiente?
(*man*era—med*ida*)
'manner—measure'
'somehow they have not been able to prepare the setting a little.'

(19) aceptan como si fuesan—como si fueran (fuesen–fueran)
'They accepted it as if they were . . .'

No. (16) is three-ways ambiguous. It could be analysed as showing a break at the superrime boundary (before the /o/), the syllable boundary (before the /m/), or the rime boundary (after the /m/). Without any knowledge about the general error patterns in Spanish, such cases cannot be decided. A syllable break is exemplified in (17). The two interactants *mata* and *pela* are blended into *mala*. This is a clear case on the proviso that a continuous analysis is preferred to a discontinuous one. A continuous analysis represents an exhaustive parsing of the blend word into a left-hand part stemming from the one interactant and a right-hand part from the other interactant. In (17), for example, *mala* is presumed to be composed of the syllable *ma* from *mata* and the syllable *la* from *pela*. A discontinuous analysis of the same slip holds that the lateral from *pela* replaced the stop from *mata* to give rise to *mala*. This description is a discontinuous one because a consonant from the one interactant is inserted between the two vowels from the other interactant. Such an analysis is at odds with the majority of blends that involve larger chunks, as in (18). Also, it does not do justice to the psycholinguistic mechanism assumed to underlie this error type. For these reasons, blend error researchers have generally favoured the continuity hypothesis (but see Laubstein [1999] for a dissenting voice). Because it was also adopted in the analysis of the German data, reasons of comparability dictated that the same classificatory strategy be applied to the Spanish materials.

Error (18) demonstrates the interaction of two trisyllabic words that are split after the onset of the second syllable. Thus, the break occurs at the superrime boundary. In (19), the final syllable is divided at the onset-rime boundary. As Spanish shows a preponderance of open syllables, such cases often involve rimes that consist only of single vowels.

Table 5.4 reports the frequency of the four error categories established earlier.

To begin with the least controversial claim, Table 5.4 leaves little doubt that the internal structure of the Spanish syllable is right-branching (contra Kubozono, 1995; see also Bertinetto et al., 1999), thereby confirming the lower part of representation (15b). The data show a very pronounced asymmetry between (super)rimes and bodies as chunks created by the break-up process. The former occur more than 10 times more often than the latter.

The second pertinent observation is that both syllable and superrime breaks figure in sizeable quantities. Breaks at the superrime boundary form

Table 5.4 Freqency of Breakpoint Involvement in Spanish Blends

Boundary Type	*Syllable*	*Superrime*	*Rime*	*Body*	*Total*
	17	23	15	3	58
	29%	40%	26%	5%	100%

the most frequent, and breaks at the syllable boundary the second most frequent, category. This co-occurrence of superrime and syllable breaks is highly remarkable. It shows that one and the same processing system may be capable of generating both error types and suggests that syllables and superrimes are less antagonistic than the contrast between the diagrams (15a) and (15b) leads us to expect. Put more bluntly, there may be something wrong about assigning representations (15a) and (15b) to different languages. It seems as if Spanish uses a representational system that combines (15a) and (15b).

On the other hand, although the contrast between (15a) and (15b) appears exaggerated in the light of the empirical data, there is a real difference between the Spanish and German slips of the tongue. The ratio of blends involving syllable breaks is significantly higher in Spanish than in German ($\chi^2(1) = 20.9$, $p < 0.001$). The processing system of Spanish seems to attribute a more important role to the syllable than that of German. This finding bears out the prediction derived from (15).

We now shift our attention from paradigmatic to syntagmatic errors. Representation (15b) supports syllable misorderings more easily than representation (15a) whereas the reverse is true of superrime misorderings. As mentioned earlier, a predominance of syllable slips in Spanish is not predicted by (15b) in view of their structural nature (and the aforementioned results for blends). Note that an analogical claim has never been advanced to the effect that representation (15a) predicts a preponderance of superrime errors (even though it predicts a majority of word-onset slips). This is because superrimes have a lower inherent cohesiveness than onsets. The former create a larger structure and consist of more diverse phonological segments (Cs and Vs) than the latter (only Cs). The expectation that is supported by representation (15) and the Structural Theory is a higher number of syntagmatic syllable slips in Spanish than in German.

As shown below, this expectation is clearly fulfilled. Excluded from the following comparison are syllable omissions that most usually are of the noncontextual kind. Because the Spanish corpus is slightly more than half the size of the German one, a meaningful comparison requires a normalization of the data. That is, the Spanish slips are multiplied by the factor 1.67 (size of German corpus divided by size of Spanish corpus). The normalized data are given in Table 5.5, which is followed by two cases of syllable

Table 5.5 Frequency of Syntagmatic Syllable Slips in Spanish and German

	Substitution	*Addition*	*Total*
Spanish	15	7	22
German	4	2	6

addition, one from Spanish (20) and the other from German (21). The syllables /ta/ and /di:/ are anticipated in (20) and (21), respectively.

(20) Pues si ése es el caso, parece que la op*ta*ción no es muy ven*ta*josa.
for: opción
'If that is the case, this option does not seem to be very attractive.'

(21) Der *di*nä—der nächste "*Di*rekte Draht" am Sonnabend in einer
[di:.ne: ne:çstə di:.rɛk.tə]
Woche.
'The next "Direct Wire" (name of a radio programme) on Saturday next week'

It is apparent from Table 5.5 that syntagmatic syllable slips are almost four times more frequent in Spanish than in German. The syntagmatic data join the paradigmatic blend data in suggesting that Spanish has a greater affinity with syllables than German (and presumably English). As the syllable's activation level is higher in Spanish than in German, more syllable slips occur in the former than in the latter language. However, the absolute number of syllable slips is fairly low in Spanish. This is expected under the Structural Theory. Because syllables are structural units, they have to be built up and reach a relatively low degree of cohesion owing to their size and their heterogeneous make-up.

This may be the appropriate moment for an excursion into French. The relative frequency of syllabic slips in Spanish raises the question of whether this effect is a particularity of Spanish or a more general characteristic of a certain set of languages. It is of special interest therefore to examine languages that are geographically and typologically close to Spanish. A case in point is French. Rossi & Peter-Defare (1998, p. 72) state that syllables have more or less the same status as error units as phonemes. In their collection of 2800 French slips of the tongue, they claim to have found as many as 90 syllable errors, half of which are reproduced in their book. In view of the limited size of their corpus, this is an enormous quantity, which appears to exceed by far not only the analogous cases in the Germanic corpora but also those in the Spanish sample. However, a closer look at the data is called for before this conclusion can be accepted as valid. Of the 45 published syllable slips, 15 may be immediately discarded as they involve omissions. Of the remaining 30 errors, only 9 stand up to a serious test. The other 21 are comprised of misclassifications and highly ambiguous cases. Two such doubtful slips are provided in (22) and (23), a clear instance of a syllable slip appears in (24).

(22) Chute verti*ni*gineuse pour Greg Lemond, manœuvre périlleuse
[vɛrtiniʒinøz

pour le pilote. for: vertigineuse.
vɛrtiʒinøz]
'the free fall of Greg Lemond, the dangerous manœuvre for the pilot'

(23) Elle montre comment la France est structurée cu*ru*—
[stryktyre kyry
culinairement.
kylinɛrmɑ̃]
'She/it shows the culinary structure of France.'

(24) On prend l'ensemble de l'in*vi*dividu sous tous les problèmes
[lɛ̃vidividy]
fonctionnels.
'We consider the individual as a whole from all functional sides.'

Rossi & Peter-Defare assert that (22) evidences the addition of an inverted syllable by which they mean a syllable-internal reordering of onset and nucleus. They take it that the sequence /in/ was inverted and added as /ni/ to the target *vertigineuse* to create the error word *vertinigineuse*. This account is almost certainly flawed. To begin with, the notion of inverted syllables is entirely ad hoc. No statistical back-up is provided for it, nor does it seem to occur as an independent phenomenon in the French data with at least a minimum frequency. What is more damaging is that the target sequence /in/ does not even form a syllable. The proper syllabification of the target word *vertigineuse* is [vɛr.ti.ʒi.nøz]. It is indefensible therefore to speak of an anticipation of a syllable.

No. (23) can be more quickly dismissed. We will ignore the fact that the error word is broken off immediately at (or after) the error unit so that we do not know how the speaker intended to carry on. This information, however, is essential for an unambiguous classification and interpretation of the malfunction. The problem in (23) is simply that the misordered sequence /ry/ was cut out of the syllable /stryk/ and therefore can by no means be treated as a perseveration of an entire syllable. At least 19 further slips of the tongue are fraught with these or other uncertainties.

A better example of a syllabic error is (24). It demonstrates the duplication of the syllable /vi/, which appears both too early and in its correct location. Because the occurrence of two separate malfunctions, to wit the anticipation of /v/ and that of /i/ is highly unlikely, it is common practice to go for the simplest explanation and posit a single malfunction that affects a syllable-sized unit.

To repeat, there are 9 clear cases of syllable slips in the French corpus. As only half of the data could be examined, this number has to be doubled to estimate the rate of true syllable errors in the complete corpus. In order to render the French data comparable with the Spanish and German ones, the number of French syllable errors is multiplied by 2.1 (size of German corpus divided by size of French corpus). This normalization yields an estimated total of 38 errors, a figure that not only exceeds that for the German data but also that for the Spanish data. There is good reason to conclude from this empirical result that the French production system is at least as favourably disposed to syllable slips as the Spanish one. The syllabic representation in (15b) is as characteristic of French as it is of Spanish.[4] We may infer from this comparison that neither Spanish nor representation (15b) have an exceptional status. Intentionally extrapolating from the French and Spanish data, we may speculate that (15b) is characteristic of the Romance languages in general. We will come back to this issue at the end of this section.

It is certainly worthwhile to examine the other predictions from representation (15b) against the French error data. Of special interest is the word-onset effect that motivated the representational distinction in (15) in the first place. Assuming that the syllabic representation in (15b) is the appropriate model for French, it is to be expected that the word-onset effect is lacking in this language. To test this prediction, recourse was taken to Arnaud's (1993, 1994) error corpus, which is available in its entirety. This sample includes 52 word-initial and 67 (non-word-initial) syllable-initial phoneme substitutions. After normalization for opportunity of occurrence, we end up with 59 word-onset versus 68 syllable-onset slips. Thus the share of word-onset errors among all onset errors is 46.5%. The null hypothesis was derived by determining the length of French words. An analysis of the first 100 target words in the Arnaud corpus yielded an average length of 1.95 syllables. This means that a chance substitution of the word onset occurs in 51.3% of cases (100:195). This percentage and the actual percentage of word-onset slips do not differ from each other to a statistically significant degree. It may be concluded on the basis of this finding that French joins Spanish in lacking a word-onset effect. This is neat confirmation not only for the hypothesis that the representational system underlying French is the one depicted in (15b) but also for the general distinction between (15a) and (15b), which appears to highlight important differences among a certain number of languages. With this perspective, we continue our comparison of German and Spanish.

For superrimes a prediction can be formulated that is the opposite of the one that guided the analysis of the status of the syllable. On the basis of (15), superrimes are expectedly more common in German (and English) than in Spanish. The Structural Theory allows one to derive a further prediction. By definition, superrimes are more complex than syllables in that they additionally involve a rime as well as a syllable boundary. Such an unwieldy structural chunk has a very low degree of cohesion and therefore a low probability of being misordered in malfunctions. The Structural Theory therefore predicts that the number of superrime slips will be lower in both languages than that of syllable slips.

With one exception to be noted below, both predictions are borne out by the data. Actually, there is only a single case in the entire Spanish collection that might be a superrime slip but it is highly ambiguous. Refer to (25).

(25) conciert—perdón, concepto en cierto modo
'concept in a certain way'

Although it may be argued that the superrime in *cierto* ousted the superrime *epto* in *concepto*, it is equally possible that the entire word *cierto* was anticipated. An argument for the latter analysis is that the stress pattern of the recipient word (i.e., second-syllable stress) encourages a word slip because the stress pattern can be preserved in the error word. In any case, superrimes are either nonexistent or close to nonexistent in the syntagmatics of Spanish.

In the German data, we find 6 superrime errors. Among them is (26), which evidences an anticipation of the superrime *ange* in the singular noun *Schlange* 'snake.'

(26) Jetzt 'ne klange— kleine Schlangenlinie.
[klaŋgə klainə ʃlaŋgənli:njə]
'now a little wiggly line'

Six superrime slips in the German dataset is a low number but clearly more than in Spanish. This result invites the conclusion that the German processing system supports superrimes to a greater extent than the Spanish one. This is another piece of evidence that bolsters the representational difference expressed in (15).

Although the general rarity of superrime errors came out as expected, superrime slips were not less frequent than syllable slips in German. Even though the prediction failed, it would seem unwise to interpret this as a major challenge to the theoretical model. The number of pertinent tongue slips is fairly small (N = 6 in both cases) and with so few data, small differences may be easily concealed by noise and possible misclassifications may easily distort the pattern of results.

The final issue relating to slips of the tongue is the distance among interacting units in syntagmatic errors. The most general and most important principle influencing error patterns is the similarity constraint. The greater the similarity is of two elements, the greater the probability of their being involved in a malfunction. Several types of similarity have to be reckoned with. The one type that is of special significance in the present context is what may be termed structural similarity. By this is meant the degree to which two elements are embedded in a similar structural representation. Let us refer back to (15). In an onset/superrime model like (15a), within-word errors are strongly discouraged because there is only one onset and one superrime.

According to the similarity constraint, a word onset needs another word onset for interaction, so it has to "look" across the word boundary to find one. This leads us to predict that languages of the (15a) type exhibit a predominance of between-word errors. Both English and German error patterns fulfil this prediction (Berg & Abd-El-Jawad, 1996).

Interestingly, the implication of (15b) is different. Apart from the fact that syllables within the same word may interact—and actually do, as in Rossi & Peter-Defare's (1998) French data—representation (15b) supports the interaction of syllable onsets with other syllable onsets from the same word. This opportunity encourages the occurrence of within-word slips. Note that one should not derive from (15b) the prediction that within-word errors will outnumber between-word errors. The syllabic representation (15b) does not discourage between-word slips. On the contrary, phonemes from different words stand a fair chance of interacting because the structural context in which they are embedded thus creates additional dimensions on which potential interactants may be similar. The prediction from (15b) would accordingly be that also (15b) languages will show a preponderance of between-word slips. However, for the reasons explained earlier, these languages are expected to produce a higher percentage of within-word errors than (15a) languages. This prediction will now be put to the test.

Del Viso et al.'s (1987) error corpus contains a total of 783 single-consonant substitutions of the syntagmatic kind. These were divided into between-word and within-word slips. An example of each is given in (27) and (28).

(27) ¿Me alcanzas una cu*r*a*ch*a? for: cuchara.
[kuratʃa] [kutʃara]
'Can you pass me a spoon?'

(28) De he*ll*o, e*ch*a—de hecho, ella no aceptó.
[εʎo εtʃa εtʃo εʎa]
'Actually, she did not accept it.'

Both (27) and (28) exemplify the reversal of single consonants. These come from the same word in (27) but from different words in (28).

Of the 783 substitution errors, 215 (27.5%) belong in the within-word and 568 (72.5%) in the between-word category. This majority of between-word slips likens Spanish to other languages such as English and German. However, the percentage of within-word slips is significantly higher in Spanish than in the Germanic languages, where it amounts to 13.7% for English ($\chi^2(1) = 74.4$, $p < 0.001$) and 6.4% for German ($\chi^2(1) = 156.7$, $p < 0.001$), (Berg & Abd-El-Jawad, 1996).[5] This is exactly as predicted by the representational difference in (15) combined with the similarity principle. We have here yet another piece of psycholinguistic evidence in favour of the claim that different representational systems underlie language production in English/German and Spanish and that this difference is captured (to some degree) by the diagrams in (15).

In the final test of this section, the analysis of the linear distance between interacting units will be extended to French. On the basis of the aforementioned results regarding the existence of syllabic slips and the non-existence of the word-onset effect, French was classified as a (15b) language. This hypothesis entails the prediction, for reasons just outlined, that French speakers produce a higher number of within-word slips than speakers of German and English. In Rossi & Peter-Defare's (1995) corpus, 339 (34.7%) of the single-segment errors are of the within-word and 638 (65.3%) of the between-word type (Mario Rossi, p.c.). This distribution is significantly different from that in English ($\chi^2(1) = 179.5$, $p < 0.001$) as well as that in German ($\chi^2(1) = 260.6$, $p < 0.001$). As can be seen from these high values, the prediction is strongly confirmed. French slips of the tongue display intriguing parallels with those in Spanish. By implication, the French language aligns itself with Spanish in being under the sway of representation (15b).

5.3.2 The Evidence from Language Structure

If the speech error data have put us on the right track, we may hope to see the ramifications of (15) not only in language production but also in language structure. More specifically, representation (15a) leads us to expect the superrime to play a certain role in lexicalized items whereas representation (15b) allows us to predict the same for syllables. One area where superrimes can be observed to play a part is reduplication, a marginal word formation process in both Spanish and German. The critical question concerns the size of the unit that is reduplicated. The aforementioned prediction can now be made more precise. Superrimes are expected to be more often involved in German than in Spanish reduplication.

Reduplication data are available for both languages. Lloyd (1966) published a list of 66 reduplicative words in Spanish, which he culled mainly from dictionaries. Wiese (1990) extracted from Bzdega's (1965) large corpus of reduplicative forms in German all those with which he was (however vaguely) familiar as a native speaker. This list is somewhat longer than Lloyd's, numbering 95 items.[6] From both corpora, all words were eliminated that were created by reduplicating the entire base. Obviously, these are irrelevant to sublexical structure. Also discarded were the three rime-based reduplications in the German list because this type does not occur at all in Spanish (probably on account of the rarity of monosyllabic words). Two superrime-based reduplications, one from Spanish and the other from German, are reported in (29) and (30).

(29) chirlo-mirlo 'half drunk, a little crazy or strange'

(30) schickimicki 'chiceria'

There are 5 superrime-based forms as against 42 other cases in the Spanish list, whereas the German data divide into 14 superrime-based and 23 other items. This difference is statistically significant ($\chi^2(1) = 8.6$, $p < 0.01$). In line with the research hypothesis, superrime-based reduplications occur more frequently in German than in Spanish, thereby providing further support for the distinction between (15a) and (15b).

A similar result can be reported for Catalan. Lleó's (1995) list of reduplicative words in this language comprises 6 superrime-based and 35 other cases. The difference between Catalan and German reduplication is also significant ($\chi^2(1) = 5.4$, $p < 0.025$), whereas Catalan and Castilian Spanish are statistically indistinguishable ($p > 0.4$). This result provides an argument for assigning Catalan to the group of (15b) languages.

By the same reasoning, syllable-based reduplications may be expected to be more frequent in Spanish than in German. Unfortunately, unambiguous examples of this type of reduplication occur in neither language. The only attested cases are those in which the base is ambiguous between a word and a syllable, as in German *Popo* 'botty.' As noted earlier, these items were left out of account.

To summarize, although the morphological evidence is not abundant, it does suggest that Spanish (and Catalan) are less likely than German to make use of the superrime in the formation of reduplicated words. This cross-linguistic difference may be argued to be brought about by different representational systems underlying these languages. German and English divide words into onsets and superrimes whereas Spanish and Catalan words are divided into syllables.

5.3.3 The Evidence from Poetic Rhymes

The final piece of evidence comes from rhyming patterns in poetry. As they contributed to establishing the superrime in English and German (see section 2.5.4), it is only natural to look at versification in Spanish. The prediction from (15) is straightforward. Spanish rhymes should be more heavily syllable-based than English or German rhymes. In view of the complete absence of syllable-based rhymes in English and German, even a modest number of tokens of this rhyme type in Spanish would bear out this prediction.

To obtain a representative cross-section of rhyming practices in Spanish poetry, it is appropriate to take many different authors from various centuries into consideration, although we can only cover a small sample of their works here. The decision to sacrifice depth for breadth diminishes the effects of possible idiosyncrasies of individual poets and thereby helps to gain a feel for what is typical of Spanish poetry in general. An anthology thus appeared to be the best choice. From Grossmann's (1960) edition of Spanish poems, 15 authors covering the period from the 16th to the 20th century were selected. All poems that are included in the anthology from these authors were taken into account, provided of course that they made use of rhymes.

The results were very homogeneous across poets and centuries. All in all, 422 rhyme pairs were examined of which a minority, 11.1%, were based on rimes and the great majority, 88.9%, on superrimes (and occasionally super-superrimes). The two types are exemplified here.

(31) signe a la ronda de an*ís*, (Ramón del Valle-Inclán, Garrote Vil)
pica tabaco la f*aca*
y el patíbulo dest*aca*
sobre el alba flor de l*is*.

The principle deciding the selection of a rime or superrime is fairly simple. A rime is chosen if the last word of the line is either monosyllabic (as in *lis* 'lilly') or finally stressed (as in *anís* 'aniseed'). In all other cases, the superrime is chosen. The fact that monosyllabic words as well as polysyllabic words with final stress are uncommon goes a long way toward explaining why rimes are dwarfed by superrimes in Spanish poetry.

Syllable-based rhymes do not occur at all. The very few cases that could theoretically be interpreted as such involve onsets that happen to be identical, as shown in (32).

(32) El hombre de estos campos que incendia los pinares (Antonio Machado, Por Tierras de España)
. . .
antaño hubo raído los negros encinares,

There is no justification for viewing (32) as being based on the identity of either the final syllable *res* or the last two syllables *nares*. Such an analysis would ignore both the almost complete absence of such cases and the stress-sensitivity of Spanish rhymes. If the final syllable was considered the rhyming part, the beginning of the rhyme would not be located in the stressed syllable, as is the poetic norm.

Thus, the empirical test produces a null effect. Syllables do not form the basis for rhyming in Spanish. Null effects are not apt to repudiate probabilistic theories. It may be assumed that the suitability of syllables as rhyming units is so low (for reasons that may be unrelated to their representational status) that they are not used at all in poetry. Critically, this assumption does not conflict with the model in (15). which claims a differential sensitivity to the syllable in different languages. Recall that a null effect was also observed in the reduplication data. Syllables were reduplicated neither in German nor in Spanish. This finding was not taken to refute (15b) as a model for Spanish because it is a real possibility that the baseline probability for reduplicative words to be syllable-based is so low that even a language with a certain affinity with syllables may fail to reach the threshold. To conclude, I tend toward the conclusion that while the rhyming data do not argue for the distinction between (15a) and (15b), they also do not constitute an argument against it.

5.3.4. Conclusion

In the foregoing, four languages have been examined with respect to the nature of the structural units into which they divide their lexical items. These languages fall into two groups: German and English versus Spanish and French (and possibly Catalan). The former group divides polysyllabic words into onsets and superrimes whereas the latter has recourse to syllables as the immediate constituents of words. Several pieces of empirical evidence were found to corroborate the distinction between superrime and syllable languages. Additional evidence for the distinction between syllabic and non-syllabic languages comes from language perception. Cutler, Mehler, Norris, & Segui (1986) argued that French listeners transform the acoustic signal into a syllabic representation whereas English listeners do not. Subsequent research replicated the syllable effect for Spanish (Bradley, Sánchez-Casas, & García-Albea, 1993) and Catalan (Sebastián-Gallés, Dupoux, Segui, & Mehler, 1992) even though it did not occur in all phonological contexts in the latter language. As is evident, the match between the production and the perception data is rather close. The conclusion seems warranted then, that the characterization of English and German as (15a) languages and of Spanish and French as (15b) languages has a certain validity.

However, stronger claims would appear to be risky. As they stand, representation (15a) leaves no room for syllables, and representation (15b) leaves no room for superrimes (although it does make a provision for rimes). Thus, the two representations argue for a qualitative difference between the languages of the one type and those of the other. This is probably a major shortcoming of the model. As suggested by the speech error and the reduplication data, the difference between (15a) and (15b) languages is quantitative rather than qualitative in nature. The so-called syllable languages are also sensitive to the superrime, as evidenced by the Spanish blend and poetry data. Similarly, the so-called superrime languages like English for example are also sensitive to the syllable, as demonstrated for adult processing by Bruck, Treiman, & Caravolas (1995) and Ferrand, Segui, & Humphreys (1997) as well as for child processing by Treiman & Zukowski (1996). The major theoretical challenge then is to incorporate syllables as well as superrimes into the two representations (15a) and (15b) without sacrificing their strengths. How this can be accomplished remains an open question.

Taking for granted that the aforementioned results are trustworthy at least to some extent, we may attempt to relate them to other differences among the languages under consideration. It should be noted at the outset that any parameter or set of parameters on which the languages are assumed to vary must be able to take into account the quantitative nature of the cross-linguistic differences. One aspect that immediately springs to mind is the genealogical differences among the languages in question. The superrime languages belong to the Germanic branch, the syllable languages to the Romance branch of the Indoeuropean family. The latent generalization here is that all Germanic languages are (15a) languages and all Romance languages are (15b) languages.

There are two weaknesses in the genealogical account, an empirical and a theoretical one. Beginning with the latter, this account is superficial as recourse to a common ancestry per se cannot replace the search for the underlying linguistic properties that unite a set of languages. From the empirical angle, the undifferentiated claim that all Romance languages behave alike cannot probably be held up. Schade, Berg, & Laubenstein (2003) report that the word-onset effect shows up in Italian (albeit weakly), a finding that does not square well with the syllabic representation assumed for Romance languages. The fact that this effect is less strong in Italian than in, let us say, English, reinforces the gradient difference that has been claimed to exist between (15a) and (15b) languages. It would appear therefore that the Germanic and Romance languages should be arranged on a continuum that does not only order the two language groups relative to each other but also the individual languages within each group relative to one another.

What might the nature of this continuum be? A promising perspective seems to be the distinction between stress and syllable timing[7] (Pike, 1945). English and German are widely regarded as being stress-timed whereas Spanish and French are considered to be syllable-timed. Here is, then, a perfect match between superrimes and stress-timed languages as well as between syllables and syllable-timed languages. While the link between the prevalence of syllables and syllable timing would seem immediately obvious, the link between stress-based rhythm and superrimes is more fragile. However, it might be possible to forge such a link because the rime is a relevant factor in stress assignment (see Chapter 2). It stands to reason that this property of rimes extends to superrimes. The claim would accordingly be that there is a connection between the representation (15b) and syllable timing, or more contentiously, that the one is the result of the other.

However, this connection is not as obvious as it might seem at first glance. It should be realized that (15b) is a part of the abstract representational system that subserves the generation of abstract phonological (and morphological) patterns whereas syllable timing is an aspect of phonetic implementation. Because the relationship between phonetics and phonology is highly complex and poorly understood, syllable timing and a syllable-based representation are not necessarily the concrete and the abstract side of the same coin. On the other hand, if it is possible to forge this link—and the above analysis suggests that it is—it is certainly a plausible one. Thus, it may be tentatively argued that syllable-timed languages possess a representational system, very much like that in (15b), which activates abstract syllable nodes to such a degree that they may serve as input to the phonetic system and shape the phonetic output accordingly. Underlying this claim is the assumption that there is no strict boundary between phonetics and phonology and that so-called phonetic principles such as timing may have repercussions in the phonological domain.

The distinction between stress and syllable timing is particularly apt in the present context as it may be conceived of in non-binary terms. Dauer (1983) proposed that languages fall on a continuum from less to more stress-timed such that each language may be characterized by an individual ratio of stress-to-syllable timing. This hypothesis explicitly allows for the possibility that conflicting rhythmic principles may co-exist in one and the same language. This accords well with the empirical facts. As Crystal (1995) showed, even such a prototypically stress-timed language as English exhibits some traces of syllable timing. The absence of a sharp boundary between syllable and stress timing may consequently be correlated with the absence of a qualitative difference between syllable and superrime languages. The more syllable-based a language's rhythm is, the greater the importance of the syllable in abstract language processing. Similarly, the more stress-based a language's rhythm is, the greater the importance of the onset-superrime distinction. Clearly, these are hypotheses that cry out for empirical testing.

It is time to venture an explanation for the partly different nature of (15a) and (15b) languages. The question is what makes Spanish more syllabic and German more "superrimey"? One possible answer turns on the average complexity of the syllable.[8] Complexity is understood here as the number of units at the slot level. The claim is that a language with a simple syllable structure gravitates toward a syllabic representation whereas a language with a complex syllable structure leans more strongly toward the superrime representation. Let us explore this hypothesis at the syllable level and assess the advantages and disadvantages of the flat and the hierarchical models of the syllable. For the sake of clarity, the argument will be rather schematic in that complexity is defined as the presence or absence of consonant clusters as well as the presence or absence of postvocalic consonants.

As stated in Chapter 2, the need for structural nodes arises only at a certain degree of complexity, to wit: a minimum of three linguistic units. On this logic, a CV syllable has a flat structure whereas a CVC syllable offers the potential of internal grouping. A language with CVC syllables may therefore be expected to have an intermediate structural node whereas a language with only CV syllables may be expected to lack it. Similarly, a language with many CVC syllables expectedly activates the intermediate node more strongly than a language with few CVC (and many CV) syllables. Further additions to the basic CV syllable involve the creation of consonant clusters whose effect will be examined in greater detail in the following discussion.

A language without clusters has the following four syllable structure types: CVC, CV, VC, and V. (For reasons of simplicity, variation in vowel length is ignored here.) A flat model thus needs four rules to transform the syllabic node into a segmental representation (see MacKay [1972] on the logic and nature of these rules). These are listed in (33). By contrast, a hierarchical model consisting of rimes, onsets, nuclei, and codas needs as many as seven recoding rules as given in (34).

(33)	σ → CVC	(34)	σ → Onset + Rime
	σ → CV		σ → Rime
	σ → VC		Onset → C
	σ → V		Rime → Nucleus + Coda
			Rime → Nu
			Nucleus → V
			Coda → C

It is obvious from a comparison of (33) and (34) that the flat model generates the four-syllable types at a considerably lower mental cost than does the hierarchical one. For a language with clusterless syllables, a flat representation seems more appropriate than a hierarchical one.

The situation is different for languages with clustered syllables. If only two-member clusters are allowed, these languages have these nine syllable types: CVC, CV, VC, V, CCVC, CCV, CVCC, VCC and CCVCC. Consequently, nine recoding rules are required in a flat model. Interestingly, the hierarchical model also requires nine recoding rules. Only the two rules Onset → CC and Coda → CC have to be added to the seven rules given in (34). This draw implies that with an increase in syllable complexity, the hierarchical representation becomes a serious contender to the flat representation. Therefore, such a constellation is likely to give rise to structural nodes.

To complete the picture, the range of syllable types will be broadened to include three-consonant clusters. All combinations considered, such a language possesses 16 syllable types, which need not be enumerated here. The flat model thus needs 16 recoding rules. The hierarchical model, by contrast, makes do with 11. The set of rules for languages with two-member clusters only has to be enlarged by the two further rules Onset → CCC and Coda → CCC. It transpires, then, that at this high degree of complexity, the hierarchical model outdoes the flat model in terms of simplicity (i.e., in terms of the number of recoding rules required). Structural representations may accordingly be expected to be preferred to structureless ones.

The general principle emerging from this analysis is that the benefit of structural representations increases with the complexity of syllable types. This principle embodies the prediction that languages with simple syllable structures tend to be flat whereas those with complex syllable structures tend to develop structural nodes and thereby unfold a stronger hierarchy. This principle will go some way toward explaining the difference between Spanish and German if it can be shown that the structure of the syllable is simpler in the former than in the latter language. This is quite clearly the case, both in quantitative and qualitative terms. With CCVCC counted once, only 6% of the Spanish syllables have two-consonant clusters whereas this is true of as much as 21% in German (compare Lloyd & Schnitzer [1967] with Berg, 1988a). Three-consonant clusters do not occur at all in Spanish but are possible both pre- and postvocalically in German. Even four-consonant clusters are attested in German, albeit very rarely. It is plain then, that Spanish syllables are less complex than German ones.

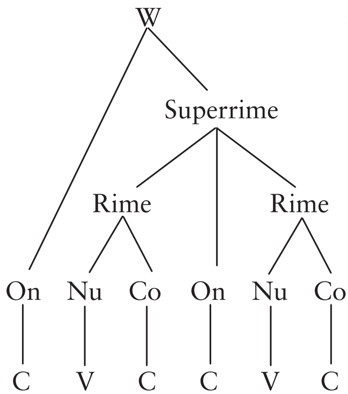
The next step extends this argument to the level of the phonological word. Attention is shifted from syllable to word structure. A more complex word structure may be expected to give rise to the onset/superrime distinction whereas a less complex word structure is conducive to a syllabic representation. Although detailed statistical analyses of German word structure are not available, it is reasonable to suspect on the analogy of the syllable patterns that German word structure is more complex than the Spanish one. This difference would explain both the salience of the superrime in German and the salience of the syllable in Spanish.

The general prediction that can be made from the complexity hypothesis is that syllable-timed languages have a significantly simpler syllable structure than stress-timed languages. Although this difference appears to typify Romance and Germanic languages, this hypothesis awaits large-scale testing.

To conclude, this section has produced evidence to the effect that languages from the same family (Indoeuropean) may significantly differ in terms of their phonological-word structure. Two points are worth emphasizing. This cross-linguistic difference is one of degree, not of kind and should therefore be captured by varying activation levels of the same units, not by different representational units. What is more important within the present framework is that the cross-linguistic differences apply to major structural units in the sense that these have to be built up in the processing of all multisyllabic words. This result is entirely expected under the Structural Theory, which predicts relatively great cross-linguistic variation in the structural domain.

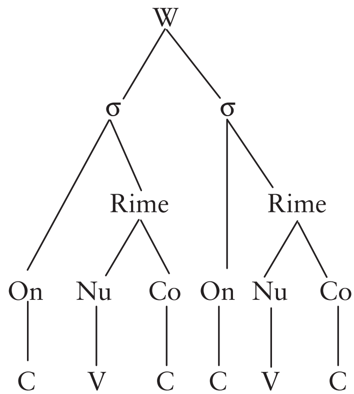
As a bridge between this and the following section, we will widen the perspective by very briefly introducing a further language. The common denominator of representations (15a) and (15b) is the existence of structural nodes between the word and the phoneme level. Actually, the existence of structural nodes is not a logical necessity. The pinnacle of structural variation is the presence of (a set of) structural nodes in one language and their complete absence in another.[9] As will be shown in more detail in the next section, Arabic is just such a structureless language. It evinces neither a word-onset effect nor a syllable-onset effect, a non-predominance of between-word slips, a lack of rime and body errors, and an absence of the parallel syllable structure constraint whereby interacting phonemes come from similar structurally defined positions (Berg & Abd-El-Jawad, 1996). All these are structural effects that are mediated by structural nodes. So in the absence of these nodes, these effects cannot arise. The three representational systems that have so far been uncovered are shown in (35)–(37) for disyllabic words of the type CVCCVC. For convenience, (15a) is repeated as (35) and (15b) as (36).

(35)



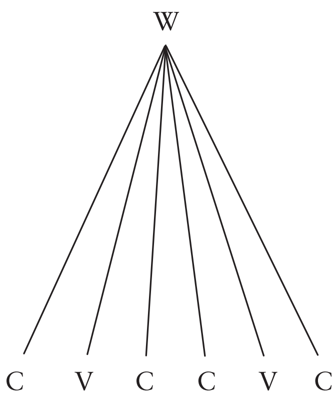
(e.g. English, German)

(36)



(e.g. Spanish, French)

(37)



(e.g. Arabic)

5.4 SYLLABLE STRUCTURE IN ENGLISH, ARABIC AND KOREAN

At the beginning of Chapter 2, the three logically possible models of CVC syllables were introduced. A syllable may possess or lack internal structure. In the former case, it is hierarchical; in the latter it is flat. Hierarchically organized syllables divide into left- and right-branching ones, depending on whether the vowel sticks more with the onset or the coda consonant. The question guiding the analyses in this section is whether all of the three models of the syllable are empirically attested (i.e., whether structural variation is at a maximum in that the range of theoretically possible variation equals the range of actually attested variation). The focus will be on individual languages that fit these descriptions. Whether there are typological preferences for any one of the three models will be explored in the next chapter.

The present section will be divided into two parts—a comparison between English and Arabic and one between English and Korean. There are two reasons for opting for two two-way comparisons instead of one three-way comparison. For one thing, this allows us to test the issue of flatness versus hierarchicalness and the issue of branching direction separately. For another, the available evidence on branching direction is quite different in kind from the evidence bearing on hierarchicalness. A compound comparison would consequently be hard put to avoid a potentially confusing mixture of research questions and methods.

5.4.1 Flat versus Hierarchical Syllable Structure in English and Arabic

For the comparison of the internal structure of English and Arabic syllables, we will draw on a selection of the criteria that were listed in section 2.5.1, in particular the evidence from speech errors, phonotactics, phonetics, and poetic rhymes. Much of the argument is based on the work of Berg & Abd-El-Jawad (1996). There are two main questions to be addressed. Do natural languages have a choice between a flat and a hierarchical syllable structure? And in case of an affirmative answer, how can the relationship between a flat and a hierarchical representation be described? More specifically, is the difference between them one of kind or of degree? As a subsidiary aspect, we will take up again the issue of the static or dynamic nature of structural representations.

5.4.1.1 The Evidence from Speech Errors

We begin with an effect whose relevance to the structural organization of language is beyond doubt. Phonological slips of the tongue in English tend to respect the parallel syllable structure constraint, which encourages the interaction of segments from similar syllable positions and discourages the interaction of segments from dissimilar ones. The critical point is that these positions are structurally defined (i.e., with respect to a set of nodes that dominate consonantal slots in the structural representation). As a consequence of this principle, onset consonants typically interact with other onset consonants but only reluctantly interact with coda consonants. The former situation is exemplified in (38), the latter in (39).

(38) *c*or*c*us. for: cor*p*us. (from Stemberger, 1983a)

(39) Tha*p*'s stu*p*id. for: tha*t*. (from Stemberger, 1983a)

The interacting phonemes /p/ and /k/ come from identical syllable (though not word) positions in (38). Both are syllable-initial. This is not so in (39) where the syllable-initial /p/ from *stupid* replaces the syllable-final /t/ from *that*. The frequency of cases like (38) and the infrequency of cases like (39) for instance is typically accounted for by the higher activation of homologous than non-homologous competitors. This difference follows from the structural specification of consonants as being onsets or codas of larger structural units. It thus is an instantiation of the ubiquitous principle of similarity to which slips of the tongue are subject. By observing structural constraints on errors, we may catch a glimpse of the structural representation underlying language production.

The parallel syllable structure constraint has been shown to hold for quite a few languages including English, German, French, and Spanish (Berg & Abd-El-Jawad, 1996; Rossi & Peter-Defare, 1995; García-Albea, del Viso, & Igoa, 1989; see also Collins & Ellis, 1992). In all these languages, the percentage of like-with-like interactions hovers around 95%. This strong adherence to the parallel syllable structure constraint is entirely compatible with representations (35) and (36). Because consonants are differentially coded (e.g., as being dominated by a word, syllable, or rime node), dissimilarities are introduced that tend to prevent onset-coda interactions. This is a very strong argument for asymmetrical coding (i.e., for a hierarchical structure of the syllable).

Arabic is very different from all these languages. Although the parallel syllable structure constraint is not completely lacking, it is much weaker than in the Indoeuropean languages, accounting for only 46.8% of the error data. Three examples from the Arabic corpus appear below.

(40) *m*ak*m*as. for: mak*b*as 'cruncher'

(41) *r*uɣfa. for: ɣu*r*fa. 'room'

(42) bur*gd*aan. for: bur*dg*aan. 'orange' (fruit)

While (40) is entirely parallel to (38), illustrating a between-syllable, within-word perseveration, (41) involves a reversal of an onset and a coda consonant from the same syllable and (42) a reversal of an onset and a coda consonant from different syllables.[10] Interactions between non-adjacent tautosyllabic consonants and those between adjacent heterosyllabic consonants occur far more frequently in Arabic than in English.

On the other hand, Arabic is exactly like the Indoeuropean languages in displaying an interaction between the distance between the interacting units and the sensitivity to the structural constraint under discussion. The closer the interactants are, the lower the sensitivity to this constraint. Thus, for both English and Arabic, this sensitivity is lower in within-word than between-word slips. Because of the generally lower sensitivity in Arabic than in English, this leads to a certain sensitivity in between-word errors and a lack of sensitivity in within-word errors in Arabic as opposed to a sensitivity in both within-word and between-word slips in English.

As the majority of Arabic slips of the tongue show little sensitivity to the parallel syllable structure constraint, Berg & Abd-El-Jawad (1996) argued that the labels onset and coda as well as intermediate nodes such as rimes are largely missing from this language. This boils down to the claim that the structure of the Arabic syllable is basically flat. However, a static representation like (1c) of Chapter 2 (or any other diagram for that matter) cannot do justice to the dynamics of language production. It was argued at length in the opening chapter that structural representations are built up gradually. This is assumed to be true also of Arabic. In this model, a (totally) flat structure marks the beginning of the activation process in all languages. The crucial difference among them is a temporal one (i.e., how long individual languages take to erect their structural representations). Most languages very rapidly transform their flat structure into a hierarchical representation and therefore show little sign of flatness. Others, like Arabic for instance, are quite slow so that they remain, for the larger part of the activation process, under the sway of a largely flat representation. Hence, it is somewhat inaccurate to say that the structure of the Arabic syllable is flat. It is more accurate to say that at any one point in the activation process, the Arabic representation is flatter than the English one.

An interesting implication of this temporal approach is that it unmasks a totally flat (syllable) structure as in (1c) of Chapter 2 and (37) as fictitious. Although certainly theoretically possible, flatness cannot serve as a general characterization of a language because all languages attempt to erect a structural representation and in so doing shift from flatness to hierarchicalness. This is a natural consequence of imposing an organization ("chunking") on the content units to be outputted.

The relative flatness of Arabic syllable structure explains its low sensitivity to the parallel syllable structure constraint. As consonants are not (strongly) coded for their structural position, they can easily interact even if one occurs prevocalically and the other postvocalically. The differential sensitivity to the structural constraint that was observed with different error categories makes sense on the assumption that these categories arise at different points in the activation process. In particular, within-word slips are presumed to happen earlier than between-word slips (in all languages). As a consequence, the former arise under the influence of a flatter structural representation and are less influenced by structural effects than the latter.

The relatively flat structure of the Arabic syllable nourishes a number of expectations of which the most obvious one is perhaps the lack of rime and body errors. Trivially enough, if there is no rime or body node, slips involving these units can hardly ever occur. And in fact, this prediction is fulfilled.

Not a single body or rime slip can be found in the Arabic error data whereas these are moderately well represented in English (see section 2.5.1.6).

Another prediction that can be derived from the flat model of the syllable concerns the distance between interacting units. The issue of how far the interactants are apart is principally determined by two factors. One is the rule that the closer two elements are, the more likely they are to interact. This follows from the common-sense principle that speakers are well-advised to activate elements that are needed sooner more strongly than elements that are needed only later. This higher degree of coactivation of close neighbours is what increases their error rate. However, this proximity effect is counteracted by the structural representation, which renders close segments dissimilar and certain distant segments similar. For example, adjacent heterosyllabic phonemes are coded as onset and coda whereas two non-adjacent consonants may both be coded as word-initial (and syllable-initial) onsets. As explained in section 5.3, the principle of similarity promotes the interaction of remote, but structurally similar units.

