20. Sign Language Phonology: ASL

DIANE BRENTARI

Subject	Theoretical Linguistics » Pholonogy
DOI:	10.1111/b.9780631201267.1996.00022.x

> After one of the Bampton lectures at Columbia in 1986, a young member of the audience approached him [Zelling Harris] and asked what he would take up if he had another lifetime before him. He mentioned poetry, especially the longer works of the 19th century poets like Browning. He mentioned music. And he mentioned sign language.
>
> –Bruce Nevin, "A Tribute to Zelling Harris"

0 Introduction

Linguists have been drawn to the study of signed languages for about 35 years because of the challenges they pose to our theoretical tools as we attempt to deal with a natural language that uses vision rather than audition. It is important to consider what the state of our knowledge about American Sign Language (ASL) is, since signed languages also offer unique opportunities for testing ideas about the nature of language itself, ideas generally formulated exclusively from observations about spoken language. Our task as ASL phonologists is to ascertain which are the minimal units of the system, which aspects of this signal are contrastive, and how these units are constrained by the sensory systems that produce and perceive them. Of all the items on the list of differences and similarities between signed and spoken languages, the areas that present the most striking divergences occur in morphophonemics and phonology. I use the term "morphophonemics" here, because there is nothing strikingly different about the types of morphemes that ASL possesses, but the interface between morphology and phonology is indeed different, given the freedoms and constraints available to the system.

Consider, for example, the treatment of grammatical aspect in ASL. Many languages from a variety of language families express grammatical aspect of the verb using primarily concatenative morphology – for example, Navajo (Hoijer 1974), Atsugewi (Talmy 1972), West Greenlandic (Fortescue 1984), Russian (Halle 1959; Chung and Timberlake 1985), and Tamil (Fedson 1981), to name just a few. In none of these spoken languages, however, is the aspectual system expressed in the phonology primarily by means of altering the distinctive feature specification within a single segment. Even in Semitic languages, which utilize the riches of nonconcatenative morphology, the lexical roots and grammatical vocalisms alternate with one another in time; they are not layered onto the same segments. In contrast, the aspectual system in ASL is achieved by layering shapes of movement onto one another. For example, the *exhaustive* aspect (meaning "perform *x* to each of a group") is a composite of two layered movement shapes. One is that of a sweeping arc, which captures the meaning "give to a group," and the other is a repeated, straight path, which captures the meaning "perform *x* to each individual." Additional small circular paths, which taken together mean "perform *x* continuously to each member of a group" can be layered onto this form, adding the "continuative" aspect. It is not the aspectual categories themselves that are unusual in ASL, it is the rendering of these categories into phonological form that is so different from its spoken language counterparts with equally rich aspectual system. The visual system allows for the exploitation of trajectory and shape of path in a simultaneous way that the auditory system does not. A comparable situation in a spoken language would be having three vowel qualities in a single syllable nucleus, each realizing separate morphemes. This difference between signed and spoken languages is one example of the kind of differences that have led phonologists to study how morphemic information is encoded in the morphophonemics in a signed language, and how phonological forms are organized by the grammar.

This chapter has two main parts. The first traces the kinds of questions phonologists have asked of signed languages, giving the reader a kind of minihistory of the development of the discipline. The second part will present some of the similarities and differences between signed and spoken language that have been well established through a variety of theoretical frameworks during the last three decades.

1 Historical Development of Phonological Issues in ASL

1.1 Simultaneous and Sequential Units

One of the most long-standing issues taken up by ASL phonologists during the last 30 years is the extent to which the underlying phonological structure of ASL is composed of sequential and simultaneous units. The first attempt by Stokoe (1960) and Stokoe, Casterling, and Croneberg (1965) to analyze lexical items into phonemes rejected the assumption imported from spoken-language phonology that sequential organization must be the most important way that signs are constructed. Stokoe proposed that we should look instead at the principal components of signs as they present lexical contrast, and he concluded that these units were simultaneously, rather than sequentially, organized. He called these components *cheremes* to distinguish them from the phonemes of speech, but the principles used for isolating one chereme from another were those of phonemic analysis. There were three types of cheremes in Stokoe's system, each of which he gave a name that was distinct from any term used in spoken-language phonology: *tab* (tabula) – one of 12 distinctive places of articulation on the body; *dez* (designator) – one of a group of 18 distinctive handshapes; and sig (signation) – one of a group of 24 distinctive aspects of movement. He established a distinct notation utilizing these categories. Stokoe Notation for the uninflected form of the sign GIVE is O_a□. The large O represents the handshape with the four fingers contacting the tip of the thumb. The subscript a indicates that the orientation of the palm is up, rather than down (Stokoe included orientation as an aspect of tabs); the □ indicates that the movement is in a direction away from the body. This analytical view of the underlying representation of signs being simultaneous (i.e., with no temporal ordering included) was adopted by Klima and Bellugi: "A simple lexical sign is essentially a simultaneous occurrence of particular values (particular realizations) of each of several parameters" (1979, p. 43). While Stokoe Notation was primarily considered a phonemic method of transcription, it was implicit in the program that the transcription could be expanded to serve as a notation for phonetic transcription if it were thoroughly fleshed out and if redundant features were added.

The notion of simultaneous organization of underlying structure in ASL was argued against, and indeed displaced, during the 1980s. Newkirk (1981), Liddell (1984), Liddell and Johnson (1986, 1989) and Johnson and Liddell (1984) presented arguments for sequential underlying structure in ASL. Morphophonemically, this was demonstrated by Supalla and Newport (1978), who cited the contrast between, for example, the infinitive TO-FLY,[1] and the verb phrase FLY-THERE. TO-FLY has a continuous movement with no obligatory periods of stasis at the beginning or end of the movement. FLY-THERE has a similar trajectory and shape of movement, but must end with a period of stasis at a particular location in space. The linguistic arguments for sequential organization of underlying phonological structure in ASL are set forth in Liddell (1984), and they can be summarized as follows:

1. During a string of signing, it may look as if the hands are in constant motion, but they are not. In signs where the hands contact the body, the range in duration of period of stasis of the hands, or "hold" duration, varies considerably – from approximately 0.1 second to 2.0 seconds (measured in frames of video footage, where 1 frame = 0.033 seconds). The hands are in stasis during roughly half

the time; therefore holds must be phonologically important, in the sense that if there is equal time taken up phonetically by Movements and Holds, they must be roughly equally important in the phonological grammar.

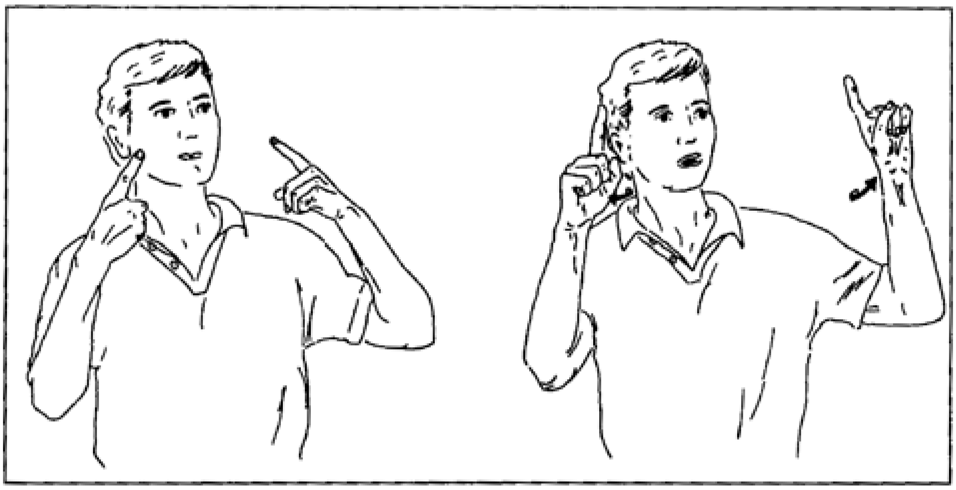
2 In signs like THINK (1), which contain a movement to a point of contact on the body, the movement has a purpose, so to speak, when contact is achieved. However, the movement is present regardless whether there is actual contact made with the body or not (i.e., even when it has no purpose); therefore, movements are phonologically important - presumably, movements with no physiologically based necessity must be phonologically important.

