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Sonority and Syllable Structure in American Sign Language

1. Goals

Speech is organized into syllables. Each syllable has a nucleus, and language-particular conditions govern the class of possible onsets and codas. The way phonological strings are organized into syllables depends on the relative sonority of segments. There is a sonority hierarchy that ranks classes of segments (or the features that characterize them) in terms of relative sonority. In a given phonological string, a segment higher in sonority

than the segments on either side is a sonority peak and is generally (but not universally) the nucleus of a syllable, with segments between sonority peaks included in the onset of the following syllable or the coda of the preceding syllable. These results on syllable structure are based exclusively on oral languages.

Do these principles hold for the many signed languages used in Deaf communities throughout the world? Are signs organized into syllables? Do syllables have an internal structure consisting of a nucleus and possibly an onset and/or coda? Is there anything corresponding to the sonority hierarchy in sign languages? Do sign languages have vowels and consonants? This article addresses these questions.

I focus on the internal structure of syllables in American Sign Language (ASL), the language of Deaf communities in the United States and most of Canada. The argument for ASL syllable structure is based primarily on distributional evidence for the distinction between the syllable nucleus, on the one hand, and onsets and codas on the other. I argue that to account for the distribution of secondary movements and handshape changes within syllables, it is necessary to distinguish between nuclei and onsets/codas.

Following Perlmutter (1991b), I assume that Movement (M) and Position (P) are the two basic segment types in ASL,[1] and that (i) signs ending in an M contrast with those ending in MP, and (ii) signs beginning with an M contrast with those beginning with PM. This yields the following types of strings of segments containing one M:[2]

(1) PMP: IMPROVE

(2) MP:

(3) PM:

(1)–(4) illustrate

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(2) MP: SICK

(3) PM: TAKE-OFF

(4) M: FLY

andler (1986a,b;
; see Perlmutter
;'' discussed by
reparation) that

1992).

(1)–(4) illustrate the fact that an M may optionally be preceded and/or followed by a P.
    Although some segments may be unspecified for place of articulation, Ps articulated
at a particular location on the body are most perspicuous. (1) consists of a P (strong
hand contact with the weak arm) followed by a movement and another P (strong hand

contact with another location on the weak arm).[3] (2) is an MP sequence: a movement followed by a P involving contact with the forehead. Since there is no particular location where the strong hand must be prior to its movement, it does not have an initial P. (3) clearly begins with a P since the strong hand makes contact with the weak hand before its movement. Since the strong hand need not be in a particular location at the end of its movement, there is no final P. (4) consists of just a movement; no position of the strong hand is specified either before or after the movement.

Some signs consist of only a P, as in (5).

(5)   P: GERMANY

In (5) the hands remain stationary while the fingers wiggle. Signs consisting of only a P have no path movement. The hands remain stationary, performing a secondary movement (finger wiggling in (5)) or handshape change.[4]

This article examines the distribution of two phenomena—secondary movements and handshape changes—in strings of segments of the form (1)–(5). I argue that their distribution provides evidence for analyzing these five sign types as syllables. Each syllable has a nucleus: the M in (1)–(4) and the P in (5). Those in (1) and (3) have a P as onset, and those in (1) and (2) have a P as coda. The way Ms and Ps are organized into syllables can be accounted for by positing a sign language analogue of the sonority hierarchy in which Ms are more sonorous than Ps. Sonority peaks are then syllable nuclei. This provides evidence that sign language phonology has the analogue of vowels and consonants: Ms correspond to vowels and Ps to consonants. This follows from their relative sonority—from the fact that they play analogous roles in the organization of the phonological string into syllables.

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[3] Following Padden and Perlmutter (1987), I call the dominant hand (the right hand for right-handed signers and the left hand for left-handed signers) "strong"; the other one I call "weak."

[4] Some signs, discussed by Brentari (1991), involve an orientation change. Some morphologically derived signs surface as a P without secondary movement or handshape or orientation change. These matters are discussed briefly in section 7.