If one of the two opposing forces disappears, the other may unfold itself in uninhibited fashion. This is precisely how the situation in Arabic can be depicted. As the structural representation is weak, it cannot oppose the proximity effect. Arabic slips of the tongue are consequently predicted to preferentially involve elements that are relatively close to each other. This is in fact the case. In contradistinction to the Indoeuropean languages, Arabic evinces a majority of within-word slips (80.5%) and a minority of between-word slips (19.5%). The varying nature of the structural representation explains not only the difference between Arabic and English but also that between Arabic and Spanish. Recall that the distance between interactants is large in English, smaller in Spanish (and French), and smallest in Arabic. English has structure above the syllable, Spanish has structure below (though not above) the syllable and Arabic has no structure at all. By implication, English discourages within-word errors, Spanish within-syllable errors, and Arabic neither. The net result is a maximum closeness of interactants in Arabic, more distance in Spanish, and a maximum distance in English.

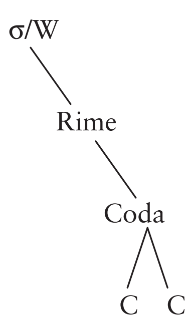
Summing up, a contrastive analysis of the error patterns in English and Arabic has revealed very pronounced disparities. These can be ascribed to structural differences between the two languages in that Arabic has a (mostly) flat and English a hierarchical syllable structure. Two aspects of this result deserve special emphasis. Firstly, framing the discussion in terms of the dichotomy "flatness vs. hierarchicalness" is somewhat misleading in that it suggests a static picture that can be neatly put down on paper. However, the previous diagrams are merely snapshots that capture only a part of reality and ignore the dynamic nature of (psycho)linguistic representations. These unfold gradually in real time and may give rise to observable behaviour at any point in the activation process. It is therefore inappropriate to speak of *the* structural representation of a language. We should rather focus on the time course of the unfolding of structural representations and examine what can, or cannot happen, during this process.

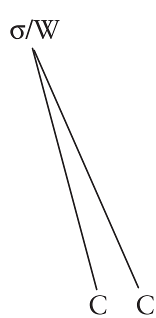
Second, it is of some theoretical import that the structural account ties together quite a number of speech error phenomena that would appear to be unrelated at first sight. Without this theoretical background, one would not expect the parallel syllable structure constraint and the word-onset effect to be related. Nor would one anticipate a link between the distance between interacting units and the occurrence of errors involving units larger than the phoneme. Significantly, the structural account establishes a causal connection among all these phenomena by putting them down to one and the same underlying principle (i.e., the velocity of the unfolding of the structural representation). This principle seems powerful enough to account for the differences between (prototypically) flat and (prototypically) hierarchical languages in general and between Arabic and English in particular.

5.4.1.2 The Evidence from Phonotactics

In view of the non-concatenative nature of Arabic, the issue of phonotactic constraints cannot be treated as in concatenative languages like English for example, mainly because adjacency cannot be that easily described. In the following, we leave out of consideration the phonotactic structure of discontinuous morphemes in which the question of rime (or body) nodes cannot be meaningfully addressed. Rime nodes presuppose the adjacency of vowels and consonants, which is not given in morphemes consisting exclusively of consonants or vowels. Instead, we will concern ourselves with a lower node, the coda, on which English and Arabic can be more directly compared. This investigation will complement the picture that emerged from the analysis of the rime node.

According to the Penthouse Principle referred to earlier, the coda is of special interest because it is relatively low in the phonological hierarchy and should therefore be a relatively cohesive unit. Trivially, if there is no coda node, two or more coda consonants cannot be cohesive at all. The representation of a two-member coda cluster in a hierarchical and a flat model is depicted in (43) and (44), respectively. Irrelevant nodes are omitted for simplicity's sake.

(43)


(44)


The two models make very different predictions about the combinatorial possibilities of coda consonants. The structureless representation (44) leads us to expect no particular phonotactic restrictions between the two consonants. However, this in no way entails the claim that any combination is possible because low-level articulatory constraints are likely to limit the combinatorial freedom. The precise impact of articulatory constraints independent of phonotactic restrictions is difficult to gauge. In contrast, the structural representation (43) imposes quite severe restrictions on the types of clusters that may occur in a language. Because the coda consonants are coactivated to a fairly high degree (due to the coda node), they may impact on each other and thereby appreciably reduce the number of acceptable neighbours. The prediction is then that a hierarchical language has far more phonotactic constraints than a flat language.

Standard Arabic licenses coda though not onset clusters.[11] According to Abu-Salim (1988), Arabic has 28 consonantal phonemes. Of these, as many as 25 (89%) can occur in both coda positions. This is a first indication that Arabic consonants tend to be positionally unconstrained even in such an expectedly restrictive context as the coda.[12] Theoretically, the 28 phonemes create 784 (28^2) clusters. This count includes those cases where a phoneme is combined with itself because Arabic permits postvocalic geminates. Abu-Salim (1988) observes a total of 504 cluster types, a figure that amounts to 64% of all theoretical possibilities. In the light of the pervasiveness of articulatory constraints, this is an astonishingly high percentage. It may be concluded that Arabic coda clusters are relatively free from phonotactic constraints.

There is no doubt that coda clusters in English and many other languages are far more constrained. Berg & Abd-El-Jawad (1996) report that English uses only 14.0% of the theoretical cluster space (and German even less). Clearly, English coda clusters are subject to phonotactic constraints to a significantly greater degree than the Arabic ones. By hypothesis, the explanation for this difference lies in the extent to which a structural representation unfolds itself in the two languages. As Arabic stays relatively flat, the coda node is only very weakly activated and therefore in no position to impose constraints on phoneme selection. By contrast, the hierarchical nature of English involves the activation of the coda node that constrains the decision on which phonemes may go with which.

Thus, the distributional analysis fully corroborates the conclusions reached through the analysis of speech errors. Whereas the latter focused on suprasegmental structure in general, the former was devoted to the coda. The fact that there is so much agreement between the two analyses suggests that a relationship exists among structural nodes. The presence of one such node makes the presence of another likely, and vice versa. This may be understood as a striving of the representational system toward internal consistency. Within certain limits, structural representations tend to be flat or hierarchical throughout. The theoretical possibility of combining flat with hierarchical aspects is apparently dispreferred.

5.4.1.3 The Evidence from Phonetics

In section 2.5.1.4, phonetic evidence was used to support the hierarchical structure of the English syllable. This approach may also serve to examine the internal structure of the Arabic syllable. Our focus will be on possible durational interactions between adjacent vowels and consonants. It was observed for English that a longer coda consonant tends to be preceded by a shorter vowel and vice versa. This tendency toward rime isochrony was taken as an argument for the reality of the rime node. Remarkably, such compensatory effects are largely absent from Arabic. Flege & Port (1981) investigated the effect of consonant voicing on the preceding vowel and found no lengthening of the vowel before voiced stops. This lack of temporal compensation was also evident in a study of Arab learners of English as a second language. These learners showed only a weak effect of voicing on the length of the preceding vowel, suggesting that they were moving from a native system with no temporal compensation to a target system with strong temporal compensation (Port & Mitleb, 1983). We may conclude that Arabic appears to lack a tendency toward rime isochrony. This is precisely what one would expect under the assumption that the nucleus and the coda are not organized in a rime structure, in other words, what one would expect in a flat structure of the syllable.

5.4.1.4 The Evidence from Poetic Rhymes

The following excursion into Arabic poetry will be very short because this area was covered in a completely different connection in Berg (2001). The logic of the argument is quite simple. If a hierarchical (right-branching) syllable structure is assumed to give rise to rime-based rhymes in English, a flat syllable structure may be expected to discourage rimes based on structural units. Concisely put, the absence of rimes would imply the absence of rhymes.

As a matter of fact, the phonological rime has never played a prominent role in rhymed poetry in Arabic. The basic rhyming unit in this language is the singleton consonant, as illustrated in (45).

(45) darab—rakib ‘to hit—to ride’

The rhyme is based on the identity of the word-final /b/. It alone suffices to create a perfect rhyme although the single consonant is often accompanied by identical material to its left and/or right. This is largely a result of language structure that makes particular consonant/vowel combinations highly likely. A quantitative analysis of Arabic rhymes yields only 4.7% rime-based rhymes. Combined with the fact that the vowels are not considered essential parts of the rhyme, this is strong indication that the Arabic rhyming tradition ignores the rime. The explanation for this is assumed to lie in the flat structure of Arabic syllables, which allows no recourse to the rime. The difference between rhyming patterns in English and Arabic can thus be attributed to differences in the hierarchicalness of their respective syllable structures.

5.4.1.5 Conclusion

Four diverse areas have been reviewed that converge on the claim that the structure of the English syllable is hierarchical whereas that of the Arabic syllable is largely flat. Although this conclusion conveniently summarizes the above pattern of results, it does not really capture the true nature of the cross-linguistic difference. Both English and Arabic start out as flat languages at the beginning of the generation process but unfold their suprasegmental representations at highly disparate speeds. Like errors, any aspect of language production must take place sometime during this unfolding process and is therefore influenced by the degree of hierarchization that has been reached at the moment of its generation. Because this unfolding is slow in Arabic, all aspects have a largely structureless quality. In contrast, the quick unfolding in English gives rise to a highly structured output.

This account entails the crucial distinction between early and late aspects of the production process because different aspects may be worked out at different moments in time. Let us assume that lexical stress is one such aspect (i.e., that it is actively computed during the production process (rather than only passively looked up in the mental dictionary). Arabic word stress is quantity-sensitive in the sense that heavy rimes attract it whereas light rimes rebuff it. Stress rules may therefore be taken as evidence for the rime. Although this pattern is not naturally predicted by the Structural Theory, it is not incompatible with it. The only assumption that would have to be made is that the computation of lexical stress is a relatively late aspect of the generation process and can make do with a relatively low activation level of the rime node. (Note that some hierarchization has been achieved at the end of the production process even in Arabic.) This hypothesis makes sense in view of the fact that vowel epenthesis and truncation are pervasive processes in Arabic and that a stress pattern cannot be properly computed unless the exact number of syllables is known, that is, relatively late in the production process.

The temporal approach advocated here sheds further light on the nature of the difference between Arabic and English. Although superficially the difference between the two languages can hardly be more pronounced, the theoretical model emphasizes their overall similarity. Actually, there is only one point of divergence although the languages are alike on all others. However contradictory it might seem to what has been stated previously, both languages draw on basically the same representational system. They have the same point of departure and the same direction in a two-fold sense: from flat to hierarchical and from neutral to right-branching. They thus activate the same structural nodes, in particular the rime node. The only difference between the two languages is that the structural nodes attain a low activation level in Arabic but a high activation level in English.

A further important aspect that emerges from the earlier analysis is the interdependence of structural nodes. Their activation levels appear to co-vary. For example, the weakness of the coda node co-varies with the weakness of the rime node. This may be a simple consequence of the architecture of the (psycho)linguistic system. Because the nodes are hierarchically organized and activation travels on the pathways connecting them, the activation of a node necessarily depends on that of its neighbours. This principle ensures that two structural nodes such as the rime and the coda tend to have similar activation levels. A notable implication of this theoretical analysis is that phonotactic constraints as one consequence of activation levels should be of a global rather than a local nature. This is to say that a given language should be characterizable as being generally constrained or unconstrained though not constrained at the rime level but unconstrained at the coda level. This prediction remains to be tested.

Another prediction that follows from the proposed model pertains to word games. Given the predominantly flat structure of the Arabic syllable, word games may be expected not to rely on the rime. Analogous games such as Pig Latin in English should not therefore occur in Arabic. This prediction stands a good chance of being true. Rime-based games do not figure among the language games that have been discussed in the relevant literature, even though this is of course no guarantee that such games exist but simply have not been reported.

5.4.2 Left- versus Right-Branching in English and Korean

Once the unfolding of the structural representation has begun, a decision has to be made as to the kind of structural unit(s) to be built up. As we know, the basic decision is a binary one. Either the system goes for left-branching and activates the body node or it goes for right-branching and activates the rime node. Although right-branching has been amply documented in previous chapters, a convincing case for left-branching in phonology remains to be made. If it could be made, we would have run the whole gamut of structural variation.

As before, our focus will be on the immediate constituents of the syllable, in particular the Korean syllable, not on lower-level structural nodes. In principle, the same pieces of evidence could be adduced that were put to good use in the preceding sections. Although pertinent naturalistic data from Korean are sparse, a truly remarkable line of experimental evidence is available and it is to this that we now turn.

In fact, a large body of experimental data has been accumulated by Derwing and associates (e.g., Derwing, Yoon, & Cho, 1993; Wiebe & Derwing, 1994, Yoon & Derwing, 2001) in an ambitious research programme of which the essential parts will be briefly reviewed. In their earlier work, Derwing et al. employed a forced-choice blending task in which subjects were offered four possibilities of blending two monosyllabic CVC words and asked to decide which of the four they preferred.[13] For example, *bug* and *cat* can be recombined in four different ways: *bat*, *kug*, *but*, and *kag*. The former two would be indicative of right-branching (as the onset-rime boundary is involved) while the latter two would be compatible with left-branching (as the body-coda boundary is involved). As expected, Derwing et al. observed a clear preference for onset-rime divisions among their English-speaking subjects. The Korean subjects, by contrast, exhibited a preference for recombinations of bodies and codas. This result is consistent with the claim that the Korean syllable is left-branching.

This noteworthy conclusion could later be reinforced by a variety of other experimental techniques. One is another judgement task in which subjects had to assess the similarity of word pairs in which the identical portions were systematically varied. One set consisted of word pairs in which the rime was identical whereas the body was identical in another set. Yoon & Derwing (2001) found that English speakers relied more heavily on the rime whereas Korean speakers relied more heavily on the body in their similarity judgements. This difference suggests opposite branching directions in the two languages.

Another technique is the concept formation task, which requires subjects to figure out for themselves the commonality of words that are presented to them successively. After each stimulus presentation and response, subjects are told whether their response is correct or not. This feedback is intended to foster the concept formation process. This task is predicated on the assumption that concept formation is all the easier, the more important the concept is in the language. The concepts at issue here are the body and the rime. Hence, Yoon & Derwing attempted to determine whether their subjects could form the concept of the rime more easily than the concept of the body or vice versa. As expected, the English subjects mastered the task of identifying the rime as the critical common property more quickly than that of identifying the body whereas the opposite result was obtained for the Korean speakers.

The next task in Yoon & Derwing's series was a reduplication task in which Korean subjects had to reduplicate the rime or body portion of CVC syllables. The subjects experienced less difficulty in reduplicating the body than the rime, thereby providing further evidence for the availability of the body unit in Korean. Comparable data from English speakers have not apparently been collected.

The final experiment was a recall task in which subjects' performance on remembering nonsense words was tested. These words were learnt in two sets, one consisting of words sharing the body and the other consisting of words sharing the rime. In line with the other experimental results, the Korean speakers were more successful on the set of body-identical words whereas the English speakers found the set of rime-identical words easier to memorize.

Yoon & Derwing were careful to rule out potentially deleterious effects such as orthography and showed that the salience of the body in Korean held good not only of adults and literate speakers but also of children and illiterates. On the basis of all their results, Yoon & Derwing conclude that the Korean syllable is unequivocally left-branching.[14] Further support for this claim comes from language structure, in particular reduplicative patterns in which the body is the major unit to be reduplicated (see Jun, 1994).

5.5 CONCLUSION TO CHAPTER 5

The overall aim of this chapter has been to investigate the extent of structural variation across languages. Our point of departure was the expectation that languages should differ considerably in terms of the structural representations that are built up in the process of preparing to speak. The strongest test of this prediction is to examine hierarchically important structural decisions such as the immediate constituents of SVO sentences, polysyllabic words, and syllables. In all three areas, major structural variation was observed. Even closely related languages such as English and German were found to differ in the role played by the structural representation. A prime research issue was the proper characterization of structural variation as a qualitative or quantitative difference. The results indicate that most of the variation is of a quantitative nature. That is to say, the same structural units are created in different languages, though their average availability is language-specific. This description accounts for the differing status of the VP in English and German as well as the differing status of the superrime and the syllable in German and Spanish. On the other hand, some of the cross-linguistic variation appears to be of a qualitative nature. Some structural nodes are apparently particular to some languages, and other nodes to other languages. For example, the body node is specific to Korean, which apparently lacks a rime node. The opposite situation holds for English. The reason for this qualitative difference is of course the mutual exclusiveness of bodies and rimes. A language cannot activate body and rime nodes simultaneously, at least not to a high degree.

The quantitative differences can all be reduced to a single principle—the speed with which the structural representation is erected.[15] Although this principle was introduced in the explanation of English and Arabic word structure, it certainly applies also to syllable structure as well as to sentence structure. To account for the differing role of the VP in English and German, it is hypothesized that the structural representation in the two languages unfolds in exactly the same direction, but that the activation of the VP proceeds more slowly in German than in English. As a result, given the same temporal constraints under which the two languages operate, English VPs have attained a higher activation level at the end of the unfolding process than German VPs. The greater strength of the VP in English implies that English is more sensitive to structural constraints, as is evident from its rigid word order. By the same logic, the lesser strength of the VP in German implies that this language is less sensitive to structural constraints, as can be seen from its greater syntactic freedom. The explanation for the slower activation of the VP in German than in English presumably lies in the greater word-order competition in the former language. This competition results from the relatively large number of alternative sentence patterns that vie with the target structure. As some are favourable, but other unfavourable, to the erection of a VP, the competition among these alternatives slows down the unfolding and leads to a relatively low activation level of the VP at the end of the generation process.

The principle of variable speed of activation is also applicable to the differing phonological-word structures in German and Spanish. Syllables are claimed to be activated more rapidly in Spanish than German whereas word onsets and superrimes are activated more rapidly in German than Spanish. This psycholinguistic principle accounts for the syllabic nature of Spanish and the onset/superrime nature of German. However, this cross-linguistic difference is gradual rather than categorical. Spanish also activates onsets and superrimes, though less rapidly and less strongly than syllables. It seems that it is possible for a language to sustain two alternative divisions of a word. Exactly how this is possible is as yet poorly understood.

It will not have escaped the reader's notice that syllable and phonological-word structure appear to be intimately related. The case of Arabic argues for a strong interdependence of syllable and word structure in that it lacks both. This is probably no coincidence. In fact, it is expected under the Structural Theory, which assumes the gradual build-up of all structural information as well as an interdependence among structural nodes as activation spreads from one structural layer to the next. The Arabic case thus is not only quite consistent but also straightforward to explain. In contrast, the Spanish case, with structure at and below but no structure above the syllable level, requires more discussion. The critical issue revolves around the prominence of the syllable. Specifically, where does the syllable get its relatively strong activation from? One possibility would be to argue that it comes from above (i.e., from the lexical level). Such a provision is made by Levelt, Roelofs, & Meyer (1999) who claim that the word node has stored with it information about the number of syllables. However, this is not a general solution to the problem. It is certainly not applicable to Arabic and probably also not applicable to English because it increases the prominence of the syllable to an undesirable degree. There is insufficient evidence for the claim that lexical representations differ so markedly from language to language. It is clearly more parsimonious if all languages include syllable information in, or exclude it from, their lexical representations.

It is even less likely that the syllable functions as a content rather than a structural unit in Spanish. Although this hypothesis would explain the enhanced prominence of the syllable, it overshoots the mark in that it accords the syllable too much prominence. Specifically, it would predict that interactants in word blends are almost always broken up at the syllable boundary, which is contrary to fact.

The only viable solution appears to be that syllables receive activation from below, that is, from the segments that make them up. (Note that precisely this is the natural direction of information flow in the Structural Theory.) However, this proposal still does not explain why syllables reach a higher activation level in Spanish than in English for example. Again, the key probably lies in the principle of competition. When there is a good deal of competition, the winner attains a lower activation level than when competition is weak. Because there are only relatively few syllables types in Spanish (see section 5.3.4), competition among them is relatively low. As a result, the winner (i.e., a particular syllable) amasses much activation. This is the explanation that the Structural Theory offers for the (relative) salience of the syllable in syllable-timed languages.

The interdependence of structural nodes raises a more general point. Arabic has been argued to unfold its suprasegmental representation more slowly than English. Is it justified to infer from this that each language can be characterized by a general parameter, which determines the speed of the erection of all its structural representations? If so, Arabic would build up its syntactic representation at the same (slow) speed as its phonological representation. Clearly, it is too early for a general answer. As far as Arabic is concerned, there is no indication that the build-up of the syntactic structure proceeds as slowly as that of the phonological structure. The slowness of the phonological component appears to be a local reaction to a local problem. What this single example appears to show is that languages have the freedom to develop solutions that are particular to one level of description.

In terms of the hierarchicalness of syllable structure, Arabic and English possibly represent rather extreme endpoints on a continuum within which there is room for more variation, though of a more minor kind. In much the same way as languages may vary in the strength accorded to the VP node (see section 5.2), languages may show variation with respect to the activation level that the rime node normally attains. One major factor influencing activation levels is the frequency with which the rime node is accessed. A language that has few closed and many open syllables obviously needs the rime node less than a language with many closed and few open syllables (see also Treiman, Kessler, Knewasser, Tincoff, & Bowman [2000] on the effects of token frequency on cohesiveness). Consequently, phonemically heavy languages are expected to assign more importance to the rime than light ones. It may be predicted, for example, that the Romance languages raise the activation level of the rime node less than the Germanic languages. Initial evidence bears out this prediction. Bertinetto (2001b) compared the characteristics of lexicalized blends (e.g., *smog*) and blend errors in several languages and found not only that all of them are right-branching but also that they vary in their degree of hierarchization. To be specific, he argued for the following arrangement of the languages on a scale of decreasing sensitivity to hierarchical effects: English > German > French > Italian. Remarkably, this order is compatible with the predictions of the Structural Theory.

The final comments pertain to branching direction. It is here that languages have to make a categorical decision. Why does the Korean syllable prefer left-branching but the English syllable right-branching? Yoon & Derwing's (2001) proposed explanation for left-branching in Korean centers around the phonotactics of the syllable. They claim that the token/type ratio of bodies is much lower than that of rimes and that this difference increases the salience of the body relative to the rime. The logic of this argument is difficult to see. To begin with, it is far from clear why the number of different types of a unit (such as the body) should correlate with its salience. At least, Yoon & Derwing do not attempt to motivate such a correlation. More devastatingly, the same fact (i.e., that the token/type ratio is higher for rimes than for bodies, has served as an argument for the reality of the rime; compare section 2.5.1.1). Clearly, one and the same empirical tendency cannot support two contrary conclusions. According to the logic spelled out in section 2.5.1.1, one would rather expect a higher token/type ratio for bodies than for rimes in a left-branching language. In any case, even if such a phonotactic bias held for Korean, it would be doubtful if it could serve as an explanation for a particular branching direction. It is certainly possible that the phonotactic bias is the effect rather than the cause of left-branching.

One reason why the Korean syllable is left-branching might be the cross-level harmony constraint (see Chapter 2). Korean has a left-branching syntax. The argument would be that the Korean syllable is left-branching because Korean generally is a left-branching language. The background assumption here is that languages actively strive toward cross-level harmony, so when one level, such as the syntactic one, has settled on a particular branching direction, other levels are likely to follow suit. Exactly such a harmonious relationship among the core levels was uncovered for English in Chapter 2. Recourse to a general branching direction preference in a particular language does not, however, explain why this preference arose in the first place. Here is another loose end waiting to be tied up.[16]

The Korean as well as the Spanish and the Arabic case outright falsify the processing model of Gupta & Dell (1999). These authors address a number of empirical effects such as the word-onset effect in speech errors and the greater phonotactic constraints between nucleus and coda than between onset and nucleus. Their major claim is that these effects follow from the sequential nature of speech production. They proceed from the experimental finding that it is easier to retrieve one out of several words sharing the rime than to retrieve one out of several words sharing the body. They go on to argue that language structure has adapted to this processing bias, hence the prevalence of right branching. As serialization clearly is a psycholinguistic universal, Gupta & Dell's model cannot help but claim that right-branching should be observed in all languages. It was shown earlier that this is simply not true. Neither right-branching nor the empirical effects on which their model is built have the language-independent status that the authors attribute to them.

It was argued in this chapter that the suprasegmental representation of Arabic remains largely flat throughout the activation process. Emphasis was laid on the claim that this flatness is not as complete as standard diagrams (like that in [37] for example) imply. This movement away from flatness entails the decision of whether Arabic should tend toward right- or left-branching. The processing-based theory presented in Chapter 2 lets us expect the former branching direction, and indeed, Arabic uses right-branching. As noted in section 5.4.1.1, the late-occurring between-word slips in Arabic testify to a word- and syllable-onset effect. Such a bias is suggestive of right-branching as the direct (non-branching) link between the onset and the syllable or word node frees prevocalic consonants from structural bonds and thus makes them prone to error. Rime slips would also be expected, but their absence finds a natural explanation in their inherent unlikelihood of occurrence (due to their segmental complexity) coupled with the infrequency of between-word errors in Arabic. However, rimes were found to play a role in the determination of lexical stress (see earlier discussion). Finally and most importantly, between-word errors are sensitive to the parallel syllable structure constraint. Thus, there is at least some evidence that Arabic is an incipiently right-branching language.[17]

6 Branching Direction (and Hierarchicalness) from a Typological Perspective

6.1 INTRODUCTION

Chapter 2 began with detailing a psycholinguistic theory that accords right-branching a processing advantage over left-branching. As this theory is independent of the nature of the linguistic material to be processed, it clearly has a universal ring. That is, it predicts that right-branching should occur more frequently than left-branching in the languages in the world. This prediction holds at all linguistic levels and will therefore be tested in the syntactic, morphological, and phonological domains. As so little typological work has been carried out on branching direction, the present chapter falls far short of providing definitive answers. It has to be rather eclectic and short and its conclusions can be no more than suggestive. Of course, only those structures can be considered for which some evidence is at hand. These are the major structures as defined in Chapter 2 with reference to English. Of the many criteria that were discussed in the said chapter, only a small minority can be employed here. The selection of these criteria is largely unsystematic, being determined only by the availability of relevant data.

6.2 SYNTAX: SUBJECT–VERB–OBJECT SENTENCES

A time-honoured tradition in typologically oriented work classifies languages according to their dominant word order in simple declarative sentences consisting of subject, verb, and object. It was argued in Chapter 1 that hierarchical structure is the result of the frequent (i.e., to the certain degree predictable) co-occurrence of two content units that contract a semantico–syntactic relationship. Tomlin (1986) showed that such a relationship is cross-linguistically contracted between the verb and the object.[1] We will take this insight as our starting point and argue (pace Tomlin 1986) that the co-occurrence of verb and object in the dominant order is indicative of the erection of a VP. The position of verb and object in declarative sentences thus serves as a clue to whether the sentences are left- or right-branching.

The three constituents S, V, and O allow for six possible combinations, two of which (i.e., VSO and OSV) have verb and object in non-adjacent positions. On the above logic, these two orders do not give rise to a VP node[2] and are therefore irrelevant to the issue of branching direction. The other four orders place verb and object next to each other and therefore support the creation of a VP. The two orders SVO and SOV point toward right-branching whereas VOS and OVS point toward left-branching. A frequency count of the six orders will help to ascertain which branching direction, if any, is cross-linguistically preferred.

As a matter of fact, quite a few quantitative analyses are available on the frequency of basic word orders. These differ widely in terms of the number of languages examined and the criteria for selecting the languages. The two main challenges in gathering a sample of languages are its representativeness and the independence of the individual data points (i.e., languages). These problems are taken into account by Tomlin (1986) and it is on his sample that the ensuing analysis rests. Of the 402 languages investigated, 348 (86.6%) are either SVO or SOV and 17 (4.2%) are either OVS or VOS. (The remaining 9.2% are verb-initial languages. OSV languages are not attested.) In accordance with the prediction of the psycholinguistic theory, we thus observe a strong predominance of right-branching languages. This asymmetry would be even stronger if we followed Pullum's (1977) suggestion to the effect that many abstruse word orders can be reanalysed as SVO or SOV. Thus, the languages of the world prefer right- to left-branching in their basic word order.

Clearly, this conclusion must be regarded as tentative, given that it is based on a single criterion (i.e., the adjacency of V and O). For the many other criteria discussed in section 2.3, only a few have been applied to individual languages. For instance, Steenbergen (1989) applied the idiomatization criterion (see 2.3.1.10) to Finnish and found only V + O idioms but no S + V idioms. Individual examples like these may be taken as support for the right-branching analysis of Finnish, an SVO language, though they have limited force from the typological angle.

It should be noted that processing ease is considered here to be one among several factors that account for basic word order. Semantic and pragmatic factors such as Tomlin's "theme-first principle" and "animated-first principle" conspire with the right-branching bias to produce the marked preponderance of SVO and SOV orders (for further factors, see Krupa, 1982).

Word orders other than S/V/O were examined from the typological perspective by Maxwell (1984). His investigation of 20 different orders, ranging from complex NPs (e.g., NPs modified by other NPs) to complex sentences (e.g., main clauses augmented by relative clauses), demonstrated that right-branching structures occur more frequently than their left-branching counterparts in his sample of languages (see his Table 5). For instance, in a tripartite structure consisting of a main clause, a relative pronoun and a relative clause, the relative pronoun always links up with the relative clause (and thereby creates a right-branching structure), but never with the main clause. Maxwell reported no example of a tripartite structure, which is always left-branching in the languages he considered. Our preliminary conclusion is, then, that right-branching is cross-linguistically favoured even for word orders other than S/V/O.

Further evidence for this claim comes from a special asymmetry between right-branching and left-branching. It seems that basically left-branching languages allow right-branching in discourse whereas the opposite situation does not hold. A case in point is Turkish whose syntax is generally left-branching. Interestingly, it shows a tendency to replace complex left-branching structures with right-branching alternatives in spoken discourse (Auer, 1990). This is the expected direction if left-branching incurs a higher processing cost than right-branching.

Thus, both basic and non-basic word orders show a predilection for right-branching. Although this agreement is a welcome result, there is no denying that the analysis of both word order types leads to inconsistencies at the level of individual languages. What should we do with languages such as Japanese, which are right-branching in their basic word order (SOV) but otherwise left-branching (Kuno, 1973)? One possibility would be to question the significance of basic word order for branching direction. Indeed, S/V/O order is different from other word orders such as P/DET/N in that the modifier-head (or phrasal-lexical) distinction is not easily applicable. Whereas the NP modifies the preposition in a PP, the VP cannot be said to modify the subject in a sentence. Whereas the preposition is a lexical unit, the subject is a phrasal one. In recognition of this difference, one might want to restrict the analysis of branching direction to those cases with a clear head-modifier (or lexical-phrasal) structure and thereby discard basic word order. Since the VP nevertheless exists, it would have to be assumed in this approach that it is definitional (i.e., given a priori).

However, this solution is not a viable one. On the empirical level, it cannot account for the different strengths that VPs may have in different languages (see Chapter 5). Furthermore, it is not justified to regard the VP as a linguistic universal in the light of free word order and VSO languages. Finally, the parallelism between basic and non-basic word orders in terms of their right-branching preference would be missed. These advantages should not be traded for the elimination of the inconsistency between basic and non-basic word orders in some languages. It thus seems wiser to live with these inconsistencies for the time being rather than to ignore basic word order altogether.

6.3 MORPHOLOGY: PREFIX–STEM–SUFFIX STRUCTURES

The empirical situation in morphology is appreciably bleaker than in syntax. Branching direction analyses hardly exist for individual languages, let alone for samples of languages. The investigation will be confined to identifying the major cut in a chief morphological complex—the prefix–stem–suffix sequence. Basically, there are only two tests that can be performed on these complexes from the cross-linguistic perspective—dissimilation and syllabification. Both are phonological criteria, which, as argued in section 2.4.1, are particularly apt to pick up morphological structure because the phonological component interprets the morphological one in language production. Dissimilation was treated under the rubric of the identity constraint in section 2.4.1.4. The fundamental insight on which the ensuing investigation is predicated is the variable nature of the identity constraint. Repeated morphemes and phonemes may, but need not, be deleted. Because of the greater structural unity between stems and suffixes in right-branching languages, the stem-suffix domain should be more susceptible to deletion processes than the prefix-stem domain. Of course, the opposite prediction holds for left-branching languages.

A test of these hypotheses is facilitated by the availability of pertinent data from a good number of languages (Dressler, 1977; Stemberger, 1981; Menn & MacWhinney, 1984). Dressler (1977, p. 43) claims that the identity constraint holds in suffixing though not in prefixing (see also Szymanek, 1980). Unfortunately, Dressler used a sample of unknown reliability in that he contented himself with enumerating individual examples from various languages. Stemberger (1981) and Menn & MacWhinney (1984) were more systematic and more extensive in their data collection. If we ignore cases of avoidance and suppletion as well as those involving free morphemes and restrict ourselves to cases of omission, Menn & MacWhinney's database contains 29 types occurring at the stem-suffix boundary or in the suffix domain as against 3 types occurring at the prefix-stem boundary or in the prefix domain. These 32 types of omission stem from a total of 17 languages of which 10 belong to the Indo-European stock. It may be tentatively concluded that there is a typological preference for the identity constraint to operate at the stem-suffix rather than the prefix-stem boundary. This is the pattern of results one would expect if right-branching was the cross-linguistically favoured branching direction in morphology.

This conclusion is amplified by resyllabification data. In a right-branching model, the stem-final consonant is more likely to resyllabify into the onset position of the suffix than is the prefix-final consonant into the onset position of the stem. The opposite prediction holds for the left-branching model (see section 2.4.1). In fact, I could not find a single language in which the prediction of the left-branching model was fulfilled. However, several languages have been reported to allow resyllabification across the stem–suffix boundary though not across the prefix-stem boundary. Among these are Dutch (Booij, 1995), German (Laeufer, 1995) and Polish (Rubach & Booij, 1990). More generally, stems and suffixes have been argued to form one prosodic domain whereas prefixes form their own domain in several languages including Korean (Han, 1993) and Hungarian (Nespor & Vogel, 1986). Even though the number of languages for which pertinent information is at hand is not excessive, they all point in the direction that is predicted by right-branching.

As in syntax, further criteria have been applied in the analysis of prefix–stem–suffix structures in individual languages. A case in point is Scalise (1986) who argues for right-branching in Italian on the basis of the morphological criterion. However limited the contribution of these individual examples may be, they strengthen the general impression that right-branching is the preferred branching direction in prefix–stem–suffix structures.

6.4 PHONOLOGY: CVC SYLLABLES

The available pool of data in phonology is somewhat more reassuring than in morphology, but still far from satisfactory. The principal problem in the phonological literature is that many scholars have simply assumed the correctness of the right-branching model of the syllable instead of taking the trouble to explicitly defend it. A number of phonologists have even gone so far as to allege that the right-branching structure of the syllable is universally true (e.g., Halle & Vergnaud, 1980; Trommelen, 1984; Fudge, 1987; Kaye, 1989). It is difficult to see what has prompted these linguists to make such a strong claim in the absence of any large-scale analyses.[3] As a response to this predicament, I have compiled a list of all those languages for which I could unearth information about branching direction. The subcolumns provide information on whether the case of a particular branching direction is well-argued or rather taken for granted.[4] Note that even in those languages in which branching direction has been studied, there is considerable latitude in how thoroughly the issue has been discussed. Some claims rely on a single, little elaborated argument whereas others are much more carefully made. Needless to say, the criteria employed are also highly different in nature, ranging from exclusively linguistic to exclusively psycholinguistic.

It is apparent from Table 6.1 that right-branching is the preferred option for CVC syllables across languages. When all languages listed in the table are taken into consideration, the score is 30 right-branching, 4 left-branching, and 2 flat languages. This preponderance persists even when all languages are filtered out for which little or no empirical support is provided. It is also clear from Table 6.1 that the right-branching bias is not a particularity of Indo-European languages. It comes out quite strongly even if the count is restricted to non-Indo-European languages.

There is no need to dwell on any individual language favouring right-branching, except perhaps on Arabic, which was classified as largely flat in section 5.4.1. As it was also described as being weakly right-branching in 5.4.3, there is no conflict with Abu-Salim's (1988) claim as to the right-branching nature of the Arabic syllable (especially as his case is not well argued).

Table 6.1 Branching Direction in CVC Syllables[5]

Right-Branching (N = 30)		*Left-Branching (N = 4)*		*Flat (N = 2)*	
s.b.a. (n = 17)	*s.h.a.a. (n = 13)*	*s.b.a. (n = 3)*	*s.h.a.a. (n = 1)*	*s.b.a. (n = 1)*	*s.h.a.a. (n = 1)*
English	Norwegian	Finnish	Guaraní	Hindi	Turkana
German	Polish	Korean			
Dutch	Armenian	Japanese			
Swedish	Kurdish				
Icelandic	Hungarian				
Spanish	Arabic				
Italian	Kayardild				
French	Kisi				
Portuguese	Wambaya				
Slovac	Kham				
Dama	Misantla Totonac				
Kabyle Berber	Uyghur				
Telugu	Mongolian				
Taiwanese					
Vietnamese					
Lao					
Chinese					

(N.B. s.b.a. = supported by arguments, s.h.a.a. = supported by hardly any arguments or no arguments at all)

The three languages for which the left-branching hypothesis is buttressed by solid empirical work are Finnish, Japanese, and Korean. In Japanese, there is a mora level in addition to the syllable and segment levels (see section 5.1), which not only makes the syllable structure flatter but also creates a different prosodic hierarchy, which makes (left-branching) mora languages incommensurate with right-branching languages (see also Miyakoda, 2002). We therefore end up with only two languages in our sample for which there is clear support for left-branching CVC syllables. The case of Korean was argued in Chapter 5. The arguments for left-branching in Finnish are mainly based on naturalistic speech error patterns, experimental evidence and word games. One such game named *kontti kieli* heavily relies on the body (see e.g., Campbell, 1980). The speech error corpus collected by Hokkanen (2001) contains body but no rime slips and (probably) has more coda than onset slips when opportunity of occurrence is taken into account. Metalinguistic tasks showing the salience of the body were reported on by Niemi (2004).

The sole serious claim in support of flatness has been advanced for Hindi. It will be recalled that a backbone of the dynamic conception of structure underlying this study is the hypothesis that languages do not stay flat throughout the planning process. It follows from this that flat languages should be exceptional and that they should not be flat throughout. The claim that a given language is flat should therefore be treated with suspicion. In fact, Ohala (1999) does not conceal her uncertainty about her flatness assumption for Hindi. Her blend experiments revealed that subjects found the CV portion in CVC syllables a more natural unit than the VC portion. However, this bias may simply reflect the Hindi writing system in which the graphs may represent a CV but not a VC unit. If the orthographic influence was eliminated, Ohala argues, we would be left with a flat syllable structure. Clearly, this is a non sequitur. For one thing, an orthographic influence has not been demonstrated. It is theoretically possible that there is no such influence and that the left-branching bias is a genuinely phonological effect. For another, even if there was such an orthographic influence, it is far from certain that after its elimination, subjects treat CV and VC portions symmetrically (i.e., as equally cohesive units). Ohala's claim about the flat nature of the Hindi syllable should therefore be treated with caution.

One phonological process that is immediately relevant to syllable structure and that has been studied in many different languages is compensatory lengthening (e.g., de Chene & Anderson, 1979; Ingria, 1980; Hock, 1986; Hayes, 1989; see section 2.5.1.9). The basic principle is that the deletion of a consonant is accompanied by the lengthening of an adjacent vowel. A typical example from the recent history of English is given in (1).

(1) Early Mod. E. calf [kalf] → calf [ka:f]

As can be seen, the disappearance of the liquid leads to a lengthening of the preceding vowel. The critical point in the present context is that in all the many languages that have been investigated, it is always the loss of the *following* consonant that entails the lengthening of the preceding vowel, but never the loss of the *preceding* consonant that entails the lengthening of the following vowel, as shown in (2).

(2) Ancient Nordic wulfa → Danish, Norwegian, Swedish ulf 'wolf'

Here, the initial consonant was deleted without concomitant lengthening of the vowel.

The interpretation of this asymmetry is straightforward. Postvocalic consonants interact with preceding vowels more heavily than prevocalic consonants with following vowels. This difference is naturally accommodated in a right-branching model. Because this asymmetry is found in so many different languages from different families, it may be suggested that right-branching is the typologically preferred structure of the syllable.

The same conclusion is invited by a cross-linguistic analysis of word games (see section 2.5.1.5). Botne & Davis (2000) investigated the sites at which syllables are broken up for the insertion of distorting material and found that the onset-rime boundary is more frequently involved than any other. This is the expected pattern if right-branching is assumed to be the typologically preferred option.

Some cross-linguistic work has been done using the poetic rhyme criterion. Fabb (1999) finds that rime-based rhyming is cross-linguistically favoured not only in adult poetry but also in children's word games. He goes on to state that alliteration occurs less frequently than rime-based rhyme in the languages of the world and that children play rime-based games even in those cultures whose poetry lacks rime-based rhyming. This may be taken as further support for the hypothesis that right-branching is the preferred option from the typological viewpoint.

As in syntax and morphology, there are applications to individual languages of individual criteria for constituency. Two pertinent examples may suffice. The phonetic criterion was applied to Italian by Farnetari & Kori (1986). They examined vowel duration as a function of number of onset and coda consonants and found that coda size was a much better predictor of vowel duration than onset size. Wijnen (1988) applied the phonetic criterion to Dutch. He examined a corpus of within-syllable self-interruptions and observed a significantly higher number of cut-offs at the onset-rime than at the body-coda boundary. These are the expected results in a right-branching model of the syllable.

6.5 CONCLUSION

The following conclusion cannot help being tentative because the typological database is extremely sketchy. There are hardly any comprehensive studies of branching direction for individual languages so that any typological approach to this issue would seem premature. However, the little information that can be culled from the available sources leans strongly in one particular direction. Hierarchical languages are more common than flat languages and right-branching is more common than left-branching in the world's languages. This preference is so strong that it is highly unlikely that a much-increased language sample would yield diametrically opposite patterns. This result is exactly as predicted by the ease-of-processing theory, which may therefore be claimed to have passed the typological test.

It is possible to combine the typological approach with the diachronic perspective taken in Chapter 4. Given the general right-branching preference, we may predict a greater likelihood of left-branching languages developing into right-branching languages than vice versa. In a notable paper, Gast (2001) showed this to be the case for Mesoamerican languages. Languages with an erstwhile left-branching structure changed toward the right-branching type whereas right-branching languages remained right-branching. However, it is doubtful that we should infer from this that left-branching languages are waning. If this inference was true, one wonders why left-branching languages did not become extinct long ago or why they came into existence in the first place.

An especially noteworthy finding is the wide agreement among the various linguistic levels. Right-branching was found to prevail in syntax, morphology, and phonology (and phonetics). This replicates from a typological perspective what was established for English in Chapter 2. The cross-level harmony constraint thus appears to have some cross-linguistic validity. However, little is known so far about the strength of this constraint.[6] It would be interesting to see whether one and the same language may have, let us say, a right-branching syntax but a left-branching phonology (or vice versa) and if so, how frequent these languages are. Finnish may be a case in point. However, there is no room for a systematic analysis because the list of languages that were examined from the syntactic perspective was not identical to the list of languages that were examined from the phonological perspective.

7 How Structure Is Acquired

7.1 INTRODUCTION

The present and the following chapter will explore the ramifications of the Structural Theory for language acquisition and breakdown, respectively. The psycholinguistic basis of the content–structure distinction implies that these two types of units constitute distinct challenges for the child. In line with the focus of this study, the present chapter will concentrate on the acquisition of structural units. Because their generation process is more complex than that of content units, the basic prediction is that children will have more trouble learning the former than the latter. Of course, this is not to say that they will not attack the acquisition of structural units until after they have completely mastered the content units. The claim is rather that content units have a head start in the learning process (i.e., children start out using content units but no structural units).[1] Once structural units have been acquired, however rudimentarily, the possibility of organizing content units in hierarchical fashion arises. As flatness requires fewer structural nodes than hierarchicalness, it may be predicted that the process of acquisition can be adequately characterized as a gradual transition from less to more hierarchical representations. The initial stages of development are accordingly under the sway of flat structures. This prediction holds for all levels of linguistic analysis.