(1) The ASL sign THINK.

3 Nonmanual signals are timed with respect to these periods of stasis and movement in the sign stream. In a sign like FINALLY (2), which contains an obligatory nonmanual feature, the form is ungrammatical unless the nonmanual feature is timed correctly with respect to the initial Hold and following Movement. The nonmanual component consists in a pursing of the lips, synchronized to the initial Hold of the sign, followed by the opening of the mouth, synchronized with the Movement of the sign, culminating with an open mouth during the final Hold of the sign.

4 Compound formation in ASL had been described, in general terms, as "temporal compression" (Klima and Bellugi 1979, p. 216). By using sequential segments of holds and movements to describe this compression, we can systematically and analytically describe the process. The example THINK-MARRY "believe" (3) was one example given in Liddell (1984). Notice that, in this analysis, the first segment of THINK and the first segment of MARRY are deleted in the formation of BELIEVE.

(2) The ASL sign FINALLY. Notice that the nonmanual feature must be correctly timed with respect to the initial and final Hold. Both figures are part of the same sign.



(3) Segmental Analysis of Compound Formation (Liddell 1984) (AP = approaching movement, H = hold; hs = handshape features; or = orientation features; loc = location features; con = contact features; NMS = nonmanual signals; subscripts index individual segments in the string.)

	THINK			MARRY				BELIEVE		
	AP_1	H_1		H_2	AP_2	H_3		H_1	AP_2	H_3
hs	1	1		C	C	C		1	C	C
or	ti	ti	+	Pa	Pa	Pa	=	Ti, Pa	Pa	Pa
loc	FH	FH		c	c	c		FH	c	c
con	–	+		–	–	+		+	–	+
NMS	–	–		–	–	–		–	–	–

The following passage summarizes the guiding principle of Liddell and Johnson's research program:

> Stokoe's proposal that handshape, movement and location are phonemic in ASL is a very appealing and long-held idea. However, the entire segment, rather than these aspects of a segment, is the ASL unit which carries out the contrastive functions of a phoneme. A preliminary look at the number of possible contrastive segments in ASL suggests that the number will be considerably larger than that found in spoken languages. If this result is born out after a thorough analysis, it would represent a very interesting modality difference.
>
> (Liddell 1984)

Current work pursues both the generalizations about simultaneous structure made by Stokoe and the generalizations about sequential structure made by Liddell and Johnson (Sandler, 1989; Brentari 1990a, 1990b, 1994; Perlmutter 1990, 1992b, 1993; Wilbur 1987, 1990).[2] First, I will discuss Sandler's *Hand Tier* phonological model (1986, 1987, 1989, 1990, 1992) to illustrate this duality between sequentiality and simultaneity in ASL in current work on segmental structure; then I will discuss major developments in work on the ASL syllable. Sandler argues for underlying representations that consist of a skeletal timing tier of the sequential units *Location* and *Movement*, comparable in some respects to consonant and vowel, respectively; these units can be, and are, sequentially ordered. Sandler's work focuses on the temporally ordered segment in sign:

> If ASL phonemes are simultaneously executed, however, a key aspect of the phonological structure of spoken words would not characterize signed words:

> sequentiality. The temporally segmented units of spoken-language phonology would not be available in sign. The more alike signed and spoken languages turn out to be, the more we can assume they are examples of the same types of cognitive operations, and the less we depend on metaphor to bridge the gap between the two
>
> (Sandler 1989, p. 3).

For example, like Liddell and Johnson (1989), Sandler (1989) analyzes compound formation and reduplication in ASL as segmental operations, and she also proposes that the ASL syllable could be a sequence of three segments Location-Movement-Location.

Along with this work on sequential structure employing a CV skeletal tier, Sandler addresses issues of simultaneity with the formalism of autosegmental phonology and feature geometry. Handshape and orientation features occupy a separate autosegmental tier, called *Hand Configuration*. Her reasons for analyzing handshape in this way are sound, and they are the classic reasons for setting up a separate autosegmental tier for a set of features (Goldsmith 1976a, b): (1) *stability*: handshape behaves autonomously in phonological rules, slips of the hands, etc.; (2) *many-to-one association*: handshape often contains two postures which associate to a single slot on the timing tier; (3) *morphological status*: ASL's system of classifiers is expressed predominantly through handshape. By introducing these arguments for a separate Hand Configuration tier, Sandler reemphasizes structural simultaneity by showing that employing full specifications for handshape on each segment is not only redundant, but it misses generalizations that are best specified by phonological constituents larger than the segment. An example of this can be seen in her analysis of the set(s) of fingers that are *selected* during the articulation of a sign. *Selected* fingers are those that make contact with the body and have a wider range of postures than the rest of the fingers; the other fingers are referred to as *unselected*. Sandler was the first to make formal arguments against the segmental specification for selected fingers, and to make a concrete proposal for selected fingers that had a larger domain than the segment (also see Mandel 1981 for this observation in ASL phonetics). We will return to this issue in our discussion of the syllable.

One way that simultaneity is explicitly addressed in the Hand Tier model is in its use of feature geometry. Sandler provides several analyses aiming to establish dependency relationships among ASL features. One of these analyses argues that the features expressing palm orientation are dominated by other handshape features expressing which fingers are selected to articulate the handshape – for example, whether the index finger alone or the index and middle finger are extended during execution of the sign. Sandler's evidence is primarily based on compound formation. In the initial sign of the vast majority of compounds in ASL, either orientation alone, or orientation and handshape features assimilate to those in the second sign of the compound. If handshape assimilates, so does orientation: that is, orientation alone may assimilate, but not handshape alone without orientation. This is illustrated in the compounds listed in (4) (from Sandler 1989, p. 93). They all have two forms, one containing partial assimilation (orientation alone), and one with total assimilation (handshape and orientation features).

(4) Compounds that have two alternants – one with total assimilation, and one with partial assimilation.

MIND-DROP	“faint”
RED-FLOW	“blood”
THINK-HOLD	“memorize”
FEMALE-MARRY	“wife”
THINK-TOUCH	“obsessed”

The earliest discussion of the syllable in ASL (Kegl and Wilbur 1976; Chinchor 1978) sketched some possible parallels between signed language and spoken language syllables based on segmental structure. This work rests primarily on the notion that a syllable in ASL must have at least one movement segment, and that movements are analogous to vowels in spoken languages, but the first linguistic evidence for syllables in ASL is given in Brentari (1990b) and Perlmutter (1992b, 1993). Perlmutter uses distributional evidence from secondary movement to show that movements function as syllable peaks when not adjacent to a movement. Further, Brentari (1990b) and Perlmutter (1992b, 1993) show that the distribution of handshape changes provides a way of counting syllables in ASL.