The results of this article hold (though in somewhat different form) regardless of whether one posits a sign language analogue of the CV skeleton of Clements and Keyser (1983), a skeleton consisting of X-slots (Levin (1985)), or a prosodic structure representing morae as well as syllables but dispensing with segmental skeleton slots, as in some versions of the moraic theory being developed by Hyman (1985), McCarthy and Prince (1986; 1990), Hayes (1989), Itô (1986; 1989), Zec (1988), and others. For this reason, I use the notations "[ ]$_M$" and "[ ]$_P$" to indicate feature complexes that constitute the melodic units of M-segments and P-segments, respectively. Each of these feature complexes is dominated by a root node. This notation is intended to be neutral between three interpretations corresponding to different versions of current phonological theory: (i) these feature complexes' root nodes are dominated by M-slots and P-slots in a skeleton; (ii) M-melodies and P-melodies are distinguished by some feature and their root nodes are dominated by X-slots in a skeleton; (iii) they are distinguished by some feature and their root nodes are directly linked to elements of the prosodic representation, with no intervening segmental slots. In section 5, where the representation of handshape and secondary movement features is discussed, some additional assumptions are made about ASL phonological representations. The chief results of this article hold, however, regardless of whether those additional assumptions are adopted.

2. Secondary Movements

2.1. The Distribution of Secondary Movements

The first argument for sonority and syllable structure in ASL is based on what I call *secondary movement:* movement of the fingers or wrist whose key characteristic is that it can occur while the hand executes a path movement. Friedman's (1977) "micro movement," Klima et al.'s (1979) "hand-internal movement" and "local movement," the "local movement" of Liddell (1984a; 1990), Wilbur (1987), and Liddell and Johnson (1989), and Sandler's (1989) "handshape internal movement" all include the movements treated as "secondary movement" here. Some of these classifications, however, also include the handshape changes discussed in section 4. I follow Liddell (1984a; 1990) and Liddell and Johnson (1989) in treating secondary movement and handshape changes as separate phenomena. Evidence for this is presented in section 5.

Several types of secondary movement have been identified in the literature, including finger bending, hooking, flattening, nodding, and others. I illustrate secondary movement with finger wiggling and circling. What is essential to the argument is the distribution of secondary movement: it can occur either on an M or on a P.[5]

2.1.1. Finger Wiggling Finger wiggling occurs in certain signs in which fingers are extended. GO-UP-IN-FLAMES (6) and the signs in (7) illustrate finger wiggling during a path movement (M); GERMANY (5) and the signs in (8) illustrate finger wiggling on a P while the hands remain stationary.

[5] Liddell (1990) points out that in his framework, in which M (Movement) and H (Hold) are posited as segment types, secondary movement can occur either on an M or on an H.

(6)   GO-UP-IN-FLAMES
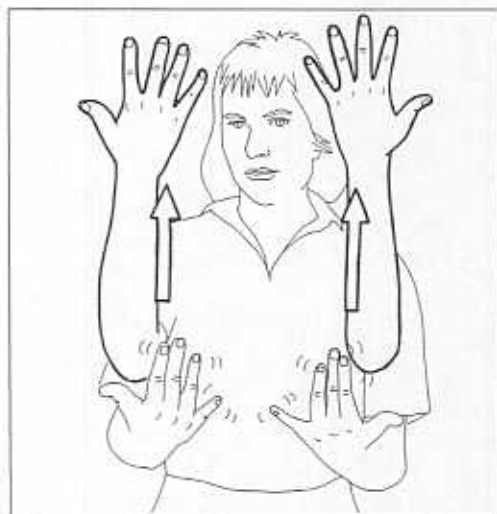
(7)   PLEASANT, FINGERSPELL, LONG-AGO
(8)   COLOR, DIRTY, WAIT, TORCH, STUDY

The key point is that finger wiggling can occur either on an M or on a P.

2.1.2. Circling   Three distinct kinds of circular movement are found in ASL. First, there are signs in which the hand makes a single circular movement, as in FACE and MOUTH. Second, there are large arc-like circular movements, as in ACT and characteristic ad-

(9)   TAPE

jectives.[6] Third, in some signs the hands make a small circling movement, as in TAPE (9) and the examples in (10).

(10)   WHEEL, COMPUTER, TALK/SAY, ALONE

Unlike the first two types of circular movements, the small circling movement in (9)–(10) can occur during a path movement, as in TRAVEL (11), CHASE, and other signs.