From the perspective of the Structural Theory it does not seem possible to predict a certain temporal order in which structural units are acquired. In particular, there is no basis for the claim that structural units at one linguistic level take precedence over those at another. These tasks may in principle be performed in parallel although this does not mean that children must work on them simultaneously. Children might adopt a strategy that is responsive to the token frequency of complex input units. If the ambient language contains many polysyllabic words with few consonant clusters, children are likely to build up a syllable node prior to a cluster node; if, however, the language contains short words with complex syllable structures, the opposite expectation holds. Token frequency is certainly not the only relevant factor. Neurological and cognitive growth undoubtedly also plays a role.

The preceding reasoning begs one important question: How do children know whether a given unit belongs to the content or the structural class? I do not pretend to have a final answer to this question, but the following scenario may not be off the mark. It seems likely that learners do not have the first idea of the distinction between content and structural units when they confront the task of acquiring a language. They may be presumed to treat all units indiscriminately as unclassified units that, once available, are accessed as more-or-less stable units in the lexicon.[2] With time, children's output increases in complexity and the need arises to create strategies that help them manage the increasingly complex processing problems. These strategies include the structural units with the concomitant changes in the architecture of, and information flow in, the production system.

This sketch of the child's linguistic development does without the assumption that a given element changes its status from a content to a structural unit in the course of the acquisition process. There is one unit for which such a metamorphosis may be claimed—the syllable, which might be held to be a content unit in child language but a structural unit in adult language (see Chapter 1). The syllable is highly relevant in the present context for another reason. This element might be argued to refute the hypothesis that children do not use structural units at the beginning of the acquisition process because their earliest utterances are seemingly made up of just this: single or reduplicated syllables. This objection can be met by claiming that children's first meaningful utterances are not syllables but monosyllabic words (Piske, 2001). This automatically follows from the way syllables and words are typically defined. Words are by definition meaningful whereas syllables as phonological units are not.[3] Because words are content units, the hypothesis of structural units being used at the onset of language acquisition collapses. Similarly, there is no basis for the claim that a change from a content to a structural unit takes place. All that has to be assumed is that syllable nodes are created at a later stage in the acquisition process.[4]

In one respect, it would seem that the predictions of the Structural Theory are entirely unremarkable. To the extent that complexity is related to structure, a lack of structure entails a lack of complexity. Children will therefore deal with less complex before more complex problems. Although this appears entirely reasonable, not all theories of language acquisition predict an increase in structural complexity in the course of language acquisition. For example, Crain (1991) claims that children's syntax is as hierarchical as that of adults. He interprets data that were taken by others to argue for flatness as failures in components other than syntax (see also Chomsky, 2005, p. 12, who suggests memory and attention limitations as potential reasons). These non-syntactic failures make the syntax look flat even though it is in fact hierarchical from the very beginning.

I mention only two problems associated with this approach—a general and a particular one. The view of learning that underlies it is puzzling indeed. Quintessentially, learning is denied a role in language acquisition. The open question is then why children take years to master a language. More specifically, it is difficult to understand why syntactic knowledge should be available right from the start whereas other (e.g., lexical) knowledge has to be painstakingly amassed.

Let us consider one well-known study asserting that children need not develop a sensitivity to (syntactic) structure because they bring it to the task of language acquisition as an innate principle. Crain & Nakayama (1987) tested whether children would front the auxiliary of the main clause or that of the relative clause when asked to turn statements such as (1) into questions. The two theoretical possibilities of fronting are illustrated in (2) and (3), respectively.

(1) The boy who is watching Mickey Mouse is happy.

(2) Is the boy who is watching Mickey Mouse happy?

(3) *Is the boy who watching Mickey Mouse is happy?

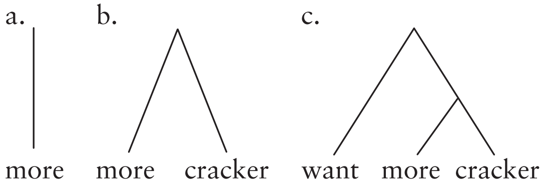
Crain & Nakayama (1987) predicted that if children use structure dependence, they will produce questions beginning with the main-clause auxiliary rather than the relative-clause auxiliary; if, however, they apply a structure-independent rule such as "Front the leftmost auxiliary," they will produce questions beginning with the relative-clause auxiliary. Although the children made many grammatical errors, those exemplified in (3) were not among them. What does this result mean? In Crain & Nakayama's view, it represents evidence for the availability of structure dependence at the onset of language acquisition. However, this is a non sequitur. The plain observation is that children do not generate forms that they have not heard in the ambient language. This absence in adult language is all that is necessary to explain the absence of sentences of type (3) in child language.[5] Thus, Crain & Nakayama's study provides no evidence for the hypothesis that structure dependence underlies their subjects' utterances or rather non-utterances.

We may now return to the Structural Theory and its predictions. What pushes the theory beyond general issues of complexity is (a) its predictions regarding areas in which structural effects or rather a lack thereof are less conspicuous, (b) the gradual nature of its predictions and (c) the unified account it provides of the difficulties language learners face at various levels of linguistic analysis. Let us examine each of these points in turn.

Beginning with (a), one area where structural effects cannot be immediately subsumed under a simple complexity metric is phonology. The interactions that take place in child language between components of the same planning unit raise issues that differ substantially from simple questions about the number of units a child is able to produce. The shorter planning span in phonology makes it possible to study underlying representations that are unobservable (and perhaps non-existent) in children's early syntax and morphology.[6] For this reason, more attention will be devoted to phonology than to syntax in this chapter. Unfortunately, morphology will not be treated at all, mainly because this area is severely understudied in those aspects that matter most here.

With respect to (b), the present framework distinguishes itself markedly from its competitors. Most other models conceive of developmental change as the creation of new nodes. Take as a typical example Greenfield's (1991) view of the acquisition of syntactic structure depicted in (4). Nodes remain unlabeled.

(4) a. b. c.



The growth of the syntactic representation is understood as a response to an increasing amount of lexical material filling one planning unit. The single lexical unit in (4a) is associated with a single syntactic slot. The two words in (4b) are linked to one syntactic slot (such as NP) to express their togetherness. Once these words make up one planning unit, they may be organized in intermediate layers as in the right-branching structure in (4c). Therefore, a new syntactic node has to be created. This represents an abrupt change from being absent to being present.

It seems to be generally assumed that hierarchical structure is created once the minimum lexical requirements are met (Pinker, 1984). Thus, the availability of a verb plus a complex object NP entails the erection of a right-branching structure as in (4c). The present model does not share this assumption. It claims instead that in the beginning stages of producing three-word sequences such as in (4c), children's syntactic representations are flat.[7] Only when they realize through their experience with the language that a VP is a useful production routine do they begin to unfold intermediate structural representations. This unfolding is a gradual process. That is, the intermediate node is weakly activated in the early phases but gradually gains strength and thereby increases the hierarchicalness of the representation. These intermediate stages between flatness and hierarchicalness are expected to give rise to distinct, observable output patterns.

The main point regarding (c) turns on the pervasiveness of structure in language. As it occurs at all linguistic levels at issue here and manifests itself in similar ways across these levels, children are confronted with similar challenges and may be expected to develop similar strategies in response to them. The Structural Theory thus establishes links between phenomena that would not normally be seen as related. Generally, structural problems at one level may be connected with those at another. A core issue is the degree of hierarchicalness of a representation that may be expected to co-vary among levels (at least to a certain extent). For instance, a structural effect such as the parallel syllable structure constraint in phonology might not be independent of a structural issue such as question formation in syntax. This is not to say, of course, that solutions to these problems must be worked out simultaneously at different levels, but it is possible that a solution at one level may facilitate finding a solution somewhere else. Unfortunately, these predictions cannot as yet be put to a rigorous test because child language researchers have tended to focus on individual linguistic levels rather than on interactions between these.

As the gradual change from flat to hierarchical representations plays such a central part in the Structural Theory and also in its application to language acquisition, it is appropriate to place this issue in a wider context. The acquisition of language may be understood as being part of a general process of cognitive growth and therefore as abiding by principles that are not particular to language but of greater generality. Hierarchization may be just one such principle. Children may accordingly be expected to follow this acquisitional path in non-linguistic tasks. This was shown to be the case in an important study by Greenfield & Schneider (1977). They had children of different age groups build mobiles using plastic straws and connectors. To facilitate the task, the children saw in front of them a real mobile that they could copy. This mobile had a typical hierarchical and symmetrical structure. The dependent variable was not primarily the nature of the child's replica of the model but the way in which it was constructed. The hierarchical complexity of the construction process was measured by counting the number of straws that join in a connector and adding up the numbers for each mobile. Greenfield & Schneider's (1977) results indicated quite clearly that hierarchical complexity increased with age, with the major development taking place between the ages of 3 and 6 years old. Hence, one chief aspect of cognitive growth is the emergence of the ability to impose hierarchical structure on content units (plastic straws in this case). This notion will now be applied to the acquisition of language.

It is customary to distinguish between first (L1) and second (L2) language acquisition and this distinction will be respected here.[8] It is motivated by the problem that it is not known for sure how much of the L1 acquisition process has to be repeated in the acquisition of L2. Although it is beyond doubt that transfer from L1 is an L2 learning strategy, the extent of transfer is much less certain. Because it cannot be taken for granted that first and second language learners employ the same strategies in mastering this feat, it is necessary to investigate the acquisition process for the two populations separately.

7.2 FIRST LANGUAGE ACQUISITION

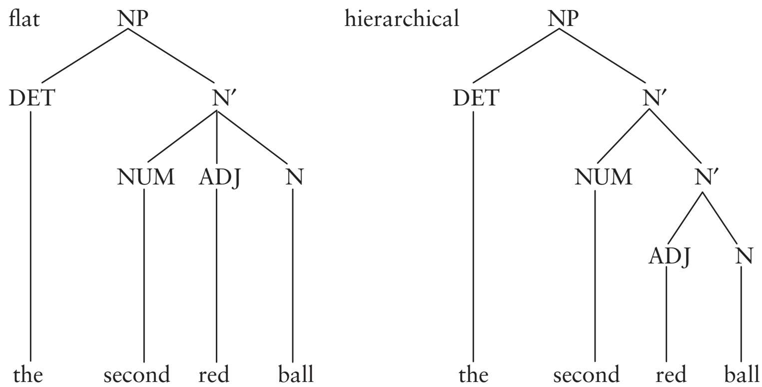
7.2.1 Syntax

As noted earlier, the Structural Theory shares many predictions with a general theory of increasing complexity. However, the Structural Theory cannot be completely subsumed under the complexity theory. The notion of complexity tends to be applied to representational rather than processing issues whereas the Structural Theory considers both. A core assumption of the latter is that the activation levels of structural nodes are gradually increased during the activation process. Since this is a change that does not affect the representational system, it is not covered by any simple version of the complexity theory.

It is well-known that children's first utterances are asyntactic in nature: They begin with single words. The first structural problems emerge at the two-word stage. Children tend to solve them by using a pivot, which usually occupies a fixed position, and combining it with a free morpheme (e.g., *allgone cookie*). The decision about hierarchicalness and branching direction does not have to be taken until the three-word stage. Here, the Structural Theory predicts that children begin with a flat structure and gradually move on to a hierarchical one (as in [4c]). Indeed, there is some support for this claim. Hill (1984) examined the relation between a child's NPs of two-, three-, and four-word length and found that the four-word utterances were combinations of two-word utterances and that the three-word utterances were reduced four-word utterances. For example, the child produced *another bear* and *mommy bear*, which were later concatenated to *another bear mommy bear*. Still later, the child deleted the first token of *bear* and produced *another mommy bear*. Hill argues that this process of concatenation and omission is only possible if the three-word utterances (and, it might be added, also the four-word utterances) have a flat rather than a hierarchical structure. Although she does not elaborate on this central point, she seems to assume that the merging of two constructions into one presupposes a position-neutral coding of the lexical constituents. This is only guaranteed in a flat model, which assigns the same syntactic status to all of them. Hill seems to further assume that the reduction of the flat four-word utterances cannot lead but to a flat three-word utterance. Although Hill's argument is of a rather indirect nature, her assumptions appear reasonable enough to serve as evidence for the hypothesis that children's early multi-word utterances at the NP level lack the hierarchical structure that is typical of adult language.

More direct evidence on the internal structure of NPs comes from Matthei (1982). He tested children's understanding of NPs in which the head is modified by a numeral and a descriptive adjective as in *the second red ball*. On the flat-structure hypothesis, the numeral is treated on a par with the adjective as would be the case in NPs with two descriptive adjectives such as *the big red ball*. On the hierarchical-structure hypothesis, however, the numeral modifies the adjective and the noun as one unit as it establishes a semantic contrast with *the first red ball*. In fact, this is the adult reading of the NP. The two structures are depicted in (5a) and (5b), respectively.

(5) a. b.



The Structural Theory predicts that unlike adults, children will assign a flat structure as in (5a) to these NPs. A comprehension task in which subjects had to pick out the target from among an array of pictured objects provided support for the flat-structure hypothesis. The claim would be then, that children move from a flat to a hierarchical representation in the course of the acquisition process.

We now move on to full sentences. A phenomenon that has received a great deal of attention over the past 20 years or so is subject–verb agreement. It is of particular interest in the present context as the factors underlying it may be linear or hierarchical. These factors can be neatly teased apart when there is a conflict between a singular and a plural noun. The two nouns can be either part of the subject-NP with postmodification as in (6) or distributed across a main and a relative clause, as in (7).

(6) The mechanic from the squalid quarters was awarded a medal.

(7) The mechanic who rescued the children was awarded a medal.

The important point to note here is that the linear distance between the singular and the plural noun is the same in the two sentences. Because of this identity, the linear model predicts an equal number of agreement errors for the two sentence types. By contrast, the hierarchical account predicts fewer errors in the (7)-type than in the (6)-type sentences. This is because the competing nouns are further away from each other in the hierarchical representation when they belong to different clauses than when they belong to the same phrase. Assuming that the flat-structure hypothesis is an adequate characterization of language acquisition, children may be predicted to make the same number of errors on both stimulus types whereas adult subjects are expected to make more errors on the (6)-type. This is precisely what Negro, Chanquoy, Fayol, & Louis-Sidney (2005) found for their French subjects.

Their results may therefore be taken as evidence for the progression from linear to hierarchical representations in child language.

As argued in the analysis of Old English syntax (section 4.2.4), the possibility of dislocating syntactic constituents is a function of sentential cohesiveness. As hierarchicalness entails a higher level of cohesiveness than flatness, dislocation is more likely in sentences with a flat than in those with a hierarchical structure. Thus, the Structural Theory predicts that dislocation occurs more frequently in child than in adult language. This seems to be the case. In a corpus of utterances made by two boys at the age of close to six, Favret (1984) found a large number of right-dislocations such as (8).

(8) It's good, the track.

Geluykens (2001) reports an occurrence of 45 right-dislocations in a 300,000 word sample comprising both spoken and written adult language. If we make the assumption that one dislocation is theoretically possible in a string of seven words on an average, this translates into a probability of 0.1% per sentence. Clearly, right dislocation is an uncommon phenomenon in adult English. We may tentatively conclude that right-dislocation occurs more frequently in child than in adult language. This difference lends credence to the claim that children's sentences have a flatter structure than adults' and therefore is in harmony with the predictions of the Structural Theory.

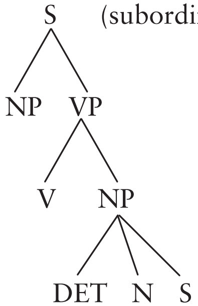
Turning to clause combining, we find a copious literature in support of the claim that juxtaposition precedes coordination, which in turn precedes subordination in ontogeny (see Bowerman, 1979 for a review). Children's first complex sentences lack any means of clause linkage. Although forming one planning unit, the clauses are simply juxtaposed. At the next stage, children use coordinating conjunctions such as *and*. In the final stage, subordinating conjunctions and complementizers appear. This developmental order is compatible with the view that the acquisition of syntax progresses in a series of steps that may each be characterized by an increase in the hierarchicalness of the structural representation. The juxtaposition of clauses is what would be expected under no structure at all. The coordination of clauses is congruent with a flat structure whereas subordination requires a higher degree of hierarchicalness.

An implication of this sequence of developmental stages is that children at the pre-subordination stage should treat complex sentences as comprising coordinated clauses. An illuminating case is provided by relative clauses such as the one in (9).

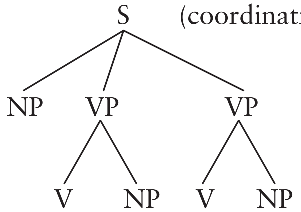
(9) The rabbit kisses the horse that jumps over the lion.

Being subordinated to its antecedent, the relative clause has *horse* as its subject in adult language. If, however, the relative clause is understood as a coordinated VP, its subject would be *the rabbit*. The two structural readings are given in (10) and (11), respectively.

(10) (subordination)



(11) (coordination)



Tavakolian (1981) looked into the question of how children interpret sentences like (9) for example and found that they identified *rabbit* as the subject of the second VP. She took this result as evidence for the claim that the relative clause is treated as a conjoined clause, which allows us to conclude that the syntactic representation is less hierarchical in the language of children than in that of adults.[9]

To summarize, all syntactic units from NPs to complex sentences are subject to the same developmental trend. They progress from less to more hierarchical through an increased number of structural nodes. On the basis of the available evidence, it was not possible to show that once these nodes have been created their activation levels gradually rise in the acquisition process. This will be done in the next section.

7.2.2 Phonology

As noted previously, the great advantage of phonology is that it allows one to catch a glimpse of the underlying representations by examining the interactions between the parts of the same planning unit. This is exactly the same strategy that was employed in the analysis of adult slips of the tongue. Unfortunately, this advantage is partly offset by the difficulty of disentangling problems with content units from effects of reduced structural representations.

Let us begin with the distance of interacting units. It was argued in the first chapter that structural representations open a planning window. A limited structural representation thus entails a small planning window. If children's representations are impoverished, they may be expected to have a small planning window and therefore produce interactions between nearby rather than distant units. This prediction is quite clearly borne out. Most syntagmatic processes in child language are usually restricted to the within-word domain (Stemberger, 1988). A paradigm example is consonant harmony, an early process whereby a phoneme is assimilated to another non-abutting one, as illustrated in (12).

(12) lilly. for: silly. (from Smith, 1973)

In Berg's (1992b) corpus of consonant harmonies, there is not a single case in which the word boundary was crossed. Other corpora (e.g., Donahue, 1986; Matthei, 1989) are less extreme in that they also include occasional cases of harmony operating across word boundaries. These results suggest that in the early phases of language development, phonological processing does not normally extend beyond the single word. This is a planning span that is significantly reduced compared to that of adults.

By the same reasoning, one would expect contextual speech errors in child language to involve units that are closer together than in adult slips of the tongue. However, the relevant findings are somewhat mixed. In fulfilment of this expectation, Jaeger (1992) found that 24.7% of the contextual slips she collected from a sizeable number of children were of the within-word type. This percentage is significantly higher than the 15.9% of within-word slips found in Stemberger's corpus of adult speech errors ($\chi^2(1) = 40.5$, $p < 0.001$). It is particularly noteworthy that Jaeger observed the highest rate of within-word slips (37%) in the earliest phases of the acquisition process (see also Jaeger, 2005). This is exactly as predicted by the Stuctural Theory.[10]

In contradistinction to Jaeger's data, Stemberger (1989), who amassed speech error evidence from two children, observed a higher ratio of between-word to within-word slips in child than in adult language. This difference between the corpora is puzzling. One speculation, noted by Stemberger himself, is that a certain percentage of the child data were misclassified as phonological-process errors although they were actually slips of the tongue. Because phonological-process errors do not normally cross word boundaries, this may have artificially decreased the rate of within-word slips.

The litmus test of phonological structure is the parallel syllable structure constraint that strongly encourages like-with-like interactions (see Chapter 5). At the very beginning of phonological acquisition, children may be expected to show no sensitivity to this constraint because their suprasegmental representations are assumed to be flat. In the midst of the acquisition process, they may be predicted to exhibit some sensitivity to it as their structural representations have reached a certain degree of hierarchicalness. This intermediate stage between no sensitivity and adult-like sensitivity is of major theoretical interest in that it evidences a hierarchical structure that is less hierarchical than in adult language (i.e., the gradual unfolding of structural representations during the acquisition process), as predicted by the Structural Theory. Unfortunately, it may be difficult to observe no sensitivity at all to the parallel syllable structure constraint because children begin with words consisting of CV syllables that cannot provide evidence for hierarchical structure (as there is nothing available but onset consonants). Closed syllables enter the stage at a later point where a minimum of structure has already been created. In fact, one might even go so far as to claim that

CVC syllables cannot be produced until the child has introduced a minimum degree of hierarchicalness into syllable structure because it is only by means of hierarchization that the child can reliably assign two consonants to different positions in the same syllable.

This is the probable reason for the fact that Jaeger (2005) did not observe a developmental trend in children's sensitivity to the parallel syllable structure constraint. Even the earliest segmental slips of the tongue of her subjects were constrained by positional similarity and this pattern did not change with age.

How does the parallel syllable structure constraint fare in phonological processes such as consonant harmony? If this constraint is in place, an onset cannot harmonize a coda and vice versa. However, such cases are anything but infrequent. Consider (13) and (14).

(13) [gik]. for: think. (from Smith, 1973)

(14) [gɔk]. for: cloth. (from Smith, 1973)

Both examples document the process of velar harmony. Whereas (13) illustrates the harmonization of the onset by the coda, the coda is harmonized by the onset in (14). (Differences in voicing may be ignored here.) Whether or not the parallel syllable structure constraint is violated in my corpus of one child's consonant harmonies depends on the length of the word. Whereas harmonized monosyllabic words cannot help violating it, most longer words involve the interaction of phonemes from homologous syllable positions. The critical factor is therefore the frequency of monosyllabic words undergoing harmony. As a matter of fact, 12% of the harmonized words are one syllable long. This is clearly less than in general language usage (and even more clearly less than in the child's lexicon) on the one hand but a non-negligible quantity on the other. Thus, it may be tentatively concluded that the parallel syllable structure constraint has begun to take effect and thereby discouraged the occurrence of harmony in monosyllabic words. However, it is still too weak to prevent such cases as successfully as a fully operative constraint would. The harmony data are therefore in line with the assumption that hierarchical structuring has begun but is still relatively underdeveloped at the time the child actively employed this process.

The second relevant phonological process is metathesis whereby two adjacent or non-adjacent phonemes from the same planning unit exchange places. Three pertinent examples are reported in (15)–(17). Note that metathesis is even more constrained than harmony in always having the word as its maximum domain.

(15) [bʌŋgɪ]. for: Gumby. (from Ingram, 1974)

(16) flim. for: film. (from Smith, 1973)

(17) [pʌk]. for: cup. (from Jaeger 1997)

Number (15) exemplifies a reversal between two onset consonants. In (16), the postvocalic lateral turns up prevocalically by swapping places with the abutting vowel. Case (17) involves the interaction of an onset and a coda consonant in the same syllable. Velleman (1996) claims that metatheses, in particular those violating the like-with-like constraint such as (16) and (17), occur more frequently in child than in adult phonologies without, however, performing a detailed comparison of the two populations. Provided the difference is real, it would find a ready explanation in the Structural Theory. Metatheses like (16) and (17) can arise in significant numbers only under a relatively flat structural representation, which blurs the distinction between prevocalic and postvocalic positions. As a result, the like-with-like constraint can be more easily violated. By contrast, these violations would normally be prevented in a fully hierarchical system.

This pattern apparently recurs in children's slips of the tongue. The consonantal segment and feature slips collected by Wijnen (1992) are composed of 33 (70%) like-with-like interactions and 14 (30%) violations of the like-with-like constraint. These percentages are remarkably similar to those of Jaeger (2005) who finds 72% non-violations versus 28% violations. It is not quite clear whether the violation rate in these corpora of children's slips of the tongue is significantly higher than that commonly reported for adult language. A statistical comparison with Stemberger's adult speech error data, in which violations make up 4.3%, reveals a significant difference ($\chi^2(1) = 12.7$, $p < 0.001$). However, no significant difference emerges when Wijnen's and Jaeger's child data are compared to Wijnen's and Jaeger's adult data, respectively. In Wijnen's case, the reliability of his results may be questioned because they are based on a mere 17 pertinent adult slips, which is clearly an insufficient data set. Jaeger's adult corpus is larger even though it is still relatively small (N = 253). Thus, the parallel syllable structure constraint provides only limited back-up for the hypothesis that the structural representation under which phonological slips of the tongue arise is less hierarchical in early child language than in adult language.

Stronger support for this conclusion comes from several other differences between children's and adults' slips of the tongue. Let us briefly discuss four effects. The first is the rate of single-segment omissions relative to non-omissions (i.e., substitutions and additions). As argued in Chapter 1, the production of any linguistic unit requires the creation of a slot and an association between the two. An omission error occurs when the association process fails because the appropriate slot has not amassed sufficient activation. Because slots are (the final) part of the structural representation, omission errors have a structural cause. We may accordingly predict a higher number of omissions in child than in adult slips. To examine this prediction, a comparison was carried out between Jaeger's (1992) child and Berg's (1988a) adult data. In fact, the prediction was borne out. A percentage of

9.8% omissions in child language accompanied 5.8% omissions in adult language, a statistically significant difference ($\chi^2(1) = 8.3$, $p < 0.01$). The elevated omission rate in child language may thus be attributed to an underdeveloped structural representation.

The second test was introduced in section 2.5.1.6 and goes by the name of the repeated phoneme effect. It captures the observation that the error probability increases if the source and error unit are flanked by an identical segment. This effect has been established for adult language and is typically explained by feedback from the segment to the syllable level and subsequent feedforward from the syllable to the segment level, which heightens the activation level of the competing phoneme in case of shared context (Dell, 1984). As the syllable belongs to the structural representation and as the latter is assumed not to be fully deployed, the repeated phoneme effect may be predicted to be weaker in child than in adult language. This is exactly the conclusion that Stemberger's (1989) data lead up to.

The third effect is closely related to the second. It concerns segment addition errors and the role of identical context. Stemberger (1989) showed for adult language that consonant additions next to another consonant have an increased likelihood of occurrence if the cluster thereby created is identical to the cluster in which the source element is located. Stemberger reports that cluster identity occurs in 51.3% of the blunderful utterances in adult language but only in 15.9% of the relevant child data. This is a statistically reliable difference that turns out as predicted.

The final effect concerns the ratio of anticipations and perseverations. In competent adult language there is a robust predominance of anticipatory over perseveratory slips. A common-sense explanation for this bias is that the processing system is more concerned with the future than the past (i.e., with preparing upcoming elements for output than dealing with already used elements; see Dell, Burger, & Svec, 1997). A closer look reveals that there is a fundamental difference between the underlying mechanisms of anticipations and perseverations. The former rely on the processing system's ability to plan ahead whereas the latter do not, as there is no reverse of advance planning (i.e., no backward planning). Changes in the extent of advance planning are accordingly predicted to influence the rate of anticipatory slips, though not that of perseveratory ones. Specifically, the lower the degree of advance planning, the less opportunity for anticipatory errors to occur. As argued in Chapter 1, the extent of advance planning is a function of the degree to which the structural representation has been unfolded. Because this capacity is hypothesized to be reduced in child language, the prediction is that the rate of anticipations relative to perseverations is lower in children's than in adults' slips.

An examination of the anticipation/perseveration ratio in various child slip collections yields mixed results. In harmony with the prediction, Stemberger's (1989) sample contains a significantly lower anticipation/perseveration ratio than his adult slip sample ($\chi^2(1) = 12.1$, $p < 0.001$).[11] This difference is even more pronounced if the adult corpus is compared to the earliest slips made by Stemberger's two children. A breakdown of their errors shows that perseverations outnumber anticipations up to age 4 and that the ratio reverses beyond that age. This reversal occurs much earlier in Jaeger's (2005) subjects who produce more perseverations than anticipations only in the earliest age group.[12] This pattern of results is clearly compatible with the claim that children gradually unfold their structural representations in the acquisition process.

However, other corpora are less favourable to the research hypothesis. Wijnen (1992) found no significant difference in the anticipation/perseveration ratio between his adult and child slips. Although this finding might be regarded as less reliable than Stemberger's owing to Wijnen's small corpora, the patterns in other error collections also conflict with Stemberger's. Both Jaeger (1992) and Gerken (1993) report a higher percentage of anticipations compared to perseverations in their child data. Without additional data collected under more controlled conditions, in particular a more accurate control of the age factor, it is difficult to reconcile this empirical conflict. As pointed out before, the problem of correct classification is particularly acute with this type of data. For the time being, the evidence from the anticipation rate for increasing hierarchicalness in language acquisition is inconclusive.

In summary, several strands of evidence have been discussed in support of the claim that children's structural representations grow in hierarchicalness over time. This hierarchization should be understood in a two-fold sense. In the first place, structural nodes have to be built up because children start out with no structural nodes at all. What they have at their disposal at the beginning of the acquisition process is only the word and phoneme nodes. The next developmental step involves the representation of syllabic information by means of structural nodes or, as Jaeger (2005) argues, syllable boundary nodes. Higher levels of phonological representation will be created subsequently. This sequence of events is exactly in accord with Jaeger's (2005, p. 183) claims.

In the second place, the availability of structural nodes has to be raised. It may be assumed that the creation of the major structural nodes takes place quickly and fairly early in phonological acquisition whereas the rise of their activation levels is a slow and gradual process that requires a good deal of exposure to, and use of, the language. During this process, children show some sensitivity to structural constraints but this sensitivity is reduced relative to the adult norm. However, the following qualification is necessary. In some cases, this sensitivity may be quite strong even in the early phases of the acquisition process.

7.3 SECOND LANGUAGE ACQUISITION

One of the two major differences between first and second language acquisition resides in the amount of experience that learners bring to these tasks.[13]

Whereas first language learners by definition are inexperienced, second language learners may draw, in one way or another, on their prior experience with their mother tongue. The critical question in the present context is the extent to which second language learners can capitalize on the structural representations that have been built up for the use of L1. The theory adumbrated in Chapter 1 leads us to expect that structural transfer from L1 to L2 will occur only on a limited scale. This is because the erection of structural nodes crucially depends on the content units and their linear order. Whether, let us say, a VP node is erected depends on the frequency of juxtaposing a verb and an object. Obviously, these patterns vary from language to language and have to be learned anew for L2. As a consequence, also the structural nodes and their characteristic activation values have to be learned anew. We would accordingly expect little transfer in the structural domain.

The prediction is, then, that as far as the structural aspects are concerned, second language acquisition will closely parallel first language acquisition. In both cases, children are expected to start out with a flat representation which gradually grows in hierarchicalness. This growth during the acquisition of L2 depends on two factors. One obviously is the degree to which L2 is susceptible of hierarchicalness, the other the degree of similarity between L1 and L2 in terms of their hierarchical structure.[14] It is unfortunate that in view of the severely limited availability of pertinent data, only a preliminary test of the above predictions is possible.

7.3.1 Syntax

A good part of the relevant literature on the acquisition of L2 syntax is centered around the dichotomy of the Full Competence Hypothesis (or Strong Continuity Hypothesis) versus the Weak Continuity Hypothesis. As its name implies, the former hypothesis denies any kind of maturation of the syntactic tree. Hierarchical structures are in place at the commencement of L2 acquisition (e.g., Hyams, 1992; Poeppel & Wexler, 1993). By contrast, the latter hypothesis holds that the only syntactic nodes that are available at the onset of L2 acquisition are VP and S (e.g., Vainikka & Young-Scholten, 1996a, 1996b). An intermediate position is taken by Dube (2000). This discussion is framed in the Principles and Parameters model, which draws a distinction between functional projections (i.e., IP, CP, DP) and lexical projections (i.e., VP and V, which correspond to S and VP, respectively, in more traditional models). Thus, the Weak Continuity Hypothesis assumes that only lexical projections undergo transfer from L1 to L2. It is worthy of note that the No Continuity Hypothesis plays no role at all in this debate. That is, the idea that neither functional nor lexical projections are transferred is not seriously considered. In fact, this is the hypothesis that emanates from the Structural Theory. It also needs stressing that the discussion in the L2 (and L1) literature is conceived of in a binary framework: A node is or is not transferred. Again, the hypothesis developed in the preceding section represents a significant departure from this philosophy.

A putative example of the Full Competence Hypothesis is the study of Cook (2003) who replicated Crain & Nakayama's (1987) analysis of question formation discussed in section 7.1 on L2 learners of English with diverse languages as their L1s. In a metalinguistic judgement task, she asked her subjects to evaluate the grammaticality or otherwise of questions in which the auxiliary had been moved out of the relative clause, as in (18), or fronted within the main clause.

(18) *Is Joe is the student who late?

Quite unsurprisingly, Cook found that most of her subjects rejected sentences such as (18). Her logic in interpreting this result echoes that of Crain & Nakayama. Because the learners have not heard such sentences in their ambient languages, they must have recourse to innate knowledge telling them that these sentences are ungrammatical. More precisely, they activate the principle of structure dependence, which these sentences violate, and on this basis reject them. As stated before, I find this argument singularly unconvincing. It may be much more plausibly argued that Cook's subjects rejected these patterns on the basis of their actual experience that they had not come across them before. That previous linguistic experience does play a role in subjects' evaluations is amply demonstrated by the finding that learners with L1s that allow movement in question formation exhibited a lower rejection rate than those with L1s that do not.[15] Thus, Cook's results argue neither for structure dependence as a principle underlying subjects' grammaticality judgements nor for its innateness.

For young children who begin to learn L2 soon after the onset of L1, the picture is quite clear. There is no evidence for either VP or S. In a detailed study of the acquisition of English as L2 by speakers of German as the L1, Wode (1981) found a great deal of parallelism between first and second language acquisition. Specifically, his subjects started with one- and two-word utterances in which either the S node or both the S and the VP node were missing. Refer to (19) and (20) from Wode (1981).

(19) one strike. (baseball)

(20) no play baseball.

As (20) lacks an overt subject, there is no basis for assigning it the status of a sentence.[16] Similarly, the production of a noun like *strike* for example in (19) does not justify the postulation of a VP.

However, the reliability of these data may be questioned. Given the young age of Wode's subjects, it is difficult to rule out the objection that they lacked structural nodes in their L2 simply because they had not yet built up these nodes in their L1. Although this objection does not salvage any hypothesis regarding the innateness of structural categories, it does salvage the transfer hypothesis in both its weak and its strong version. It is necessary therefore to take a look at other learners in which the establishment of structural nodes for L1 is not in doubt.

An appropriate testing ground is foreigner talk, the language that adult speakers are in the process of acquiring in a naturalistic, untutored context. This learning situation is not unlike that of the children discussed previously and in fact, what we find is utterance types that are very similar to (19) and (20). A great deal of research was done on the language of immigrant workers who had come to Germany without any knowledge of German. Whatever their first language, their L2 utterances were found to exhibit a similar structural typology. Even those who had worked in the country for several years frequently used what we may loosely call a telegraphic style. Three examples, taken from Clyne (1968), are provided below. The reconstructed full meaning is given in double quotes.

(21) Nett. 'nice' "This is nice."

(22) Nachher Griechenland. 'later Greece'
"I will go to Greece later."

(23) Hier alles saubermachen. 'here everything to clean'
"I (have to) clean everything here."

Whereas neither (21) nor (22) contain a verb, (23) has no subject. Therefore, (21) and (22) may be claimed to lack a VP and (23) an S node.

Meisel (1975) cautioned that the aforementioned utterances might also have been produced by native speakers on certain occasions. As Clyne (1968) provides only little pragmatic context for these utterances, this possibility cannot be completely ruled out. However, it is extremely unlikely that all the patterns of foreigner talk can be reduced to simple imitations of native speech. If that was so, foreigner talk would not have the grammatically deviant characteristics that it generally has. It is much more likely therefore that the simplified forms in (21)–(23) are truly reductions that possess an impoverished syntactic structure. Or, to put it the other way around, because the speakers have not mastered the relevant structural nodes, their L2 output is syntactically deficient. This is so despite the fact that the mastery of the corresponding L1 nodes is undisputed.

Summing up, there is evidence to suggest that syntactic transfer from L1 does not automatically take place even in those cases where L1 and L2 share the same structural nodes. This is true of both child and adult learners, so even the full mastery of the same nodes in L1 is no guarantee for successful transfer. On the theory developed here, this is hardly surprising as the deployment of structural nodes depends on prior experience with L2 content units. This is not the kind of information that can be taken over from the native language. Thus, it may be argued that the syntactic representation in beginning (and even more advanced) L2 speech is relatively flat.

7.3.2 Phonology

The analysis of structural representations in phonology can probe more deeply and stands on firmer ground than was possible in the syntactic arena because of the availability of more detailed studies, in particular that of Poulisse (1999). Basically, the nature of suprasegmental representations in L2 can be addressed using the same data types as in the investigation of L1. These are mainly phonological processes and phonological slips of the tongue. Let us note at the outset that consonant harmony, which is of a syntagmatic nature and therefore has a bearing on structural issues seems to be largely absent in L2 acquisition. If it occurs at all, it is probably too transient to be distinguishable from true slips of the tongue. The ensuing analysis will therefore be restricted to metathesis that appears to be a more common process in L2 phonology.

The general prediction for metathesis in L2 acquisition is the same as for L1 (see section 7.2.2). Due to the weakness of the structural representation whose function it is to individualize the content units and thereby to keep them distinct in processing, L2 learners are expected to produce a higher rate of metatheses than competent adult speakers. The available data clearly bear out this prediction. Although, as in L1 research, a direct comparison between L2 learners and competent native speakers has not been conducted, metathesis as a phonological process in adult language (as well as in adult corpora of slips of the tongue) is such an extremely uncommon phenomenon that even a low number of reported cases in learner language suffices to prove the point. In fact, as Kløve & Young-Scholten (2001) argue, metathesis in L2 acquisition occurs on a par with other processes such as deletion and epenthesis. It can be found in different L2s, across a variety of language learners and involves both consonant–consonant and consonant–vowel sequences. An example of the former type is given in (24), one of the latter type in (25). Both were uttered by Cantonese speakers learning Norwegian.

(24) [vist]. for: vits 'joke' (from Kløve & Young-Scholten, 2001)

(25) [tu:r]. for: [tru:] 'belief' (from Kløve & Young-Scholten, 2001)

The frequency of these cases varies considerably from task to task and from language to language but is clearly higher than in competent adult language. Kløve & Young-Scholten argue persuasively that the structure of the L1 syllable is a major factor determining the frequency of metathesis. However, interference from L1 is not the only possible account. The L2 data can also be taken to mean that the learners have not yet mastered the linear order of the phonemes of a word and therefore have not yet established the correct association between slots and fillers. This problem may be presumed to spring from a weak structural representation which does not sufficiently constrain the association process and therefore allows incorrect associations.

We will now proceed to an analysis of non-process-oriented data. Two corpora of slips of the tongue in L2 acquisition have been reported on in the pertinent literature, both from native speakers of Dutch acquiring English as their second language. James (1984) focused on a single category that is highly relevant in the present context—syntagmatic phoneme errors (N = 418). Poulisse's (1999) corpus includes all error types (N = 2000). Of the 498 phoneme slips, more than half are of the contextual type. These numbers are large enough to perform statistical tests on them. The subjects in the two studies are of various levels of proficiency, ranging from near-beginning to fairly advanced students. For most of her data, Poulisse presents a very valuable breakdown by proficiency level.

The general prediction for the L2 data is clear. Because their suprasegmental representations are expected to be flatter than those of fully competent language users, L2 learners will exhibit a reduced sensitivity to structural effects. This prediction will be examined in the following series of tests.

We will begin with a problem that has a time-honoured tradition in linguistic research—the phonological status of affricates. On the basis of her speech error data from competent native speakers, Fromkin (1971) argued for the monophonematic rather than the biphonematic analysis of English affricates. In all her examples, affricates behaved like single units (i.e., their constituents were never individually involved in the malfunction, as shown in [26]).

(26) an ex [tatʃ nap] tennis player. for: an ex to*p* no*tch* tennis player. (from Fromkin, 1971)

As can be seen, the constituents of the affricate /tʃ/ are simultaneously dislocated. However, with the advent of multi-tiered representations in theoretical phonology, the monophonematic linear analysis turned obsolete. It was superseded by a two-tiered conception in which the two phonemic constituents on the melody tier were associated with a single consonantal slot on the skeleton tier (Clements & Keyser, 1983; see section 1.4). This theoretical innovation amounts to the conjecture that the biphonematic rather than the monophonematic interpretation is the correct one. However, such a claim can only go through if it receives empirical support. In particular, speech error data should also include cases of affricate split-up. Indeed, such cases do occur, though at an extremely low frequency. A pertinent example from my German error corpus appears in (27). It involves the German affricate /ts/, which is highly similar to English /tʃ/ in its behaviour.

(27) den Scheitel tschiehen— ziehen.
[ʃaɪtəl tʃi:n— tsi:n]
'to make a parting'

No. (27) documents a split-up of the affricate /ts/. Its second constituent /s/ is supplanted by the word onset consonant /ʃ/ from *Scheitel* whereas its first constituent is left untouched.[17] This error is only possible if /ts/ is assigned a biphonematic value. Hence, both the typical and the exceptional cases are captured by the assumption that affricates are highly cohesive biphonematic units. Their high degree of cohesion is brought about by their association with a single position at the CV tier (or slot level). This analysis accounts for the function of affricates in fully developed adult phonologies.

For learner phonology, the Structural Theory allows us to make the following prediction. Cohesiveness is not only a function of the number of slots to which content units are linked but also of the degree of co-activation of the phonemes, which is regulated by the superordinate structural unit. As the slot level is part of the structural representation, cohesiveness manifests itself as a structural issue. Thus, an underdeveloped structural representation leads us to expect a reduced cohesiveness of affricates during the acquisition process.

Dutch is an apposite language in which to test this prediction. As it lacks /tʃ/ and /dʒ/ (Booij, 1995), their acquisition in L2 cannot be influenced by transfer from L1. In point of fact, Poulisse's data show that her L2 learners split the English affricates /tʃ/ and /dʒ/ much more frequently than do native speakers. Consider (28) and (29).

(28) *ch*ea*ch*er. for: *t*eacher. (from Poulisse, 1999)

(29) ea*sh*. for: ea*ch*. (from Poulisse, 1999)

According to Poulisse, the affricate /tʃ/ in (28) was created by the additive anticipation of /ʃ/. The opposite process happened in (29) where the first part of the affricate was omitted. These cases would be hard to explain if affricates were indivisible units. Poulisse argues that these slips are unlikely to be substitution errors because if they were, affricates would be expected regularly to interact with other phonemes. This, however, is not so. They almost always interact with /t/ or /d/ in her data.

It may be inferred that the cohesiveness of affricates is gradually increased in L2 acquisition until it reaches the adult norm. In line with this explanation, Poulisse states that almost all errors on affricates were made by the less advanced learners. In this account, the biphonematic analysis of affricates is true of both learner and adult language. The only developmental change that assumedly takes place is an increase in cohesiveness. Whether this involves a change from a two-slot to a one-slot representation for affricates, as Poulisse argues, cannot as yet be determined. Such a change is possible though not necessary because the degree of cohesion of affricates in the early phases of L2 acquisition is currently unknown. Only if their cohesiveness is extremely low at the beginning can Poulisse's claim as to the cluster-like nature of early affricates be upheld. In either case, the change is a structural one, so the prediction of the Structural Theory is fulfilled.