Perlmutter (1992b, 1993) concluded that movements are indeed more sonorous than positions and that movements are analogous to vowels in spoken languages, thereby supporting the pretheoretic notion expressed in early work. In addition to these broad categories of movements and positions, there is a full sonority hierachy in ASL, which can only be arrived at by comparing simultaneously occurring features (Brentari 1994). These matters will be discussed in more detail in the next section on the syllable and the phonological word in ASL, but I mention this work here to show that simultaneous and sequential structure have both been shown to be important for describing segments and syllables in ASL.

As we will see in the description of ASL phonological structure below, the question of analyzing ASL by means of simultaneous or sequential structures and constraints on form appears in many of the central concerns of ASL phonologists. Among them are syllabification, the relationship of the two hands in two-handed signs, and the problem of devising tests which will establish a sonority hierarchy for ASL.

2 Sketch of ASL Phonological Structure

In order to conceptualize and catalogue our current knowledge about ASL, I will group issues roughly into three categories: (1) issues concerning the syllable and the phonological word; (2) redundant features and those issues that concern constituents larger than the word; (3) issues that surround underlying representations. I have chosen this tripartite division of the issues simply as a useful organizational tool, and to avoid couching the following observations in theory-internal terms that might make the discussion less accessible.

2.1 Syllables and Words In ASL

Let us now turn to the level of the phonology responsible for constructing well-formed syllables and words. We will assume that at this level of the phonology, only distinctive features are taken into account by the phonological system. This would be true from the perspective of lexical phonology (Kiparsky 1982c, Mohanan 1986) or from that of a nonderivational, harmonic approach (Goldsmith 1990, 1993a).

2.1.1 Words in ASL

It is here that constraints are spelled out on the two hands used in executing ASL signs. While they are physiologically independent, to a large extent the two hands are phonologically interdependent. They must, together, form a single phonological string. Although it is physically possible to do something like "talk out of both sides of your mouth" in sign, the two hands are virtually never engaged in separate messages presented simultaneously under typical conversational conditions. Some signs in ASL are specified in the lexicon as two-handed. A signer is linguistically either left-hand or right-hand *dominant*, depending on which hand typically executes one-handed signs. We will refer to this hand as *H1*, also called the *active* or *strong* hand in the literature. The other hand will be called the *H2*, also known as the *passive, base*, or *weak* hand. Battison (1978) captures some aspects of the interdependence between the two hands in two principles he calls the Symmetry Condition and the Dominance Condition, given in (5a, b).

> (5) (a) The Symmetry Condition
> If both hands of a sign move independently, then both hands must be specified for the same location, the same handshape, the same movement (whether performed simultaneously or in alternation), and the specification for orientation must be either symmetrical or identical. (Battison 1978, p. 33)
> (b) The Dominance Condition
> If the hands of a two-handed sign do not share the same specification for handshapes, one

hand must be passive while the active hand articulates the movement, and the specification of the passive handshape is restricted to a small set (B, A, S, C, O, 1, 5). (Battison 1978, p. 33)

The Symmetry Condition captures the idea that H2 may always copy featues from H1 at no cost. The Dominance Condition expresses the relationship of the two hands when they are not identical. Some signs which obey the Symmetry Condition are given in (6a); some signs obeying the Dominance Condition are given in (6b).

(6)

(a) Signs obeying the Symmetry Condition [note columnar structure]

GESTURE	SAUSAGE	SEPARATE	WORLD
VACATION	CLOTHES	DESTROY	MOCK
BEAR	AMAZED	SIGN	TRAVEL-AROUND

(b) Signs obeying the Dominance Condition

START	HELP	PUT-DOWN	PAY-OFF
SODA-POP	ENOUGH	BACKGROUND	PASSPORT
SHOW	FULL		

The Dominance Condition also expresses the fact that only three types of handshapes are allowed on H2: the handshape where all fingers are active (that is, the "4" handshape), the handshape where only the index finger is active (that is, the "1" handshape), or one where no fingers are active (that is, the "A" or "S" handshape). These three possibilities, combined with the finger positions "open," "closed," "flat," "curved," and the thumb positions "opposed" and "unopposed" account for this set of seven handshapes that are allowed on H2.[3] These parameters are shown in (7).

(7) Handshapes available to H2

	Selected fingers	Thumb position	Handshape position
B	"4"	opposed	open
A	none	unopposed	closed
S	none	opposed	closed
C	"4"	opposed	curved
O	"4"	opposed	flat
1	"1"	opposed	open
5	"4"	unopposed	open

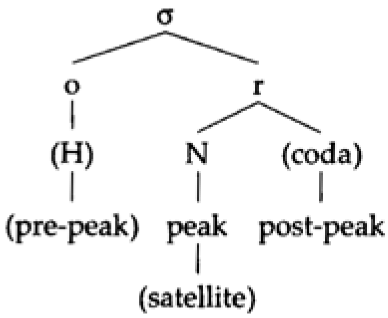
These handshape features are the only distinctive features that can appear on H2 when not also appearing on H1. No other handshape, movement, or orientation features can occur independently on H2. In addition to these H2 constraints, there may be a maximum of one set of features specified for H2 per word (Brentari 1990a, p. 132); that is, there are no signs that change H2 values word-internally, independent of H1.[4] Since H1 and H2 are participating in sign production at the same time, we cannot capture the restrictions on H2 without a constraint expressed in terms of simultaneous structure. Further, this constraint must have a larger domain than the segment. While there is no space to present the alternatives here, competing proposals for the treatment of H2 and an analysis of H2 as a syllable coda are presented in Brentari and Goldsmith (1993).

The number of contrastive positions assumed by H1 – open, curved, flat, closed – is limited within a monomorphemic word (Sandler 1989, p. 72; Brentari 1990b). There is a maximum of one flat or curved handshape per monomorphemic word (Brentari 1990b). Phonological tendencies also exist concerning the area of location – that is, place of articulation. Battison (1978) and Sandler (1987) observed that there is a strong (though not exceptionless) tendency for monomorphemic words to contain a single distinctive place of articulation.

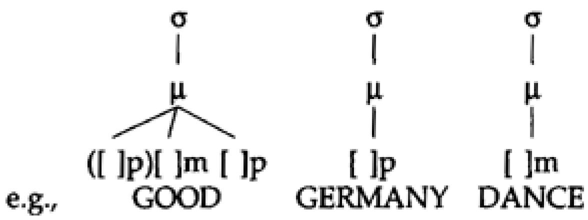
2.1.2 The ASL syllable.

ASL phonologists have not reached a consensus concerning the ASL syllable, so here I can only present conclusions based on converging evidence from several analyses. Clearly, the syllable does important work for ASL, but the idea of a syllable based solely on sequential elements is of limited utility in this language, given all the simultaneous morphonological and phonological structure present. There have been three syllable templates proposed (Wilbur 1987, 1990; Perlmutter 1990, 1992b, 1993; Brentari 1990a; 1993). While differing considerably in their details, they are all centrally based on the idea that the syllable is sensitive to dynamic information along some scale of sonority (Corina 1990; Brentari 1990a, 1990c).