(11)   TRAVEL
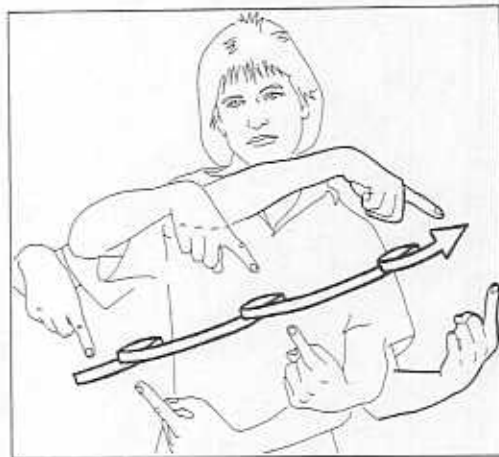
This shows circling (as opposed to the other two types of circular movements) to be a secondary movement.

Like GERMANY (5), the signs in (9)–(10) consist of just a P, but they have circling instead of finger wiggling. These signs have no path movement; the hands are stationary, performing only a secondary movement. Circling has the same distribution as other secondary movements: it can occur on an M, as in (11), or on a P, as in (9)–(10).

2.1.3. Conclusions   Finger wiggling and circling have been used to illustrate secondary movement in ASL signs. There are also others, most thoroughly described and analyzed by Liddell (1990). Liddell analyzes some secondary movements as oscillations between two handshapes or two orientations, but does not decompose wiggling and circling in this way. Regardless of whether or not such an "oscillation" analysis is adopted for certain secondary movements, the key point (also noted by Liddell) is that secondary movement can occur either on an M or on a P.[7]

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[6] Characteristic adjectives are identified by Klima et al. (1979, chap. 11) and discussed in greater detail by Padden and Perlmutter (1987), who formulate an informal rule to account for them.

[7] Liddell's observation is embedded in the theory of segmental structure developed in Liddell (1984a) and Liddell and Johnson (1986; 1989), under which the two segment types are Movement and Hold. For comparison of that theory with the one adopted here, see Perlmutter (1991b).

2.2. *Environments That Systematically Exclude Secondary Movements*

Although secondary movements can occur either on an M or on a P, there is a striking contrast between Ms' and Ps' ability to support secondary movement that has not been noted in the literature. An M can always have secondary movement, regardless of its environment. A P, on the other hand, cannot have secondary movement if it is adjacent to an M.

First consider finger wiggling. GERMANY (5) illustrates finger wiggling on a P. However, neither a PM sequence with finger wiggling on the initial P, as in (12), nor an MP sequence with finger wiggling on the final P, as in (13), is a possible sign in ASL.