A closely related prediction pertains to consonant clusters. Their degree of cohesion is expectedly lower in learner than in adult language. In fact, Poulisse reports a low number of cluster slips in her data (N = 13). Compared to the number of single-consonant substitutions (N = 197), the cluster rate amounts to 6.2%. In Nooteboom's (1969) corpus of L1 adult slips in Dutch, this percentage is significantly higher (16.3%): $\chi^2(1) = 12.2$, $p < 0.001$. We may therefore conclude that consonant clusters display a greater degree of cohesion in adult language than in L2 acquisition, again in fulfilment of the prediction of the Structural Theory.

A similar logic applies to rimes. In a relatively flat, right-branching syllable structure, nucleus-coda sequences have a low cohesiveness. Therefore, rime slips are rather unlikely. During language acquisition, rime errors are accordingly expected to occur less frequently than in adult language. The empirical data support this prediction. While Poulisse has 7 rime errors in her corpus of 2000 learner slips, Stemberger (1983a) has as many as 53 in his sample of 6300 adult errors. If we ignore the fact that two different languages are at issue here, this difference turns out to be statistically significant ($\chi^2(1) = 5.1$, $p < 0.025$). It is worth the while to add that there are no body slips in Poulisse's data. In conjunction with the several rime errors, this is a clear indication that the syllable has begun to assume a hierarchical right-branching structure in the acquisition of English as a second language.

The following test provides an opportunity of directly comparing L1 and L2 acquisition. Section 7.2.2 reported on the absence of the repeated phoneme effect in the acquisition of English as the mother tongue. For exactly the same reasons that were given earlier, the repeated phoneme effect is predicted to be missing or at least weaker in learner than adult language. Again, the prediction of the Structural Theory matches the empirical patterns. Poulisse reports a rate of 16.8% consonant slips that are flanked by identical phonemes. As it turns out, this error rate is higher, though not significantly higher than Dell's (1984) chance estimate of 10% ($\chi^2(1) = 2.3$, $p > 0.1$). So if the repeated phoneme effect exists at all in L2, it is fairly weak. In any case, it is about as weak as in L1 and clearly weaker than in competent adult language.

The anticipation/perseveration ratio was also discussed in connection with L1 acquisition. The basic idea was that different error mechanisms underlie the generation of anticipations and perseverations and that anticipations depend on the size of the planning window in a way that perseverations do not. Because this size is limited in a reduced structural representation, L2 learners may be predicted to produce relatively fewer anticipations and therefore to have a lower anticipation/perseveration ratio. Poulisse's data confirm this prediction. She found an almost balanced percentage of anticipations (53.3%) and perseverations (46.7%) among the contextual substitutions. This result is significantly different from both Nooteboom's (1969) L1 adult data from Dutch (anticipations: 78.3%, perseverations: 21.7%; $\chi^2(1) = 31.1$, $p < 0.001$) and Stemberger's (1989) L1 adult data from English (anticipations: 71.9%, perseverations: 28.1%; $\chi^2(1) = 5.9$, $p < 0.02$). As predicted, the anticipation/perseveration ratio is lower in learner English than in native English (and native Dutch). The expected interaction between linguistic competence and the anticipation/perseveration ratio receives further amplification from a breakdown of the data by proficiency of learner group. In Poulisse's corpus, the anticipation/perseveration ratio increases with proficiency level.

While the preceding analyses were restricted to substitution errors, the following test compares the frequency of the major descriptive categories. As argued in section 7.2.2, omission errors are predicted to be more frequent in language acquisition than in competent adult language because part of their origin lies in a weak structural representation, in particular the slot level. Regarding the frequency of additions, the Structural Theory makes two contrary predictions. On the one hand, this category expectedly shows a lowered error rate in the case of a weak structural representation because additions require an additional slot that would be hard to generate given that even the intended slots are not sufficiently activated. On the other hand, the quantity tier is responsible for generating the intended number of slots. If this function cannot be properly fulfilled, slots may not only be undergenerated but also overgenerated. This is because the structural representation may be too weak to *prevent* the creation of an unintended slot. Consider as an example the competition between an intended single consonant and an unintended cluster slot (i.e., the typical situation in which an addition error would occur). If the single-consonant slot is strongly activated, it will keep the activation level of its competitor, the cluster slot, low and therefore reduce the likelihood of an addition error; if, however, the single-consonant slot is only weakly activated (due to an underdeveloped structural representation), it cannot suppress its competitors as successfully and therefore the cluster node stands a good chance of outstripping the target slot, in which case an addition error would arise. Note that the strength of the inadvertent cluster slot is multiply determined. It is not only a function of the weakness of the target slot but also of the strength of appropriate content units, which are activated in parallel and therefore almost always available.

Table 7.1 compares the frequency of the three major descriptive error categories in Poulisse's learner corpus and Berg's adult corpus.

A first observation to make about Table 7.1 is the almost equal frequency of substitutions in the two corpora. Note in this connection that single-segment substitutions are assumed to be unaffected by structural constraints. Hence, the difference predictably lies almost exclusively in the rate of additions and omissions. As revealed by the χ^2 test, omissions occur significantly

Table 7.1 Frequency of Substitutions, Additions, and Omissions in Learner and Adult Language

Category	*Substitutions*	*Additions*	*Omissions*	*Total*
Learner corpus	374 (77.8%)	40 (8.3%)	67 (13.9%)	481
Adult corpus	1094 (79.4%)	203 (14.7%)	80 (5.8%)	1377

more often than non-omissions in Poulisse's data as compared to Berg's ($\chi^2(1) = 32.3$, $p < 0.001$). By contrast, additions occur significantly less often than non-additions in the learner error corpus than in the adult error corpus ($\chi^2(1) = 13.0$, $p < 0.001$).

Both the elevated rate of omissions and the lowered rate of additions are as predicted by the Structural Theory. Both empirical effects are due to an insufficient activation level of slots.

However, an apparent inconsistency between Poulisse's L2 data and Jaeger's (1992) L1 data (see section 7.2.2) cannot be overlooked. Whereas the L2 data show a decrease, the L1 data show an increase in the addition rate. This difference is statistically reliable ($\chi^2(1) = 25.2$, $p < 0.001$). It is highly remarkable that this empirical picture evinces the same ambivalence as the theoretical model, which predicts both effects. This suggests that both of the contrary accounts of the change of the addition rate under a weak structural representation may be correct.

The preceding analysis precipitates the question of when a weak structural representation entails an increase or a decrease in addition errors. The few available data might lead one to believe that an increase is characteristic of L1 acquisition whereas a decrease is typical of L2 acquisition. Only a considerably richer data base could help us establish whether this hypothesis is viable. In any event, such a claim would only scratch the surface because it does not identify the specific differences between L1 and L2 acquisition that might be held accountable for the different addition rates.

The following test focuses on the frequency of contextual versus non-contextual slips. Non-contextual errors require no planning span whatsoever. All they need is a competitor to the target in the linguistic system. In stark contrast, contextual errors are heavily dependent on advance planning. A longer planning span raises the number of potential competitors and therefore the probability of error. Conversely, a lower rate of contextual errors is expected in a system with a limited look-ahead capacity. As a weak structural representation limits the planning window, learners' slips may be predicted to show a lower contextual/non-contextual error ratio than adult slips. This is indeed the case. Poulisse notes that contextual slips have a share of 52.2% among all phonological errors whereas Stemberger (1989) reports a much higher proportion of 85.1%. This difference is hugely significant ($\chi^2(1) = 255.0$, $p < 0.001$). We may conclude that part of the explanation for the low rate of contextual errors in learner language is a reduced planning span, which in turn results from a weak structural representation.[18]

The next issue to be taken up is the word and/or syllable onset effect, which captures the predominance of onset over coda slips. Its bearing on the nature of suprasegmental representations was explained in Chapter 5. To recap briefly, in a hierarchical right-branching word or syllable structure, there is a major asymmetry between the onset and the (super)rime. As the onset is structurally isolated and usually accommodates a single consonant, it is particularly error-prone. The lesser the hierarchy, the lesser the onset/coda asymmetry and the lesser the preponderance of onset slips. From this follows the prediction that, if second-language learners have a weak structural representation, they will make relatively fewer onset errors than competent adults.

Again, Poulisse's data are in accord with this prediction. There are 106 (45.5%) word-initial or 149 (63.9%) word- or syllable-initial slips among a total of 233 single-consonant (and feature) substitutions. Discarding all ambisyllabic as well as cross-positional slips, we find 80.8% word- or syllable-onset errors in Stemberger's (1989) adult corpus. The rate of initial errors proves to be higher in the adult than in the learner data ($\chi^2(1) = 31.1$, $p < 0.001$). This finding lends further support to the claim that the suprasegmental representation of L2 learners is less hierarchical than that of fully competent adults.

A corollary of this analysis is the prediction that the rate of onset errors should rise as the learners' command of the foreign language improves. Poulisse's materials are equivocal on this score. Whereas the percentage of syllable-initial slips increases, that of word-initial slips decreases with proficiency level. The increase in the former category is about the size of the decrease in the latter, such that the rate of coda errors remains relatively constant across proficiency levels. It is not clear how to interpret these trends. It might be that the data are marred by proficiency-related variations in the structure of the lexicon. Poulisse speculates that the proportion of monosyllabic words may be higher in the less than in the more advanced learners. This might explain why the rate of syllable-onset slips increases with linguistic competence, but it fails to explain the decrease in word-onset slips.

The final analysis revolves around the parallel syllable structure constraint, perhaps the most important window on structural representations. Its logic need hardly be repeated. The better it is observed, the more hierarchical the structural representation. Processing systems with a weakly hierarchical representation like learners' are therefore expected to exhibit a reduced sensitivity to the parallel syllable structure constraint. Also this prediction is borne out by the empirical data. Stemberger (1985) records 4.3% violations in his adult sample, which is significantly less than the 22.6% reported by Poulisse ($\chi^2(1) = 69.0$, $p < 0.001$). This relatively high incidence of violations of the like-with-like constraint is cemented by a similar trend in James's (1984) corpus of L2 slips. In particular, he notes the frequent occurrence of within-syllable slips, which of necessity ignore the parallel syllable structure constraint. A case in point is presented in (30) in which the coda consonant is anticipated into the onset of the same syllable.

(30) [θaʊθ]. for: south. (from James, 1984)

It is also worthy of note that this slip type involves a minimum distance between error and source unit. Its frequency in James's collection is not surprising in the light of the limited planning span that has been assumed to characterize learners' processing systems.

By way of summary, it is striking that all tests of the weak-structure hypothesis proved to be positive. There is strong support for the claim that an underdeveloped suprasegmental representation typifies the output of second-language learners. This conclusion is not vitiated by some of Poulisse's longitudinal data, which suggest that the development from an underdeveloped to a fully developed structural representation may not be linear. As the beginning and end points are clear, there is no way around the assumption that L2 learning is characterized by an increase in hierarchicalness. It should also be noted that the comparison of different error corpora is not always a straightforward matter (in particular if they come from different languages) because individual researchers tend to focus on somewhat different aspects and may adopt slightly different strategies of error classification. However, this probably does not undermine the overall conclusion as almost all statistical tests yielded very high χ^2 values. Nevertheless, it would certainly be desirable to elicit experimental data from second-language learners.

7.4 CONCLUSION

The primary result of this chapter is that language acquisition can be profitably described in terms of a gradual unfolding of structural representations. Learners start out with little structure and progress by creating new structural units, organizing them hierarchically, and increasing their activation levels. These characteristics are assumed to hold for all levels of linguistic analysis even though the relevant phenomena are not equally easy to observe at the different levels. Phonology affords a privileged vantage point through the study of the interactions of concurrently planned units. Such interactions occur less often at the lexico-syntactic level at which the units involved have to travel longer distances. This uncommonness follows from the requirement of a larger planning window than is possible for learners at an early stage.

Another important result of the present chapter is the substantial similarity of the structural constraints to which first and second language acquisition are subject. L2 learners go through virtually the same developmental stages as L1 learners. As far as the structural side is concerned, they are apparently unable to capitalize upon their previous language learning experience. In other words, transfer from L1 is not a major option for them. This might seem especially surprising in the area of phonological acquisition. As the word and syllable structure of Dutch and English are not so dissimilar, one might expect transfer to play a pivotal role. The reason that it does not lies in the dependence of the structural units on the content units. Because the content units have to be newly learnt, both in terms of phonemes that do not exist in L1 and their combinatorial possibilities, structural units cannot be blindly borrowed from L1. Their creation cannot precede that of content units. Furthermore, the development of structural units is a slow process as learners take a long time to work out the transitional probabilities that are specific to L2. These particularities of the target language severely limit the possibility of transfer from L1. According to the Structural Theory, basically the same situation obtains in syntax although this could not be demonstrated as convincingly as for phonology. Note that this conclusion is entirely compatible with the assumption that the greater the structural commonalities between L1 and L2, the greater the opportunity for transfer.

8 How Structure Breaks Down

8.1 INTRODUCTION

This chapter in many ways resembles Chapter 7. This is mainly due to the parallels between learner language and aphasic language as two manifestations of less than competent language use. The general prediction of the Structural Theory regarding language breakdown is the same as for language acquisition: Aphasic output is predicted to be characterized by a lowered sensitivity to structural constraints. That is to say, brain damage or any other kind of neurological disorder is expected to reduce the capacity to unfold the structural representation, which is consequently flatter than in so-called normal language. The underlying assumption here is that the activation process is disrupted in aphasia (e.g., Ellis & Young, 1988; Haarmann & Kolk, 1991; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997). If structural units cannot be properly activated, the structural representation will be impoverished and therefore relatively flat.

The same general prediction for language acquisition and breakdown may seduce one to view the one process as the reverse of the other, much in the spirit of Jakobson (1941). Indeed, the Structural Theory assumes a fundamental similarity between the two and even a return in aphasia to a state that is typically found in acquisition. The Structural Theory cannot help but predict a similarity between the mental representations of aphasics and learners. As both populations represent departures from a norm that can only be undershot, their psycholinguistic systems should lack the hierarchicalness that is characteristic of linguistically competent speakers. However, a focus on underlying similarities in no way denies the existence of vast disparities ranging from experience with language use to compensatory strategies. A disrupted system that used to function perfectly is certainly not the same as a developing system that had never reached the ideal state before.

A cornerstone of the Structural Theory is the differential ease of access of content and structural units. This psycholinguistic principle leads to the prediction that structural units will generally be more severely disrupted in aphasia than content units. It is plausible to argue that tasks that are difficult for healthy adults (in relative terms) will be even more difficult for aphasics. This issue is taken up in section 8.5.

As is well-known, aphasia is not a uniform phenomenon. On a priori grounds, all aphasic syndromes are equally germane and deserve to be taken into consideration, as the content–structure distinction is assumed to be a general property of the human processing device. This nourishes the bold expectation that the structural representations are disrupted in all, or at least the frequent, types of aphasia.

As in Chapter 7, (derivational) morphology will be neglected mainly because the production of trimorphemic words tends to exceed aphasics' linguistic abilities and also because little work has been published in this area. Hence, the focus will be on syntax and phonology. The latter will be given special emphasis for three reasons. One is that phonology grants a deeper insight into the nature of less-than-fully hierarchical structural representations than syntax. This parallels the situation encountered in L1 and L2 learners. The second reason is that error patterns appear to be less syndrome-specific in phonology than in syntax. Although it is not disputed that the major aphasic syndromes lead to phonetic-phonological errors that tend to occur at somewhat different stages in the production process (Kohn, 1988), the similarities among these errors warrant subjecting them to the same tests. This will allow us to draw fairly general conclusions about aphasic language. The final reason is that the predictions of the Structural Theory are less remarkable for syntax than for phonology. Because syntax is structure, the theory predicts that syntax is particularly vulnerable in aphasia. This prediction is no different from that of the syntactic-deficit theory, which has been well researched and met with general acceptance. A positive result would therefore provide only weak evidence for the Structural Theory as such, because everything that is true for the new theory is also true for the old one. This does not mean, however, that the two theories are identical. The Structural Theory is much more embracing than the syntactic-deficit theory insofar as it covers all structural aspects of language, not just syntax. In contrast, the notion of structure has been less often applied to phonological deficits. It is here that the Structural Theory can be put to a less obvious test and, in case of a positive outcome, demonstrate its generality and hence its superiority to other theories.

The fact that structure plays a role at several linguistic levels raises the possibility that one cause (i.e., a structural problem) may be responsible for deficits at different levels. It is important to realize that this is not a necessary implication of the Structural Theory for the following two reasons. The first has to do with the nature of the empirical data under examination in this chapter. There is no guarantee that syntactic and phonological structure is subserved by exactly the same neurological tissue. Given the real possibility that different areas of the brain may be implicated, it is almost to be expected that syntactic structure may be lesioned independently of phonological structure. The second reason is more psycholinguistic in nature. In local connectionist (as well as linguistic) models there are different nodes for syntactic and phonological structure. For instance, there is hardly any way in which a VP and a rime node can be said to be related to each other. They are as distinct as, let us say, a phoneme and a word node. In contrast, the Structural Theory, although recognizing the distinctness of the VP and the rime node, highlights the fact that both these nodes are structural in nature and therefore similarly susceptible to a structural processing deficit. Hence, to the extent that the structural representations at different levels overlap in an abstract functional sense[1] and/or are subserved by similar neurological mechanisms, the Structural Theory predicts a nonindependence between structural deficits in syntax and phonology. More particularly, the size of the planning window in syntax might be expected to co-vary with the size of the planning window in phonology. We examine this interaction in section 8.4.

As in the case of language acquisition, an important break with most previous modelling efforts in aphasiology lies in the rejection of the binary approach. There seems to be a general consensus, especially among students of agrammatism, that language breakdown involves the loss (or preservation) of linguistic categories (see discussion to follow). A category is available or unavailable. No intermediate stages are possible. The adoption of binarity is surprising in the light of the enormous variability that is typical of aphasic language. Be that as it may, the prediction of the Structural Theory is that pathological speech is characterized by a reduced availability of structural nodes. That is to say, the nodes as such are not normally destroyed (except for the most severe forms of aphasia) but only a limited amount of activation accumulates on them. This is what leads to a weakly hierarchical representation.

The focus on impairments of hierarchical structure in language raises a more general issue. If we expect patients to have difficulty erecting a structural representation for language and if hierarchical organization is a general property of action systems (as argued by Miller, Galanter, & Pribham, 1960; and Norman, 1981), then we may also expect aphasics to show deficits in erecting hierarchical structure in non-linguistic domains. As will be recalled, exactly the same prediction was made for first language acquisition. Grossman (1980) addressed this issue by testing aphasics on a variant of Greenfield & Schneider's (1977) mobile construction experiment. He examined the constructional abilities of five populations: Broca's aphasics, Wernicke's aphasics, non-aphasic patients with damage to the right hemisphere, Korsakoff's patients, and normal controls. Their task was to draw from memory as well as to copy hierarchical trees by means of tongue depressors. Grossman stated that only Broca's aphasics constructed trees that were significantly less hierarchical than those of the control subjects. Instead of a hierarchical plan, Broca's aphasics employed a linear, chain-like strategy in the making of their constructions. However, as Grossman's Figure 4 shows, all pathological populations produced constructions that had a lower measure of hierarchicalness than those of the controls. In particular, whereas the control subjects' constructions were fully hierarchical (100%), Wernicke's aphasics scored slightly below 80% hierarchicalness. Taken at face value, this would seem to be an appreciable difference, but apparently it was not large enough to reach standard levels of significance. It may be concluded from Grossman's study that both aphasic groups exhibited a reduction in their ability to construct hierarchical diagrams as compared to normals even though this ability is more strongly impaired in Broca's than in Wernicke's aphasics. As Broca's and Wernicke's aphasia constitute major syndromes of language breakdown, we may tentatively argue that aphasic patients in general suffer a deficit in the hierarchical organization of non-linguistic action. At the same time, the severity of the deficit varies with type of aphasia.

This chapter is organized as follows. A basic distinction will be made between childhood and adulthood aphasia. The first two sections look into syntactic and phonological aspects of aphasia in adults, respectively. The third briefly introduces childhood aphasia, and the fourth is concerned with a possible link between syntactic and phonological disturbances.

8.2 ADULTHOOD APHASIA

8.2.1 Syntax

As, according to the Structural Theory, a syntactic disorder is a structural deficit, a disruption of the syntactic component may be predicted to figure prominently among aphasics. This is in fact the case. Huber, Poeck, & Weniger (1997) present a quantitative analysis of 528 aphasic patients. Of the six commonly recognized types of aphasia, the four most frequent ones are: global (35.8%), Broca's (19.3%), Wernicke's (17.6%), and anomic (14.4%). The two most frequent syndromes, making up more than half of all cases, unquestionably affect syntax. One of the defining features of Broca's aphasia is agrammatism. It is clearly the majority view in aphasiology that the underlying cause of Broca's aphasia is a syntactic deficit (e.g., Caramazza & Zurif, 1976; Berndt & Caramazza, 1980; Saffran, Schwartz, & Marin, 1980; de Bleser & Bayer, 1988; Ouhalla, 1993).[2] Also the output of global aphasics is clearly syntactically disrupted.

The analysis of Wernicke's aphasia in terms of a syntactic impairment requires a closer look. Although it is generally agreed that syntax is impaired in Wernicke's aphasia, aphasiologists are divided over the underlying mechanisms of this deficit. Stockert & Bader (1976) claim that the syntactic component is basically intact (see also Butterworth & Howard, 1987) and that the locus of the impairment is the lexicon. In this view, the syntactic disorder is "only" a reaction to the lexical disturbance. Radford et al. (1999) claim that this is the received wisdom in aphasiological research. However, they clearly overstate their case. Bates, Friederici, Wulfeck, & Juarez (1988) report that both Broca's and Wernicke's patients show a reduction of syntactic complexity as measured by the ratio of main to subordinate clauses relative to control subjects. A comprehension experiment conducted by Kolk & Friederici (1985) in which the understanding of reversible SVO sentences was tested revealed that Wernicke's aphasics have difficulty assigning functional roles to words on the basis of syntactic clues alone. These results lend credence to Heeschen's (1985) claim that syntax is not secondarily but primarily disrupted in the paragrammatic output of Wernicke's aphasics. This hypothesis is buttressed by theoretical arguments. It is unlikely that all syntactic problems can be put down to a lexical deficit. If this were the case, syntax could be reduced to the lexicon. However, although there is an undeniable connection between, let us say, the argument structure of verbs and syntax, other parts of the lexicon such as nouns have little impact on syntax. What is more, if the lexicon is assumed to feed the syntax, we would expect an impaired lexicon to send insufficient activation to the syntactic component. This would result in insufficient activation being circulated in the syntactic module. The output of such a system would consequently be agrammatic rather than paragrammatic, as is customarily observed with Wernicke's patients. In a nutshell, it remains mysterious how an impaired lexical system could lead to an overactive syntactic system.

Syntax is largely spared in anomic aphasia, the least common of the four syndromes. We thus end up with the following picture. If Wernicke's patients are regarded as having a basically intact syntax, more than half of the aphasic population (55.1%) suffer from a syntactic deficit; if Wernicke's patients are considered to also be syntactically disordered, almost three quarters of the aphasic population (72.7%) have an impaired syntax. In either case, the conclusion is as predicted. Syntax is a preferred locus of impairment in aphasia. According to the Structural Theory, the explanation for this vulnerability lies in the assumption that syntax is structure and that structure is particularly prone to disruption.

With this general background, let us take a closer look at agrammatism. However, before proceeding to the analysis, it is important to point out that because syntax is not a homogeneous notion, neither can agrammatism be. Goodglass & Menn (1985) mention the following diverse aspects of syntax that may be individually or jointly affected in agrammatism: word order, inflections, free-standing grammatical morphemes, prepositions, pronominalization, agreement, embedding, and relativization. All these aspects clearly have to do with syntax, albeit to differing degrees and for different reasons. We will select a few areas where the relevance to syntax is particularly obvious. All these may be formulated as predictions from the Structural Theory even though they are also predicted by the theory of agrammatism. However, as was previously explained, there are two major disparities. Whereas current versions of the theory of agrammatism adhere to the philosophy of binarity according to which syntactic categories may be lost or preserved, the Structural Theory adopts a gradual approach in which syntactic nodes may be available to varying degrees both from one patient to another and from one speaking situation to another in the same patient.

In addition, the two theories differ in their assumptions about the underlying problem. Whereas the syntactic-deficit hypothesis views agrammatism as a syntactic disorder, the Structural Theory views it as a disruption to the structural component of language (see Chapter 1). All of the following predictions can be traced back at least in their essence to Jakobson (1956) under what he named a *contiguity disorder*.

First, if a problem arises in the generation of structural representations, the number of sentence types will be reduced. In particular, those that require a higher number of syntactic nodes will be more strongly impaired than the simpler types. Subordination will be replaced with coordination and coordination will be replaced with juxtaposition. Second, if syntactic information is only available on a limited scale, rules that make crucial reference to it will tend not to apply. A paradigm case in this connection is agreement. Third, words that fulfil a mainly syntactic function in a sentence will tend to be lost because they depend on the availability of structural information. Fourth, for the same reason, word order will tend not to be governed by syntactic principles. Jakobson refers to word order as being "chaotic" but this is not an adequate description. The opposite of "syntactic" is not necessarily "chaotic," as there may be other principles such as semantic and pragmatic ones that will take control. Or else word order may simply be determined by the order in which the concepts spring to the speaker's mind (Goodglass, Berko Gleason, Ackerman, Bernholtz, & Hyde 1972).

Clearly, all of these predictions are borne out. Depending on the severity of the disorder, the sentences of English agrammatics usually have an SV or SVO structure, provided the patients are at all able to produce sentences as rhythmically coherent units. Asyntactic utterances such as single words with relatively long pauses are of course much more typical. This has been documented over and over again for many different languages (Menn & Obler, 1990).

In a comparison of English and Spanish agrammatics, Benedet, Christiansen, & Goodglass (1998) found that the Spanish patients correctly produced subject–verb agreement in 64% of cases whereas the English speakers scored worse at 42%. Of special interest in the present context is the gradual nature of the impairment. Getting every other response right can be explained neither by assuming that the relevant nodes are spared nor by assuming that they are lost, as is generally done in the literature (e.g., Ouhalla, 1993; Hagiwara, 1995; Friedman & Grodzinsky, 1997). Only a model that incorporates variable activation levels can account for these intermediate levels of performance.

The vulnerability of syntactically determined free-standing words was nicely demonstrated by Friederici (1982). She examined subjects' performance on formally identical prepositions in German, which may have a semantic (e.g., *the train* for *Dundee*) or a syntactic motivation (e.g., *Don't wait* for *me*). Friederici found that the German agrammatics had significantly less difficulty with the semantic than the syntactic prepositions. As these were otherwise identical, it may safely be concluded that the underlying problem is of a syntactic nature.

This conclusion is corroborated by agrammatic aphasics' difficulty in forging the appropriate links among the words of a sentence. Zurif, Caramazza, & Myerson (1972) required subjects to select the two words from a given sentence that they felt went best together. These data served as input to a hierarchical clustering analysis as applied by Levelt (1969; see Chapter 2). The results indicate that agrammatic aphasics paired content words with each other rather than content and function words, as the control group did. For example, in the sentence *The baby cries*, the grammatical subject was associated with the verb by the aphasics but with the determiner by the normal speakers. This suggests that aphasics are incapable of associating function words with their corresponding content words, which is clear evidence of a syntactic impairment.

Word order was long felt to be relatively spared in English-speaking agrammatic aphasics. However, the observation that word order is superficially intact should not be taken to imply that the syntactic system is operative (i.e., responsible for it). As shown by Saffran, Schwartz, & Marin (1980), it is true that agrammatics have no difficulty producing the correct word order in sentences like *The boy hits the ball* for example. However, agrammatics frequently err on sentences like *The ball hits the boy* in which they tend to reverse the order of the two nouns. Saffran, Schwartz, & Marin's explanation is that their subjects employ a semantic strategy whereby the more animate noun comes first. Because animate nouns make better subjects than inanimate ones (Corrigan, 1986), the agrammatics' semantic strategy yields the correct word order most of the time and thereby covers up their syntactic deficit.

The fifth and final prediction was not included on Jakobson's (1956) list of features of a contiguity disorder but is a core aspect of the Structural Theory. The syntactic representation in agrammatic patients is expected to be less hierarchical in that fewer structural nodes are created, and those that are reach a relatively low level of activation. Note that this prediction is to some extent independent of the word order problem because an SVO sentence can be correctly or incorrectly produced with or without a VP (even though the existence of a VP reduces the likelihood of an ordering error). Let us begin with an apposite remark by Rizzi (1985). He starts out from the claim that (the syntax of) languages can be classified in binary terms into configurational and non-configurational ones. In his view, agrammatism may be profitably described as a switch from a configurational to a non-configurational syntax. That is to say, English agrammatics use a system of rules and representations that is inappropriate in their own (configurational) language but it would be quite appropriate in a non-configurational language. Rizzi thus likens the disordered language of aphasics in configurational languages to the correct language use of competent speakers in non-configurational languages.[3]

Unfortunately, Rizzi does not adduce a shred of evidence to support this claim, which therefore remains entirely speculative. What makes his hypothesis so doubtful is his reliance on the binary conception of syntactic structure, which is quite clearly fallacious. Languages are not either configurational or non-configurational. They fall on a continuum on the configurationality scale (which certainly is multidimensional; see Chapter 4). However, once the binary approach is relinquished, Rizzi's hypothesis loses its essence on the one hand but begins to resemble the prediction of the Structural Theory on the other. The revised version of Rizzi's contention would then be that agrammatic language is predictably less configurational than normal language.

In fact, a number of studies have recently begun to explore this issue (e.g., Hagiwara, 1995; Friedman & Grodzinsky, 1997; Friedman, 2001). All of these works are framed in a model of syntax that is much more richly structured than previous accounts (see Pollock, 1987). To be more specific, it adopts the S and VP nodes from earlier models (not without relabeling them) and postulates above them the following hierarchy of nodes (from bottom to top): Agreement Phrase (AgrP), Negation Phrase (NegP), Tense Phrase (TP), and Complementizer Phrase (CP). The central claim of the aforementioned research is that agrammatism is adequately described as a loss of these functional categories. Two aspects of this claim are of particular importance. One is that a disruption invariably occurs from bottom to top. By virtue of a one-sided dependence of a subordinate on a superordinate node, a destruction of the lower node automatically entails the loss of the higher node ("the tree-pruning hypothesis"). Conversely, an intact node implies that all nodes below it must also be accessible. Thus, this model makes very clear predictions as to what is and what is not possible in aphasia. The other aspect is that the hierarchical tree provides a means of capturing between-subject variation. The severity of agrammtism may be defined by variable "cut-off points" in the tree diagram. The lower in the hierarchy the cut-off point is, the more severe the disruption.

There is a puzzling mismatch between the aforementioned accounts in the literature and the aphasiological data. True, the general finding is that the higher the position of a functional node in the syntactic hierarchy, the greater the likelihood of its disruption in aphasia. This is evidence for the arrangement of the nodes in the hierarchy proposed by theoretical syntacticians. However, the aphasic data do not support a strict interpretation of this hierarchy to the effect that damage to one node renders a superordinate node inaccessible. Similarly, an intact node is no guarantee that a subordinate node remains unimpaired. Let us look at the two points in turn.

The aphasic data show that when a certain node is damaged, a lower node may also be disrupted. A case in point is the differential behaviour of aphasics regarding tense and agreement. Because AgrP is lower in the hierarchy than TP, the former may be spared while the latter is damaged though not vice versa. What we find, however, in the aphasiological literature is that both aspects are compromised, though to varying degrees. Although tense marking is always more severely affected, agreement cannot be said to be functioning properly. Friedmann (2001) himself reports 9% agreement errors for his Arabic patients. Benedet et al. (1998) report 31.2% agreement errors for their Spanish and 58.0% for their English subjects. None of these figures can be taken as evidence for intact processing of the agreement feature.

The aphasic data similarly demonstrate that when a certain node is damaged, the higher node need not be fully destroyed. Let us compare aphasics' performance on TP and CP. Hagiwara's (1995) subjects had relatively minor problems with TP but scored c. 70% correct on the CP task. This fairly high score can by no means be regarded as back-up for the claim that the CP node is lost. Similar observations hold for other functional categories.

Hence, there are strong grounds for rejecting the tree-pruning hypothesis. Although the hierarchical organization of functional categories is bolstered, the binary nature of this model needs to be abandoned. Nodes are not either intact or destroyed. They may function more or less well. That is to say, they vary in their ability to pass on activation to their neighbours. The fact that higher nodes function less well than lower ones is entirely expected because activation spreads bottom-up in the structural system (see Chapter 1). So, if a lower node relays an insufficient amount of activation to its superordinate node (as a consequence of its impairment), the higher node will necessarily reach a lower activation level than the lower one. As a result, processing is all the more disordered, the higher one climbs in the syntactic tree. The basic claim is then that the syntactic tree (i.e., the representational component) is largely identical in aphasics and normals. The real difference between them lies in processing (i.e., in the ability to sufficiently activate syntactic nodes using a bottom-up strategy).

It may be concluded that the aphasiological data provide neat support for the Structural Theory. The syntactic representation underlying agrammatic speech is less hierarchical in the sense that the structural nodes are only weakly activated (and the more weakly so, the greater their dependency on other nodes). It is not necessary to assume that structural nodes are completely destroyed, even though this might happen in the severest forms of aphasia and would not be incompatible with the Structural Theory. For the vast majority of cases, however, it would seem appropriate to characterize agrammatic aphasia as a processing rather than a representational deficit.

8.2.2 Phonology

Unlike syntax, phonology gives us the opportunity of contrasting the erroneous output of normals and aphasics because both populations make similar errors in rather large numbers. These are called slips of the tongue in normals and (phonological) paraphasias in aphasics. Such an approach allows a direct comparison of the representations assumed to underlie normal and pathological language production. The obvious prediction of the Structural

Theory is that phonological paraphasias arise under a weak structural representation and therefore show weaker structural effects than slips of the tongue. The comparison is greatly facilitated by the fact that the errors made by the two populations can be described in terms of exactly the same categories.

Information on phonological paraphasias was extracted from a good number of published works. The slip of the tongue data mainly come from Stemberger's and my own corpus. Although our focus is on English, we will not stop short of other languages primarily because the predictions from the Structural Theory apply to all languages. Another reason is that the requisite quantitative data are not always available for English.

The ensuing examination will cover nine areas, each of which has a strong bearing on structural issues. The structural relevance of most of the tests has been explained before. When a novel test is introduced, the logic will be explained at the beginning of the relevant subsection. As in previous analyses, content units will be ignored even though mention will briefly be made of them in the conclusion to the present chapter in an attempt at comparing the severity of deficits involving structural and content units. Each of the following subsections is devoted to testing one prediction from the structural theory.

8.2.2.1 Contextual versus Non-Contextual Errors

We will begin with the distinction between contextual and non-contextual errors that was discussed in section 7.2.2. Our starting point is that contextual errors are dependent on a planning span whereas non-contextual ones are not. With a reduction of the planning span, the opportunity for contextual errors diminishes. Their probability of occurrence is higher when larger distances can be covered (witness the predominance of between-word slips in English documented in Chapter 5). If aphasics have a flatter suprasegmental representation than normals, we may predict a higher rate of non-contextual errors in aphasia than in normal language. A contextual and a non-contextual paraphasia appear in (1) and (2), respectively.

(1) [tri:t] for: Crete. (from Blumstein, 1973)

(2) [ki:mz] for: teams. (from Blumstein, 1978)

These two paraphasias illustrate problems with the series of stops. Whereas [k] is replaced by [t] in (1), [t] is replaced by [k] in (2). The first error is contextually motivated as there is a source at the end of the error word whereas no such source can be identified in the second.

For normal adult speakers of English, Stemberger (1989) reports 1845 contextual as against 324 non-contextual tongue slips (i.e., 85.1% vs. 14.9%), hence a clear majority of contextually determined errors. This makes good sense when the context is understood as facilitating a possible malfunction. By contrast, the aphasiological literature is unanimous in reporting a comparatively larger proportion of non-contextual paraphasias. Pate, Saffran, & Martin (1987) observed an almost equal rate of contextual and non-contextual errors for an English-speaking conduction aphasic. Another conduction aphasic, tested by Wilshire & McCarthy (1996), produced 42.4% contextual errors. Schwartz, Saffran, Bloch, & Dell (1994) found a similar rate of contextual errors (54.2%) for a jargon aphasic. This result was replicated by Monoi, Fukusako, Itoh, & Sasanuma (1983, Appendix 2) for conduction aphasia in Japanese. The same authors found an even higher rate of non-contextual consonant errors in Broca's aphasics in both a naming (65.8%) and a repetition task (74.8%). (For vowels, the percentages for non-contextuals were somewhat lower [at 38%]). In an analysis of Broca's aphasia in Finnish, Niemi, Koivuselkä-Sallinen, & Hänninen (1985) noted a ratio of 2:3 for contextual versus non-contextual paraphasias. A very similar rate of non-contextuals (63.8%) was observed in a sample of errors produced by a group of German-speaking Wernicke's aphasics (Allerbeck, 2000). The Swedish data reported by Söderpalm (1979) represent the most extreme case. In her corpus, non-contextual errors account for 81% of the cases.

We may conclude from these data that non-contextuality plays a more important part in paraphasias than in slips of the tongue. The difference between the two data types is statistically significant beyond the 0.001 level for all samples. This conclusion holds for all the languages studied and all major types of aphasia. Thus, there is empirical back-up for the following three claims. First and foremost, the enhanced degree of non-contextuality in paraphasias suggests a weak structural representation to which aphasic language is subject. Second, the underdeveloped suprasegmental representation appears to be a language-independent effect in aphasia. All languages attempt to erect structure (and are more or less successful in this regard, as the case of Arabic shows, see Chapter 5). A disordered processing system is even less successful on this task, irrespective of the nature of the individual language. However, it makes sense to predict that a disruption caused by aphasia will be less conspicuous in a language with a relatively flat structure than in one with a strongly hierarchical structure.[4] Finally, it is remarkable that the major aphasic syndromes are so homogeneous in their non-contextuality. Although it would be desirable to have more data on Wernicke's aphasics, the available evidence points toward a similar phonological processing deficit in the three kinds of aphasia. To be specific, all three types of aphasics seem to have trouble concurrently activating the segments contained in the same planning unit.

8.2.2.2 Omissions versus Non-Omissions

It was argued in Chapter 7 that a weak slot level as part of the suprasegmental representation increases the probability of omissions. We would thus predict an elevated rate of omissions in aphasic as compared to normal language, just as was predicted and observed for learner language. My German speech error collection encompasses 105 (4.1%) omissions as against 2453 (95.9%) non-omissions. This percentage may serve as a baseline to which the paraphasias will be compared. An example of a paraphasic omission is provided in (3).

(3) [si:] for: ski. (from Blumstein, 1973)

In her seminal work on phonological paraphasias, Blumstein (1973) observed for her English-speaking subjects 24.7% omissions in Broca's aphasia, 24.3% in conduction aphasia and 30.3% in Wernicke's aphasia. None of these differences among the aphasic syndromes reaches standard levels of statistical significance. Twenty-eight percent omission errors are reported by Shewan (1980) for Broca's aphasia and at least 32% by Hatfield & Walton (1975) also for a Broca's aphasic. For conduction aphasia in the same language, Pate et al. (1987) identify deletions as the most frequent error category at 47.8%. A very similar percentage (i.e., 46.2%) is reported by Kohn (1989) for the same syndrome.

Data from other languages by and large confirm this pattern. Omissions constitute the absolute majority (52.4%) in a French-speaking conduction aphasic examined by Béland, Caplan, & Nespoulous (1990). A group of Norwegian-speaking conduction aphasics made 33.2% segmental deletion errors (Moen, 1993). In two studies of aphasia in Spanish, omissions form the second most frequent error category after substitutions: 20.7% in a large group of aphasics of all types (Ardila, Montañes, Caro, Belgrade, & Buckingham, 1989) and 31.5% in a group of mostly Broca's (Ferreres, 1990). For German-speaking Wernicke's aphasics, Allerbeck's (2000) data attest to an omission rate of 19%.

It is quite obvious that the omission rate of aphasics is substantially higher than that of normals. All comparisons are highly significant. This difference holds for all three aphasic syndromes as well as all languages that have been investigated so far. Even in languages such as Arabic in which normal speakers do not apparently produce deletion errors, we would expect a relatively higher omission rate in aphasics. However, this prediction has yet to be tested. A final piece of evidence may be noted that is consonant with the aphasic nature of omission errors. Béland & Paradis (1997) report a case of progressive aphasia in which the rate of omissions increased considerably as the illness worsened.

8.2.2.3 The Distance Between Error and Source Unit

Contextual errors allow us to measure the distance between the error and the source segment. A convenient and linguistically pertinent approach, which was employed in Chapter 5, is the binary division of contextual errors into within-word and between-word errors. The following examples come from a conduction aphasic tested by Kohn (1989).

(4) [kʌkin]. for: pumpkin.

(5) J*a*n*e* r*ai*n—r*a*n home.

As for (4), it is highly likely that the [k] in the first syllable is a copy of the [k] in the second. Thus, source and error are part of the same word. By contrast, a word boundary was crossed in (5) where the vowel in *Jane* replaced that in *ran*.

As an underdeveloped suprasegmental representation leads to a smaller planning window, aphasics are predicted to evince a higher rate of within-word errors than normal speakers. As discussed in section 5.3.1, between-word errors are the rule in slips of the tongue. Stemberger (1985) notes a proportion of 86.3% for his English data and Berg (2006) a proportion of 90.1% for his German data. Unfortunately, the aphasiological literature does not regularly draw a clear distinction between within-word and between-word paraphasias. In many publications, the error type is an artifact of the method used. For instance, a single-word production task such as object naming involves a strong bias toward within-word errors. The general impression one gains from a perusal of the literature is that, to the extent that paraphasias are at all contextually determined, the within-word type is the rule. When the between-word domain is scrutinized, this is notable enough to be mentioned in the title of the publication (see Kohn & Smith, 1990). One of the few studies that allows us to attack this issue directly is Blumstein (1973). Although she applies the distinction between within-word and between-word errors to anticipations and perseverations, it is unfortunate that she fails to do so for exchanges. We may surmise that most, if not all of her paraphasic exchanges are of the within-word type because it is known from the speech errors of normals that the interacting units in exchanges tend to be closer together than those in anticipations and perseverations (Berg, 1988a). It stands to reason that this effect carries over to aphasia. If all reversals are counted as within-word errors, we obtain a proportion of between 43% and 73% within-word errors for the three aphasic syndromes under investigation. If the reversals are left out of account, the rate of within-word errors ranges between 35% and 66%. When the data for the three populations are pooled together (and reversals excluded), within-word errors are the absolute majority (61.4%). On either count, then, within-word paraphasias are more common in aphasic than in normal language. Supplementary evidence comes from a small sample of Swedish paraphasias collected by Söderpalm (1979), which contains 10 within-word versus 3 between-word cases (77% – 23%). This pattern is diametrically opposite that reported for normals. Thus, the available evidence is clearly consonant with the research hypothesis.

8.2.2.4 Reversals versus Switches

The next test focuses on the frequency of certain error categories and is closely related to the preceding as some classes are distinguished by the distance between the interacting units. Reversals, for example, are defined by the presence of a minimum of one stationary element that the interacting units skip. In contrast, switches are characterized by the adjacency of the interactants. The reason for this distance-based distinction is that switches and exchanges display disparate properties such as allowing or disallowing the interaction of consonants and vowels. This is illustrated by the following two paraphasias. No. (6) exemplifies a reversal of consonants and (7) a switch between a vowel and a consonant. More specifically, (6) involves the interaction of [tr] and [ts] and (7) the reordering of [y:] and [l]. Both were committed by German-speaking Wernicke's aphasics.