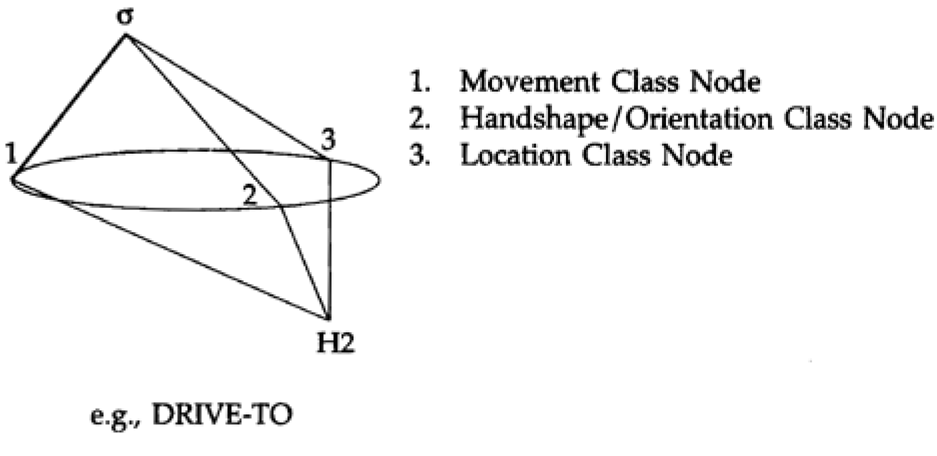
(8) Syllable template (Wilbur 1987, 1990)



(9) Syllable template (Perlmutter 1990)



(10) Syllable template (Perlmutter 1990)



The three syllable templates are presented in (8), (9), and (10). Wilbur (1987, 1990) proposes a template with a flat structure, with an optional onset, a branching rhyme containing a three-way branching nucleus, and an optional coda. She uses this template to describe ASL reduplication of stems to form nouns. Perlmutter proposes a moraic model of ASL syllable structure, and argues for a taxonomy of three types of syllables in ASL. He uses his syllable template to explain the distribution of the three types of holds in ASL. Both Wilbur's and Perlmutter's models have strong similarities to the syllable in spoken languages in their use of sequential units in defining subsyllabic constituents. The template shown in (10) is a proposal for a nonhierarchical, simultaneous syllable template (Brentari 1990a; Brentari and Goldsmith 1993; Brentari 1993), with the syllable nucleus indicated by a bold line. This structure is used to explain the behavior of H2 in syllables and in phonological words, and the behavior of alternating movements. The class nodes for movement (1), handshape/orientation (2), and location (3) are indicated in (10) around the circle. The relationship of handshape and orientation is adopted from Sandler (1989).

Let us consider how these models deal with the questions regarding (1) what evidence there is that the signing stream consists of syllables as in spoken language; (2) whether syllables have the same internal structure as spoken language syllables; and (3) how syllables are counted in ASL.

One way that all of the three above proposals count syllable nuclei is by counting movements, but the three do not agree on what can count as a lexical movement. Perlmutter (1992b, 1993) argues that secondary movements in ASL, which are small, uncountable repetitions of a movement, handshape change, or orientation change, dock onto syllable peaks, and I have adopted this diagnostic in my work as well. Another way of counting syllables is by observing the behavior of handshape changes. Brentari (1990b) and Perlmutter (1992b, 1993) both conclude that there can be a maximum of one set of selected fingers per syllable in ASL, but there can be two positions of the hands. Perlmutter calls the former *handshape contrasts* and the latter *handshape contours*. So far, then, while all three proposals accept lexical movements for identifying syllables, only Perlmutter and Brentari use secondary movements and handshape changes to count and identify syllables. Perlmutter and I differ in the extent to which we consider ASL syllable-internal structure to be like that of spoken languages. Perlmutter argues for a syllable-internal structure very similar to that of spoken languages, based on adjacent root nodes and moras similar to that put forth in Hayes (1989a). Brentari (1990a, 1990b, 1990c, 1994) and Brentari and Goldsmith (1993) argue for a syllable-internal structure different from that found in spoken languages. We argue for a simultaneously organized syllable at the level of the phonological word on the basis of the behavior of H2 and on the finer distinctions that can be made in establishing a visual sonority hierarchy using simultaneously occurring features.

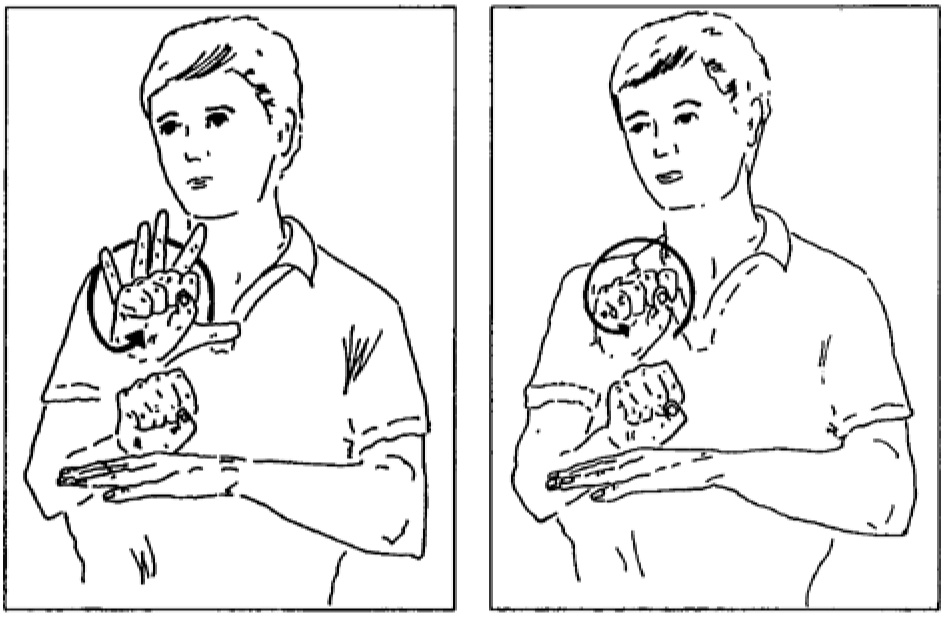
No discussion of the ASL syllable would be complete without discussing *visual sonority*. Lexical movements, handshape changes, orientation changes, and location changes can all occupy a syllable peak.[5] Blevins (1992a), Corina (1990), and Brentari (1994) have all proposed sonority hierarchies, which are given in (11). Two things should be noted about these proposals. First, there is complete agreement among them that movement is the most sonorous element. Second, Blevins's term "non-static articulator" encompasses Corina's "handshape change," "orientation change," and "location change," and my hierarchy focuses on distinguishing among handshape change, orientation change, and secondary movement. In other words, each proposal makes progressively finer distinctions (ordered a, b, c) among members of the class of "non-static articulators."