(12)   (Impossible Sign)
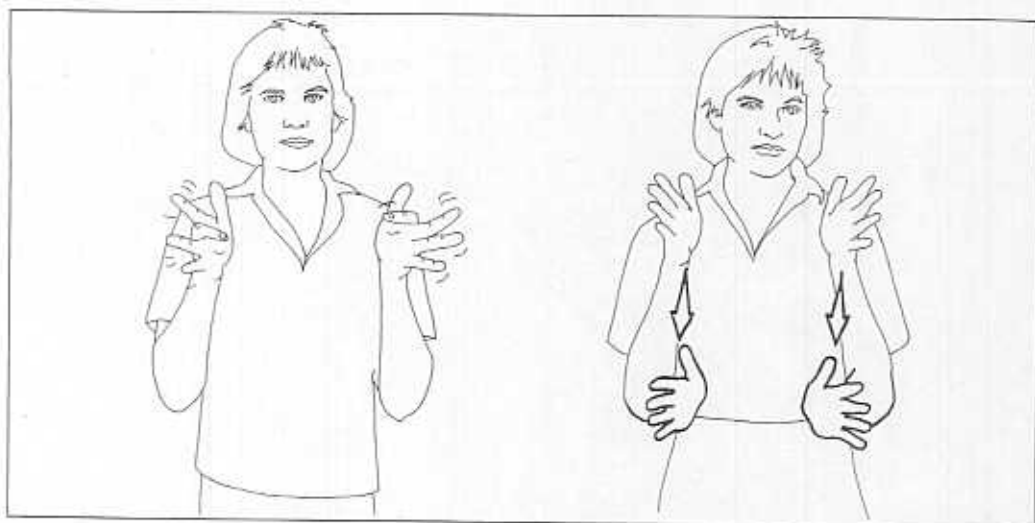
(13)   (Impossible Sign)
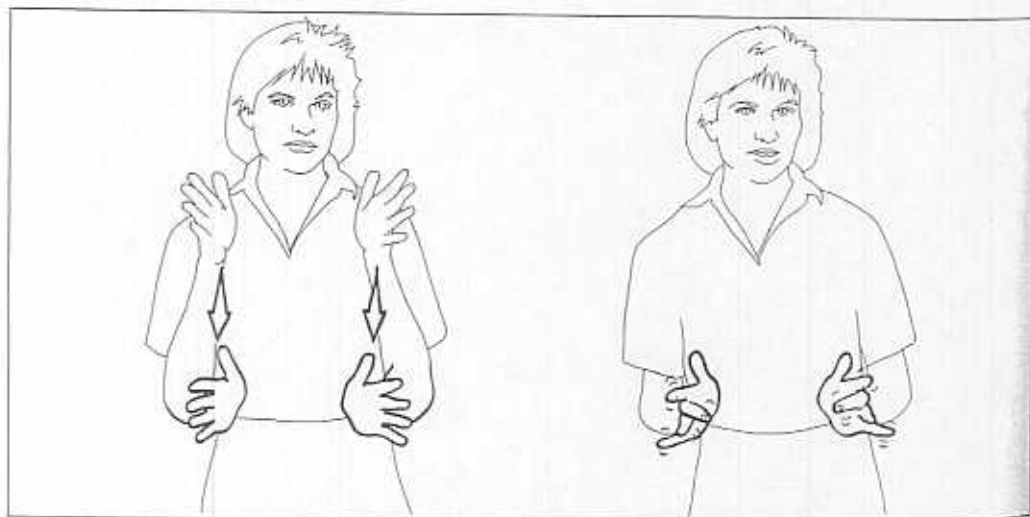
These signs a
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(15)   (Im

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[8] Some morph
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These signs are easy to pronounce, but they are not possible lexemes.

Similarly, circling is possible on a P, as in TAPE (9), but not on a P that precedes an M, as in (14), or on a P that follows an M, as in (15).

(14)   (Impossible Sign)
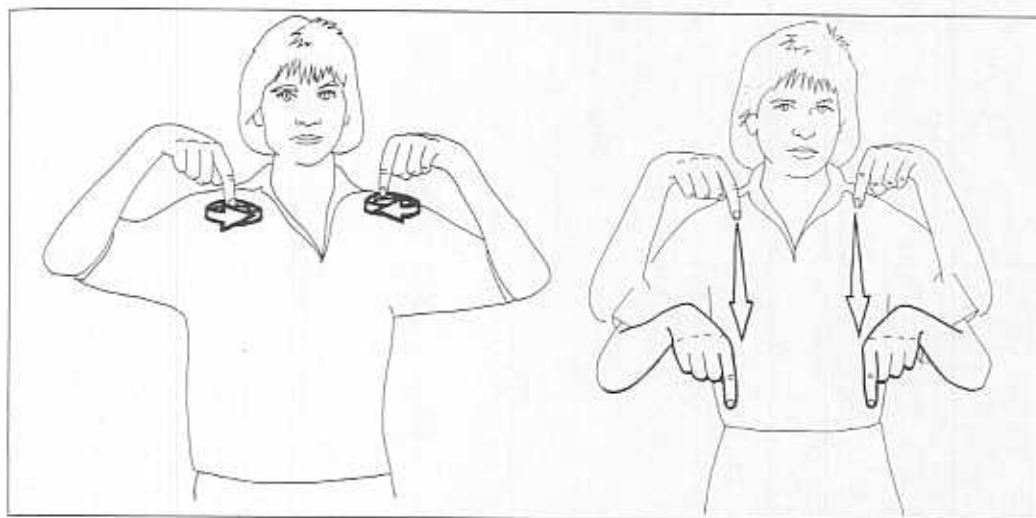
(15)   (Impossible Sign)
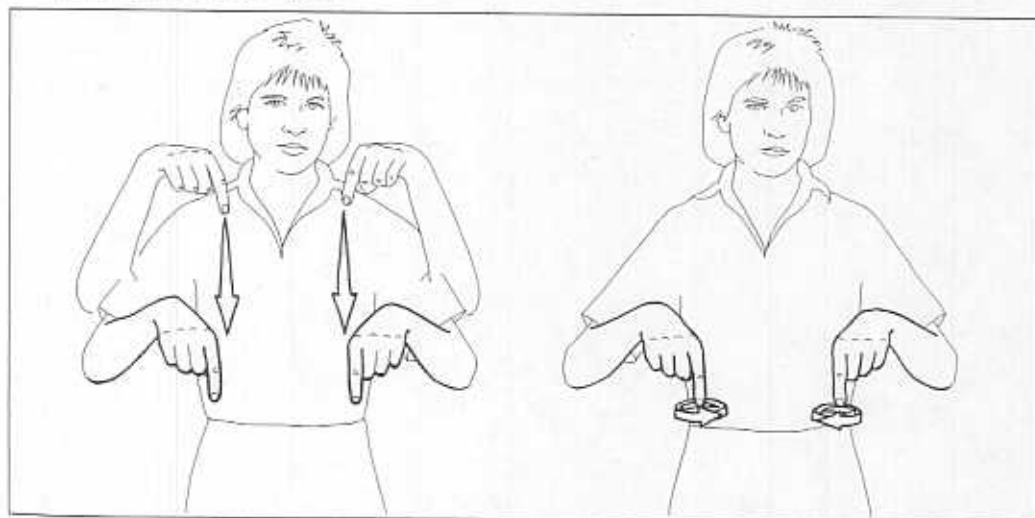
Again, the impossible sequences are easy to pronounce, but they do not occur in ASL lexemes.[8]