(6) [tri:tso:nə]. for: Zitrone [tsi:tro:nə] 'lemon' (from Allerbeck, 2000)

(7) [kly:ʃraŋk]. for: Kühlschrank [ky:lʃraŋk] 'refrigerator' (from Allerbeck, 2000)

Because the distance between the interacting elements is larger in reversals than in switches and because the interaction of distant units in paraphasias was found to be discouraged in the previous subsection, it may be predicted that the rate of switches is higher whereas the rate of reversals is lower in aphasics than in normals. Harley's corpus of English slips of the tongue contains 262 exchanges (209 between-word and 53 within-word cases) and 2 switches. A similar bias can be observed in other samples. This strong asymmetry may serve as the basis for a comparison with paraphasias.

Unfortunately, the aphasiological literature does not often carefully distinguish between reversals and switches. Blumstein (1973), for instance, lumps the two classes together under the rubric of metathesis. Her data are therefore unusable in the present context. Generally speaking, aphasiologists are unanimous in stressing the rarity of exchange errors. If they occur at all, they tend to involve interactants that are separated by only a minimum of segments. Söderpalm (1979) found only 2 in her corpus both of which are of the within-word type. In their sample of between-word paraphasias, Kohn & Smith (1990) did not find a single instance of a reversal. More specific information is available from Niemi et al.'s (1985) Finnish corpus in which 7 reversals accompany 7 switches (5% each of the entire database). Exactly the same distribution can be observed in Allerbeck's data from German-speaking Wernicke's aphasics who produced 3 reversals and 3 switches (2.3% each of the entire database).

Despite the fragmentary nature of the data, the prediction of the Structural Theory seems to be fulfilled. Exchanges clearly have a lower share in paraphasias than in tongue slips. Although switches are uncommon in both aphasic and normal language they appear to be more frequent among paraphasias than tongue slips. These differences arguably are linked to the reduced planning span, which discourages the occurrence of exchanges and encourages the occurrence of switches.

8.2.2.5 The Parallel Syllable Structure Constraint

The distinction between reversals and switches has implications for one of the most powerful principles governing phonological speech errors—the parallel syllable structure constraint (see sections 5.4.1.1 as well as 7.2.2). One of the main reasons why switches occur so seldom in slips of the tongue is that they perforce violate the structural constraint. This is because two contiguous segments cannot have the same structural description (consider e.g., the two stops in *napkin*). The prediction from the Structural Theory is straightforward. As sensitivity to the parallel syllable structure constraint is an index of the hierarchicalness of the suprasegmental representation, aphasics may be expected to show a lesser sensitivity to this constraint than normal speakers.

The slips of the tongue are remarkably homogeneous across several languages. The violation rate is 4.3% for English (Stemberger, 1985), 4.9% for German (Berg & Abd-El-Jawad, 1996) and 4% for Spanish (García-Albea, del Viso, & Igoa, 1989). Even though precise numbers are not often given, there is little doubt that the parallel syllable structure constraint is relaxed in aphasia. The English-speaking conduction aphasic studied by Kohn (1989) produced 16% violations. Dressler, Magno Caldognetto, & Tonelli (1986) published an analysis of a subset of their corpus of Viennese German paraphasias in which 6 of their 19 reversals (32%; switches excluded) disregarded the like-with-like constraint. A similar violation rate (35%) was reported for German-speaking Broca's and Wernicke's patients alike (Knels, 2001; Allerbeck, 2000). A lower percentage of violations (5.4%) was found in the output of Italian-speaking aphasics (Dressler, Tonelli, & Magno Caldognetto, 1987). However, this percentage is clearly less than the 1% violations that occurred in the normal sample. It is possible that structural characteristics of Italian are responsible for the generally lower violation rates. Of course, the difference between the tongue slips and the paraphasias matters more than the percentage levels.

We may conclude from this dicussion that paraphasias are less sensitive to the parallel syllable structure constraint than slips of the tongue. This is true of all the languages examined and apparently of all three aphasic syndromes. This relaxation is a further piece of evidence in support of the hypothesis that the suprasegmental representation of aphasic speakers is less hierarchical than that of normals.

8.2.2.6 The Word-Onset Effect

Another important finding from English and German speech error analyses is the vulnerability of word-onset processing. The claim that this vulnerability is a structural effect was defended in section 5.2. To briefly repeat the logic, the degree of embeddedness of a unit in the suprasegmental representation serves as an index of its susceptibility to malfunction. Because word onsets are structurally isolated in English, they are free to (preferentially) interact with other onsets. In a weak structural representation the distinctiveness of word onsets is reduced, hence their greater resistance to malfunction. We therefore predict a lower share of word-initial errors in paraphasic than in normal language.

There is a certain difference in the strength of the word-onset effect in English and German tongue slips. Shattuck-Hufnagel (1987) reported a proportion of 82.3% of the contextual errors in her English collection whereas my German sample contains only 61.0% (Berg & Abd-El-Jawad, 1996). The reasons for this disparity probably lie in different classification strategies and/or certain structural differences between the languages.

There is good reason to make the general claim that the word-onset vulnerability is less strong in paraphasias than in slips of the tongue. In their analysis of two German-speaking Wernicke's aphasics, Stark & Stark (1990) maintained that the coda was more strongly impaired than the other syllabic constituents. However, statistically speaking, this is only true for one of the patients. The other showed an equal involvement of onsets and codas (47.3%–52.7%), with errors on the vocalic portion excluded. In any case, onsets are clearly not the predominant error locus. Unfortunately, Stark & Stark did not distinguish between word and syllable positions, but they do provide information on monosyllabic words. For these, very similar patterns can be observed as for polysyllabic items (see their Table 13.3). We may thus conclude that the word onset is not particularly error-prone in the two subjects under investigation.

More direct evidence is available from the other studies of aphasia in German. Allerbeck (2000) reported 30.8% involvement of the word-onset position for Wernicke's aphasia and Knels (2001) noted 22.6% word-initial paraphasias for Broca's aphasia. The same bias toward word-onset stability was detected by Kohn (1989) for an English-speaking conduction aphasic. Her patient made 4 word-initial versus 14 final errors (22%–78%). This asymmetry was replicated in her follow-up study (Kohn & Smith, 1990). The bias was equally strong (25%–75%) in a conduction aphasic tested by Wilshire & McCarthy (1996). An examination of a group of English-speaking Broca's aphasics with apraxia of speech revealed that word-initial consonants were slightly less accurately produced than word-final ones (Trost & Canter, 1974). Klich, Ireland, & Weidner (1979) obtained a similar pattern in which the final-error preference reached statistical significance

($\chi^2(1) = 67.5$, $p < 0.001$). Similarly, Burns & Canter (1977) reported a significantly higher number of final-position as compared to initial-position errors made by Wernicke's and conduction aphasics.

The vulnerability of codas appears to be cross-linguistically valid. Law (2004) examined a transcortical motor aphasic with Cantonese as his mother tongue whose errors involved coda positions in between 60% and 83% of cases (depending on the particular task). For their Finnish-speaking subjects, Niemi et al. (1985) found more paraphasias in word-internal than in word-initial sites but fewer paraphasias in word-final than in word-initial positions. Because the word-internal set was not differentiated (for example in consonants and vowels), it is difficult to compare the word-initial errors to this heterogeneous class. In any event, the percentage of word-initial paraphasias (35%) is within the range observed for other aphasics.

One partially dissenting voice is Blumstein (1973). Although she reported a slight preponderance of word-final over word-initial paraphasias in Wernicke's aphasia, the Broca's and conduction aphasics in her study made more errors in word-initial than in word-final sites. It is conceivable that the susceptibility to word-onset errors interacts with the level at which the errors arise. Canter, Trost, & Burns (1985) showed that the more clearly paraphasias are of a phonemic nature, the stronger the trend for them to occur in final position. In contrast, the more phonetic errors were found to be (slightly) more probable in initial sites. A similar bias toward initial-position involvement was apparent in Johns & Darley's (1970) analysis of a group of dysarthric patients although the authors did not explicitly contrast initial and final positions.

It is unlikely that these divergences can be accounted for by syndrome-specificity. As the studies cited demonstrate, different patients with the same syndrome may behave in different ways—consider the conduction aphasics in Kohn (1989) and Kohn & Smith (1990) versus those in Blumstein (1973) as well as the Broca's aphasics in Trost & Canter (1974) versus those in Blumstein (1973). We thus have to cope with a certain inconsistency in the data.

Despite this minor equivocalness, the major point to be made seems sufficiently clear. Aphasic speakers experience *less* difficulty with word-initial loci than competent speakers (in relative terms). With the aforementioned reservation, this conclusion applies to all three syndromes as well as to all languages investigated. There is some preliminary evidence that a distinction needs to be made between phonological and phonetic processing. The word-onset stability in aphasia appears to be stronger in the former than in the latter case. However, this difference in no way invalidates the comparison between paraphasias and slips of the tongue. Because the latter are clearly of a phonological nature, it is appropriate to compare them to phonological paraphasias. As these constitute the error type that exhibits the word-onset stability, the contrast that has been established between paraphasias and tongue slips is highly likely to be real.

8.2.2.7 Directionality

The issue of directionality turns on the ratio of anticipations to perseverations and was discussed in the previous chapter. It is a structural effect because anticipations presuppose a planning window. The smaller the size is of this window, the lower the anticipation/perseveration ratio. It may therefore be predicted that aphasics, who are assumed to have an underdeveloped structural representation, will show a lower anticipation rate than normals.

There is wide agreement in the speech error literature that anticipations (both complete and incomplete) are generally more frequent than perseverations. Stemberger's (1989) English corpus comprises 838 anticipations and 510 perseverations (62.2%–37.8%). A somewhat higher anticipation rate obtains in my German slips collection (68.7%–31.3%). This difference suggests that it may be useful to have separate baselines for English and German.

Generally speaking, one of the distinctive features of aphasic language is its proclivity for perseverations (e.g., Allison & Hurwitz, 1967; Hudson, 1968; Buckingham, 1985). Although this phenomenon is often associated with the processing of meaningful units like words for example, there is no evidence that it does not extend to the phonological level. In fact, Schwartz, Saffran, Bloch, & Dell (1994) reported 32% anticipations in the speech sampled from an English-speaking jargonaphasic, which is significantly less than the anticipation rate in English slips of the tongue. The consonantal anticipations made by Kohn's (1989) conduction aphasic ran to 56%. However, the numbers are too low to warrant a statistical treatment. The same is true of other aphasiological samples (e.g., Söderpalm, 1979). Blumstein's (1973) data exhibit a trend in the expected direction for Wernicke's and conduction aphasia, though not for Broca's aphasia. However, standard levels of significance are not attained.

The data from the German-speaking aphasics present a similar picture. Allerbeck (2000) found a 40.5% anticipation rate for her group of Wernicke's aphasics. This is significantly less than that of normals ($\chi^2(1) = 12.5$, $p < 0.001$). It is true that Knels's (2001) data from Broca's aphasics point in the same direction but the absolute numbers are so low that the χ^2-test yields a non-significant result ($p > 0.1$).

A firm conclusion is hampered by the lack of large-scale collections of paraphasias. Many corpora are just too small for a meaningful comparison between normal and aphasic language to be carried out. It would seem that the predicted effect is not particularly strong and also that it is weaker in Broca's than in the other syndromes. However, a trend in the expected direction is almost always discernible. Thus, it may tentatively be concluded that the anticipation/perseveration ratio is lower in aphasic than in normal speakers. This may be taken as suggestive evidence for the hypothesis that aphasic language is generated under a less hierarchical representation than normal language.

8.2.2.8 Length of Target Word

The word in which a phonological distortion occurs has a certain length that is customarily measured in syllables. The question that arises at this point is whether the probability of error is a function of the length of the target word. Could it be that the error rate increases with the number of syllables per word? To address this question, the first 1024 items from Harley's speech error corpus (Boxes 1–7) were examined for the length of the word in which the slip occurred. A baseline for comparison was provided by Denes's (1963) word length count on the basis of both scripted and unscripted spoken English. The results are contained in Table 8.1.

The picture that emerges from Table 8.1 is exceptionally clear. The error mechanism in healthy adults is sensitive to the variable under discussion. Longer words are significantly more error-prone than shorter ones ($\chi^2(5) = 494.5$, $p < 0.001$). More specifically, the switch point occurs between mono- and disyllabic words. Whereas monosyllabic items accommodate fewer errors, polysyllabic items house more errors than would be expected by chance.

The length of words is clearly relevant to the suprasegmental structure. The longer a word, the more suprasegmental structure has to be erected not only at the slot level but also above it. The aphasics' assumed difficulty in building structure is likely to compound the general difficulty of dealing with longer words that we find in normal speakers. We may accordingly predict that aphasics will show a greater sensitivity to the word-length effect than normals. There are several detailed aphasiological studies that allow us to test this prediction. A certain drawback arises in the comparison of the normal and pathological data because the former were culled in naturalistic and the latter in more carefully controlled conditions. The paraphasic data are made available in the form of the proportion of errors to the total number of possible responses. Such information is not available from slip corpora, which supply data on the relative frequency of error types though not on the absolute frequency of error occurrence. To eliminate the unequal opportunities of error occurrence due to frequency differences in general language usage, the number of naturalistic slips was divided by the total

Table 8.1 Error Rate as a Function of Length of Target Word

Word Length (in Syllables)	*One*	*Two*	*Three*	*Four*	*Five*	*Six*	*Total*
Error-free speech	17798 (77.2%)	3969 (17.2%)	1004 (4.4%)	240 (1.0%)	38 (0.2%)	0 (0.0%)	23049
Slips of the tongue	502 (49.0%)	344 (33.6%)	112 (10.9%)	55 (5.4%)	9 (0.9%)	2 (0.2%)	1024

number of words per length category in the lexicon. This was done in Table 8.2 on the basis of Table 8.1.

The aphasiological materials to which the normal data are compared come from two sources. Caplan (1987) presents in-depth analyses of the speech of one conduction aphasic, and so do Pate, Saffran, & Martin (1987) with a similar case. Caplan's data (from his Table 5) were collapsed across experimental conditions (naming, reading, repetition). Pate et al.'s data (from their Table 4) were difficult to collapse across task conditions and were therefore limited to the word reading condition. Caplan's maximum stimulus length is three syllables, Pate et al.'s four. Table 8.2, which reports the relative error probability of the different word categories in the three data sets, therefore covers only the words from one to four syllables in length.

Despite the reservations that may be levelled against the direct comparison of the normal and the pathological data, Table 8.2 leaves little doubt that the relative error probabilities are higher for paraphasias than for slips of the tongue. Note that this procedure is highly conservative. The error probabilities for the normal data are almost certainly too high. Linguistically competent speakers do not err on every 4th quadrisyllabic word. However, even this excessively high figure does not fail to disclose the enormous difference between the slip data and the paraphasias. This disparity begins to emerge at the level of disyllabic words and becomes stronger as the words get longer. The most extreme case can be seen in the Pate et al. data where every quadrisyllabic word is in error.

The preceding analysis invites the conclusion that the normal and pathological data are subject to the same constraint—error rate increases with word length. However, the two data sets are differentially susceptible to this effect. It is stronger in paraphasias than in tongue slips. This is an additional piece of evidence to support the claim that the unfolding of the suprasegmental representation is disrupted in the aphasic patients who have been included in the earlier comparison. Even though the length effect has not yet been documented for all aphasic syndromes and for many languages, it would seem to have a great potential for generalization.

Table 8.2 Relative Error Probability of Words of Different Length (in %)

Word Length (in Syllables)	*One*	*Two*	*Three*	*Four*
Slips of the tongue	2.8	8.7	11.2	22.9
Paraphasias (Caplan)	0.01	18.7	44.5	—
Paraphasias (Pate et al.)	1.0	19.0	38.8	100.0

8.2.2.9 Size of Error Unit

The final effect to be examined is the size and frequency of the units involved in malfunctions. The most frequent case in phonological slips of the tongue is of course the single segment. Occasionally, larger units may be affected, in particular consonant clusters, but also consonant–vowel structures may act in unison. However, as shown in Chapter 1, all of these combinations are fairly incohesive, with clusters being more cohesive than VC sequences, which in turn are more cohesive than CV sequences. These differences emanate from the hierarchical nature of the structural representation.

In a flat model without any suprasegmental structure, the only phonological error that may happen is the single-phoneme slip as there is no consistent way of binding two phonemes together. The assumption that aphasics have an underdeveloped structural representation thus leads to the prediction that the proportion of single-element to more complex (e.g., CV and VC) errors will be higher in paraphasias than in slips of the tongue. There is also a second prediction possible. As noted in section 2.5.1.6, normal speakers make significantly more VC than CV slips. To the extent that these mistakes occur at all in aphasia, the expectation is that the number of VC and CV errors will be more nearly equal. To be more specific, although the asymmetry may be preserved in aphasia, it is predictably less pronounced than in the tongue slip data.

Strong support for the first prediction comes from a comparative study of slips of the tongue and paraphasias in German. Dressler, Magno Caldognetto, & Tonelli (1986) report that 65% of the tongue slips involve single segments whereas 35% involve larger phonological units. By contrast, 95% of their paraphasias are segmental in nature whereas only 5% are not. This difference is statistically significant ($\chi^2(1) = 30.4$, $p < 0.001$). Unfortunately, Dressler et al. do not break down their data according to the categories of relevance here, so the second prediction cannot be addressed. A very similar picture can be gained from Monoi et al.'s (1983) investigation of Japanese Broca's and conduction aphasics. Whereas the latter population made 97.6% segmental and 2.4% non-segmental errors, the former group produced as few as 2 out of 511 (0.4%) non-segmental paraphasias. This percentage is even lower than that reported for the German subjects. Shewan's (1980) examination of English-speaking Broca's aphasics also yields a very low rate of phoneme-sequence errors (1.3%, syllable errors excluded). The testing of a mildly impaired English-speaking conduction aphasic gives rise to 9.7% body and rime errors (Wilshire & McCarthy, 1996). Blumstein (1973) also notes the overwhelming predominance of segmental paraphasias but does not provide any numbers.

To the best of my knowledge, only two studies have published a quantitative analysis of CV and VC errors in aphasia. Such a comparison can be found in Wilshire & McCarthy's (1996) detailed investigation of an English-speaking conduction aphasic. This patient made 4 body and 11 rime errors on a word-sequence repetition task. This distribution is significantly different from Stemberger's (1983a) slip of the tongue data (4 body vs. 53 rime errors) ($\chi^2(1) = 4.4$, $p < 0.05$). The fact that the χ^2 value is so low certainly is a consequence of the low number of paraphasic errors. A comparison in terms of percentages brings out the magnitude of the difference much better: 7%–93% for slips of the tongue as against 27%–73% for paraphasias. The second study, to wit: Kohn (1989), has too few complex errors for a comparison to be meaningful.

To conclude, both predictions receive support from the aphasiological literature. Aphasics tend to produce relatively more single-segment errors than do normals. Also, the ratio of VC to CV errors appears to be more balanced in paraphasias than in slips of the tongue. The two effects follow quite naturally from the assumption that aphasic language is generated by a less hierarchical representation than is normal language. Because the structural representation is weakened following brain damage, structural effects such as the cohesiveness of phoneme sequences and the asymmetry within the syllable dwindle.

8.2.2.10 Conclusion

In the foregoing, a series of nine tests were conducted with an eye to determining structural differences between slips of the tongue and paraphasias. The Structural Theory led us to predict that aphasic patients would generally exhibit less sensitivity to structural effects than normal speakers. The noteworthy finding is that this prediction was fulfilled in all of the nine tests. In only one test (i.e., the word-onset effect) was there some minor disagreement, which does not, however, affect the overall result that the word onset is less often involved in phonological paraphasias than in slips of the tongue. This consistency is all the more surprising as both within-subject and between-subject variability is so commonly associated with aphasic output. There are thus three conclusions of some significance to be drawn from the previously discussed analysis. Foremost in the present connection is that this consistency justifies ascribing the nine empirical effects (or ten, if the two tests in the previous subsection are counted separately) to one and the same underlying "error mechanism." Of course, it is not logically necessary for all effects to have the same origin, but the fact that they co-vary to a considerable extent lends credence to the claim that they are not independent and that they share at least one underlying cause.[5] This cause is assumed to be an underdeveloped suprasegmental representation to which the generation of aphasic language is subject. That the structural representation is particularly prone to being affected by brain damage is entirely expected under the Structural Theory, as structural units are difficult to process even in normal language production. Note that the diminution of structure does not stymie the production system. Comprehensible output is still possible but at a slower pace, in smaller chunks, and with disparate error patterns.

The second conclusion is amazing in the light of the enormous behavioural differences on which the distinction among the major aphasic syndromes rests. The clinical impression one gains from listening to, let us say, Broca's and Wernicke's aphasics, can hardly be more divergent in terms of syntax and prosody, and yet on the structural characteristics that have been investigated here, there is a noteworthy similarity among the aphasic syndromes. All aphasics appear to perform similarly in the structural–phonological domain. This is not to say that the structural effects need to be equally strong in all types of aphasia. This is almost certainly not the case. What is claimed, however, is that all aphasics presenting with a phonological disorder show a reduced sensitivity to structural effects, even if this reduction may be minimal.[6] For example, Wilshire & McCarthy's (1996) patient suffered from only a mild form of aphasia as attested by the relatively high number of CV and VC errors that evidence a largely intact suprasegmental system. On the other hand, the fact that his CV/VC error ratio is more balanced than in normal speakers is a sign of the slight disintegration of the structural system. The strongest claim is then that aphasics cannot be phonologically disordered without having an underdeveloped suprasegmental representation.

The third conclusion also pertains to the homogeneity of the data. Not only the differences among the aphasic syndromes but also the cross-linguistic differences have little effect on the error patterns. This is quite unexpected in view of the diversity of linguistic patterns. The explanation for this homogeneity lies in the claim that all languages attempt to erect a suprasegmental structure and that any problem connected with this erection process leads to a less hierarchical representation, regardless of the language in which this problem crops up. Between-language variation is introduced by the speed with which the suprasegmental representation is unfolded (see Chapter 5), so cross-linguistic variability in phonological paraphasias is brought about by differences in the velocity of the erection process. Obviously, a language that has a relatively slow pace can decelerate less than a language with a rapid pace. The main point, however, is that only deceleration occurs in aphasia in whatever language.

These are undoutedly all very strong claims that were made on the basis of the empirical data in connection with the Structural Theory. Clearly, the available evidence is far from complete and the Structural Theory is limited in the sense that it covers only one part of language. However, it is by pushing a theory to its limits that we open it to falsification and thereby pave the way for a better model.

8.3 CHILDHOOD APHASIA

The term *aphasia* is typically used to refer to disruptions of a system that used to be fully developed and fully operational. However, language disorders may also occur in children (i.e., before full linguistic maturity has been reached). For these children, the prediction of the Structural Theory is patently clear. In general terms, it is to be expected that the reduced-hierarchicalness account provides an adequate characterization of childhood aphasia. However, an even stronger prediction follows from the Structural Theory. Given that normally developing children have an underdeveloped structural representation (see Chapter 7) and that adulthood aphasia is characterized by the same, aphasic children should suffer the same deficit with double severity. Specifically, they would be expected to produce an even less hierarchical output than age-matched normally developing children.

Cromer (1978) reviewed several theories of developmental aphasia and came to the conclusion that only the assumption of an impaired hierarchical structuring was vindicated. Five diverse lines of evidence deserve mention in the present context—three from language production and two from non-linguistic skills. Beginning with the last, Cromer (1981) tested a group of aphasic children on a variant of the by now familiar mobile construction task. His subjects were instructed to copy a drawing of a tree structure on a piece of paper as well as to copy a real mobile using straws and connectors. Cromer used a group of congenitally deaf children as controls. The method of calculating hierarchicalness in the copy was adopted from Greenfield & Schneider (1977). The result of the experiment was that the hierarchicalness score was significantly lower for the aphasic than the deaf children. It seems justified to generalize from this that the same difference, if not a larger one, holds between aphasic and healthy children. Cromer further observed that if the linguistically disordered children succeeded in the task, they replaced the hierarchical with a sequential strategy. Thus, both of the aforementioned predictions are confirmed. A deficit in erecting hierarchical structure provides an appropriate description of the non-linguistic skills of disordered children. Furthermore, this deficit is more severe than in normally developing children.

The other non-linguistic skill is rhythmic ability.[7] Martin (1972) and subsequently Liberman & Prince (1977) argued that rhythmic activity is hierarchically organized. Arhythmia may therefore be taken as an index of a hierarchicalness deficit. Kracke (1975) investigated aphasic and normally developing children's ability to identify and retain rhythmic sequences and found that the performance of the former was significantly poorer than that of the latter group. As in the mobile construction task, the aphasic children were found to employ a sequential strategy whereas the normal children used what Kracke calls a Gestalt strategy. As this strategy is assumed to involve hierarchical structure, it may be concluded that the aphasic children have a reduced ability to erect a hierarchical representation as compared to their normally developing peers.

The third piece of evidence comes from Cromer's (1981) analysis of the writings of aphasic children who were completely unable to understand and produce spoken sentences (although single-word production and comprehension was basically alright). As in the mobile construction task, the aphasic children's performance was compared to that of profoundly deaf children. Cromer found a lower number of phrases, embeddings, conjunctions, relative clauses, verb complements, and adverbs modifying adjectives in the writings of the aphasic than in those of the deaf subjects. All these properties are structural in nature (i.e., they presuppose the erection of a syntactic representation). If this erection process fails or stops mid-way, only a reduced syntactic complexity is attainable.

Although the remaining lines of evidence come from the lexical domain they are of special interest as they are syntactically "loaded." This is particularly evident in the grammatical category of case that is coded in the English pronoun system. As case is uncontroversially determined by syntax, whereas other grammatical categories such as gender and number are not, an underdeveloped structural representation predicts more problems with the former than the latter categories. Pronouns represent an ideal testing ground for this hypothesis because they code all three pieces of information. We would accordingly expect more pronoun case than pronoun number or gender errors in language-impaired children. In a series of studies, Moore (1995, 2001) addressed this prediction and found strong support for it.

The final test involves verbs. What makes this lexical category relevant in the present context? It was argued in Berg (1998) that word classes can be arranged on a continuum of increasing/decreasing syntacticity and that verbs rank highest on the syntacticity scale. This hypothesis allows us to predict that verb use is especially vulnerable in disordered children. Precisely this is the outcome of a study by Watkins, Rice, & Moltz (1993). Although they did not directly compare verbs with any other word class, they documented a lower number of verb types in language-impaired children than in their normally developing peers. This finding suggests a particular difficulty associated with acquiring verbs, a difficulty that is nicely accounted for by the assumption that verbs are particularly sensitive to syntactic effects.

The conclusions for the linguistic skills match those for the non-linguistic skills. A structural account adequately captures the linguistic features of aphasic output. Equally important, the structural representations of aphasic children are even less hierarchical than those of their normally developing peers. These are robust conclusions that are supported by highly different types of evidence.

Let us now turn to disordered phonology. According to Nettelbladt (1983), severely aphasic children are subject to strong syntagmatic processes that impose restrictions on the possible co-occurrence of phonemes in larger units such as syllables and words. Typical cases of syntagmatic limitation include consonant harmony, a low number of word patterns, short words, and the absence of consonant clusters. All of these aspects are likely to have a structural cause. Clusters constitute the most obvious case. If structural nodes such as onset and coda cannot be activated, clusters cannot be associated with structural positions and consequently cannot be produced.

Word length was treated in section 8.1.2. Clearly, the longer the word is, the more slots have to be created. Because this is a structural operation, a reduced availability of structural information automatically cuts down the size of words. A limited number of word patterns is also a clear indication of structural problems as word patterns are usually defined in terms of C/V units. The lesser their availability is, the lower the number of word patterns. Structural origins may also be assumed for consonant harmony. Note that structure protects non-adjacent consonants from interfering with each other. For example, if there are neither onset nor coda nodes, prevocalic and postvocalic consonants can readily interact (due to their similarity in terms of consonantalhood); if, however, prevocalic and postvocalic consonants are coded as onset and coda consonants, the risk of their interacting is low (due to their dissimilarity). Harmony involves precisely this interaction between non-contiguous consonants. A representational system with strong structural nodes is therefore more likely to prevent consonant harmony than one with weak structural nodes.

The conclusion that the foregoing analysis supports is that children with a disordered phonology suffer more strongly from a deficit in the unfolding of the suprasegmental representation than normally developing children. This is not to say that all of the aforementioned characteristics of phonologically disordered children are exclusively structure-based. The limitations on word size, for example, may very well also evidence a problem with activating content units. However, such an account is not applicable to the absence of clusters of the type /AB/ when the phonemes /A/ and /B/ have been mastered individually. Similarly, a content-unit deficit cannot account for the limited number of word patterns when these are independent of any particular phonemes. Hence, a structural deficit is clearly implicated in the output of children with disordered phonologies.

To summarize, evidence has been adduced from diverse skills in support of the hypothesis that aphasic children are plagued with a disruption to the structural representation of language. This structural problem may manifest itself in the syntactic and the phonological component. Furthermore, there is support for the claim that aphasic children's structural representations are even less hierarchical than those of normally developing children.

8.4 A LINK BETWEEN SYNTACTIC AND PHONOLOGICAL DISTURBANCES?

In the aforementioned spirit of taking the Structural Theory to its extremes, we now address another issue that ensues directly from the model and therefore allows the formulation and testing of novel predictions. However, the correctness of the predictions hinges on an uncertain background assumption. As long as this background assumption does not stand on firm ground, the predictions cannot be enunciated with a high degree of confidence. This uncertainty accords the present section a distinctly "experimental" flavour. Nevertheless, it was deemed useful to develop the argument in an effort to shed light on an area that has hitherto remained largely unexplored.

Our point of departure is the fact that structure can be found at both the syntactic and the phonological levels. The Structural Theory emphasizes these cross-level similarities and assumes that a disruption to the structural component of language may manifest itself in both the syntactic and the phonological domains. That is, language breakdown in aphasia should not affect a single linguistic level in isolation but concurrently all levels at which structure plays a role.

Let us begin with adult language and contrast the two classical syndromes—Broca's and Wernicke's aphasia. Following the analysis offered in section 8.2.1, we will start from the not undisputed assumption that the syntax of Wernicke's aphasics is less strongly disrupted than that of Broca's, given the greater planning span and fluency of the former as compared to the latter group. The overgeneration of syntax in Wernicke's aphasia is taken to reflect a syntactic deficit and the fact that so much syntax is generatable indicates that the basic system is available. Given the hypothesis that Broca's aphasia is describable as a more severe structural disorder than Wernicke's, we would predict phonological paraphasias to be less structure-sensitive in Broca's than in Wernicke's patients.

We will briefly discuss three empirical effects. The outcome of the first test would seem to be a foregone conclusion even though it is not. This test turns on the distance between interacting segments in phonological paraphasias. On the assumption that the structural component is more disrupted in Broca's than in Wernicke's aphasics, we may predict Broca's paraphasias to exhibit a smaller distance and Wernicke's paraphasias to exhibit a greater distance between the interactants. This prediction is not a trivial consequence of the fact that Broca's aphasics tend to produce much shorter sentences than Wernicke's. The greater planning span evident in the syntax of Wernicke's than in that of Broca's patients does not necessarily force the two groups to employ different strategies of phonological processing. For example, it is quite possible for Wernicke's patients to adopt a strategy of minimum look-ahead in phonology while going for greater look-ahead in syntax.

Inspection of Blumstein's (1973) data shows that this prediction is fulfilled. She broke down the contextual errors in her corpus into within-word and between-word cases. Excluding reversals that Blumstein treats in undifferentiated fashion, we find 66.2% within-word errors in Broca's patients but only 35.0% in Wernicke's. This difference is statistically significant ($\chi^2(1) = 14.4$, $p < 0.001$). We thus conclude that the phonological planning span is smaller in Broca's than in Wernicke's aphasics and that the reduced planning span in Broca's aphasia at the syntactic level co-varies with their reduced planning span at the phonological level. Although this interaction between syntax and phonology may be of the less remarkable kind, it is worth stressing that it is far from a necessary one.

The second test centers around the incidence of omissions. As omissions are structure-dependent errors and as Broca's aphasics are presumed to be more disrupted in their structural component than Wernicke's, we would expect the former to produce relatively more omissions than the latter group. This prediction is supported by data from German patients though not by Blumstein's (1973) analysis of her English aphasics. Knels's (2001) Broca's patients made 37.7% deletion errors whereas Allerbeck's (2000) Wernicke's patients made only 19.8% deletion errors. The χ^2 test shows this difference to be statistically significant beyond the 0.02 level. As this result cannot be replicated for the English-speaking aphasics, it should not be taken as unambiguous support for (this aspect of) the Structural Theory.

The third test is focused on the word-onset effect. If word-initial errors are evidence of a well-developed suprasegmental representation and if Broca's aphasics are generally less sensitive to structural effects than Wernicke's, we may predict a lower rate of word-onset paraphasias in the former than in the latter population. As noted in section 8.1.2.6, German-speaking Broca's patients made 22.6% and Wernicke's patients 30.8% word-initial errors. This difference reflects a trend in the predicted direction but does not reach standard levels of significance ($p > 0.1$). Again, Blumstein's data for English do not replicate this trend. It might be wise not to place too much reliance on her findings in this respect as the rate of word-onset errors in her total sample is at odds with many other published reports. In any case, this pattern of results is difficult to interpret. The least that can be said is that this variation is less likely to be introduced by cross-linguistic processing differences than by methodological differences.

It is possible to extend the study of the interaction between syntax and phonology from adult patients to children with specific language impairment. On the assumption of an underdeveloped integration of linguistic components in child language, we might expect little interaction of syntax and phonology in first language learners. Interestingly, the clinical picture seems to suggest otherwise. In a real-word repetition task, Menyuk & Looney (1972) observed a significant correlation of syntactic and phonological error rates in English-speaking language-disordered children. Although suggestive, this result is not easy to assess in the present context because the distribution of errors across the content and structureful domains is not known. More informative is a study by Panagos & Prelock (1982) in which greater structural complexity at the phonological level increased the number of syntactic errors.

In an examination of Swedish language-disordered children, Nettelbladt (1992) distinguished between paradigmatic and syntagmatic problems with the phonological representation. According to her definition, paradigmatic processes include non-contextual segment substitutions whereas syntagmatic processes involve simplified word and syllable structures, reduplications, and harmonies. Nettelbladt observed that the children with a syntagmatic phonological disorder also suffered a syntactic disturbance. The simplifications found at the phonological level paralleled the simplifications at the syntactic level. For example, these children omitted consonants from clusters as well as bound morphemes from words. At the sequencing level, they had word order problems in syntax and produced consonant harmonies in phonology. This is another instance of the cross-level harmony constraint. The Structural Theory makes a noteworthy prediction about the incidence of these disturbances. As both syntax and syntagmatic phonology depend on the availability of structural representations and as structure is more difficult to process than content, a combined syntactic-phonological syndrome should be particularly common among language-disordered children. In fact, this is in accordance with Nettelbladt's data. Although her sample is limited, there is a majority of children with a syntactic-phonological deficit.

For what it is worth, this section has hinted at the possibility that a relationship may obtain between syntactic and phonological disturbances. Such a relationship is expected to hold in a model that takes aphasia to be a disruption to the structural component of language and assumes structure to be vulnerable at all linguistic levels at which it plays a role. Owing to the scarcity of pertinent data (and some inconsistency therein), the link between syntactic and phonological disorders could not be established with certainty even though a complete independence between syntax and phonology appears highly improbable. So, if anything, the present section attests to the crying need for more focused, large-scale studies.

8.5 CONCLUSION TO CHAPTER 8

This chapter has developed and tested the hypothesis that aphasia may be understood as a disruption to the structural component of language. This claim by no means denies the vulnerability of content units in aphasia. It just places the focus on the structural side and was formulated in an attempt to determine how much the Structural Theory contributes to an understanding of language breakdown. The overall picture that emerges from the preceding analyses is that the Structural Theory has a substantial contribution to make. While some of its predictions are largely redundant with other theories that view (agrammatic) aphasia as a syntactic deficit, it suggests that the disruption to the syntactic processor is but one instance of a more general disruption to the structural component. All major aphasic syndromes are often accompanied by the occurrence of phonological paraphasias that are characterized by a marked disturbance of the suprasegmental representation. This manifests itself in a reduced sensitivity to structural effects, which in turn is evidence for a less hierarchical structure than is encountered in normal speakers. This conception could be profitably extended to developmental aphasics who were predicted and found to erect an even less hierarchical structure than do normally developing children and adult aphasics.

The aphasiological data strongly support the claim that the breakdown of the linguistic system is not absolute but obeys the "principle of graceful degradation." The gradient weakening of the structural representation accords us a glimpse in a processing system that has preserved some but not all of its sensitivity to structure. That is to say, certain syntactic operations such as agreement can in principle be carried out but may also fail. In the phonological domain it was shown that the frequency of error types that are discouraged by a full-blown structural representation increases under a weak structural representation. Inversely, error types that are encouraged by a fully developed representation have a lower frequency under a weak structural representation (e.g., word-onset errors). This complementarity offers not only strong support for the Structural Theory, it also shows that aphasia cannot be understood as a general increase in the rate of errors as compared to normal speakers ("the exacerbation theory"). It seems more appropriate to view aphasia as a shift in error patterns (see also Sgaramella, Ellis, & Semenza, 1991, and Dell, Schwartz, Martin, Saffran, & Gagnon, 1997).

Intimately connected with the gradience issue is the claim that aphasics' deficits are of a processing, not of a representational nature. Typically, aphasics suffer no loss of representational categories. What is lost, however, is the free availability of these categories. The higher their position in the structural hierarchy is, the lesser their availability, as activation is assumed to spread bottom-up in the structural system. The reduced availability of structural units was observed at both the syntactic and the phonological level, suggesting that the two levels are organized in similar ways.[8]

It is certainly not a logical necessity that every aphasic with whatever syndrome exhibits an elevated rate of phonological paraphasias. However, it is a remarkable finding that phonological paraphasias are a frequent concomitant of (syntactically or otherwise defined) aphasia and quite homogeneous across syndromes. This has a curious two-fold implication. It suggests a certain independence between aphasia type and phonological paraphasias on the one hand and a certain dependence of phonological paraphasias on higher-level deficits on the other. The latter conclusion follows from the primary top-down information flow from meaning to sound in language production. The former conclusion hints at the possibility that Broca's and Wernicke's aphasics may be less distinct than is commonly thought (see Heeschen, 1985; Bates, Friederici, & Wulfeck, 1987, as well as Haarmann & Kolk, 1992 for a forceful defense of this view).

A central tenet of the Structural Theory is that structural nodes are more difficult to activate than content nodes. This difference entails the prediction that it should be possible to discern a dissociation between the two types of units in aphasia. To be more specific, we should find that the processing of structural units is impaired whereas that of content units is relatively spared (though not vice versa). An adequate test of this hypothesis presupposes the study of content units in isolation from structural units. One area where this condition is ideally met is the information exchange between the phoneme and the feature level. This takes place in ignorance of structural aspects because the decision on which phoneme to select for a particular position has no impact on the availability of a particular slot.

The processing interactions of phonemes and features are elucidated in phoneme substitution errors. Basically intact processing can be seen in error patterns that are characterized by a significantly lower number of feature changes than would be expected by chance. For instance, the substitution of /b/ by /p/ counts as a one-feature change (i.e., voicing) whereas the substitution of /b/ by /h/ counts as a three-feature change. Importantly, the minimal-distance principle is observed in the segmental substitution slips of competent adult speakers. By contrast, processing between the phoneme and feature levels may be thought disrupted when the interacting phonemes differ on more features than would be expected by chance.

We are now in a position to make the aforementioned prediction more precise. On account of the assumed differential difficulty of processing content and structural units, we predict a similarity relationship between interacting phonemes in paraphasias, exactly as we find in slips of the tongue. This prediction is perfectly fulfilled. Such a similarity relationship has been observed in a variety of languages (e.g., Green, 1969; Blumstein, 1973; Martin & Rigrodsky, 1974; Keller, 1978, all on English; Klein & Leuninger, 1988 on German; Moen, 1993 on Norwegian; Nespoulous, Lecours, & Joanette, 1982 on French; Niemi et al., 1985 on Finnish; Monoi et al., 1983 on Japanese; Law, 2004 on Cantonese). What is of particular significance in the present context is that this phoneme similarity effect shows up in exactly the same patients for which the build-up of the structural representation has been argued to be troublesome. It may thus be suggested that an impaired processing of structural information is often accompanied by a largely unimpaired processing of content units, precisely as predicted by the Structural Theory. Note, however, that these are preliminary results that call for more detailed investigations.

Finally, it may not be amiss to draw attention to the similar outcomes of this and the preceding chapter. Both language acquisition and language breakdown were found to follow the same path. This path may be conceived of as a straight line connecting the extreme poles of flatness and hierarchicalness. In the acquisition process, L1 and L2 learners move from less to more hierarchical whereas adult aphasics move in the opposite direction. Developmental aphasics may be assumed to move from less to more hierarchical more slowly than normally developing children. These analyses automatically follow from the simple nature of the path. Movement along it can only be forward or backward. Although there is no claim that all of language acquisition and breakdown can be captured by this theoretical framework, it has proved capable of accounting for the bulk of the empirical data presented in this chapter.

9 Structure Across Output Modalities

9.1 INTRODUCTION

All conclusions that have so far been reached about language have been based on the analysis of spoken language. By implication, it has been implicitly assumed all along that language can be equated with spoken language. However, this assumption is not necessarily correct. Viewed from the production angle, language typically materializes in the form of three activities—speaking, writing, and typing.[1] Without any confirmatory evidence, there is no reason to assume that the role of the structural component is identical across the three modalities. Therefore, an examination is required that compares these activities from a structural perspective. If no major differences emerge, the strategy of analysing spoken language as a means of understanding language in general would indeed be justified; if, however, the role of structure is modality-specific, it would be fallacious to look on language as a homogeneous object and make general statements about it. A probe into the non-spoken modalities might thus turn out to be a much-needed corrective to premature claims about language whose proponents have taken their cross-modal validity for granted.

The Structural Theory makes certain predictions as to where cross-modal differences may or may not occur. Actually, speaking, writing, and typing are basically similar in that they require the linearization of linguistic elements (i.e., the activation of intended units in their correct order, that is, at appropriate moments in time). It will be recalled that in the Structural Theory the slot tier is assumed to take care of precisely this task. We would therefore expect the slot tier as a prerequisite for linearization to be involved in all these linguistic activities. Furthermore, as gemination occurs in all modalities, the quantitative tier is also expected to be a modality-neutral requirement. However, given that the slot tier is part of the structural representation, the elements that are represented at the slot tier may allow for variation across modalities. Another potential source of variability is the degree of hierarchicalness of the structural representation. According to the Structural Theory, this representation opens the planning window. How wide this window is opened is clearly variable, as the previous chapters have demonstrated. It is quite possible therefore that speaking, writing, and typing differ in terms of the size of the planning window that they require.