(11) Sonority proposals
(a) Blevins: Path Movement > non-static articulator > static articulator > location-hold
(b) Corina: Movement > handshape change = orientation change > location change
(c) Brentari: Movement > handshape change > orientation change > secondary movement

Perlmutter (1992b, 1993) concludes that Movements are more sonorous than Positions but this is similar to saying that vowels are more sonorous than consonants, and a very broad generalization. To make these careful distinctions among non-static articulators, a simultaneous local domain (i.e., the syllable) is necessary. Corina argues that the Sonority Sequencing Principle, which states that "between any member of a syllable and the syllable peak, only sounds of higher sonority rank are permitted" (Clements 1990; see also chap. 6 in this volume) is not adhered to in signed languages. Corina (1990) writes, "The ASL syllable does not seem to honor a principle which sequences elements within a syllable in terms of sonority, a principle which on some accounts holds for spoken languages." By observing the behavior of properties of a sign that can occupy a syllable peak under various phonological conditions, the relative sonority among these properties can be determined; that is, which property is the preferred syllable peak when a sign has two of these dynamic elements (Corina 1990; Brentari 1994). Corina observed signs that have two variants – one variant containing a handshape change and a lexical movement, and the other containing just one of these. He argued that the one deleted was the less sonorous one. In signs containing lexical movement and handshape change or orientation change, the lexical movement will be the preferred syllable peak, manifested by the fact that it is the property preserved when one of these two properties is deleted. This is shown in the two variants of the sign APPOINTMENT, given in (12a and 12b). One variant contains a lexical movement and a handshape change, while the other contains only the lexical movement.

In Brentari (1994), I employ a linguistic test developed by Perlmutter (1992b, 1993). This test involves observing where secondary movements *dock* to determine the syllable peak in a sign. These results were born out in the test of secondary movement docking. Since Corina's work establishes that path movement is more sonorous than handshape change, I will illustrate here how secondary movement docking distinguishes the sonority value of handshape change and orientation change, showing that handshape change is more sonorous than orientation change. We see the test for secondary movement docking in the ASL pair EXCERPT and EXCERPT [habitual]. EXCERPT contain a

(12) Two variants of the ASL sign APPOINTMENT. (12a) is articulated with a handshape change and a movement; (12b) is articulated with a movement only (i.e., without a handshape change).



(a) (b)

handshape change and an orientation change; EXCERPT [habitual] contains only a handshape change. The pair EXCERPT and EXCERPT [habitual] are given in (13a and 13b).

Using a sequential syllable, we can capture generalizations about reduplicated forms and phrase-final lengthening, as well as the timing of nonmanual features with respect to segmental structure originally observed by Liddell (1984); using a simultaneous syllable, we can capture generalizations about sonority, and about the behavior of H2 in two-handed signs.

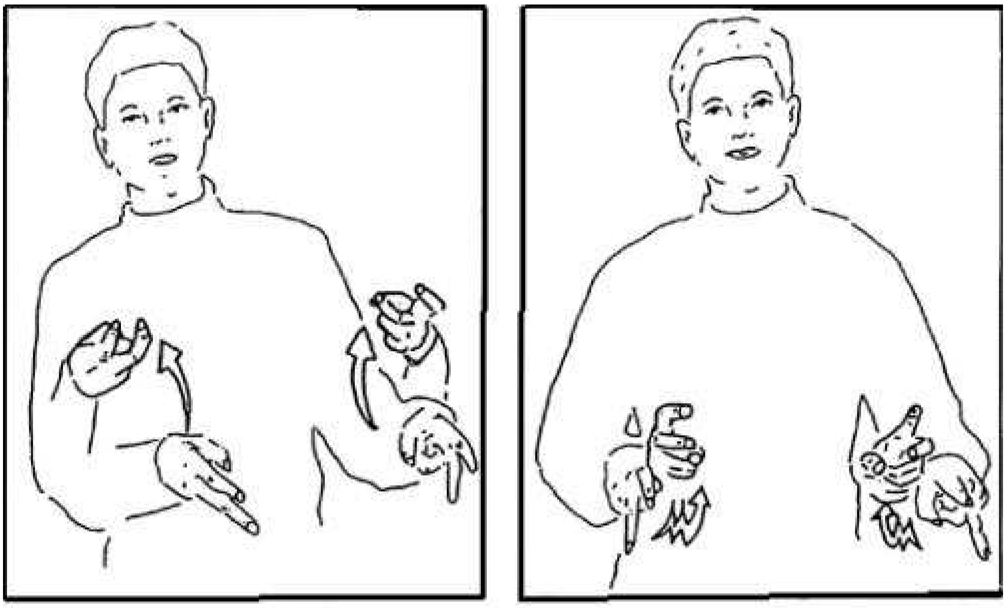
A summary of the facts we have discussed about phonological words in ASL is given in (14).

(14) Word-Level Summary

1. H2 can only be specified for the features [closed] and [peripheral] and may only contain selected finger constellations 1 and 4, and the closed variant of these, the fist.[6]
2. H2 may be specified independently from H1 once per word.
3. There is a maximum of one curved or flat handshape per phonological word.

4. At this level the syllable is constructed on dynamic properties of the sign.
5. The sonority hierarchy in ASL is based on the dynamic properties of signs.

(13) The ASL signs EXCERPT and EXCERPT [habitual]. EXCERPT (13a) is articulated with a handshape change and an orientation change; EXCERPT [habitual] (13b) is articulated with a handshape change only (i.e., without an orientation change).



(a) **(b)**

2.2 The Phrase and Redundant Features in ASL

It is clear that signing activity can be divided into periods of stasis and movement. In developing their framework, Liddell and Johnson (1989) use this overt "phonetic" distinction and make the units of stasis and movement the foundation of their model. They call these units *Holds* and *Movements*, respectively; a hold must be a period of stasis of at least 0.1 seconds (100 msecs). They incorporate this division into Holds and Movements into the underlying structure of their analysis. Sandler (1987, 1989) divides the static and dynamic units into *Locations* and *Movements*, with a location defined in terms of an obligatory place of articulation. The other two models (Perlmutter 1990, 1992b, 1993; and Brentari 1990a, 1990c) do not use a segmental timing tier, but phonetically Perlmutter labels bundles of features containing dynamic elements *Movement feature bundles*, and those containing static features *Position feature bundles*. Regardless of the label – or whether or not the segments must be crucially divided into two groups – there are static and dynamic aspects in the phonetic signal.

Let us first address redundant segments in the system. We have strong evidence that there are redundant holds and movements in the signed string. I will use *hold* as a generic term for static segments and *movement* as a generic term for dynamic segments. Perlmutter (1989) has presented compelling arguments for a phrase-final Mora Insertion rule ($\emptyset \rightarrow \mu / \_\_\_\#\#$) – an analysis which provides evidence for the predictability of the three ways that signs can be terminated. Perlmutter specifically addresses the role of the mora as a timing unit in ASL. Phrase-internally, signs can either have no hold (in signs where a position shares a single mora with a movement) or a short hold (in syllables composed of a single Position). Phrase-finally signs can have (1) no hold in signs consisting solely of a bidirectional movement (e.g., DANCE, AWKWARD)[7], (2) a short hold for phrase-final Positions that share a mora with an adjacent movement, or (3) a long hold in syllabic Positions in phrase-final position. Syllabic Positions are syllables constructed without a path movement, but which contain two different specifications for another feature (i.e., those that spell out handshape change or orientation change) that can constitute a well-formed syllable in ASL.

In addition to Mora Insertion, which primarily illuminates redundancies in holds, we have a Movement

Insertion rule that supplies a movement between two nonidentical locations postlexically (Sandler 1989, p. 139) ($\varnothing \rightarrow M / L_1$___$L_2$). This rule applies both word-internally and across word boundaries. In addition to these phrase-level rules, we can make a generalization about phrase-level assimilation; namely, it occurs regressively. An example of regressive assimilation of handshape cited in Liddell and Johnson (1989) occurs in the phrase ME CURIOUS, where the handshape of CURIOUS occurs on ME as well, replacing the handshape normally used in ME.