Are there any reasons that would lead us to expect modality-specific differences in the structural representation? Among the numerous differences that exist between speaking and writing (see Drieman, 1962; Rubin, 1980; Chafe, 1982; Halliday, 1987; Biber, 1988; Scheerer, 1993), we focus only on those for which their relevance to structural issues is not a remote possibility. The first important aspect is a temporal difference. Writing is about 3 to 4 times slower than speaking (Newman & Nicholson, 1976; Hotopf, 1983; Miller, Grosjean, & Lomanto, 1984). This difference does not seem to be a result of language users being generally less practised in writing than in speaking. What effect may speed of motor execution have on the structural representation? It is reasonable to expect higher speed to require a higher degree of advance planning, which offers the opportunity of exerting control over a longer stretch of planned speech. So if a problem comes up in a later part of the utterance, it is discernible at an earlier moment in processing. As a consequence, there is more time to solve it and thereby prevent an error or the abortion of the utterance. Thus, the argument is that a higher speech rate may require a larger planning span, which in turn requires a more hierarchical structural representation.

The second difference turns on the codes used in speaking and writing. Whereas speaking uses a phonological code, writing relies on a graphemic code. If abstract phonemic and graphemic representations are penetrated by realizational aspects, the structural representation may vary across modalities.

We note as the third difference that speaking uses an auditory-temporal code whereas writing (like typing) employs a visual–spatial code. However, this difference is deceptive because when speaking and writing are viewed as processes rather than products, both converge on the same challenge (i.e., that of producing units in a certain order in real time).

The nature of these units may, however, be unequal and this leads us to the fourth difference. The units used in writing are usually regarded as discrete whereas those used in speaking are continuous. As a casual look at spectograms reveals, there are no clearly demarcated boundaries between phones, they typically run into one another. This does not hold good of writing where it is possible (though not necessary) to have blanks between adjacent letters and thereby realize discrete units. Even if no blanks are made, it is usually clear where one letter ends and another begins. In any case, there is no such overlap as in speaking. Of course, the same applies to typing, which is even more discrete than writing because typewritten letters are not linked in the way adjacent letters usually are.[2] What is the implication of this difference for the structural representation? The more overlap, the greater the necessity of advance planning. Speaking may consequently be expected to evolve a more hierarchical representation than writing and typing.

It emerges from the preceding discussion that there are a number of cross-modal differences that potentially impinge on structural representations. The least that can be concluded is that these differences seem important enough not to dismiss the possibility of structural differences among the modalities out of hand. If structural differences occur, we would expect the representation underlying speaking to be more hierarchical than that underlying writing and typing.

Another conclusion that is invited by this analysis is that of the three modalities under investigation, writing and typing seem to be more similar to each other than either of them is to speaking. So if differences in structural representation occur, we would expect to find them between writing and typing on the one hand and speaking on the other. Whether writing and typing share identical structural representations cannot be predicted with certainty.

9.2 DATA ANALYSIS

Although it is undisputed that speaking and writing have to be distinguished at some point in a model of language production, it is less than clear at which. I will take it as given that the two modalities need not be distinguished at and above the morphological level and that the distinction is most pertinent below the morphological level. The ensuing empirical analysis will therefore be limited to linguistic units smaller than the morpheme. The data that will be drawn on are malfunctions arising in the processes of speaking, writing, and typing (i.e., slips of the tongue, the pen, and the typewriter key). These offer the great advantage of being highly comparable as they are quite similar in nature, that is, they are all inadvertent deviations from the language user's intention.

The slip-of-the-tongue data come from the corpora that were previously utilized, in particular Stemberger's and my own. The slip-of-the-pen data were taken from two sources. Wing & Baddeley (1980) published in full a collection of spelling errors that were gleaned from university entrance examination papers written by 40 secondary school leavers. The authors introduced a distinction between pen slips and convention errors, the latter resulting from a lack of orthographic knowledge. Since our interest is in performance errors only, the convention errors were not included in the analysis. Further, all slips of the pen whose misordered graphemes potentially have a morphological status were also eliminated. Finally, clear cases of phonetic spelling such as *idear* for *idea* were discarded. This left us with 721 pen slips altogether.

The Wing & Baddeley corpus was supplemented by a second database that was compiled by myself through the monitoring of my own writing activities. The Berg corpus is smaller (N = 415) and possibly less representative than Wing & Baddeley's because it is a single-subject study. However, there are also advantages in having the perpetrator and the analyst in one person. For one thing, it is not always easy to decide whether an error reflects a lack of competence or is a performance phenomenon. As I can certainly assess my own knowledge of spelling more accurately than that of others, a sample of self-made pen slips is less likely to be contaminated by true spelling errors than a collection of other-made slips. For another, the analysis of spontaneous errors is often bedevilled by the fact that language users abort their utterances mid-way (i.e., before the error is completed). This early self-interruption upon the detection of trouble may create an ambiguity that makes an error hard to classify. The following slip of the pen illustrates this problem.

(1) Voicing is very hard to rel—realize on obstruents in final sites. (from Berg, 1997)

As it is not known how the writer would have gone on, this error is open to several interpretations. It may be an incipient switch (if the writer had gone on with an <a>) or a deletion (if the writer had gone on with an <i>). This interpretative difficulty is alleviated in self-made slips because writers very often (though certainly not always) have a preview of about one letter, that is, they may be aware of which letter they are going to write next. Obviously, this is the critical information that is needed for correct classification, which in turn is a prerequisite for a reliable quantitative analysis. For further methodological issues, the reader is referred to Berg (1997).

The slip of the key data were extracted from scientific publications dealing with linguistics and related disciplines. They were mostly collected by proofreading journal articles that I had read for content before. Data sampling was brought to a close when a total of 500 typographical errors had been collected. Of course, there is no guarantee that all misprints in the articles scrutinized have been caught. It is even likely that some of them went unnoticed. All I could do to keep this selectivity within reasonable bounds was to focus all my attention on spotting errors and ignore the content to the greatest possible extent.

It is clear that the typographical errors under examination are the remaining few to have survived the several rounds of proofreading to which a scholarly article is usually subjected before and during the production process. It stands to reason that this proofreading heavily biases the error distributions to the effect that only those errors make it into the printed version that are most difficult to notice. A likely hypothesis is that the grosser the deviation from the intended output, the easier the error is to detect. The remaining slips would then be those in which the discrepancy between intended and actual output is relatively minor.

Unfortunately, this problem is difficult to deal with because we lack a comprehensive probe into the differences in the distribution of easy and hard-to-detect errors. For the time being, the only possible way out is to compare the hard-to-detect data with more balanced corpora. To the extent that such corpora are available, the samples agree to a surprisingly high degree, at least with respect to many aspects around which the following cross-modal analysis is centred (see Berg [2002a] for details).

The aspects on which the slips of the tongue, the pen, and the key will be compared are precisely those that have figured prominently in the analysis of cross-linguistic differences (Chapter 5), language acquisition (Chapter 7), and language breakdown (Chapter 8). Naturally, these are the points that are of immediate relevance to an understanding of the structural component. The logic of the argument will accordingly be exactly as in the previous chapters and will not be repeated in full. Examples of slips of the pen and the key will be provided in each subsection. The former error type is abbreviated as SP, the latter as SK. All data are from English.

9.2.1 Contextual versus Non-Contextual Errors

As in section 8.1.2, the first distinction to draw is that between contextual and non-contextual errors. Two pertinent slips of the key follow.

(2) SK: it is important to re*b*em*b*er an historical coincidence / for: re*m*ember.

(3) SK: Then there are special *d*roups. / for: *g*roups.

In (2), the first <m> of the second syllable of *remember* was replaced with the <b> from the third syllable of the same word. The nearby <b> thus motivates the occurrence of the slip. No such motivation is discernible in (3), which is therefore classified as non-contextual.

Table 9.1 presents the number of contextual and non-contextual slips in speaking, writing, and typing. The written-language data were taken from Wing & Baddeley's corpus of pen slips, the spoken-language data from Stemberger's corpus of tongue slips. The logic underlying the following analysis is that the higher the rate of contextual errors, the larger the planning span and hence the more hierarchical the structural representation.

Table 9.1 Frequency of Contextual and Non-Contextual Slips in Speaking, Writing, and Typing

	Contextual	*Non-Contextual*
speaking	1845 (85.1%)	324 (14.9%)
writing	514 (74.1%)	180 (25.9%)
typing	359 (71.8%)	141 (28.2%)

As Table 9.1 shows, contextual slips outnumber non-contextual ones in all three output activities. The highest rate of non-contextual errors occurs in typing. However, the difference between contextuals and non-contextuals in typing and writing is not statistically significant ($\chi^2(1) = 0.9$, $p > 0.3$), leading us to conclude that contextuality has the same status in these two modalities. On the other hand, the incidence of contextual slips is significantly higher in speaking than in writing ($\chi^2(1) = 44.1$, $p < 0.001$) and typing ($\chi^2(1) = 49.9$, $p < 0.001$). The finding that contextuality plays a more important part in speaking than in writing and typing suggests that the former modality is guided by a more hierarchical structural representation than the latter two modalities. No difference in hierarchicalness is observed between writing and typing.

9.2.2 Descriptive Error Categories

At the descriptive level, slips are customarily categorized into three major groups—substitutions, additions, and omissions. All of the errors just discussed involve substitutions. Examples of an addition and an omission are provided in (4) and (5), respectively.

(4) SK: Thus the in*i*tuitive version of Lounsbury's hypothesis was supported. / for: intuitive.

(5) SK: For example, the phonologi_al time node generates more impulses per second / for: phonologi*c*al.

The error in (4) contains one <i> too many whereas the error word in (5) lacks a <c>.

A heightened rate of omissions would be expected under a weak structural representation because omissions may result from the insufficient activation of slot units. For additions, the predictions of the Structural Theory are more ambiguous. As explained in section 7.2.2, an underdeveloped structural representation may lead to an increase or a decrease in the incidence of addition errors. The decrease in additions may be motivated in the same way as the increase in deletions. The increase in additions may arise because the insufficient activation of slot units cannot prevent the overgeneration of both quantitative and qualitative units, which is tantamount to addition errors. It is not easy to predict which possibility will obtain under which circumstances. One speculation is that aphasic speakers will show a decrease in additions on account of a general reduction of activation levels whereas normal speakers will show an increase in additions because they do not suffer the said problem. Because writers and typists are normal in this sense, they may be expected to produce relatively more additions than speakers.

Table 9.2 reports the frequency of the three descriptive error categories in speaking, writing, and typing. With respect to slips of the tongue, the

Table 9.2 Frequency of Substitutions, Additions, and Omissions in Speaking, Writing, and Typing

	Substitutions	*Additions*	*Omissions*
speaking	2249 (88.0%)	200 (7.8%)	107 (4.2%)
writing	295 (45.5%)	95 (17.6%)	199 (36.9%)
typing	217 (43.4%)	83 (16.6%)	200 (40.0%)

substitution data, both contextual and non-contextual, come from Stemberger (1985), the addition and omission data from Stemberger & Treiman (1986). The slips of the pen are again Wing & Baddeley's.

It can be seen from Table 9.2 that the distribution of slips of the tongue across the three descriptive categories is very different from that of slips of the pen and the key whereas the proportions of substitutions, additions, and omissions are highly similar in handwriting and typewriting ($\chi^2(2) = 1.0$, $p > 0.5$). The difference between tongue slips and pen slips is highly significant ($\chi^2(2) = 693.2$, $p < 0.0001$), as is the difference between tongue slips and key slips ($\chi^2(2) = 675.7$, $p < 0.0001$). The rate of omissions is dramatically higher in writing and typing than in speaking. The percentage of additions in writing and typing is double that in speaking.[3] Both findings conform to the predictions of the Structural Theory. It may therefore be argued that the units of the slot tier are less strongly activated in writing and typing than in speaking. This is a consequence of the claim that the structural representation is weaker in the former than in the latter modalities.

9.2.3 The Distance Between Error and Source Unit

The next distinction applies only to contextual slips and focuses on the distance between error and source unit. As before, the critical criterion is whether or not a word boundary is crossed. A between-word slip of the pen is exemplified in (6) and a within-word case in (7).

(6) SP: Only those words w*o*re—were taken into consideration

(7) SP: may induce the listener to categorize it fa*sl*—falsely as another phoneme.

No. (6) evidences the perseveration of the vowel grapheme <o> across a word boundary, (7) the switch of two adjacent consonants in the same word. The larger the distance is between error and source unit, the larger the planning span and therefore the more hierarchical the structural representation. Table 9.3 draws on exactly the same databases as Table 9.1.

Table 9.3 Frequency of Between- and Within-Word Slips in Speaking, Writing, and Typing

	Between-Word	*Within-Word*
speaking	1605 (87.0%)	240 (13.0%)
writing	106 (20.6%)	408 (79.4%)
typing	39 (10.9%)	320 (89.1%)

Inspection of Table 9.3 shows diametrically opposed tendencies. The preponderance of between-word slips in speech is about as strong as the preponderance of within-word errors in writing and typing. Not surprisingly, the difference between speaking and writing is hugely significant ($\chi^2(1) = 921.9$, $p < 0.0001$), as is the difference between speaking and typing ($\chi^2(1) = 836.1$, $p < 0.0001$). Although both slips of the pen and the key exhibit a clear preference for within-word slips, this preference is significantly stronger in the typographical than in the spelling errors ($\chi^2(1) = 15.5$, $p < 0.001$).

The interpretation of these results is straightforward. The capacity of looking ahead is much more fully deployed in speaking than in writing and typing. The planning span appears to be even shorter in typing than in writing. These differences are readily explained on the assumption that the structural representation unfolds in more hierarchical fashion in speaking than in writing and typing. The latter two modalities are dominated by a fairly flat representation that imposes a considerable "short-sightedness" on language users. Writers and typists seem to adopt a word-by-word strategy, at least as far as the build-up of a graphemic representation is concerned.

9.2.4 Reversals versus Switches

Reversals and switches are distinguished by the distance of the interacting elements. This distance is zero in the case of switches (i.e., no intervening material) but larger in the case of reversals. As argued in the preceding subsection, slips of the pen and the key arise within a smaller planning span than slips of the tongue. We would accordingly expect switches to occur more commonly in writing and typing than in speaking. The opposite claim holds for reversals. An example of a switch was provided in (7) shown earlier, a reversal of two graphemes is illustrated in (8).

(8) SP: de*dic*e. for: decide.

Table 9.4 presents the number of exchanges and switches in the three modalities. The speech error analysis is based on Harley's corpus, the writing error

Table 9.4 Frequency of Reversals and Switches in Speaking, Writing, and Typing

	Reversals	*Switches*
speaking	262 (99.2%)	2 (0.8%)
writing	7 (21.9%)	25 (78.1%)
typing	7 (6.6%)	99 (93.4%)

analysis on Wing & Baddeley's. Only the unambiguous cases from Wing & Baddeley's collection are taken into consideration (for a fuller analysis, see Berg, 2002a).

The disparity between speaking on the one hand and writing and typing on the other can hardly be more pronounced. Whereas reversals constitute the overwhelming majority in speaking, switches by far outnumber exchanges in writing and typing. The difference between tongue slips and pen slips is statistically significant ($\chi^2(1) = 202.2$, $p < 0.0001$), as is the difference between tongue slips and key slips ($\chi^2(1) = 326.1$, $p < 0.0001$). A significant difference also exists between pen slips and key slips ($\chi^2(1) = 7.5$, $p < 0.01$). However, it is questionable whether a great deal of theoretical significance should be attached to the latter finding. It is likely to be a methodological artifact. Reversals are easier to notice than switches as the former involve two problems in separate places whereas the latter involve two problems in (almost) the same place. When this particular site is not closely attended to, the error may be missed. In reversals, by contrast, it is possible to fail to spot the one problem but still detect the error because the second problem has been spotted. As noted earlier, there is the real danger that conspicuous errors do not survive the proof stage. Reversals may therefore have been effectively eradicated from typewritten texts and consequently be underrepresented among the slip of the key data.

The results in Table 9.4 leave no doubt that speakers operate with a larger planning span than writers and typists. It follows from this that a more hierarchical structural representation is unfolded in speaking than in writing and typing. There is a remarkable complementarity between this and the preceding subsection. For both writing and typing, section 9.2.3 showed a higher interferential effect within words than between words and the present subsection showed a higher interferential effect between adjacent than between non-adjacent units. Taken together, these findings imply that the interferential effect increases as the linear distance between potential interactants decreases. This constitutes further evidence for the weakness of the structural representation in writing and typing.

9.2.5 The Parallel Syllable Structure Constraint

The distinction between reversals and switches has implications for the parallel syllable structure constraint. Not all error classes can be equally sensitive to it. Because switches by definition involve contiguous units and because these units cannot be homologous, switches necessarily flout this constraint. However, many within-word and all between-word reversals are free to respect it. The parallel syllable structure constraint was respected in (2) but disrespected in (7).

If handwriting and typewriting are less hierarchical than speaking, we may expect a higher violation rate of the parallel syllable structure constraint in the former than in the latter modalities. Table 9.5 addresses this issue. The same databases were used as before with the exception of my corpus of self-produced slips of the pen, which has been added for comparative purposes. The data were broken down according to whether the word boundary was or was not crossed.

It is immediately apparent from Table 9.5 that the parallel syllable structure constraint is far less respected in writing and typing than in speaking. All comparisons reach statistical significance beyond the probability level of 0.0001. The two slip of the pen corpora are statistically indistinguishable ($\chi^2(1) = 0.3$, $p > 0.3$), attesting to the reliability of both data sets. Further, there is a significant difference between slips of the pen and the key ($\chi^2(1) = 18.7$, $p < 0.001$). It is not clear how the latter difference should be interpreted because slips of the key differ from slips of the pen only in the within-word but not in the between-word domain. If there is a real difference, it should show up in both domains. It may well be that there is a real

Table 9.5 Violation Rate (in %) of the Parallel Syllable Structure Constraint in Speaking, Writing, and Typing (Consonant Substitution Errors Only)

	p.c. : p.p.	*p.c. : p.p*	*p.c. : p.p*
	Within-Word	*Between-Word*	*Total*
speaking	60 : 220 (21.4%)	28 : 1735 (1.6%)	88 : 1955 (4.3%)
writing I (Wing & Baddeley)	91 : 46 (66.4%)	33 : 52 (38.8%)	124 : 98 (55.9%)
writing II (Berg)	152 : 85 (64.1%)	20 : 37 (35.1%)	172 : 122 (58.2%)
typing	93 : 18 (83.8%)	5 : 8 (38.5%)	98 : 26 (79.0%)

(Note: p.c. = position-changing; p.p. = position-preserving) difference but that the number of pertinent key slips in the between-word domain is too low to bring it forth.

Another result that emerges from Table 9.5 is that all modalities exhibit less sensitivity to the parallel syllable structure constraint in the within-word than in the between-word domain. This highly consistent effect shows that the (in)sensitivity to structure is multiply determined and that the individual factors contributing to the reduction of this sensitivity are additive. The explanation for the lesser structure sensitivity of within-word as compared to between-word errors is assumed to be the following. Within-word slips arise at an earlier point in processing at which the hierarchical structure has only been weakly unfolded and are therefore less subject to the parallel syllable structure constraint than between-word slips (see Berg & Abd-El-Jawad, 1996).

To conclude, it transpires that speaking is much more sensitive to the parallel syllable structure constraint than writing, which in turn might be more sensitive to it than typing. This cross-modal difference is enormous. Whereas violations are exceptional in speaking, they are in the majority in handwriting and typewriting. This differential sensitivity lends credence to the claim that speaking is erected under a more hierarchical representation than writing and typing.

9.2.6 The Word-Onset Effect

The next effect to be studied is the vulnerability of word-onset processing in English. As explained before, it is a structural effect because this error-proneness follows from the lack of embedding of word-initial consonants in the suprasegmental representation. If this representation is weak, the difference between word-onset and non-word-onset consonants is small and so the word-onset effect tends to be absent. We may therefore use the word-onset effect as a test case for the hierarchicalness of the three modalities in question. An example of a word-onset slip was given in (3), a non-word-onset error appeared in (2). For the following analysis, a rigorous definition of word onset was used according to which only those errors that occurred as the very first consonant were included in this category. All others were assigned to the non-word-initial set. As information on the rate of thus-defined word-onset errors has not been published for English, I had to fall back on my German collection for which we have no reason to expect major differences from English. Although this is a less than ideal procedure, the empirical pattern is so clear-cut that a slight language-specific distortion would not change the levels of statistical significance. The results are tabulated in Table 9.6. As in the preceding table, a distinction was drawn between within-word and between-word slips.

The findings displayed in Table 9.6 are very clear. The proportion of word-onset errors is much lower in slips of the pen and the key than in slips of the tongue. The difference between tongue slips and pen slips is highly

Table 9.6 Rate of Word-Onset Errors (in %) in Speaking, Writing, and Typing (Consonant Substitution Errors Only)

	w.i. : non-w.i. *Within-Word*	*w.i. : non-w.i.* *Between-Word*	*w.i. : non-w.i.* *Total*
speaking	26 : 44 (37.1%)	647 : 377 (63.2%)	673 : 431 (61.0%)
writing	2 : 412 (0.0%)	5 : 104 (4.6%)	7 : 516 (1.3%)
typing	1 : 31 (3.1%)	4 : 8 (33.3%)	5 : 39 (11.4%)

(Note: w.i. = word-initial)

significant ($\chi^2(1) = 625.7$, $p < 0.0001$), as is the difference between tongue slips and key slips ($\chi^2(1) = 43.1$, $p < 0.001$). Also, there are significantly more word-onset errors in typing than in writing ($\chi^2(1) = 17.2$, $p < 0.001$). What is noteworthy beyond these statistical tests is the extreme rarity of word-initial errors in writing, and to a lesser extent, in typing. This justifies the claim that the word-onset vulnerability in speaking is accompanied by a word-onset stability in writing and probably also in typing. It is not known which modality-specific factors so effectively protect the word-onset position from error.

In consonance with the results of Table 9.5, the data are highly consistent as regards the interaction between the word-onset effect and the distance between the interacting units. In all three modalities, the word-onset effect emerges significantly more strongly in the between-word category than in the within-word set. This is entirely expected on the view that between-word slips arise later than within-word slips and that the later errors display more sensitivity to structural effects than the earlier ones.

The only doubtful aspect about Table 9.6 is the slip of the key data. It can readily be seen that the absolute number of pertinent errors is quite low. This means that random fluctuations would have a rather large effect on the percentage of word-initial slips. It therefore seems advisable not to place too much emphasis on the difference between slips of the pen and the key. It might be that this difference lessens with a larger and less biased data base.

Despite this uncertainty, it is patently clear that speech errors, writing errors, and typing errors arise under radically different structural representations. Whereas speaking is governed by a hierarchical representation, writing and typing are guided by a largely flat representation. However, as the between-word errors show, also this relatively flat representation unfolds some degree of hierarchicalness at later stages of processing.

9.2.7 Directionality

To repeat, contextual slips may be subdivided according to whether the error unit precedes or follows the source element. The former type is commonly referred to as anticipation and was illustrated in (2), while the latter is known as perseveration and was exemplified in (6). If the planning span is small, the number of anticipations is low. Thus, a weak structural representation is predicted to lead to proportionally fewer anticipations than a fully developed one. The tongue slip data are based on my own error collection. As usual, the pen slip data are based on the Wing & Baddeley sample.

Table 9.7 reveals an interaction between directionality and modality. The ratio of anticipations to perseverations is significantly higher in slips of the tongue than in slips of the pen ($\chi^2(1) = 7.7, p < 0.01$) as well as in slips of the key ($\chi^2(1) = 6.3, p < 0.02$). By contrast, slips of the pen and the key are statistically indistinguishable ($\chi^2(1) = 0.6, p > 0.3$).

In comparison with previous analyses, it is notable that the difference between speaking on the one hand and writing and typing on the other is much less dramatic (though still reliable). This suggests that the ratio of anticipations to perseverations cannot be so easily changed. Why is it so difficult to substantially decrease the rate of anticipations? Even a reduction of the planning span appears to leave enough opportunities for anticipatory errors. A look-ahead of only the upcoming units in the current word is sufficient for anticipatory slips to arise as the predominant error type because the activation level of upcoming units is still higher than that of already-used elements. This may explain why the anticipation/perseveration ratio does not differ across modalities as radically as the effects previously discussed.

The results of Table 9.7 may be interpreted as follows. Speaking allows for a higher anticipation rate because of its larger planning span whereas the smaller planning span in writing and typing reduces the incidence of anticipations. Hence, the latter two modalities are subject to a less "far-sighted" (i.e., less hierarchical) structural representation than speaking.

Table 9.7 Rate of Anticipation and Perseveration Errors in Speaking, Writing, and Typing

	Anticipations	*Perseverations*
speaking	1626 (68.7%)	742 (31.3%)
writing	178 (60.5%)	116 (39.5%)
typing	37 (54.4%)	31 (45.6%)

9.2.8 Length of Target Word

We proceed to an examination of the length of the target word, which is usefully measured in syllables. It is appropriate to focus on the target rather than the error word because the actual malfunction occurred in the target word (and thereby turned it into an error word). In any event, target and error word differ in length only very rarely. It was shown in section 8.1.2.8 that there is an interaction between the length of the target word and the probability of speech errors. These occur more frequently in longer than in shorter words. This effect was argued to be of a structural nature as longer words require not only a larger number of slots but also more hierarchy above the slot tier. Given that this effect arises under a full-fledged structural representation, it is to be expected that a reduced structural representation will strengthen this interaction and lead to relatively more errors in longer words.

To test this prediction, the length of the target word in slips of the tongue was determined on the basis of the first 1024 items from Harley's speech error collection (Boxes 1–7). This information is contained in Table 8.1 and incorporated in Table 9.8. The length analysis for slips of the pen was carried out on Wing & Baddeley's complete sample (save some unclear cases). By the same token, all of the items in the key slip corpus were taken into consideration. Syllable number for the written and typed words was calculated as if these words were spoken.

There is a remarkable regularity in Table 9.8. The target words in slips of the tongue decrease in frequency as their syllable number increases. Monosyllabic words form by far the most frequent class, making up almost half of the entire data set. By contrast, the frequency curve peaks in the disyllabic words in slips of the pen and in the trisyllabic words in slips of the key. There is a steady decrease to the left and the right of these peaks. It is obvious from the percentage figures in Table 9.8 that the average length of the target word increases from slips of the tongue to slips of the pen to slips

Table 9.8 Error Rate as a Function of Length of Target Word in Speaking, Writing, and Typing

Word Length in Syllables	*One*	*Two*	*Three*	*Four*	*Five*	*Six*	*Seven*	*Total*
speaking	502 (49.0%)	344 (33.6%)	112 (10.9%)	55 (5.4%)	9 (0.9%)	2 (0.2%)	0 (0.0%)	1024
writing	188 (26.6%)	226 (32.0%)	163 (23.1%)	91 (12.9%)	32 (4.5%)	5 (0.7%)	1 (0.1%)	706
typing	70 (14.0%)	115 (23.0%)	127 (25.4%	114 (22.8%)	64 (12.8%)	10 (2.0%)	0 (0.0%)	500

of the key. All the statistical tests yield highly reliable results. The difference between tongue slips and pen slips is significant ($\chi^2(5) = 143.4$, $p < 0.001$). The same holds true of the difference between tongue slips and key slips ($\chi^2(5) = 375.5$, $p < 0.001$) and that between pen slips and key slips ($\chi^2(5) = 76.5$, $p < 0.001$).[4]

A major finding from section 8.1.2.8 was that the error probability in speaking increases with word length. This effect shows up more strongly in handwriting and even more strongly in typewriting. The explanation that may be offered for this pattern is that the structural representation is weaker in typing and writing than in speaking and therefore less able to protect processing on longer words from going awry. It may be concluded for all three modalities that the weaker the structural representation, the higher the error rate in longer words.

9.2.9 Size of Error Unit

The final analysis concerns itself with the size of the error unit. If there was no suprasegmental structure at all, the only units that could be involved in errors would obviously be content units. At the submorphemic level, only segment-sized (and feature) slips would be eligible. The stronger the structural representation, the higher the number of "unorthodox" slips such as CV and VC errors. This number may therefore be taken as an index of the hierarchicalness of the structural representation. In the following, the frequency of these unorthodox errors will be compared across the three modalities. The expectation is that if writing and typing are governed by a weaker structural representation than speaking is, slips of the tongue will show a higher rate of complex errors than slips of the pen and the key.

Before the analysis proper, it is necessary to make brief mention of an error type that seemingly affects larger units but should not be included in this cross-modal comparison. This category involves geminates (i.e., adjacent identical units), as illustrated in (9).

(9) SK: so as to provide a channel of co*nn*u*m*ication between researchers / for: communication.

No. (9) documents the exchange of a single consonant (<n>) and a geminate consonant (<mm>). Such errors may (and do) occur in writing and typing because these two modalities allow the gemination of many letters and keys in ordinary language use. However, this is not so in speaking. Within-morpheme gemination is absent in the phonology of English. Hence, slips involving geminates are perforce missing from English speech error corpora. This cross-modal asymmetry makes it advisable to ignore this error type in the ensuing analysis.

Let us begin with slips of the tongue. As noted in section 2.5.1.6, Stemberger (1983a) has 57 CV and VC errors in his corpus. This amounts to approximately 1% of the entire database and c. 3% of all phonological errors. The number of cluster errors of all types (i.e., CC → CC, C → CC, and CC → C) in his collection is not available. However, my German data show cluster errors to be relatively frequent (N = 132, only two-consonant clusters counted). These constitute 2.2% of the entire data set and 5.3% of all phonological slips. As Stemberger's and my corpus are similar in size, the percentages across the collections are roughly comparable and may be added up. Other phonological units such as syllables and superrimes need also to be taken into consideration. As a rough guideline, we may estimate that approximately 10% of all phonological slips of the tongue involve units larger than the single phoneme.

Slips of the pen present a different picture. There are hardly any writing errors in which more than a single grapheme is affected. My sample of pen slips contains only one (ambiguous) CC and one VC but no CV error. Apart from a number of complex masking errors that straddle syllable boundaries, only one (ambiguous) CC and one (ambiguous) CV slip are attested in Wing & Baddeley's database. The latter two slips are reproduced in (10) and (11).

(10) SP: While traversing flat lat—land the only work (from Wing & Baddeley, 1980, Box 30)

(11) SP: molecules to actually ve—leave the mass of (from Wing & Baddeley, 1980, Box 22)

A likely interpretation of (10) is in terms of a coda error. The complex target coda <nd> was replaced by the simple coda <t>. However, as we do not know what was to come subsequent to the error grapheme, this interpretation is not the only possible one. Case (11) may be classified either as an anticipatory substitution of <l> by <v> or as an omission of the sequence <lea>. Only on the latter interpretation would we have an instance of a CV slip.

In terms of percentages, it is obvious that less than 1% of the pen slips implicate more than a single grapheme. The pronounced rarity of these errors cements the claim that the predominance of single-element errors is more extreme in pen slips than in tongue slips.

Turning to slips of the key, we find a situation that parallels the patterns in slips of the pen. My corpus of typographical errors includes only two slips that affect two units simultaneously. These are given in the examples to follow.

(12) SK: The typical Old English diphthongs were all monoph_ongized / for: monoph*th*ongized

(13) SK: and geminate pseudo-substi_tions. / for: substi*tu*tions.

As can be seen, both slips demonstrate the deletion of material. The digraph <th> is dropped in (12) and the sequence <tu> is omitted in (13). The latter case corresponds to what would count as a syllable in spoken language. Substitutions and additions of consonant clusters or CV and VC combinations are lacking. Clearly, these few cases constitute less than 1% of the key slip collection.

It can thus be established with certainty that the predominance of single-unit errors is higher in slips of the pen and the key than in slips of the tongue. Whether there is also a difference between key slips and pen slips is impossible to tell in the light of the extremely low number of pertinent cases in the two modalities. At present, there is little indication of a differential proneness to two-element errors.

By way of conclusion, slips of the pen and the key have been found to involve complex units appreciably less often than slips of the tongue. As complexity is a function of cohesiveness and cohesiveness a function of hierarchical structure, writing and typing may be argued to be subject to a less hierarchical representation than speaking. A synthesis of the preceding subsections will be offered next.

9.3 DISCUSSION

The major result of this chapter is exceptionally clear. Language is not a homogeneous object about which general statements pertaining to its structural representation can be made. The concept of language has to be broken down into its output activities for which disparate properties obtain. Whereas speaking is influenced by a strongly hierarchical representation, writing and typing are under the sway of a relatively flat structural representation (contra Weingarten, Nottbusch, & Will [2004] whose model does not predict any of the differences observed in the present chapter). Hence, language should be viewed as a modality-specific phenomenon. This claim has vast implications for linguistics, which can only be briefly touched on here. Perhaps the most general implication is that the homogeneity assumption that tacitly underlies a good deal of linguistic research can no longer be taken for granted. Although it is not necessarily the case that all properties of language are modality-specific, this chapter has shown that even such core areas as structural representations are not exempt from cross-modal variability. It is therefore not possible to argue that cross-modal variability can be neglected because it affects only the peripheral aspects of language.

It follows from this that all the claims that have been made within the homogeneity assumption need to be reassessed. It has to be examined whether a hypothesis that has been put forward about language in general has to be reinterpreted as a hypothesis about a particular modality. Relevant examples abound. Is the syllable a property of language or rather a property of spoken language? Is (multiple) centre-embedding a property of the English language as such or a property of written English? A third example of the modality-specificity of linguistic constructs will be discussed in greater detail later on. There may not be simple answers to these questions as it is quite possible that the cross-modal differences are of a quantitative nature. Even so, it may not be justified to make modality-neutral claims about language on the basis of a single output modality.

Although the empirical data revealed a striking consistency in that all nine tests set speaking apart from handwriting and typewriting, the relationship between the latter two modalities is more difficult to establish. In four of the nine tests, no statistically significant difference between slips of the pen and the key was observed. In another four, slips of the pen evinced a greater sensitivity to structural effects than slips of the key whereas the reverse was true of only one test (namely the word-onset vulnerability). At present, it is not clear whether writing and typing are structurally alike or whether the structural representation is weaker in typing than in writing. The relatively minor difference between writing and typing leads one to suspect that the inconsistency may be attributable to methodological differences in data collection. It will be remembered that the keying error corpus is possibly more biased than the writing error corpus. It cannot be ruled out that this bias has distorted the results of some tests, though not those of others. Only a fully representative slip of the key collection can tell.

Although all nine criteria yielded significant differences between speaking on the one hand and writing and typing on the other, the extent of the differences varies greatly. At the low end of the scale, the difference between speaking and writing in terms of the anticipation/perseveration ratio was relatively small whereas, at the high end of the scale, the ratio of within-word to between-word errors was diametrically opposite in speaking and writing. One possible explanation for this is that there is a limited independence between the empirical effects and that these are facilitated by several mechanisms of which the structural representation is only one. It is probable that the various effects require partly individual explanations. In the case at hand, it would seem that the planning span is so severely reduced in writing relative to speaking that the ratio of between-word to within-word slips is overturned. However, this paring down of the planning span need not affect the anticipation/perseveration ratio to the same extent as the proportion of within-word to between-word slips because upcoming elements may always be more strongly activated than already-used elements, irrespective of the size of the planning window. This principle would guarantee that the anticipation/perseveration ratio may remain largely unchanged even if the size of the planning window is reduced. Nonetheless, because the two empirical effects are of a structural nature, they co-vary to a certain degree. The general claim, then, is this. All nine empirical effects co-vary but the degree of co-variation of any two effects is variable. This is because the degree to which a given effect is structural in nature is variable.

As another example of the limited independence between the empirical effects discussed in section 9.2, let us return to contextuality and the distance between error and source unit. The difference between speaking and the other two modalities was found to be much more pronounced with respect to the distance between error and source unit than with respect to contextuality. This suggests that more is at issue than just cross-modal differences in window size. If this explanation was sufficient, one might have expected either a lower rate of non-contextual, or a higher rate of between-word, pen, and key slips. The fact that neither of these expectations is fulfilled does not follow directly from the Structural Theory. It suggests a certain independence between contextuality and the distance of interacting units. The empirical effects reported in Table 9.1 and Table 9.3 may be accounted for by claiming that the activation strategy employed by writers and typists has a narrow focus. The graphemes belonging to a given word are activated fairly strongly, whereby non-contextual intrusions are given little chance, whereas the graphemes belonging to words not currently being written or typed are hardly activated at all, whereby between-word interactions are hardly given any chance. However, there is also an underlying mechanism common to the two empirical effects under consideration. With less look-ahead (due to less hierarchicalness), there is concurrently a lesser opportunity for between-word slips and a lesser opportunity for contextual slips to arise because the number of contextual competitors is lower. Indeed, this interaction between contextuality and distance, expected as it is from the perspective of the Structural Theory, is evident in the error patterns.

The nine criteria examined earlier were directed at determining the hierarchicalness of the structural representation across modalities, in particular at how strongly structural units are activated. Quite independent of the issue of activation levels is the nature of the representation of the linguistic units. The Structural Theory makes some intriguing predictions in this regard. Two types of linguistic units are of relevance here—the quantity units and the slots. As structural units, slots are predicted to be a possible source of cross-modal variability. Thus, structural variation applies not only to the activation levels of structural units but may also extend to their representational status. In contradistinction to this, the Structural Theory predicts no variation with quantity units for the simple reason that they belong to the class of content units. Let us begin, then, with a brief foray into the content domain.

Building on the discussion of the quantity level in section 1.4, we will enquire into its reality in writing and typing. The most compelling evidence for the quantity tier is the double dissociation of quantity and quality. That is to say, it should be possible to observe errors that occur solely on one level but not on the other. Relevant cases permitting us to study the individual contributions of the two levels involve the interaction of singletons and geminates. This interaction may take one of two forms, as illustrated in (14) and (15).

(14) SP: an intermediate level of vigilance may in general be su*ccif*ic—sufficient for monitoring position A.

(15) SK: and will be able to reject incorrect names pro*ferr*ed by the examiner. / for: proffered.

Number (14) exemplifies a reversal of qualitative information whereas (15) attests to a transposition of quantitative information (and nothing but). In (14), the two qualitative units, <f> and <c>, swap places. As such, they are blind to the number of times they are to be produced (i.e., to the information coded at the quantity tier). Owing to this representational independence, the singleton <c> is geminated and the double <ff> is degeminated. Thus, the exclusive locus of the error is the qualitative tier. In (15), by contrast, the order of the qualitative units is left untouched. What is exchanged is the doubling feature and the "singling" feature. Accordingly, the geminate <ff> is degeminated and the singleton <r> is geminated. As only quantitative information is involved, this error can be exclusively located at the quantity tier. Taken together, errors (14) and (15) evidence the double dissociation between the quantity and the quality levels in writing and typing. It may be concluded that, in conformity with the Structural Theory, qualitative and quantitative units in their quality as content units are cross-modal constants.

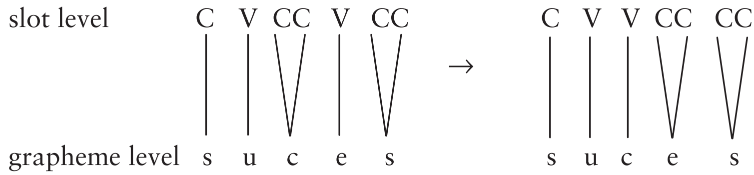
We now move on to an analysis of the cross-modal representation of the units coded at the slot level. Errors (14) and (15) documented the interaction of two consonantal graphemes. However, this is not the only possibility. What we also find is the interaction between a consonant and a vowel grapheme of which one is a singleton and the other a geminate. An example from writing is given in (16), one from typing in (17).

(16) SP: atmosphere can be su*cee*ssfully—successfully used in buildings. (from Wing & Baddeley, 1980)

(17) SK: I believe it is impo*sii*ble to find a situation / for: impossible.

Both errors are of the same type. Whereas the correct order of the units is preserved, the doubling and the singling feature exchange places, with the former docking on the <e> and the latter on the <c> in (16). A similar account is appropriate for (17). The two errors thus resemble (15). However, they differ from (15) not only in terms of the units involved but also in terms of their (non)adjacency. The critical question is under what representational system such slips may arise. If writing and typing are assumed to make use of the same inventory of slots as speaking (i.e., C/V-units), a malfunction at the quantity tier in (16) would take the following form. For simplicity, the quantity and the slot tier will be conflated in the following diagrams. The distinction at issue here is that between the quality tier on the one hand and the quantity and slot tiers on the other.

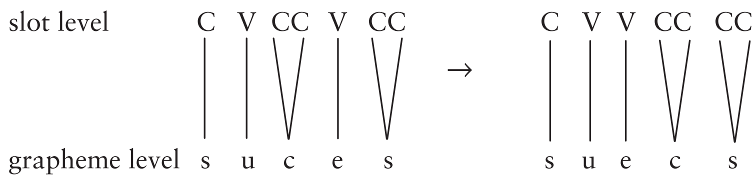
(18)



Although (18) generates the superficially correct error *suceess*, this account is not viable. The representation in (18) is ill-formed because consonant graphemes are associated with V-slots and vowel graphemes with C-slots. There is no sense in which the <c> in (16) can acquire vocalicness. If anything, it is a consonant *tout court*. What is more, if a C- or V-slot can freely dominate any element at the grapheme tier, it does not make any difference whether a C- or a V-unit is chosen in any particular case. By implication, the distinction between consonantal and vocalic slots would be redundant and lose all of its motivation.

This problem is avoided if it is assumed that the slot and the grapheme tier are simultaneously affected in (16). The corresponding representation is depicted in (19).

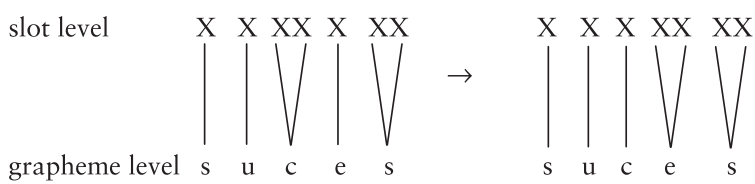
(19)



Although this representation is linguistically well-formed, it fails for the simple reason that it generates the wrong result, to wit: *sueccss*. It is proper therefore to stand by the claim that the grapheme tier is not implicated in error (16).

The upshot of the foregoing discussion is that if the error arises at the slot/quantity tier, the distinction between consonantal and vocalic slots cannot be upheld. The only appropriate representation would then be a neutral category, which may be termed X-slots and may freely associate with consonant and vowel graphemes. Hence, the only successful way of deriving the error *suceess* appears to be to argue that X-units at the slot level have been reversed. This process is graphically represented in (20).

(20)



It may be inferred that writing and typing are significantly different from speaking. Whereas the slots in speaking are specified for consonantalhood and vocalicness, the slots in writing and typing are unspecified. There thus is a representational difference between the oral and the written modalities (in addition to the processing difference in the unfolding of their structural representations). An explanation for this disparity is not hard to find. Speaking involves a phonological code and therefore is liable to specify its slots in phonological terms, or to be more precise, in terms of the major phonological categories. In contrast, the phonological code plays no primary role in writing and typing. Hence, there is no reason for specifying these slots phonologically. This is tantamount to claiming that the distinction between consonants and vowels is inapplicable in these two modalities.

To conclude, there is ample support for the Structural Theory, which predicts more freedom in the structural than in the content domain. As slots are structural units, they are expected to be open to modality-specific influences, and indeed they are. However, this modality-specific difference could not be observed among content units.

This chapter has been exclusively concerned with output modalities. This is a natural spin-off function of the grounding of the Structural Theory in language production. An examination of input modalities and a comparison of input and output modalities is beyond the scope of this work.

The cross-modal commonalities and disparities have now been described in some detail. This almost completes the survey of the factors impinging on structural representations. The next and final chapter will approach the issue of structure from a bird's-eye perspective.