Let us now address redundant features in the system. We noted above that a signer is either left-hand or right-hand dominant. The *ipsilateral* side is the side of the signing hand, and the *contralateral* side is the other, the side opposite the signing hand. ASL has vertical and horizontal place of articulatory contrast, reflected in the distinctive feature [Vertical Place of Articulation] ([VPOA]) for the vertical dimension, and [contra] and [distal] for the horizontal dimension (Brentari 1990a). The values for [VPOA] slice the signing space into distinct horizontal areas – e.g., head (with finer distinctions within the head, such as forehead, eye), shoulder, torso, etc. The two values for [contra] divide the signing place into ipsilateral and contralateral sides of the body, and the two values for [distal] divide the signing space into a radial area approximately a forearm's length from the body and one that is further away from the body. APPLE vs. ONION, signed at the cheek and eye respectively, exhibit a vertical contrast. PITTSBURGH and LEATHER – signed on the ipsilateral and contralateral side of the body at the shoulder – exhibit horizontal contrast.

A default specification is filled in for [contral] in cases where none is specified.[8] To illustrate this, if a [Vertical Place of Articulation], such as [VPOA: cheek] is specified for the sign APPLE and no value for the [contra] feature is specified, the value is filled in as [–contra] by rule (Liddell and Johnson 1989). Signs exhibiting the redundant value [–contra] are given in (15). Another redundancy in the feature system at this level concerns the Vertical Place of

Articulation. This is a default value – namely [VPOA: torso] – filled in if no other value for VPOA is specified. Signs exhibiting a redundant Vertical Place of Articulation [VPOA: torso] are given in (16).

(15) Phonetic [–contra] redundancy

APPLE	ONION	TOUGH	BROKE (no money)
SHAVE	THROW	SUBSCRIBE	THINK

(16) Phonetic [VPOA: torso] redundancy

ROCKET	CHEESE	ABOUT	SAUSAGE	WORK
JAPAN	WHITE	LIKE	ENTHUSIASM	BACKGROUND

A summary of the phrase level facts we have discussed in the above section is given in (17).

(17) Phrasal-level summary
1. There is a basic division between static and dynamic segments – Holds and Movements respectively.
2. Hold length is predictable.
3. Epenthetic movements occur between any two nonidentical locations.
4. Phrase-level assimilation occurs regressively.
5. Feature redundancies include:
a. an unspecified value for [Vertical Place of Articulation] – [torso]
b. an unspecified value for [contra] – [–contra].

In sum, the evidence concerning H2 and sonority points to the need for a syllable template and phonotactics that are constructed on the basis of simultaneous dynamic properties. The evidence from the distribution of phrase-final holds points to the need for a second set of constraints on the sequentially ordered units (i.e., moras, segments) in constituents which may extend beyond the phonological word. While the issue is far from settled, it appears that ASL utilizes a different syllable template at different levels of the phonology. Evidence for languages using different syllable templates at the word level and phonetic level has been found for Malayalam and Luganda (Wiltshire 1991a, 1991b). For example, Malayalam licenses a small subset of consonant features in coda position at word level and two onset positions; however, at the phonetic level codas are disallowed and license a third position.

2.3 Underlying Representation

Let us now turn to the most abstract level of phonological representation of ASL, where morphemes are encoded into phonological structures. Let us assume that this level adheres to principles of contrastive underspecification, since we know very little about what a universally unmarked set of features across sign languages would contain. If we use radical underspecification, all unmarked and redundant features are eliminated from underlying representations, while in contrastive underspecification only redundant features are eliminated (Archangeli 1988a).

In order to frame our next discussion, I would like to group languages of the world into four groups which highlight their morphophonemic structure, as in (18). Languages are grouped according to their preferred number of morphemes and syllables per phonological word. Group 4 is composed exclusively of signed languages.

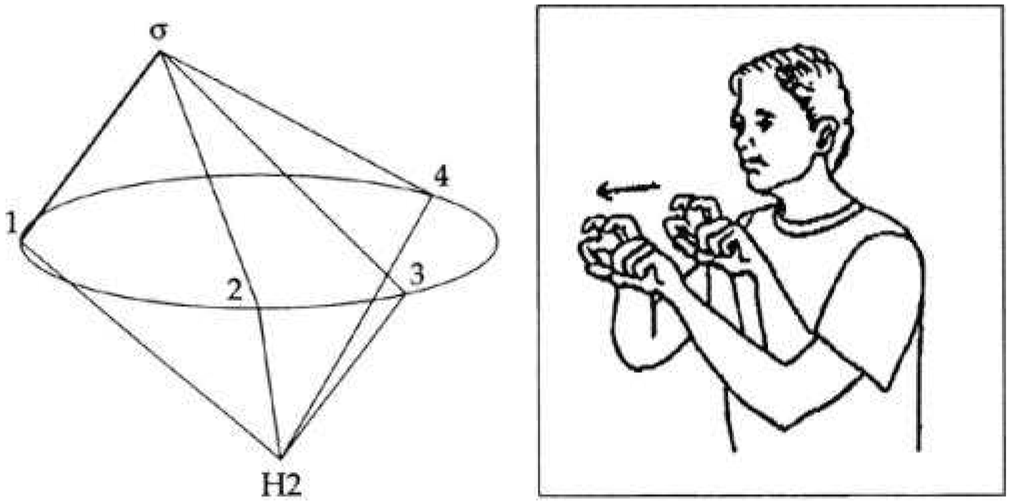
(18) Morphemes/syllables in natural languages
Group 1: monomorphemic/polysyllabic – e.g., English, French
Group 2: monomorphemic/monosyllabic – e.g., Chinese, Thai
Group 3: polymorphemic/polysyllabic – e.g., Greenlandic, Turkish
Group 4: polymorphemic/monosyllabic – e.g., ASL (Supalla 1982), Italian Sign Language (Corazza 1990), Swedish Sign Language (Wallin 1990), New Zealand Sign Language (Collins-Ahlgren 1990)

The groups in (18) identify general preferences for morphophonemic realization; these are not hard and fast laws, to be sure, but the words in these languages largely conform to these generalizations. The structural diversity in ASL lexical items can be expressed in the following way (this description follows analyses contained in Johnson and Liddell 1984, Perlmutter 1989, and Supalla 1982). (1) There is a very small set of polysyllabic/monomorphemic lexical items – e.g., BACKGROUND, CURRICULUM, SOCIAL WORK. To my knowledge, these are all forms etymologically related to English borrowings, expressed in fingerspelling (this is a way for ASL to spell out words using a handshape for each English letter; see Battison 1978). (2) There is a set of monomorphemic/monosyllabic signs, referred to as "frozen" signs – e.g., ADMIT, UNDERSTAND, SHIRT. (3) There is a group of stems that are referred to as "incomplete." Most of these are polymorphemic/monosyllabic; a few are polymorphemic/polysyllabic. That is, the word may contain values for additional morphological material, such as classifier, verb agreement, or aspectual morphology, e.g., GIVE (classifier, verb agreement, aspect), LOOKAT (aspect), INVITE (verb agreement). See (19).

(19) Structural diversity in ASL
1. Monomorphemic/polysyllabic forms – BACKGROUND, SOCIAL-WORK
2. Monomorphemic/monosyllabic forms – UNDERSTAND, ADMIT, SHIRT
3. Polymorphemic/monosyllabic forms:
(a) Incomplete stems[9] 3sg-GIVE-4sg ("She gave her") TELL-3sg ("Tell him") GIVE-2pl ("Give all of you")
(b) Verbs of motion and location small animal- JUMP-ONTO- flat surface HOLE expand in size over a period of time

(4) In the portion of the lexicon known as the "verbs of motion and location" (Supalla 1982, 1985), each feature or cluster of features represents a morpheme. (20) gives an example of such a form. The features and representation used here are from Brentari (1990a; 1993).

(20) This example of an ASL verb of motion and location means "two hunched, upright beings make their way carefully forward side by side from point 'a' to point 'b.'"



Distinctive features	*Morphological identity*
1. Movement Class Node	
[tracing: straight]	move forward
2. Handshape/Orientation Class Node	
[selected fingers: 1]	upright beings
[H2: radial plane of finger]	side by side
[-peripheral]	stooped
[-closed]	
[prone]	facing forward
3. Location Class Node	
[HPOA: proximal], [HPOA: distal]	from "a" to "b"
4. Nonmanual Class Node	
[pursed lips]	carefully

This sort of example is by no means unusual in ASL. The formalism represents the simultaneous possibilities of the ASL syllable by simulating threedimensional space by the circle. The nucleus is shown by a bold line - here, [tracing], which is a lexical movement features. In this particular case, both H1 and H2 realize each of the features (they are identical); the features are associated to the class nodes indicated, although the problem of their particular organization remains unresolved. This representation shows the sheer volume of morphological information that can be captured in one syllable. Further, this type of syllable-to-morpheme structure - nine morphemes to one syllable - is surely a striking difference between spoken and signed languages, one conditioned by the differing feedback loops that the two types of languages use. Since signed languages use the visual-gestural (as opposed to the auditory-spoken), they are more likely to incorporate the task of parsing simultaneous information into their grammars.

Despite an emphasis on simultaneity in underlying structure, ordering of morphophonemic material does occur in ASL. For example, the two values for [distal] in (20). These must be ordered with respect to one another if we are to have the beings moving correctly with respect to spatial mapping (Padden 1990; Liddell 1993). In addition to this type of ordering, fingerspelling must allow ordering of [Selected Finger Constellation] features. This accounts for the ordering that occurs in the polysyllabic/monomorphemic forms cited in Perlmutter (1992b, 1993), and those noted in Supalla and Newport (1978) - i.e., the contrast in pairs such as FLY and FLY-THERE noted earlier. There are also forms where places of articulation must be ordered (GOOD, GOAT, NUN). The type of ordering discussed here (that is, the ordering of specific occurrences of features) along with the syllable templates discussed earlier, taken together provide a way of expressing contrast in ASL that need not resort to the fully specified segments of Liddell and Johnson (1989) in underlying structure.

To address the nature of distinctive features in ASL, we return to the citation above from Liddell (1984), suggesting that the number of distinctive features in ASL is considerably larger than that found in spoken languages. Descriptively, we know the regions of the body, handshapes, and movements that are contrastive, as we do for thumb position and orientation. However, providing the *distinctive feature system* these contrasts express is another matter. Liddell and Johnson's (1989) phonetic transcription makes no effort to limit itself to differences that are contrastive, with its 126 handshapes, 51 locations on the body, 27 locations in space, and 70 locations on H2. The Hand Tier model (Sandler 1989) contains 16 handshape features, 4 features for orientation, 16 for location, and 1 movement feature. While Liddell and Johnson's (1989) 299 features are extremely useful in doing transcription, further phonological analysis is necessary to determine which features are distinctive in ASL, and whether they are n-ary, binary, or privative. Brentari (1990a) has proposed a group of 20 distinctive features by reorganizing the observations of Liddell and Johnson, by eliminating redundancy where it can be ascertained, and by using 7 n-ary, 8 binary and 5 privative features.[10] There is a parallel move in spoken languages in uniting places of articulation, such as labial, dental, velar, etc., under the single feature [place of articulation] (McCarthy 1989b). If Liddell and Johnson's 299 contrasts must all be separate features, there is indeed a strong modality difference between signed and spoken languages in this regard. If we admit n-ary features to the system and the 20 distinctive features can handle the data, there is no modality difference between the number of distinctive features in spoken and signed languages, and Jakobson's observation that there are approximately 20 distinctive features in any natural language holds for signed languages as well as spoken languages, as far as initial study indicates.

If we eliminate the syllable template from underlying structure, there are several types of phonological information other than the phonological features themselves that are available at this level. I would like briefly to sketch the role that feature geometry, markedness, and sonority play in ASL's underlying representations. All three are types of phonological information that may be present in underlying representation and that could feed other aspects of the phonology. We have already seen that a sonority hierarchy plays a role in constructing syllables. Since this information must be readily available to syllable structure, and since sonority is not predictable from any phonetic measure in a definitive way, it must be present in underlying representations (see Zec 1988 for a discussion of these matters for a set of spoken languages).

Markedness has proved useful for reducing the information necessary in underlying representation of ASL. I have proposed an explicit set of criteria for markedness in handshape (Brentari 1990a); see (21).

(21) Markedness Criteria in ASL Handshapes

	More marked	Less marked
1. Frequency of occurrence	less frequent	more frequent
2. Order of acquisition	acquired later	acquired earlier
3. Allows handshape change	disallow change	allow change
4. Contrasts in position	fewer contrasts	more contrasts[11]
5. Classifier forms	no	yes
6. Independent H2	no	yes

Battison (1978), Mandel (1981), McIntire (1977), and Friedman (1977) observed a range of behaviors in two groups of selected fingers: the group that contains the index finger (and optionally the thumb) [Selected Finger Constellation: 1] and the group that contains all four fingers (and optionally the thumb) [Selected Finger Constellation: 4]. These two selected finger constellations are the earliest acquired handshapes, they allow the fullest range of possiblities for handshape position and handshape change, they are the easiest to produce, and they are the most frequently occurring. These are also the two selected finger constellations that appear on H2 when H2 and H1 are nonidentical. These observations allow us to conclude that these are the least marked of all selected fingers in ASL. In two-handed signs where the two hands are nonidentical, two sets of handshape features will be realized on the surface, yet the underlying representation need not contain two completely specified handshapes in order for us to know which features associate to H1 and which associate to H2. Examples of the kinds of predictions given the markedness criteria in (18) are (1) if the specification [H2] is the only indication that the sign is twohanded, we can assume that H2 copies everything from H1 and has no independent values of its own; (2) if a selected finger constellation is other than 4 or 1 it must be assigned to H1; (3) if a feature has two ordered values on it [-closed] before [+closed], that feature must be assigned H1. In addition, Mohanan (1991) has proposed that unmarked (his *non-dominant*) feature values should tend to be (1) easy targets of assimilation, (2) the output of neutralization rules, and possibly (3) prone to elision. These characteristic are true for [Selected Finger Constellation: 1] and [Selected Finger Constellation: 4]. The facts about underlying structure we have discussed are summarized in (22).