10 The Whys and Wherefores of Structure

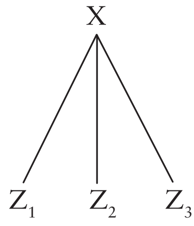
10.1 INTRODUCTION

The overall aim of this concluding chapter is to formulate a set of constraints on the structural component in a theory of language. The analysis revolves around the following three major questions: (1) Are hierarchical representations "better" than flat representations? (2) What factors facilitate or inhibit the emergence of structure? (3) Is structure sensitivity a design principle of language? The three questions are obviously related. If there is a general advantage in having hierarchical rather than flat representations, it makes sense to probe into the conditions under which structure is likely, or unlikely, to unfold. If we can determine where structure prevails and where it does not, we are in a position to gauge whether structure is a defining or marginal property of language. This monograph will be concluded by placing this issue in a wider perspective. It will not only be asked how essential structure is to language but also whether structure is uniquely human and therefore whether it serves as a criterion to set off human language from animal communication systems.

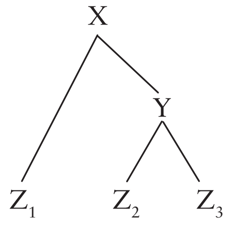
10.2 THE BENEFIT OF HIERARCHICAL RIGHT-BRANCHING REPRESENTATIONS

For convenience, flat and hierarchical structures are repeated here as (1), (2) and (3).

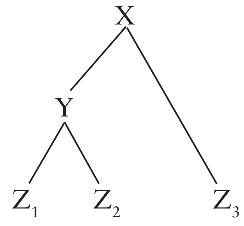
(1)



(2)



(3)



The comparison of (1) and (2–3) cannot help but begin with stating an advantage of the flat structure. Trivially, this representation has one node less than the hierarchical one. The underlying assumption here is that the lower the number of nodes (and levels), the less complex the representation and therefore the greater the ease of processing. Although this assumption is certainly not generally wrong, it overlooks one critical variable, to wit: time. This assumption takes for granted that all nodes in the three diagrams must be simultaneously available. However, this is not necessarily so. Consider the hierarchical representations. If some sequentiality is allowed, we may assume that processing proceeds roughly in two steps. In the first step, the immediate constituents of X are activated whereas the second phase sees the activation of the immediate constituents of Y. The large advantage of this two-step procedure is that in each phase, the number of nodes to be activated is actually *lower* than in the flat representation. Whereas the latter has to deal with four units, the former has to deal with only three. The seeming disadvantage can thus be turned into a processing advantage for the hierarchical representation.

The addition of an intermediate node Y in (2) and (3) corresponds to what is known as chunking in memory research (e.g., Miller, 1956; Dirlam, 1972). The basic insight is that chunking decreases working memory load by subsuming smaller units under a larger one (Nettle, 1995). However, to repeat, this claim can only be upheld if the smaller units are presumed to be temporarily neglected. In any case, the notion of chunking has been applied to different aspects of human information processing. Whereas Dirlam (1972) focuses on information retrieval, Miller (1956) and Nettle (1995) are concerned with the storage capacity of short-term memory. Both aspects are clearly relevant to language production and therefore play a role in the following account.

In the process of preparing utterances, speakers have to transform a parallel cognitive representation into a sequential phonetic output. Given the temporal relationship of high-level planning and low-level execution, it may be safely assumed that parallelness dominates in the early phases and serialness in the later phases of the production process (e.g., Dell, 1988; Sullivan & Riffel, 1999; O'Seaghdha & Marin, 2000).[1] Parallelness and serialness are antagonistic strategies with opposite properties. Whereas parallel strategies are fast and error-prone, serial strategies are slow and relatively immune to error. Because speakers have to utter a high number of units in quick succession (especially at the lower end of the linguistic hierarchy), they are likely to make use of parallel processing as much as possible without running the risk of major interference. At the same time, they have to take into account that the eventual output must be serially ordered and accordingly they resort to serial processing. We therefore adopt as a working hypothesis that speakers attempt to make use of *both* parallel and serial processing to the greatest extent possible.

With this "double duty" in mind, let us return to diagrams (1), (2), and (3). It is one of the main claims of this section that the conflicting needs of parallel and serial processing underlie the creation of hierarchical structure. To see this, consider again diagram (1). A flat representation supports either a completely parallel strategy whereby all four nodes are simultaneously active, or a completely serial strategy whereby X is activated first, then Z_1, then Z_2, and finally Z_3. The fact that all other nodes are switched off while the current one is on implies a "stoccato" mode of processing, which would be incompatible with low-level phenomena such as coarticulation. Thus, the flat representation fails to allow for a combination of parallel and serial processing strategies. By contrast, it is the great advantage of the hierarchical representations in (2) and (3) to provide for just this. The first processing step involves the parallel activation of Y and Z_1 (or Y and Z_3, for that matter). At least for the right-branching structure, this means that planning and execution can be carried out at the same time. While Z_1 is being executed, the activation of Y ensures the preparation of the upcoming units. Of course, this is an ideal processing strategy as it provides for an optimal interlocking of planning and execution. The second processing step witnesses the activation of the immediate constituents of Y, with a certain advantage being given to the prior unit. The (right-branching) hierarchical structure thus is superior to a flat structure because the former allows for more efficient production planning than the latter. This is the psycholinguistic explanation for why languages gravitate toward hierarchical structure (as argued before), even though there are many factors that stand in the way of its smooth build-up.

The same diagrams may contribute to our understanding of why right-branching is preferred to left-branching not only in English but probably also cross-linguistically (though not universally). The left-branching model gives simultaneous attention to aspects of planning and execution. However, the temporal relationship between planning and execution is less than optimal in this model. The element that is needed first (i.e., Z_1) is not directly activated but only via the intermediate node Y. Another disadvantage is that the final unit (i.e., Z_3) is activated early on although it is needed only later. This lack of congruence between planning and execution is the assumed reason for the inferiority of the left-branching model.

The disadvantages of left-branching raise the question of why it is not completely absent from the languages of the world. A possible answer was provided by Auer (2007). He starts out from the well-known correlation between head-modifier order and branching direction. Right-branching goes together with head-modifier order whereas left-branching co-occurs with modifier-head order. The latter order has an immense advantage for the listener in that it greatly increases the probability of anticipating upcoming elements. The kind of expectations that are generated may be illustrated by the adjective–noun order. Once an (attributive) adjective is produced, the listener can deduce that a noun is about to come. Such knowledge clearly facilitates the decoding process. In this sense, right-branching may be argued to be speaker-oriented, whereas left-branching is more of a listener-oriented strategy.

This psycholinguistic account of the two opposite branching directions brings with it an interesting prediction. Given that the first element to be outputted can be only indirectly activated in the left-branching model but directly activated in its right-branching counterpart, processing may be predicted to be slower in languages of the former than in languages of the latter type. There is one noteworthy study that directly compared processing difficulty in a right-branching language (i.e., English) and a left-branching language (i.e., Japanese). Mazuka (1998) measured reaction time as well as error rate in several tasks involving the comprehension of complex sentences by English- and Japanese-speaking children. Despite similar linguistic abilities, the Japanese learners were found to react significantly more slowly and to make significantly more errors than their English peers. This finding may be taken as support for the claim that left-branching incurs a greater processing difficulty than right-branching.[2] Thus, the three structural models depicted in (1)–(3) can be arranged on a scale of processing (in)efficiency (from less to more efficient): flat, hierarchical left-branching, hierarchical right-branching. This hierarchy predicts that flat structures will be least commonly found, whereas hierarchical right-branching structures will be most commonly found in the languages of the world, with hierarchical left-branching structures taking an intermediate position. Although this prediction is supported by the analysis of syllable structure in Chapter 6, a great deal more research is required before we know whether it is generally true.

10.3 ADDITIONAL FACTORS INFLUENCING HIERARCHIZATION

The enquiry into the structural component of language has uncovered a number of factors that either facilitate or inhibit the unfolding of hierarchical representations. This set needs to be supplemented by two further factors that have been reported in the pertinent literature and possibly by a third, which has hitherto been ignored.

10.3.1 A Personal Variable: Verbal Ability

Virtually all work in linguistics and psycholinguistics is based on a set of homogeneity assumptions. In particular, personal variables have been almost totally neglected in adult-language research (but see e.g., Barlow [2001], and Yip [2003], for notable exceptions). The general posture seems to be that all speakers of a given linguistic community, however narrowly defined, build up the same (psycho)linguistic representations and employ essentially the same processing strategies. With respect to hierarchicalness and branching direction, it would be assumed that all speakers of a given language adopt one of the three models in (1)–(3) and even hierarchize structural representations to largely the same extent. This assumption implicitly underlies everything that has so far been stated in this monograph.

However, this assumption has to be questioned. There is one study suggesting that individual subjects in an experimental setting hierarchize to different degrees. Treiman, Fowler, Gross, Berch, & Weatherston (1995) compared the performance of students from Wayne State University and Dartmouth College. The two institutions differ greatly in their entrance requirements. Dartmouth as a private university has a much higher percentage of students who were outstanding high-school graduates than Wayne State, a public university. Accordingly, Wayne State students performed more poorly than Dartmouth students on the Scholastic Aptitude Test, which includes a section on verbal ability. The subjects' task was to alter nonsense stimuli by replacing individual phonemes or phoneme sequences in specific positions in words of varying length. This task requires subjects to build up a short-term memory representation of these phoneme strings in order to manipulate them. There is evidence to suggest that subjects with a high verbal ability score generally have a better short-term memory (see Hunt, Lunneborg, & Lewis, 1975). From this link it may be predicted that the two populations will behave differently in the experiments to be reported below.

To derive more specific predictions, a better understanding of the nature of the task is needed. The ease with which phonemes are manipulated is viewed as an index of the hierarchical structure that subjects impose on the stimuli. If onset and coda phonemes are substituted with equal ease, this is taken as evidence for a flat structure, which assigns an equal status to onset and coda consonants; if, however, onsets are replaced more easily than codas, subjects may be hypothesized to have erected a hierarchical right-branching representation, which assigns more structural freedom to prevocalic than to postvocalic consonants.

As pointed out in the previous section, hierarchization alleviates working-memory load. Notably, two contradictory predictions can be generated from this hypothesis. We may start from the assumption that high verbal speakers put their working memory to better use than low verbal speakers by hierarchizing to a greater extent. If this is so, high verbal subjects may be predicted to build up more hierarchical representations than the less verbal ones. However counterintuitive it may seem, the opposite prediction is also possible. Because high verbal subjects have a better working memory, there may be less need for them to have recourse to hierarchization, as their better memory allows them to carry through the experimental task without it. High verbal subjects would accordingly be expected to hierarchize less than low verbal subjects.

As it turned out, the latter prediction was supported by the experimental results. Treiman, Fowler, et al. found that Dartmouth students were generally less sensitive to syllable structure than Wayne State students. In the easier tasks, the former group showed no such sensitivity whereas the latter did, whereas in the more difficult tasks, both groups exhibited some sensitivity to syllable structure, with the onset-coda asymmetry being more pronounced in the Wayne State than in the Dartmouth undergraduates.

These findings furnish valuable insight into the structural component of language. Provided it is justified to generalize from this laboratory situation to ordinary language use, the degrees of hierarchization may be claimed to be partially determined by personal characteristics, in particular working memory capacity. Furthermore, hierarchization may be conceived of as a compensatory strategy that is used to overcome memory limitations. As Treiman, Fowler, et al.'s experiments suggest, when it is unnecessary to erect a hierarchical representation—because enough storage space is available—speakers do not do so.

At first sight, this perspective on structure appears irreconcilable with other evidence. It is uncontroversial that young children have a poorer short-term memory than adults. According to this logic, the former would have to be assumed to be more hierarchical than the latter in order to make up for capacity limitations. However, the opposite is true. As shown in Chapter 7, children develop less hierarchical representations than adults. The same argument could, of course, be made for aphasics. This apparent contradiction can be reconciled by distinguishing between what is (im)possible and what is (un)necessary. Taking for granted that a hierarchical representation is more complex than a flat one, we may posit that children and aphasics are less hierarchical than competent adults because they lack the mental resources to deploy a fully hierarchical representation. By contrast, high verbal speakers are less hierarchical than low verbal ones because it is unnecessary for them to be more hierarchical. That is to say, they could in principle be more hierarchical but opt not to because there is no reason for them to expend more mental energy. In this way, high verbal speakers are akin in their performance to children and aphasics even though the reasons for this similar behaviour are vastly different.

To conclude, all of the evidence is compatible with the hypothesis that a flat structure is something like a fall-back and a hierarchical structure something like an add-on. Unlike the add-on, the fall-back is relatively cost-free. The fall-back is used when there is no alternative or when it is unnecessary to put in more effort. This does not mean, however, that the add-on is only used in exceptional circumstances. It is quite regularly used in ordinary speaking situations, which may be argued to be demanding enough to require the support of hierarchical representations. By contrast, it may now be argued that hierarchical representations are not strongly unfolded in writing and typing because they are not necessary in these modalities.

10.3.2 The Impact of Syntax on Phonological Processing

The following effect illuminates an interaction between different levels of the structural system. The particular question is whether disrupted processing at the syntactic level leads to disrupted processing at the phonological level (see section 8.4). In a notable experiment, Shattuck-Hufnagel (1982) addressed herself to this issue. The dependent variable was the rate of word-initial phoneme errors. As will be recalled from previous chapters, the word-onset vulnerability is hypothesized to be a structural effect. The weaker the structural representation is, the weaker the word-onset effect. The independent variable was the nature of the stimuli that the subjects were asked to repeat in an error elicitation task. While the stimuli consisted of word lists such as *boss-ditch-beach-deuce* in one experimental condition, they consisted of phrases such as *with a boss in the ditch at the beach with a deuce* in the other. The obvious difference between these materials is that phrases are syntactic units whereas asyndetic word lists are asyntactic. We therefore assume a flat syntactic structure for the latter and a hierarchical structure for the former condition. If syntax and phonology operate independently of each other, no difference between the experimental conditions would be expected. However, the subjects made a significantly larger number of word-onset slips during the repetition of phrases than during the repetition of word lists ($\chi^2(1) = 17.2$, $p < 0.001$). This finding suggests that a flat syntactic representation entails a flat phonological representation, which is the assumed reason for the absence of the word-onset effect in the word-list condition. While the nature of this interaction (whether it is mediated or not) and its underlying processing mechanisms are not yet well understood, it seems that the possibility for an interaction between non-abutting structural components has to be allowed for. The main point in the present context is that a weakly developed structural representation at the syntactic level can be identified as one reason for a weakly developed structural representation at the phonological level.

10.3.3 Production Rate

10.3.3.1 Introduction

Chapter 9 found a major difference in the sensitivity of speaking and writing/typing to structure. However, it did not examine the reasons for this disparity. This difference might be due to inherent differences between these output activities such that speaking is structure-sensitive simply because it represents a spoken modality. As we know from Chapter 5, the case of Arabic proves this hypothesis wrong. Although spoken, it evinces very little structure sensitivity. The true reason must therefore lie in a concomitant, not an inherent property of the various modalities. As noted in section 9.1, a principal difference between speaking and writing is the much higher production rate in the former as compared to the latter activity, and it is on this aspect that the present section is focused.

Let us begin by examining what requirements a high production rate imposes on the processing system. When a given set of units has to be outputted at a fast rate, the system has a theoretical choice of two processing strategies. It may either increase the speed of activating imminent units or it may increase the planning frame (i.e., the number of [more distant] units that are put in a state of partial activation). If neither of these strategies is adopted, the system might be running on thin air and have no fully activated element to output. The former strategy probably is of little help because the activation of mental nodes is generally faster than motor execution, no matter how fast a sequence of units is articulated (MacKay, 1981). The movement of articulators or the wrist is clearly more time-consuming than the generation of an abstract programme. The latter strategy has the function of increasing the look-ahead capacity of the system. This is a highly desirable consequence because it gives the system more time to make decisions as problems can be spotted earlier and therefore dealt with more successfully. The situation is not unlike that of a fast driver who is well advised to have good sight in order to be able to react appropriately. The upshot of the argument is that enlarging the planning frame is an efficient method of ensuring a faster production rate while maintaining fluency.

There are basically two ways in which the planning frame can be enlarged—the linear and the hierarchical strategy. According to the former, the activation of upcoming units is a function of their linear distance from the current unit. According to the latter, the activation of upcoming units is a function of their (structural) similarity to the current unit. Although the linear strategy seems simpler and more adequate for motor execution, the hierarchical strategy more faithfully respects the interdependence of linguistic elements irrespective of their eventual position in an utterance and hence is more adequate for the earlier planning stages. Given that our focus is on planning rather than execution, it may be suspected that the enlargement of the planning frame occurs by means of the hierarchical strategy. This leads us to predict an interaction between production rate and hierarchization. The faster a string of elements is outputted, the more hierarchical the mental representation underlying this activity. Inversely, a low production rate is more compatible with a flat representation. This prediction will be put to the test in the following experiment.

10.3.3.2 Method

The overall aim was to design an experiment in which production rate was the only variable while (almost) everything else was held constant. That is, one and the same output activity was to be performed at a fast and a slow rate. It was decided to study typing and in particular the performance of skilled and unskilled typists (see e.g., Gentner, 1983; Salthouse, 1984; MacKay, 1985 for differences between the two populations). The idea was that unskilled typists automatically perform slow and skilled typists fast (Grudin, 1983). Of course, this decision entailed two different groups of subjects, which cannot but introduce a certain variation in the light of the fact that any two groups can never be entirely homogeneous. However, having the same group of subjects perform at a fast and a slow pace appeared even less desirable because it would have involved selecting skilled typists who would have to type slowly, a highly artificial task that would require them to suppress their typing skills and thereby introduce processing strategies of unknown impact. Specifically, it is unclear, if not doubtful, that skilled typists asked to pare down their output rate mimic the behaviour of unskilled typists performing at their typical rate. The alternative of having unskilled typists perform as fast as skilled typists is of course unrealistic.

The next decision involved operationalizing the concepts "skilled" and "unskilled." It was clear at the outset that subjects could not be divided into skilled and unskilled typists on the basis of their self-assessment or on their subjective estimation of whether they considered themselves fast or slow performers. It was decided therefore to resort to a two-step procedure. In the first step, subjects were asked whether they had any formal typing qualifications and how much time they spent typing per day. This step served to make sure that there was a roughly equal number of subjects with a (probable) profile of skilled typists and subjects with a (probable) profile of unskilled typists. The second and crucial step was to have the subjects type a text (see the following) and allocate them on the basis of their typing rate to either the fast or the slow group. Because time was the critical variable, these objective data were deemed more reliable than those collected in the first step.

Subjects. A total of 40 subjects took part in the experiment. Most of them were students from the Department of Psychology at the University of Dundee, Scotland, but there were also students and staff from other departments as well as some non-students. The sex of the participants was not taken into account.

Procedure. The subjects were to copy-type a text as fast as they possibly could. They were told not to correct errors and refrain from pressing the backshift key, which was immobilized. Subjects were notified of this change to their keyboard. This move was expected to increase the number of "visible" errors and avoid ambiguities in error classification due to premature abortion of the erroneous string of letters. Prior to the actual experiment, subjects were given a warm-up task that required them to type the sentence *The quick brown fox jumped over the lazy dog* as many times as possible for a certain time. The time the subjects took to finish copy-typing the text was measured using a stop watch. Subjects were tested individually.

Materials. The selection of an appropriate text for copy-typing was guided by the desire to obtain an intermediate difficulty so that the subjects were encouraged to read closely but were not overtaxed. The topic should be of general interest and comprehensible without detailed background knowledge. Deciding on the length of the text involved a compromise between the requirements of amassing a sufficiently large error sample and of preventing fatigue on the part of the subjects, especially those with little practice. The choice fell on an excerpt from Pfaff (1979) on bilingualism in the United

States. The excerpt began at the top of p. 292 ("Spanish has been . . .") and ended in the middle of p. 293 of the original (". . . strategy of neutrality"). The text was slightly altered by leaving out references, numbers, diagrams, quotations, and a few sentences that were deemed to contain certain distracting elements. Although it was taken from a scholarly journal, it did not contain any jargon after this alteration. The text was comprised of 378 words.

10.3.3.3 Results

At first, the forty subjects were divided into slow and fast typists. Completion time varied between 10 and 103 minutes. The slowest subject was truly exceptional—the second slowest took 41 minutes—but because her error rate was not deviant, she was not discarded from the analysis. The assignment to the two groups was motivated by the desire to create two groups of equal size. This led to an arbitrary cut-off point at 19 min. Subjects who took less than 19 min. were assigned to the fast group whereas those who took more than 19 min. were assigned to the slow group. Because of the continuous nature of subjects' production rate, this had the effect that the fastest members of the slow group and the slowest members of the fast group were barely distinguishable. In response to this potential problem, the analyses were performed on two samples, the entire and the reduced one, as will be explained later.

All lexical and morphological errors were excluded, and so were regular spelling variants such as *favour* ~ *favor*. Also disregarded were all slips involving typographical devices such as inadvertent capitalizations, punctuation (e.g., a comma for a full stop), the inadvertent stroke or non-stroke of the space bar, and the misuse of slashes and brackets. This reduction left us with 1352 slips of the key, yielding an average of 34 slips per subject. The error range was from 16 to 100.

The following analysis will focus on some of the critical structural tests that have repeatedly been used in this piece of writing. Therefore it is unnecessary to detail their logic again. The time hypothesis makes the general prediction that the errors produced by the fast group will be more sensitive to structure than the errors made by the slow group. Table 10.1 presents an overall classification of the typographical errors into the most frequent categories.

Prior to the actual analysis, let it be noted that my intention is not to compare the present typing error sample and the one discussed in the preceding chapter (however tempting such a comparison might be) but to investigate the possible interaction of production rate and hierarchicalness. The error classes in Table 10.1 were defined both in terms of basic descriptive categories and size of error unit or number of positions involved.

The first salient result is what is generally known as the speed-accuracy trade-off. Significantly more errors occur in the fast than in the slow

Table 10.1 Frequency of Basic Error Classes as a Function of Production Rate

Error Class	*Fast*	*Slow*	*Total*
Single-key substitution	216 (61.5%)	135 (38.5%)	351
Single-key addition	371 (64.6%)	203 (35.4%)	574
Single-key omission	76 (35.0%)	141 (65.0%)	217
Adjacent switch	121 (77.6%)	35 (22.4%)	156
Other cases	32 (59.3%)	22 (39.6%)	54
Total	816 (60.4%)	536 (39.6%)	1352

condition ($\chi^2(1) = 29.2$, $p < 0.001$). That this effect is not stronger can be explained by the assumption that the fast typists are more practised than the slow typists and the fact that practice is known to reduce error rate.

There are two classes that deviate from the 60–40% error bias in favour of the fast condition. Omissions are significantly below this average value ($\chi^2(1) = 69.4$, $p < 0.001$), that is, they are more likely to arise in the slow condition, whereas adjacent switches significantly exceed this average ($\chi^2(1) = 22.0$, $p < 0.001$). The former effect has clear structural implications, the latter does not. Throughout this book, omissions have been taken to reflect activation problems at the slot level, which is structural in nature. Thus, the distribution of omission errors suggests a weaker structural representation underlying the performance of slow as compared to fast typists. This result accords well with the research hypothesis.

Arguably, the strong predominance of adjacent switches in the fast condition reflects a monitoring problem. Adjacent switches can only arise if the typist has not noticed the trouble in the first position and therefore "completes" the error in the second position. The efficiency of monitoring is a matter of available time, so slow typists may more efficiently monitor their output than fast typists. The former group is therefore more likely to catch the error mid-way and prevent an adjacent switch from happening. Because the other (contextual) error types do not involve adjacent positions, typists have more time to detect them, hence the lesser preponderance of these errors in the fast condition.

It is surprising that additions represent the single most frequent error category in Table 10.1. As discussed in section 7.3.2, additions are more difficult to interpret from a structural perspective than omissions as the Structural Theory is compatible with an increase and a decrease in addition errors as a result of a weakened structural representation. In any case, additions do not figure more prominently in the slow than in the fast condition compared to the other error classes. They thus do not provide any evidence for the hypothesis that the slow condition is structurally more impoverished than the fast condition. The only claim that additions buttress is that their excessive frequency argues for a weak structural representation governing the performance of both fast and slow typists.

We move on to the parallel syllable structure constraint, which may be legitimately regarded as the most reliable structural test. The general prediction is that key slips occurring in the slow condition will be less subject to the parallel syllable structure constraint than those occurring in the fast condition. Three samples were designed to test this prediction. The first is the complete corpus of contextual single-key errors. The second is restricted to contextual single-key substitutions because the parallel syllable structure constraint can be best examined on the basis of substitution data. This is because additions and omissions necessarily entail a change of syllable structure and hence do not provide as good a testing ground as substitutions. The third sample, termed the reduced sample in Table 10.2, contains all three descriptive error classes but eliminates the data from the 8 subjects who took between 17 and 20 min. to type the text. This move served to banish the grey area between the fast and the slow typists and thereby created two more clearly distinct groups.

As can be seen from Table 10.2, the violation rate is higher in the slow than in the fast condition in all three samples. However, this increase is nowhere statistically significant. The only point that can be raised in favour of the research hypothesis is that the strongest increase occurs in the same sample that is typically used in the literature to test the parallel syllable structure constraint. And indeed, an increase of approximately 19% is usually sufficient to attain standard levels of significance. However, the number of pertinent cases is so low that there is no way of rejecting the null hypothesis. Also the reduced sample does not provide a convincing argument for the research hypothesis. It is only minimally different from the complete

Table 10.2 Violation Rate of the Parallel Syllable Structure Constraint as a Function of Production Rate

	Fast			*Slow*		
	Position Preserving	*Position Changing*	*Violation Rate*	*Position Preserving*	*Position Changing*	*Violation Rate*
complete sample	59	87	59.6%	31	55	64.0%
substitution sample	18	13	41.9%	9	13	59.1%
reduced sample	55	76	58.0%	23	42	64.6%

Table 10.3 Non-Contextuality Rate as a Function of Production Rate

	Fast			*Slow*		
	Contextual	*Non-Contextual*	*n.c. Rate*	*Contextual*	*Non-Contextual*	*n.c. Rate*
complete sample	334	429	56.2%	201	275	57.8%
reduced sample	273	336	55.2%	146	208	58.8%

(n.c. = non-contextuality)

sample. It may be concluded that there is either no increase in violation rate from the fast to the slow condition or that the present test is not sensitive enough to pick up this increase.

In view of this interpretative difficulty, three further tests were conducted. The first looks at the rate of contextual errors. According to the working hypothesis, contextual slips will be relatively more common in the fast than in the slow condition because they are more structure-dependent. Table 10.3 shows this to be the case neither in the complete nor the reduced sample. Thus, the non-contextuality rate lends no support to the research hypothesis.

The next test compares the frequency of within-word and between-word errors. The prediction here is that proportionately more within-word slips should occur in the slow than in the fast condition because within-word errors arise under a weaker structural representation than between-word errors. Refer to Table 10.4.

The close resemblance between Tables 10.3 and 10.4 is notable. While there is a slight increase in the proportion of within-word errors from the fast to the slow condition, it falls far short of being statistically significant

Table 10.4 Rate of Within-Word Errors as a Function of Production Rate

	Fast			*Slow*		
	Between-w.	*Within-w.*	*w.w. Error Rate*	*Between-w.*	*Within-w.*	*w.w. Error Rate*
complete sample	43	289	87.0%	16	184	92.0%
reduced sample	32	243	88.4%	11	140	92.7%

(w. = word; w.w. = within-word)

($\chi^2(1) = 1.8$, $p > 0.2$ for the complete sample; $\chi^2(1) = 2.0$, $p > 0.2$ for the reduced sample).

The final test focused on the anticipation/perseveration rate. It is based on the premise that anticipations depend to a larger degree on the strength of the structural representation than perseverations. Therefore, a higher perseveration rate is expected to occur in the slow than in the fast typing condition. This prediction may be examined on the basis of Table 10.5.

The results in Table 10.5 differ from those in the previous tables. There is a significant increase in the perseveration rate as we go from the fast to the slow condition ($\chi^2(1) = 4.4$, $p < 0.05$ for the complete sample; $\chi^2(1) = 4.5$, $p < 0.05$ for the reduced sample). Although the statistical effect is not particularly strong, it is stronger than in the preceding analyses. As in previous tests, no difference between the complete and reduced samples can be detected.

To conclude, this series of tests fails to arbitrate between the two alternative views of no effect at all and a real effect but too weak to be picked up. Some tests yield significant results, others do not. If they do, the effect is rather weak (as in Table 10.5); if they do not, the non-significant outcome may be due to the low number of data points (Table 10.2, substitution sample). All differences, however small, are in the predicted direction. In all tests the reduced sample yields slightly higher percentages in the slow condition than the complete sample does, even though the number of data points is of course lower. This hints at the possibility that with a larger temporal difference in the performance of fast and slow typists, the predicted effect might emerge more clearly. In view of this state of affairs, it seems premature to reject the research hypothesis at this point. It is quite possible that with larger subject groups, larger differences between them and tighter experimental controls, a more convincing case could be made. At present, there is only little evidence to support the claim that typists erect a less hierarchical structural representation at a slow production rate but a more hierarchical representation at a fast production rate.

Table 10.5 Perseveration Rate as a Function of Production Rate

	Fast			*Slow*		
	Anticipation	*Perseveration*	*p. rate*	*Anticipation*	*Perseveration*	*p. rate*
complete sample	171	92	35.0%	81	68	45.6%
reduced sample	142	80	36.0%	59	54	47.8%

(p. = perseveration)

10.4 THE RELATIVE UNIFORMITY OF STRUCTURAL REPRESENTATIONS

A major thrust of this monograph has been to propose one and the same explanation for a variety of quite diverse phenomena. Arabic phonology, child language and non-spoken modalities, to name but a few, were all argued to be under the sway of a weak structural representation. This is a bold claim indeed that entails an intriguing prediction. If the underlying explanation is the same, the properties of these diverse "languages" should also be the same. However, two caveats have to be entered at this point. The Structural Theory allows for differing degrees of weakness of structural representations. It is perfectly conceivable to find a relatively weaker representation underlying the one "language" and a relatively stronger representation underlying the other. There is an interesting perspective here. If the same or a similar degree of weakness emerges in disparate "languages," we may wonder whether there is something like a default value for structural weakness. In addition, the Structural Theory is quite compatible with "special effects," be they language-specific or modality-specific, to influence empirical patterns. With these two qualifications in mind, we may examine the possibility that the empirical effects found across the diverse "languages" will be similar or even identical. In order to ensure comparability and to carry out a particularly strong test, two radically different data sets have been singled out for comparison: slips of the tongue in Arabic and slips of the pen and the key in English. This prediction will be subjected to seven tests, all of which figure on previous pages of this book. To this end, we will come back to some of the data that were presented in Chapters 5, 8, and 9.

The first test to be performed measures the distance between interacting phonemes. The critical variable is whether the interactants stay within the limits of the word or cross the word boundary. The results are tabulated in Table 10.6.

It is plain to see how similar the proportions of within-word and between-word slips are among the three data sets. The Arabic speech data and the English writing data are almost identical ($p > 0.3$). Although there is a statistically significant difference between Arabic slips of the tongue and English

Table 10.6 Frequency of Within-Word and Between-Word Errors in Speaking (Arabic), Writing (English), and Typing (English)

	Within-Word	*Between-Word*	*Total*
speaking (Arabic)	330 (80.5%)	80 (19.5%)	410
writing (English)	408 (79.4%)	106 (20.6%)	514
typing (English)	320 (89.1%)	39 (10.9%)	359

slips of the key ($\chi^2(1) = 11.5$, $p < 0.001$), it should be stressed that the two data sets are in the same general area (i.e., they display a strong predominance of within-word errors). We may conclude that the distance between the interacting units in these diverse types of errors is remarkably similar.

The parallel syllable structure constraint will be examined next. The aforementioned distinction between within-word and between-word slips is retained in Table 10.7 which by and large replicates the results of Table 10.6. Arabic speech errors and English writing errors pattern similarly whereas typing errors stand apart. Focusing on the totals, there is no difference between the Arabic slips of the tongue and the English slips of the pen ($\chi^2(1) = 0.4$, $p > 0.3$). The same is true of the category of within-word slips ($\chi^2(1) = 0.8$, $p > 0.3$). Only in the between-word subset do these two error types exhibit a significant difference ($\chi^2(1) = 8.0$, $p < 0.01$). By contrast, the difference between the Arabic tongue slips and the English key slips is significant for all three categories ($\chi^2(1) = 26.2$, $p < 0.001$ for the totals). It needs to be emphasized that this difference arises only because the violation rate in the typing errors is more extreme than that in the writing errors. The general tendency to ignore the parallel syllable structure constraint is clearly discernible in all three data sets. It is worthwhile to add that the three categories are similar in another respect. All of them show a highly significant decrease in violation rate as we move from the within-word to the between-word domain. Our conclusion is that despite certain differences arising mainly between the two English data sets, there is an overall similarity between the Arabic and the English materials.

The next empirical effect to be studied is the anticipation/perseveration ratio. In the Arabic speech error corpus, the number of anticipations and perseverations is relatively low, but of course this does not affect the analysis of relative frequencies that is reported in Table 10.8.

Table 10.7 Violation Rate (in %) of the Parallel Syllable Structure Constraint in Speaking (Arabic), Writing (English), and Typing (English)

	Within-Word	*Between-Word*	*Total*
	p.c. : p.p.	*p.c. : p.p.*	*p.c. : p.p.*
speaking (Arabic)	172 : 106 (61.9%)	13 : 57 (18.6%)	185 : 163 (53.2%)
writing (English)	91 : 46 (66.4%)	33 : 52 (38.8%)	124 : 98 (55.9%)
typing (English)	93 : 18 (83.8%)	5 : 8 (38.5%)	98 : 26 (79.0%)

(English; p.c. = position-changing; p.p. = position-preserving)

Table 10.8 Rate of Anticipation and Perseveration Errors in Speaking (Arabic), Writing (English), and Typing (English)

	Anticipations	*Perseverations*	*Total*
speaking (Arabic)	34 (56.7%)	26 (43.3%)	60
writing (English)	178 (60.5%)	116 (39.5%)	294
typing (English)	37 (54.4%)	31 (45.6%)	68

It can be seen from Table 10.8 that the anticipation/perseveration ratio in Arabic slips of the tongue is similar to that in English slips of the pen and the key. Neither the difference between the tongue slips and the pen slips nor the difference between the tongue slips and the key slips is statistically reliable (both p's > 0.3). In short, the three data sets are entirely homogeneous on this score.

We now return to the distance between interacting segments. As defined earlier, switches involve the misordering of adjacent units whereas reversals involve the misordering of non-adjacent ones. Before we turn to the analysis proper, it is necessary to recall the conditions under which switches may, or may not, arise. Errors occur within the limits of what is possible (i.e., allowed by the rules of the individual language). In particular, phonological errors are constrained by phonotactic rules, which in turn are fed by articulatory constraints. Hence, the likelihood of switches in the spoken medium is severely reduced. As writing and typing do not use a phonological code, no such constraints are expected for these two modalities. By implication, switches are inherently more likely in writing and typing. This difference has to be borne in mind when the frequency of switches is compared across modalities. It is clearly unrealistic to expect an identical reversal/switch ratio for slips of the tongue and the pen, regardless of language. What we may expect, however, is a sharp increase in the number of switches relative to reversals in Arabic speech errors. Table 10.9 therefore also provides the ratio for English slips of the tongue as a baseline for comparison.

It is immediately apparent from Table 10.9 that Arabic speech errors take an intermediate position between English slips of the tongue, the pen, and the key. There is a significant difference between Arabic and English speech errors ($\chi^2(1) = 87.2$, $p < 0.001$), which is mainly caused by an enormous increase in switches in Arabic as compared to English. At the same time, Arabic speakers are significantly less likely to produce switches than English writers ($\chi^2(1) = 29.8$, $p < 0.001$) and English typists ($\chi^2(1) = 131.2$, $p < 0.001$). In the light of the disparate constraints under which speaking and writing/typing operate, this finding is entirely expected. Because it is brought about by factors that are not structural in nature, it will not be given further attention. Of greater theoretical importance in the present context is that

Table 10.9 Rate of Reversals and Switches in Speaking (English and Arabic), Writing (English), and Typing (English)

	Reversals	*Switches*	*Total*
speaking (English)	262 (99.2%)	2 (0.8%)	264
speaking (Arabic)	230 (70.6%)	96 (29.4%)	326
writing (English)	7 (21.9%)	25 (78.1%)	32
typing (English)	7 (6.6%)	99 (93.4%)	106

the prohibition on switches, which is so characteristic of English speech, is relaxed in Arabic. If we assume that the remaining difference between Arabic tongue slips and English pen/key slips is occasioned by modality-specific factors, it may be argued that the difference between the Arabic and the English speech errors has a structural cause. To conclude, when modality-specific influences are factored out, the Arabic slips of the tongue may be claimed to be similar to the English slips of the pen and the key.

We proceed to an examination of the differential involvement of segments within larger units, in particular the proportion of word-onset to non-word-onset errors. For comparative purposes, Table 10.10 reproduces the pertinent German speech error data from Table 9.6. The data are broken down into within-word and between-word errors, as was done in Table 10.7 above.

Table 10.10 Rate of Word-Onset Errors (in %) in Speaking (German and Arabic), Writing (English), and Typing (English)

	Within-Word	*Between-Word*	*Total*
	w.o. : Non-w.o.	*w.o. : Non-w.o.*	*w.o. : Non-w.o.*
speaking (German)	26 : 44 (37.1%)	647 : 377 (63.2%)	673 : 431 (61.0%)
speaking (Arabic)	70 : 260 (21.2%)	28 : 52 (35.0%)	98 : 312 (23.9%)
writing (English)	2 : 412 (0.0%)	5 : 104 (4.6%)	7 : 516 (1.3%)
typing (English)	1 : 31 (3.1%)	4 : 8 (33.3%)	5 : 39 (11.4%)

w.o. = word-onset

As in the previous analysis, the Arabic data sit comfortably between the German speech errors and the English writing and typing errors. The rate of all word-onset slips in Arabic is significantly lower than in German ($\chi^2(1) = 164.9$, $p < 0.001$) but significantly higher than in English writing ($\chi^2(1) = 117.8$, $p < 0.001$) and somewhat higher than in English typing. The latter difference just fails to reach standard levels of significance ($\chi^2(1) = 3.6$, $p < 0.07$), which is probably due to the low number of relevant items in the typing error sample. The same results obtain for both the within-word and the between-word domain, suggesting that some of the production constraints are identical across the two conditions.

It seems justified to put down the reduced error rate of word-onset errors in Arabic as compared to German to structural factors. However, it is much more difficult to make sense of the discrepancy between the Arabic speech and the English non-speech data. Why do the two data types not produce the same rate of word-onset errors? It seems that the burden of explanation falls squarely on the non-speech rather than the speech data. Whereas the latter implicate word onsets roughly at chance levels,[3] the former display a word-onset stability. Clearly, the fact that a certain phenomenon occurs less frequently than expected by chance requires more of an explanation than a phenomenon that occurs at chance levels. However, it is not at all obvious what renders the word onset so immune to malfunction in slips of the pen and the key. All we can suggest at this point is that this immunity seems to be a modality-specific effect. Setting aside this problem, we may conclude that the Arabic speech errors and the English writing and typing errors go in the same direction and distance themselves very clearly from the slips of the tongue found in other languages.

The prefinal point can be quickly dealt with. Errors involving more than one segmental unit simultanenously have not so far been observed in Arabic (Berg & Abd-El-Jawad, 1996). As shown in section 9.1.9, the same error type occurs in infinitesimal numbers in English writing and typing. There is thus a clear convergence between Arabic tongue slips and English pen or key slips in their reluctance to implicate units larger than the segment.

Finally, a comparison will be made among the three descriptive categories of substitution, addition and omission. It has repeatedly been argued in the preceding chapters that the strength of the structural representation affects the rate of omission errors (and obliquely, the rate of addition errors), though not the rate of substitution errors. For Arabic speech errors, we would consequently predict a higher rate of additions and omissions than is observed for English slips of the tongue. However, this prediction is clearly disconfirmed. On the contrary, what we obtain is a total absence of additions and omissions among the phonological speech errors in Arabic. Only substitutions are attested.

Although this difference is quite surprising at first glance, it is even expected within the Structural Theory. What we have come across is a special effect that is radically different from the ones encountered before.

Whereas the previous ones were argued to be modality-based, this cannot be so in the present case because the Arabic data are not in the general area of the English slips of the pen and the key but even more extreme than the English slips of the tongue. The explanation for this particularity of the Arabic errors must therefore be a language-specific effect. In fact, such an explanation is not hard to come by. Arabic is a so-called template language that codes certain general meanings in the form of structural templates (i.e., CV patterns; McCarthy, 1981). In the course of the derivation, these CV patterns are associated with strings of root consonants (and vowels), implying that the CV patterns and the consonantal roots are separately stored in long-term memory. This makes the CV patterns content units in the Structural Theory. As content units, they are more powerful than as structural units. The power of the CV patterns can be seen in the association process between the CV pattern and the consonantal roots. In case of a mismatch between them, the CV pattern wins out. If, for example, the CV pattern provides for more consonantal slots than there are root consonants to fill them, the final root consonant is doubled in satisfaction of the requirements imposed by the CV pattern. The opposite situation in which the CV pattern is changed in accordance with the root consonantism is not found. This asymmetry makes it quite clear that CV patterns have a privileged status in Arabic (see also Boudelaa & Marslen-Wilson, 2004).

It is now a relatively straightforward task to account for the absence of additions and omissions because the linguistic difference translates easily into a processing difference. The advantage of CV patterns may be understood as an elevated level of activation that these patterns reach during language production. These higher activation levels give CV patterns the strength to preserve their integrity in the face of competition from the consonantal roots. By their very nature, addition and omission errors alter the shape of the CV patterns. Because such an alteration is prevented by the strength of the CV patterns, these error categories fail to see the light of day in Arabic. There is little doubt, then, that the exceptional patterning of the speech errors in Arabic with respect to the descriptive categories is a language-specific effect, which does not undermine the claim that the structural phonological representation unfolds only weakly in Arabic.

By way of summary, Arabic slips of the tongue and English slips of the pen and the key have been found to exhibit a fairly high degree of similarity. This convergence is quite unexpected in view of the fact that considerably different languages and modalities are involved. By contrast, it is entirely expected from the perspective of the Structural Theory, which claims that the different data sets arise under a similar structural representation. However, this is not to say that the three data types must pattern identically in all respects. The Structural Theory is certainly compatible with language- and modality-specific effects that exist over and above structural effects. And, of course, the Structural Theory is compatible with differences between the data sets that are occasioned by differing degrees of hierarchicalness.

Interestingly, the empirical data did not really favour this latter possibility. The keying errors occasionally appeared to be less hierarchical than the writing errors but this difference was not consistent enough to warrant a general conclusion along these lines. There is also no evidence for the hypothesis that there is a difference in hierarchicalness between Arabic tongue slips and English pen or key slips. This may appear surprising given the disparity of the data types. It seems that the nonconcatenative morphology of Arabic and the slower production rate in writing and typing (among other reasons) have largely the same effect on processing at the submorphemic level. Whether this is coincidental or whether there are good reasons for it remains to be seen.

10.5 THE ROLE OF STRUCTURE DEPENDENCE IN LANGUAGE AND LINGUISTICS

It is time to take stock. Below is a list of "languages" that, at one or more levels of analysis, exhibit a reduced sensitivity to structure.