(22) Summary of facts about underlying structure
1. Morphophonemic information is sequentially ordered.
2. Selected finger constellations are ordered in fingerspelling and fingerspelled borrowings.
3. There are case of feature ordering on a single tier for some signs.
4. Sonority information is specified here.
5. Markedness criteria can determine which features associate to H1 and which ones associate to H2.
6. Feature geometry is specified here.

3 Discussion

The tension described here in ASL between simultaneous and sequential structure exists in work on the phonology of spoken languages as well, but the problems have not taken the same form. For example, the idea that sequential organization of segments must be central at all levels of phonological analysis has been called into question in spoken language phonology by McCarthy (1989b), who points out that, given morphological and prosodic well formedness constraints, the extent to which segments must be ordered in the underlying representations of each lexical item varies widely. On the one hand, English has few morphological constraints and a liberal syllable template, allowing almost all distinctive features in coda position in the coda as well as in the onset. For these reasons, English is a language that requires a great deal of sequential ordering. On the other hand, languages with morphological templates (e.g., Arabic in the extreme case, Yawelmani to a lesser degree)[12] or languages with a highly restrictive syllable template (Luganda, for example, which allows only the feature [nasal] in the coda) will need little or no underlying ordering of featural material because the morphological and/or prosodic templates can perform this work. In addition to using syllable restrictions to eliminate item-specific sequential ordering, there are other mechanisms that might function in this way. For example a dynamic feature, such as [delayed relase] for affricates, actually captures the [-continuant] > [+continuant] ordering since the progression of the articulatory gesture is from completely obstructed to approximate contact, rather than the reverse. The use of dynamic features in spoken-language feature systems is not as prevalent as it is in sign, since a visual linguistic system can be very sensitive to shape and manner of articulatory movement in a way that audition can not. A dynamic feature, such as [direction of movement], in ASL can predict the initial and terminal locations.

ASL is a language that can provide us with a great deal of information about aspects of underlying structure involving underspecification and feature systems. Since simultaneity in sign is impossible to ignore, we can explore the upper limits of phonological information that the brain can process at one time. It is clear that the auditory system does not have the capability to approach the upper limit since the physiological range of possibilities, at any one moment, for articulatory movements is much narrower in the vocal tract than in the signing space. We assume that the restrictions on the physiological possibilities are taken into consideration by the grammar. The question of how many distinctive contrasts the grammar can process within a single simultaneous unit is more aptly asked of signed languages than of spoken languages.

In addition, we must construct a feature system for ASL that takes into account the radically different constraints and potentials that signed languages have, given the use of the visual system for perception and the wider range of articulators available. The articulators in sign – the arms, the hands, the body, the face – are also larger than their counterparts in spoken language – the tongue, the velum, the larynx, etc. Further, from the point of view of motor control, there are qualitative differences between the articulators used in signed and those used in spoken languages. While the tongue, the velum, and the larynx are articulators composed of soft tissue, the arms and hands contain a number of joints as well. These comparatively different properties influence the range of motion of the articulators, as well as the properties exploited for meaningful contrast. Work in this area has begun (see Lane, Boyes-Bream, and Bellugi, 1976; Mandel 1981; Corina 1990; Brentari 1990c; Ann 1991), and this task of composing a distinctive feature system for ASL will provide a test of such long-held assumptions as the preference for binary features.

While there are still many issues that are unresolved in ASL phonology, we have learned a great deal about ASL specifically, and how signed languages are organized in general. It is true that familiarity with sign language phonological studies requires an initial effort to become acquainted with the details of the phonetic system and how these relate to the phonology, the rewards make the effort worthwhile. It is not the case that signed languages present just another set of interesting language facts: signed languages can allow us to study the link between nonlinguistic cognitive processes and linguistic ones in a way that spoken languages cannot, in part because the visual system in humans is much better understood than the auditory system. Its location in the brain on the posterior parietal surface makes it more accessible for direct investigation by evoked potential studies and metabolic tracing studies. Further, the visual system of higher order nonhuman primates is much more similar to ours than is their auditory system, and because of this we can make inferences about the human visual system from studies done on the visual systems of these animals that we cannot make from similar studies done on the auditory system in nonhumans. We have been able to ascertain that lesions in Broca's area and Wernicke's area of the left hemisphere result in the same type of linguistic disruptions in both signed and spoken languages (Poizner, Klima, and Bellugi 1987). From this we can conclude that, regardless of the evolutionary roots of language, the visual system of signers can be linked to the linguistic centers of the brain in the same way as the auditory system of nonsigners. As a result of this convergence, we are able to test our phonological models in a way not available for spoken language, and we can see that work on signed languages is central for our understanding of how linguistic and nonlinguistic capacities of the brain feed into one another.

This work was supported in part by NSF grant BNS-9000407, awarded to Howard Poizner at the Center for Molecular and Behavioral Neuroscience, Rutgers University. Special thanks to David Perlmutter, Wendy Sandler, and Caroline Wiltshire for comments on earlier drafts of this paper.

1 English glosses of ASL signs are presented in uppercase letters. Hyphenated glosses (e.g., TO-FLY) indicate that they are executed as a single word in ASL. When the words “movement” and “hold” appear with an upper case “M” and “H,” they refer to Liddell and Johnson's segment classes; otherwise these terms refer to the static and non-static aspects of the sign signal.

2 Here I am only citing comprehensive proposals for the entire phonological component of ASL, during the period of time in question. There are many other works that have taken up specific problems in the phonological systems of ASL.

3 Thumb position is contrastive on H1 (see Brentari 1990a, pp. 67-69; Moy 1990); these specifications are redundant on H2.

4 Naturally, if H2 is identical to H1, H2 may copy the change on H1, as in the signs in (8).

5 A handshape change involves a change in selected fingers or finger position during the articulation of a syllable (e.g., “closed” to “open” in the sign UNDERSTAND). An orientation change involves the change in orientation of the palm (e.g., “palm down” to “palm up” in COOK). Secondary movements are small, uncountable, rapidly repeated instantiations of movements, handshape changes, or orientation changes, similar to a “trilled” manner of articulation in spoken languages.

6 [Closed] is a feature included in several feature systems to date (Boyes-Braem 1981; Sandler 1989; Liddell and Johnson 1989); [peripheral] is a feature argued for in Brentari (1990a, 1990b).

7 This is a logical extension of the analyses in Perlmutter (1990, 1992b, 1993).

8 This set of facts is more complicated than this in signs that undergo metathesis - DEAF, MEMBER, FLOWER, etc. See Brentari 1990c for further discussion.

9 Gender is not marked in ASL.

10 A change in the feature [H2] is reflected here, which must be n-ary if it is to capture the contrast in place of contact and orientation between pairs, such as WITH and WORK.

11 By "position" I mean the four contrastive handshape positions: open, closed, flat, and curved.

12 Sandler (1989) argues that ASL has morphological templates and Liddell and Johnson (1986) have proposed an analysis of "inchoative" or "unrealized-inceptive" verbal aspect using morphophonemic frames.

Cite this article

BRENTARI, DIANE. "Sign Language Phonology: ASL." *The Handbook of Phonological Theory*. Glodsmith, John A. Blackwell Publishing, 1996. Blackwell Reference Online. 31 December 2007 <http://www.blackwellreference.com/subscriber/tocnode?id=g9780631201267_chunk_g978063120126722>

Bibliographic Details

The Handbook of Phonological Theory

Edited by: John A. Glodsmith
eISBN: 9780631201267
Print publication date: 1996