- free word order languages such as Old English (Chapter 4)
- VSO languages (Chapter 6)
- nonconcatenative languages such as Arabic (section 5.4)
- "smart" language (section 10.3.1)
- asyntactic language as exemplified by word lists (section 10.3.2)
- "slow" language (?) (section 10.3.3)
- handwritten and typewritten language (Chapter 9)
- child language (L1) (section 7.2)
- foreign language (L2) (section 7.3)
- aphasic language (Chapter 8)

This list provides a useful summary of the areas that have been treated in more or less depth in this book. It is anything but complete. No mention has been made of pidgin and creole languages, which might be seen as likely candidates for not-so-hierarchical representations. The same goes for the language of the elderly. MacKay & James (2004) found a higher rate of omission errors as well as a higher rate of non-initial sound errors made by older adults in comparison to younger adults. Both results would be compatible with the claim that the structural representations of older adults are less hierarchical than those of younger adults. Moreover, "special" languages like sign language and Morse code may shed further light on the issue at hand. For example, Wilbur & Allen (1991) argued that the internal structure of the syllable in American Sign Language is inherently flat. It may also be enlightening to extend the database to non-linguistic skills such as piano playing. As music is a rhythmical activity that is organized in bars, the beats may be defined with reference to their position in the bar.

Two beats may accordingly share the same position in different bars or they may occupy structurally different positions. If a note is inadvertently replaced by another one nearby, it can be determined whether the error involved a like-with-like interaction or an interaction of unlike elements.[4] MacNeilage, Studdert-Kennedy, & Lindblom (1985) speculate that the analogue of the parallel syllable structure constraint is not respected in musical performance. However, as hard data are at a premium, this issue is entirely open. Finally, all of our efforts have been focused on the productive side. Comparatively little is known about the unfolding of structural representations in language perception (see e.g., Floccia, Kolinsky, Dodane, & Morais 2003). One might expect certain parallels between production and perception, but also differences. For instance, because reading is much faster than writing in linguistically competent adults, it is quite possible that a more hierarchical representation is erected in the former than in the latter activity. Needless to say, a great deal of further research is required.

The aforementioned list will form the basis for the ensuing evaluation of the principle of structure dependence. In the linguistic literature, this notion has usually been treated in either/or fashion. Either a given operation is, or is not, structure-sensitive. As the foregoing analyses have amply shown, this approach is inadequate as all empirical effects are characterized by more or less structure sensitivity. There were no cases of total blindness to structure even though handwritten and typewritten language was not too far from this extreme. I submit that at least a minimum of structure dependence emanates from a combination of two factors. For reasons of communicative efficiency and speed, there is an ever-present desire to open the planning window, which is tantamount to building up hierarchical structures, even if this desire may be counteracted in many different ways. However, these inhibitory forces cannot be completely successful because the planning of an utterance takes time, and time works in favour of hierarchicalness. Thus, the inhibitory forces can only slow down the unfolding of structural representations, but they cannot entirely prevent them. So linguistic effects that arise at a late stage in the activation process are bound to display a certain structure sensitivity. For the same reason, a total structure dependence is inconceivable. As representations are built up in real time, early effects necessarily exhibit a diminished structure dependence. The moral of this story is that it makes little sense to ask whether linguistic effects are, or are not, structure-dependent. A more appropriate approach is to probe into the strength of structure dependence. By implication, structure dependence exists as a gradient, though not as an absolute notion.

In examining the list more closely, one might be inclined to believe that most forms of language that show a reduced sensitivity to structure do not constitute the core of linguistic enquiry and therefore cannot be used to reliably assess the role of structure dependence. For instance, written and typed language might be held to be marginal as secondary manifestations of the primary spoken medium. Also, child language might be regarded as an underdeveloped form of language and therefore irrelevant to a theory of fully developed language. I do not think that this argument stands up to closer scrutiny. What should be reasonably covered by a theory of language? There are at least two possible stances one could take. In the restrictive view, a theory of language attempts to account for all languages spoken by linguistically competent adults and nothing but. In the broad view, by contrast, all forms of language without exception contribute to informing linguistic theory. By generally accepted standards, theory A whose empirical coverage includes and extends that of theory B is considered superior. We will accordingly opt for the broad view. However, even if the narrow perspective was adopted, the objection cannot be sustained. There are a good number of items on the list that clearly fall within the range of the restricted view. Free word order languages and those with a nonconcatenative morphology are indubitably within the purview of any linguistic theory. Therefore, eliminating the "deviant" forms of language is pointless and even counterproductive as it ignores the notable links that exist between the so-called core and periphery.

The rather large number of items on the list suggests that the erection of hierarchical structure is only possible if a relatively high number of conditions is met. This is not to say that hierarchical structure is exceptional, but the fact that spoken Modern English fulfils these conditions so nicely should not blind us to the reservation that other languages (in addition to the historical forerunners and the non-spoken forms of Modern English) may just evince less structure sensitivity. This leads us directly to Chomsky's (1972, p. 30) claim that structure dependence is a language universal. I will leave aside my irritation at how one can possibly make such a claim at a time when only a minority of languages has been sufficiently investigated. There are at least two readings of the term "language universal." In its weak form, it may be understood as occurring to an unspecified extent in some domains in all languages whereas in its strong form, it may be taken to mean that all rules in all languages are sensitive to structure (for the latter view, see Chomsky, 1975, p. 28). The strong version is the simpler model in that in contradistinction to the weak one, it needs no theory about when structure sensitivity holds sway and when it does not (in one and the same language).

It may be that the claim about universality has deflected linguists' attention from phenomena that do not fit the theory. Perhaps the most blatant case of structure independence comes from phonology (see Comrie, 1990). As is well-known, lexical-stress rules may be completely insensitive to structure. To select but a few examples, Finnish has consistent initial stress, Polish words bear stress on the penultimate syllable and French words are finally stressed. What these and many other languages exhibit is what Freidin (1991) believes should be banned from the theoretical machinery of linguistics—the counting property. As the previous examples show, languages count syllables in order to stress their lexical items correctly, and they may do so from left to right or from right to left. Significantly, the counting property is not restricted to phonology. Comrie (1990) argues that it is also operative in syntax. He discusses a case of structure blindness in Serbo-Croatian where certain clitics always occur in the second slot of a sentence irrespective of whether this rule places the clitic inside or outside a constituent. In the following example, the beneficiary breaks up the subject-NP *taj pesnik* 'that poet.'

(4) Taj mi pesnik čita danas knjigu. (from Comrie, 1990)
that to-me poet reads today book
'That poet is reading a book to me today.'

As is evident, the strong version of the universality claim cannot be upheld. Not all linguistic rules are structure-sensitive. The weak version thus is to be preferred even though it is rather uninteresting unless it is supplemented by a theory about where to expect structure sensitivity and where to expect structure insensitivity. While such a theory is not in the offing, the preceding chapters have identified a very high variability in structure sensitivity and a considerable number of factors that countermand hierarchicalness. Pensalfini (2004, p. 368) may be right in arguing that structure dependence occurs to some extent in all human languages. However, the critical point is that it emerges only under certain favourable circumstances and that it is a gradient property.

One of the deeper motives behind the quest for design principles of language is the desire to find out what is distinctively human about human language. By identifying such traits, one would catch a glimpse of human nature. This approach entails a comparison of human and animal language. The critical question in the context of this work is, then, whether structure dependency is uniquely human or also found in the animal kingdom.[5] We therefore finish off with a brief look at animal communication systems.

It has to be made quite clear at the outset that any comparison between human and animal languages is severely hampered by a two-fold problem: for one thing, the anthropocentric perspective that we cannot help but impose on animal language and for another, our modest understanding of how most species communicate. The outcome of any such comparison must therefore be of a preliminary nature and is likely to be rendered obsolete by new discoveries.

Three essential parts of the model of human language that has been developed in this monograph are relevant for the following discussion—the hierarchical layering of linguistic levels, the distinction between content and structure, and the continuum from flatness to hierarchicalness of the structural representation. Crucially, there is a one-sided logical dependence between these three aspects. A subsequent aspect presupposes a prior one. If the notion of hierarchical levels does not exist, we cannot have the content/structure distinction as the two require a separate hierarchy of their own.

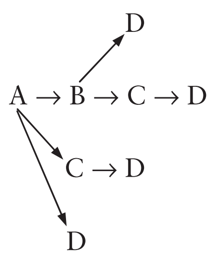
And if structural units do not exist, it makes no sense to ask whether the structural representation is flat or hierarchical. It seems justified to reinterpret this logical order in terms of an evolutionary order: the dependent aspect could phylogenetically develop only subsequent to the independent one.

It might be tempting to deny these three aspects a role in animal language. When Frisch cracked the code of bee communication in the 1920s, he identified several distinctive loci of information in the bee dances including the number of repetitions of round dances and the direction in which the bee's head points during the wiggly dances (Frisch, 1993). What is of crucial importance for our purposes is that the bee dances are holistic Gestalts, that is, they are not segmentable. Segmentation as a process whereby a representation is broken down into smaller elements inevitably creates a hierarchy of levels. We may say, then, that bee dances lack a hierarchical organization.

Is this true of all animal communication systems? In the 1980s, Hailman and co-workers as well as Sossinka and Böhner before them made a highly significant discovery (see Sossinka & Böhner, 1980; Hailman, Ficken, & Ficken, 1985; Hailman & Ficken, 1986). They found out that the calls of certain bird types possess a hierarchical structure. In other words, bird song was found to be segmentable. Sossinka & Böhner, working on the zebra finch, managed to identify not only two, but even three hierarchical levels in bird song. They distinguish among notes as the smallest units, motifs at the next level up and strophes at the highest level. Motifs are defined as sequences of notes and strophes as the combination of a set of introductory elements and motifs. Individual strophes tend to be separated by silent intervals, suggesting that these form complete coding units. A hierarchy of levels in which smaller units are combined to create larger ones was established for the first time for the animal kingdom.

In their analyses of chick-a-dee calls, Hailman et al. focused on the combinatorial possibilities of the smallest units. The total set of basic elements they identified for chick-a-dees comprised of only four notes, termed A, B, C and D for ease of reference. Seconding Sossinka & Böhner (1980), they found that the order in which the note types appear is relatively rigid. In particular, they were able to formulate a "grammar" that generates all permissible call types (but does not generate the impossible ones). This grammar takes the following simplified form.

(5)



The order of note types is fixed insofar as a given letter can only be followed by another letter that comes later in the alphabet. Thus, AB is licit whereas BA is not. What is not indicated in (5) is that each note type is optional and can be followed by itself an arbitrary number of times. Hence, call types may range from single note tokens to extended sequences such as AAAABCD. This simple grammar successfully accounts for more than 99% of the items in a large corpus of chick-a-dee calls.[6]

It is easy to see that this animal language is capable of generating a large number of different calls on the basis of a very small inventory of notes. However, it is not quite accurate to say, as Hailman & Ficken (1986) do, that this system is open-ended because it generates an unlimited number of note types. It is true that the possibility of endlessly repeating one note type and thereby producing an infinite number of different calls ensures a potentially unlimited creativity of the system. However, this possibility is a rather more theoretical than real one in that processing limitations make it highly unlikely for the listening bird to remember whether it has heard, let us say, six or seven repetitions of one note type. We may assume therefore that only a low number of repetitions may have a distinctive function or that repetitions have no distinctive function at all. In either case, the system may be regarded as possessing a limited productivity.

Whether the grammar in (5) should be called a syntax, as Hailman & Ficken do, depends on what a syntax is expected to do to deserve its name. Clearly, it is a syntax in the sense that it generates a string of basic units in a certain linear order. However, a true serial-ordering device is capable of producing basic units in variable, if not in any order. This is because of the independence between the nature of linguistic units and their order in an "ideal" system (see Lashley, 1951). However, this is not the kind of syntax we find in chick-a-dee calls. Although the syntactic component combines smaller units into larger ones, it basically generates a Markov chain in which the preceding element may be used to predict the following one. This is a rudimentary type of syntax whose processing power is restricted to deciding whether the upcoming unit should be a repetition of the previous one or whether the next or the next but one or the next but two letter in the alphabet should be produced.

Is there any evidence for the distinction between content and structure in the language of chick-a-dees? If, as claimed by Hailman & Ficken, the system is open-ended, the answer is probably in the affirmative. Recall that a structural unit is one that is not stored in long-term memory and therefore has to be built up. Chick-a-dee calls do appear to be built up even if the principles underlying this process do not seem to be very sophisticated. Although it cannot be entirely ruled out that the birds retrieve all possible call types from memory, this would seem to be a very unlikely scenario in view of the productivity of the system, however limited it may be compared to human languages. Thus, it may be tentatively concluded that notes represent content units and calls structural units. The content/structure distinction does seem to be applicable to this type of animal communication system.

Taking the existence of structural units for granted, we may even address the issue of flat versus hierarchical representations. Is there any evidence for internal structure in chick-a-dee calls? If so, a pair of adjacent notes such as CD in the call BCD would have to contract a special relationship. Hailman, Ficken, & Ficken (1987) started out from the observation that the transitional probability from the prior to the subsequent note is quite high. They reasoned that if AB in the call ABC enjoys a privileged status, the doublet AB should predict the occurrence of C with greater accuracy than the single note B. Interestingly, the predictability of C was only slightly enhanced when AB was taken into account, suggesting that AB does not constitute a unit above the note level. This finding is consonant with the claim that chick-a-dee calls form a linear string of notes without any internal hierarchical structure.

This foray into animal communication has provided some insight into how uniquely human structure dependence is. The most significant result is that although evidence for internal hierarchical structure could not be found, the preconditions for finding it are satisfied. Bird song is not only segmentable but also seems to make use of the content/structure distinction (if only to a limited degree). Clearly, these are giant steps toward structure dependence, steps that would have been considered unthinkable only a few decades earlier. As further progress in our understanding of animal communication is made, zoologists might discover that other species have completed the final step (i.e., the transition from flat to internal hierarchical structure). This step would certainly not seem more tremendous than the previous ones of segmentation and productivity. So the chance of success may not even be too slim. However, even if it should turn out to be the case that structure dependence is alien to the animal kingdom, it would have to be acknowledged that the gap between animal and human language has narrowed[7] and that the remaining barrier, although still significant, does not seem insurmountable in principle. This assessment is strengthened by the fact that so many forms of human language have been found to exhibit a reduced sensitivity to structural effects. Structure dependence as a unique property of human language thus does not seem to be a safe bet.

Notes

NOTES TO CHAPTER 1

1. The only allegedly dissenting voice is Paul (1880) to whom Stemberger (1985, p. 48) attributes the claim that sentences are long-term memory units. However, my own reading of Paul's major work suggests otherwise. He (1880/1975, p. 110) makes it quite clear that most sentences are not learned by heart but composed in the act of speaking.
2. Needless to say, this claim in no way conflicts with speakers' general ability to memorize complete sentences or even longer stretches of speech.
3. Again, there are certain marginal cases that do not, however, undermine the general argument. For instance, the celebrated juncture in *night rat*e versus *nitrate* involves a word boundary in addition to a syllable boundary and therefore compares apples with oranges.
4. This is not to say that the process of taking a unit off the shelf is an atemporal one or even a non-issue in psycholinguistics.
5. The same argument carries over to lexical structure (i.e., the organization of the feature complex that makes up a word's meaning; see Andrews, 1988 for a review). A classic case is the semantic structure of the verb *to kill*, which was decomposed into (cause(become(not(alive)))) by McCawley (1968). As indicated by the bracketing, this linear representation translates into a hierarchical right-branching structure. No matter what the merits of such an analysis are for linguistics, it is clear that the linearization of semantic features lacks psycholinguistic support because semantic features are accessed in parallel as much as their phonological counterparts (provided they exist at all, see Roelofs, 1997).
6. Regarding a piece of information as redundant does not mean that it is generally unnecessary in the production process.
7. It has the further advantage of providing an account for some of Meijer's (1996) results, which look puzzling from the perspective of the standard two-tiered framework. In particular, Meijer found no difference between short and long vowels. This finding might be explained by assuming that his experiments tapped into the slot rather than the quantity level. Another possible explanation is that Meijer's findings are language-specific. Dutch, the language in which the experiments were carried out, has no consistent vowel length contrast and therefore may not have relegated quantity to a separate tier. Empirical evidence to support this supposition was presented in Berg (1988b). If this hypothesis is correct, it would lead to the prediction that Meijer's results would have been different if the native language of his subjects had been German.
8. I owe this observation to Ulrich Schade.

9. Note, however, that this gap in the morphology of Modern English is accidental rather than systematic. Old English provides an example of a language with a connection between different morphological categories. This link is created by the fact that *full* existed not only as an independent stem but also as a prefix as well as a suffix (e.g., *fullneah* 'very near' vs. *gesundfull* 'prosperous'). This versatility forms the basis for the prediction that interactions between prefixes and suffixes should not be categorically ruled out in Old English.
10. In a sense, this is reminiscent of Hawkins's (1994, p. 62) perceptual principle of higher node construction, which is illustrated here from the production perspective.
11. With a sufficient degree of embeddedness, structural units may also determine the cohesiveness of other structural units.
12. Thus, there is only one possible direction from less to more structure in language production. The opposite case of dehierarchization makes no sense from the psycholinguistic perspective. However, it has been invoked in a linguistic analysis of phonological derivation. Gussmann (1991) conjectured that a hierarchical syllable structure is eliminated by a process of structure flattening in the course of the phonological derivation. Dehierarchization, Gussmann argues, is needed to take account of "late" events such as ambisyllabicity and the incorporation of extrasyllabic consonants. These arguments are fairly weak. There is no compelling reason to assume that extrasyllabic segments can only be incorporated into a flat syllable structure, not even to assume extrasyllabicity. It is equally unclear why ambisyllabicity should necessitate a flat representation. Hence, the notion of dehierarchization is unfounded.
13. This is not their only function. Morgan and co-workers showed that the identification of constituent structure is a prerequisite for the successful acquisition of a linguistic system (Morgan & Newport, 1981; Morgan, Meier, & Newport, 1987).
14. The importance of this property can hardly be overstated, not only because it has enormous explanatory potential but also because it is not accurately represented in references to my previous work (e.g., Prunet, Béland, & Idrissi, 2000; Boudela & Marslen-Wilson, 2001; Frisch & Zawaydeh, 2001).
15. In apparent opposition to what was said in section 1.3, the compound *timetable* is here assumed to be represented in long-term memory. This is something of a simplification. As pointed out previously, compounds have both a contentful and a structural component, but this duality would have been difficult to represent in this schematic diagram.

NOTES TO CHAPTER 2

1. This relationship is typically described in terms of modifier–head order. However, many linguists have gone further and applied branching direction to two-element sequences (e.g., Bichakjian, 1987; Frazier & Rayner, 1988; Bauer, 1995). Modifier–head sequences are regarded as left-branching and head-modifier sequences as right-branching. This equation is normally taken for granted and its logic rarely spelled out in detail. At first sight, it would even appear nonsensical to describe a representation as left- or right-branching when it lacks this property by definition. However, this move becomes less puzzling if understood as a special case of a more general principle. It is predicated on the observation that modifer–head languages are left-branching and head-modifier languages right-branching. However, the strength of such a correlation is not known. What we do know from Dryer's (1992) work is that the modifier–head and the branching-direction approach are not equivalent. This

is not particularly surprising as the former invokes dependency and the latter constituency. It is advisable therefore to keep the two separate and restrict the analysis of branching direction to three-element sequences.

2. The advantage of a right-branching strategy has been argued for various reasons in numerous works including Yngve (1960); Forster (1966); Tannenbaum, Wood, & Williams (1968); Levin, Grossman, Kaplan, & Yang (1972); Kimball (1973); Krupa (1982); Kemper (1986); and Bichakjian (1987); for dissenting voices, see for example, Lust (1983); Frazier (1985); Frazier & Rayner (1988). Most of these arguments are psycholinguistic in nature, though not formulated in the planning/selection framework adopted here.
3. In all fairness, it should be mentioned that Lyons and Yule do give a single criterion, that of paradigmatic distribution, but they do not show in any detail how and why it works.
4. In addition to these three analytical levels, constituent structure may also be examined in the prosodic domain, which will, however, not be dealt with in this book.
5. We note an interesting similarity in the role of left-branching in morphology in section 2.4.1.
6. For a critique of the use of paraphrases in linguistics, see Donalies (1999, p. 333). She argues persuasively that paraphrases do not serve as arguments. They are but illustrations.
7. Note that this is not to claim that initial stress is a hard and fast criterion for the identification of compounds. As Olsen (2000) argues, compounds may also carry the main stress on the second morphological element (e.g., *ocean habitat*). Whatever the precise status of these units, limiting the corpus to initially stressed items is a conservative strategy that leads to the inclusion of items whose word status is not in doubt even though it may underestimate the true extent of compounding.
8. Actually, this is an oversimplification. Clause boundaries seem to be capable of blocking this rule, which shows its basic sensitivity to syntax and hence its potential to distinguish between different kinds of syntactic boundaries.
9. I would not go so far as to claim that branching direction is artifactual here because it is not a priori clear that all relevant criteria point in exactly the same direction.
10. All the works just cited deal with English syllables. Unsurprisingly, the differences of opinion multiply when other languages are taken into account.
11. I am hard put to resist the temptation to challenge Vennemann's comparison with physics. The fact that we do not as yet understand the nature of light might mean that the categories we have applied to it are inappropriate. Perhaps the dichotomy of continuous versus discrete states is not the ideal way of coming to grips with the essence of light. However, this is clearly not what Vennemann has in mind. There is no indication in his text that he questions the usefulness of investigating syllable organization in terms of hierarchicalness and branching direction.
12. Strictly speaking, inhibitory links are not necessary to bring about between-segment competition (see Peterson, Dell, & O'Seaghdha, 1989). Whatever its ultimate basis, competition is all that matters here and this latter notion is not in doubt.
13. There is a missing link in this argument. A differential ease of access does not translate directly into permissible or impermissible linguistic patterns. There exists a complex relationship between language structure and processing, which is investigated in detail in Berg (2001).
14. As an aside, let it be noted that words with long vowels are generally more frequent than those with short ones (56.7% vs. 43.3%). A likely explanation

for this difference is that monosyllabic words have few segments to guide language comprehension. This brevity makes it desirable to give at least the vowel a maximum of phonetic substance to facilitate the decoding process. Accordingly, long vowels are preferred to short ones.

15. Note in passing that this balance is not in harmony with Vennemann's (1988a) ideal stressed-syllable types, according to which a short vowel should be followed by a single consonant and a long vowel by none at all.
16. At the featural level, Kessler & Treiman also find evidence for phonotactic restrictions between (non-adjacent) onsets and codas. These are of an inhibitory nature in the sense that highly similar or identical segments are avoided in these positions. In all probability, these restrictions have nothing to do with structural asymmetries in the syllable but with the fact that both onsets and codas accommodate consonants whose parallel access requires activation spread in exactly the same subnetwork.
17. The assumption here is that ambisyllabicity occurs at the boundary of a stressed and unstressed syllable, as in *hammer*. This domain makes sense from the psycholinguistic view-point because stressed syllables are better able to attract consonants than unstressed ones (compare Treiman & Danis, 1988a). However, less is known about possible interactions at the boundary of two unstressed syllables as in *cigarette* and *Canada*. Whether or not the /g/ in the former and the /d/ in the latter item are ambisyllabic remains to be investigated.
18. When duration assumes a distinctive function, it is called length and coded at the quantity level (see Chapter 1).
19. Content-wise it would have been more appropriate to include this analysis in section 2.5.1.1, but the current train of thought let it fit in gracefully here.
20. This is directly opposite to the claim made by Tabain, Breen, & Butcher (2004).
21. The claim that all languages of the world favour consonant-initial over vowel-initial syllables is a myth that needs to be dispelled. Although it is undisputed that the CV structure is the strongly preferred option, this tendency should not be confused with a universal one that, by definition, allows no exceptions. Such exceptions do, however, exist. Breen & Pensalfini (1999) present the case of Arrernte, an Australian language, in which at the surface phonetic level three quarters of the words begin with a vowel and only one quarter with a consonant. In this language, then, CV is certainly not the predominant pattern.
22. This explanation is similar in spirit to that put forward for the suffixing preference by Cutler, Hawkins, & Gilligan (1985).
23. Fudge (1987) argues for model (11c) although all the evidence he adduces supports the onset-rime distinction but does not speak to any deeper levels of embedding.
24. Note that this is not generally true. Stemberger (1983b) for one argues that this does not hold good of diphthongs whose constituent parts share one slot.
25. This psycholinguistic result finds an interesting parallel in diachronic data. In the history of English, postvocalic /r/ and /l/ appear to have changed the preceding vowel to a greater extent than any other consonant. Witness for example the development from Middle English *thirde* [θird] to *third* [θɜ:d] and from Middle English *talken* [talkən] to *talk* [tɔ:k]. This influence is expected if there is a close affinity between the vowel and the liquid.
26. Selkirk (1981) argues that also the prosodic structure of English is predominantly right-branching, so that the above result may even be more general than the analysis in this chapter suggests.

NOTE TO CHAPTER 3

1. There is another effect of the variable size of linguistic units. Assuming that there is an upper limit to the number of units that can be simultaneously processed (irrespective of their size), larger units will generally require a larger planning window than smaller units. This is in fact the case. As has been demonstrated by Hohenberger & Waleschkowski (2005), the planning window is considerably larger in syntactic and morphological than in phonological processing.

NOTES TO CHAPTER 4

1. Two further syntactic developments may be linked to this positional constraint. Both passive and raising constructions have seen a gain in frequency from Old to Modern English. One effect of these constructions is that the semantic weight of the subject is augmented. Compare the active sentence *Someone hurt my pride* to its passive counterpart *My pride was hurt* as well as the non-raised structure *It is said that John has grown a beard* to its raised counterpart *John is said to have grown a beard*. In both cases, the change is from a semantically empty to a semantically loaded subject noun. If the subject-filling constraint is understood not only syntactically but also semantically, the diachronic increase of passive and raising constructions may be claimed to be distantly related to the heightened importance of structural relations.
2. The relationship between the availability of a phrasal node and the existence of a corresponding pro-form is ill-understood at this stage of enquiry. There is probably no necessary reason why a highly available phrasal node must entail a pro-form, but it is not implausible that a highly available phrasal node facilitates the emergence of a pro-form. Thus, the high availability of a node may be a necessary, though not a sufficient condition for the rise of particular syntactic units or functions.
3. This ambivalence explains the disagreement among historical linguists as to their proper characterization. While the existence of modals is categorically denied by Lightfoot (1979), it is acknowledged by many others such as Denison (1988), Warner (1990), and Kemenade (1992; see also Plank, 1984).
4. The only exception is *though*, which serves the double function of conjunction and adverb in Modern English.
5. This presupposes of course that the processing system is capable of extrapolating the frequencies of structural patterns. The psychological evidence in favour of a wide-ranging sensitivity to frequency is overwhelming (see Hasher & Zacks, 1984).
6. The genitive plural suffix *-ræ* may be ignored here as it is an inflectional morpheme.
7. The only exception to this is the category of stem-stem-suffix combinations, which have been somewhat on the wane. This decrease may follow from the decline of the frequency of this type of compounding. A more general explanation in terms of a tendency toward analyticity is inappropriate as it is incompatible with some of the other developments. Table 4.1 does not lend support to the hypothesis that English word structure has become more analytic at the level of compounding and derivation.
8. I am reluctant to interpret this ban as an orthographic convention as Old English knew no codification.

9. Considering this, one may wonder why the number of left-branching cases is not even higher. The simple answer is that by far the largest subcategory involves the prefix *ge-*, which is never stressed.
10. It is worth mentioning in this regard that in Modern German separable prefixes are also stressed (e.g., *áb-schlagen* 'to cut off') in contradistinction to the inseparable prefixes.
11. Whether these pairs occur significantly more, or less, often than chance is immaterial in the present context as both a lowered and a heightened occurrence of a given phoneme pair would be evidence for an interaction of its constituents.
12. This change is also reflected in the stress rules formulated by Halle & Keyser (1971) in their historical account of the English stress system.
13. Instead of vowel alliteration, it may be more appropriate to speak of zero alliteration, a term suggested by Jakobson (1963).

NOTES TO CHAPTER 5

1. The results pertaining to clause function will not be reported here mainly because the relevant cross-linguistic aspects are covered in the next subsection.
2. For ease of reference, the verb will also be called a constituent here.
3. Berg (1991) found that the position of lexical stress does not affect the Spanish error patterns. By implication, it also does not affect the structural representation. Diagram (15b) is consequently assumed for both initially and finally stressed items.
4. Further support for the syllabic slant of French is provided by the fact that French has a language game that involves inverting entire syllables (Sherzer, 1982; Lefkowitz, 1991).
5. This cross-linguistic difference is confirmed by another Spanish speech error corpus in which the rate of within-word slips is even higher (38.7%; see Pérez, Santiago, Palma, & O'Seaghdha, 2007, p. 224).
6. I am thankful to Richard Wiese for placing this list at my disposal.
7. This distinction will be accepted as valid here although it is far from uncontroversial. On the one hand, there is strong empirical support for it. Grabe, Post, & Watson (1999) measured vowel durations in English and French and found that these are more equal in French than in English, exactly as expected under the assumption that the former language is syllable-timed and the latter stress-timed. The same difference was obtained for syllable duration both in adult and child language (Fant, Kruckenberg, & Nord, 1991; Levitt & Utman, 1992). On the other hand, Roach (1982) casts serious doubt on this distinction as he finds no consistent difference in terms of variability of syllable duration and of inter-stress intervals. This negative result does not mean, however, that the distinction is without value. It may be that this distinction is epiphenomenal and that its true roots lie in areas other than rhythm (see Bertinetto, 1979 and Dauer, 1983 for a list of phenomena that may co-vary with rhythmic differences). In essence, it all depends on how rhythm is defined and operationalized. One particular definition may not yield any differences between stress- and syllable-timed languages whereas another may be quite successful. A promising solution was developed by Ramus, Nespor, & Mehler (1999) who defined rhythm as the alternation between vocalic and consonantal portions in a given language.
8. This idea was suggested to me by Ulrich Schade (see also Dauer, 1983).

9. For ease of exposition, the wording of this and the following sentences is more contentious than is warranted by the empirical data. See later discussion for qualification.
10. The observation that onsets and codas interact so freely constitutes strong evidence for the claim that an onset allophone (e.g., [k-]) is phonologically identical to its corresponding coda allophone (e.g., [-k]), i.e., that there is only one phonemic category /k/, contra Bybee [2001]).
11. This is the reason why only coda clusters can be subjected to a comparative analysis.
12. Of course, the term *coda* is used here merely as a convenient label, not as a theoretical notion relevant to Arabic.
13. Note that this is a metalinguistic task that should be carefully distinguished from Treiman's (1983) blending experiments as well as from naturally occurring blends. Conclusions based on one data type thus need not generalize to another.
14. There is one potential challenge to this conclusion, but it is without effect. If Korean had a moraic tier, the cohesiveness of CV might be put down to the claim that it constitutes a moraic unit. In that case, the branching direction issue would not have the same meaning as originally conceived. However, Korean lacks moras (Minegawa-Kawai, 1999) and therefore this interpretative difficulty does not even arise.
15. A theoretical objection has to be met at this point. The Structural Theory rests on a critical background assumption—that of a fixed time span for the activation process. This assumption may be questioned. One might wonder why the variable speed of the build-up process cannot be nullified by a variable amount of time during which linguistic representations are erected. To be specific, a slower activation process might be compensated for by a longer period of time allocated to language planning. Apparently, this option is not available. If it was, Arabic would be as structure-sensitive as English. One plausible explanation for this is the limited storage capacity of working memory (Baddeley & Hitch, 1974; Just & Carpenter, 1992). Because of this limited capacity, information can be retained only for a limited period of time (Hulme & Tordoff, 1989). Therefore, the gradual build-up of linguistic representations cannot extend indefinitely and the system must output that which has been accomplished within the temporal limits imposed by working memory.
16. One pertinent suggestion comes from Fodor, Bever, & Garrett (1974) who argue on the basis of Yngve's (1960) model that left-branching may facilitate language perception (whereas right-branching facilitates language production). Consider the three-element sequence ABC. In a left-branching language, listeners may assign constituent structure at the earliest possible moment because the sister constituents AB are the first to be taken in. In a right-branching language, by contrast, the build-up of constituent structure cannot occur until the listener has encountered the final element. Although interesting, this proposal begs the question of why Korean is a "perceptual language" and English a "productive language" (see also Chapter 10).
17. Note that in the activation framework espoused here, this hypothesis is by no means incompatible with the aforementioned claim that Arabic is a largely flat language.

NOTES TO CHAPTER 6

1. Chomsky (1988) even regarded this bonding as a linguistic universal.

2. It may be noted in passing that VP nodes have even been posited for OSV languages (McCloskey, 1983) as well as for languages with a relatively free word order (Stucky, 1983). These proposals will be left out of consideration because they invoke criteria for determining VPs, which are not compatible with the ones used here.
3. The few typological studies of syllable structure (e.g., Bell, 1971) do not explicitly address the issue of branching direction. This is also true of the Stanford Phonology Archive (Crothers, Lorentz, Sherman, & Vihman,1979). In their typological analysis of syllable types, Kaye & Lowenstamm (1981) take right-branching for granted and do not consider any alternatives to it.
4. One might argue that the languages for which the empirical evidence adduced is weak had rather been left out of account. However, it may be safely assumed that no linguist would adopt the right-branching model if she or he had evidence to the contrary. The use of this model for a particular language may therefore be taken to imply that the data from this language are at least compatible with right-branching.
5. (Sources: English: Kessler & Treiman, 1997; German: Berg, 1989b; Dutch: Trommelen, 1984; Swedish: Linell, 1978; Icelandic: Árnason, 1984; Spanish: Harris, 1983; Italian: Bertinetto, 2001b; French: Bertinetto, 2001b; Portuguese: Mateus & d'Andrade, 2000; Slovac: Rubach, 1998; Dama: Cruttenden, 1992; Kabyle Berber: Bader, 1989; Telugu: Sailaja, 1999; Taiwanese: Wiebe & Derwing, 1994; Vietnamese: Dình-Hoà, 1997; Lao: Morev, Moskalev, & Plam 1979; Chinese: Shen, 1993; Norwegian: Kristoffersen, 2000; Polish: Rubach & Booij, 1990; Armenian: Vaux, 1998; Kurdish: Shokri, 2002; Hungarian: Siptár & Törkenczy, 2000; Arabic: Abu-Salim, 1988; Uyghur: Hahn, 1991; Mongolian: Svantesson, Tsendina, Karlsson, & Franzén, 2005; Kayardild: Evans, 1995; Kisi: Childs, 1995; Wambaya: Nordlinger, 1998; Kham: Watters, 2002; Misantla Totonac: MacKay, 1999; Finnish: Niemi & Laine, 1997; Korean: Yoon & Derwing, 2001; Japanese: Kubozono, 1989; Guaraní: Gregores & Suárez, 1967; Hindi: Ohala, 1999; Turkana: Dimmendaal, 1983.)
6. A notable historical development toward cross-level harmony was reported by Payne (1993). She claims that Panare, an Amazonian language, assimilated its hierarchical clause structure to the flat structure of nominal expressions and thereby made clause structure non-configurational.

NOTES TO CHAPTER 7

1. This claim appears to be directly opposed to MacNeilage & Davis's (1990) hypothesis that frames are acquired prior to content units. However, different types of structural units are apparently at issue. Whereas my claim pertains to structural units, MacNeilage & Davis's looks as if it refers to both the slot level and the structural domain (see section 1.4 for an account of this difference). It is not quite clear whether and how the two views can be reconciled. I suspect that that which MacNeilage & Davis regard as syllables are actually words (see discussion to follow).
2. Of course, the hierarchical system of content units is also not present from the beginning but has to be gradually deployed. It seems plausible that children start out at the word level, then create the phoneme level and finally the feature level. As the acquisition of content units is not our main concern, this issue will not be pursued any further.
3. That these words are monosyllabic is a simple spin-off of the minimum complexity principle.

4. An implication of this view is that early processes in child language that are typically considered to be syllable-based have to be reinterpreted as being word-based. Reduplication is one case in point (e.g., Ferguson, Peizer, & Weeks, 1973). It would have to be assumed that the reduplicated part in [mama] is the word rather than the syllable. This would imply that these words should also occur in their non-reduplicated form. Whether this is actually the case remains to be seen. In any case, Jaeger (2005) presents a good deal of evidence showing that syllables play hardly any role at the onset of language acquisition. This is exactly as would be expected under the Structural Theory. A further implication concerns the prelinguistic stage. Babbling cannot be regarded as involving structural units like syllables for example. As defined in this book, content and structureful elements are *linguistic* units. Therefore, the distinction between content and structure is not applicable to the prelinguistic stage. What is involved in babbling can be more appropriately described as articulatory gestures.
5. Note that this account in no way implies that children can never produce forms they have not been exposed to. Of course, they can, but this does not warrant the inverse conclusion that what they have been exposed to, or rather not been exposed to, cannot shape their productions or rather non-productions.
6. For example, the acquisition process has to be fairly advanced for children to produce trimorphemic words. Prior to this stage, the question of branching direction cannot be meaningfully addressed.
7. Thus, the criticism that the phrase-structure approach postulates a discontinuity between the two-word and the three-word stage in language acquisition (Ninio, 1994) does not apply to the present model.
8. However, no distinction will be made between tutored and untutored second language acquisition.
9. Tavakolian considers the conjoined-clause analysis a universal, innately determined hypothesis that the child brings to the task of language acquisition. In the framework advocated here, there is certainly no need to make such a claim. Children's interpretative strategy of treating (4) as (5) emerges as a direct consequence of an underdeveloped structural representation. It is a transitional stage that appears and disappears as the child gradually builds up its system of syntactic nodes.
10. It is an interesting topic for future research to determine why phonological-process data tend to stay within the confines of the word whereas even in the beginning stages of phonological acquisition, between-word slips outnumber within-word slips. It appears that somewhat different processing constraints are operative in the two cases.
11. For this calculation, incomplete and complete anticipations were thrown together. Between-sentence perseverations were not taken into account.
12. This change is due to both an increase in the rate of anticipations and a decrease in the rate of perseverations. In all probability, this decrease has nothing to do with a changing degree of advance planning. Rather, it evidences an improved functioning of the self-inhibition mechanism.
13. The other is age-related differences in neurological, cognitive, emotional, social, etc., growth.
14. The deeper reasons why similarity has a facilitatory effect are as yet poorly understood. The key to an understanding may be the notion of distributed representations (e.g., McClelland, Rumelhart, & Hinton, 1986). If the information to be represented is similar, be it in L1 or L2, it is coded in partly the same nodes. It is easy to see that learning is facilitated when some of the nodes that are needed are already available.

15. For a highly instructive attack on the poverty-of-the-stimulus argument, see Haskell, MacDonald, & Seidenberg (2003).
16. The construal of (20) as a sentence is often justified by positing null elements (i.e., syntactic slots are assumed to be generated but left unfilled). I find this procedure unacceptable because it allows us to posit any kind of "ghost elements," which leads to a scientific model that is insufficiently constrained by "hard facts."
17. Note that the affricate /tʃ/ is not part of the phonological system of Standard German.
18. This conclusion leads us to expect an increment in contextual errors as the learners move closer to native-speaker competence. However, this expectation is not fulfilled. Poulisse's data exhibit an inverse relationship between the number of contextual errors and the learners' proficiency level. I have no explanation to offer for this pattern. It is hard to believe in view of the uncontroversial observation that competent speakers make relatively more contextual errors than less competent ones. How else can we explain this difference unless by assuming that the rate of contextual errors increases with linguistic competence?

NOTES TO CHAPTER 8

1. This would be natural to expect in a psycholinguistic model with distributed representations (e.g., McClelland, Rumelhart, & Hinton, 1986).
2. Some dissenting voices believe that agrammatism should be understood as a phonological (Kean, 1979) or a lexico-syntactic deficit (Bradley, Garrett, & Zurif, 1980). However, it may be argued that these studies have mistaken effect for cause.
3. An interesting implication of Rizzi's conjecture is that agrammatism in non-configurational languages should be unobservable. As there is nothing for agrammatic patients to fall back on, their output should be identical to that of normal speakers. In other words, agrammatism should apply vacuously, as it were, in non-configurational languages.
4. Another important variable shaping aphasic language is the satisfaction of the phonological well-formedness condition. For example, the plural marker *–e* in Italian (e.g., *pizz-a* → *pizz-e*) is more resistant to loss than the plural marker *–s* in English (e.g., *book* → *book-s*) because its deletion leads to a real word in English (*book*) though not in Italian (**pizz*; see Grodzinsky, 1984). What Grodzinsky claims for inflectional morphology can be quite naturally extended to phonology.
5. It is not claimed here that there is a total dependence among all nine effects. This is because most, if not all, observable phenomena have multiple causes. This state of affairs introduces a certain degree of independence between any two effects as they may share some causes though not others. It is therefore quite possible for two effects to evince only a limited degree of co-variation even though they share one underlying cause. So if we should find an aphasic who, let us say, makes a high number of contextual errors (untypical of aphasics) and a relatively low number of rime errors (typical of aphasics), we would not be forced to abandon this part of the Structural Theory. Such a dissociation is not categorically ruled out, in particular as different parts of the structural representation are involved in the two error types. However, over a sufficiently large number of cases, the Structural Theory leads us to expect an interaction between the number of rime errors and that of contextual errors. It can therefore be invalidated only by group, not by single-case studies.

6. Note that this conjecture does not conflict with Kohn's (1988) claim to the effect that different types of aphasics tend to produce paraphasias at different linguistic levels. Providing that the structural effects at the phonological level reach into the phonetic stage—evidence in favour of this assumption was presented in section 2.5.1.4—paraphasias occurring at different levels may be subject to similar structural constraints.
7. Of course, this is not to deny that rhythm also plays an important part in the perception and production of speech.
8. This limited availability also explains the generally longer reaction times found in aphasic populations (e.g., Montgomery, Scudder, & Moore, 1990).

NOTES TO CHAPTER 9

1. We will ignore more specialized productive activities such as singing, signing, and morsing.
2. This does not conflict with the possibility that there may be temporal overlap (i.e., non-discreteness) in the mental programming of the key strokes.
3. Note that this difference is based on a rather low addition rate in Stemberger's speech error corpus. This rate is higher in my German data. If the German speech error corpus had been taken as the basis for comparison, the increase in additions in writing and typing would have been only slight. It is advisable therefore to take this result with a pinch of salt.
4. The only seven-syllable target word was excluded from these calculations.

NOTES TO CHAPTER 10

1. Note that even low-level processes require a certain amount of parallelness, as evidenced by the ubiquity of coarticulation.
2. Note in passing that Mazuka herself does not discuss this conclusion.
3. Berg & Abd-El-Jawad (1996) report that the rate of Arabic word-onset slips is at chance level in the within-word category and above chance in the between-word category.
4. This situation bears an obvious resemblance to the interaction of phonemes from similar or different syllable or word positions in slips of the tongue.
5. In generative linguistics, the question of what is uniquely human is usually addressed within the conceptual framework of innateness (e.g., Chomsky, 1975; Hornstein & Lightfoot, 1981; Lasnik & Uriagereka, 2002). However, it is not justified to equate the two notions. A certain property may be innate and genetically coded in distinct species. Also, distinct species may exhibit the same property without it being genetically transmitted. The issue of innateness is thus irrelevant to the ensuing comparison of human and animal language.
6. Hailman, Ficken, & Ficken (1987) note that violations of this ordering principle do occur, though at an extremely low rate. Whether such inversions represent intentional output or "slips of the beak" is difficult to ascertain.
7. See Salwiczek & Wickler (2004) for a survey of the amazing parallels between human language and birdsong in general and Güttinger (1979) in particular on the distinction between structure (higher-order temporal constraints) and content (individual notes). It may be worth adding that birds even respect the Penthouse Principle (see Chapters 4 and 5; Hultsch, Mundry, & Todt, 1999, p. 91).

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