[8] Some morphologically derived forms with a secondary movement on an initial P followed by an MP suffix are discussed in Perlmutter (1992).

The sign DREAM (16) consists of a PMP sequence.

(16) DREAM

The initial P has contact of the extended index finger of the G handshape with the forehead. The hand then moves away from the forehead while the index finger bends repeatedly, coming to rest in the final position away from the forehead. The M thus has secondary movement (finger bending), but neither the initial nor the final P does. DREAM (16) thus illustrates the fact that an M can have secondary movement, but a preceding or following P cannot.

3. An Explanation: Syllable Structure and Sonority

3.1. Syllable Structure

How can the distribution of secondary movements be explained? Positing syllable structures like those in oral languages provides an explanation.

The segment sequences we have considered are given in (17)–(21). For each segment in these representations, "OK" indicates that secondary movement is possible on that segment, and "*" indicates that it is not.

(17) [*]$_P$ [OK]$_M$ [*]$_P$
(18) [OK]$_M$ [*]$_P$
(19) [*]$_P$ [OK]$_M$
(20) [OK]$_M$
(21) [OK]$_P$

Two generalizations emerge from the data. First, secondary movement is always possible

on an M. Second, with the important exception of (21), secondary movement is not possible on a P. This exception is the key to the puzzle: What explains the contrast between the possibility of secondary movement on the P in (21) and its impossibility in (17)–(19)?

If, instead of Ms and Ps, we had vowels and consonants, as in oral languages, we would have the following distribution:

(22) [*]c [OK]v [*]c
(23) [OK]v [*]c
(24) [*]c [OK]v
(25) [OK]v
(26) [OK]c

Viewing the distribution of secondary movements in these terms, we would conclude that it is to be accounted for in terms not of segment types but of syllable structure. We would analyze the segment sequences in (22)–(26) as syllables. The contrast between vowels and consonants is accounted for in terms of their ability to function as the nucleus of a syllable:

(27) a. A vowel is always a syllable nucleus.
     b. A consonant can be the nucleus of a syllable only if it is not adjacent to a vowel.

(22)–(25) are thus syllables whose nuclei are vowels. (26) is a syllabic consonant, that is, a consonant functioning as syllable nucleus. The difference between the consonant in (26) and those in (22)–(24) is that only the former is a syllable nucleus. This contrast between consonants functioning as syllable nuclei and those in onset or coda position correlates with their ability to have secondary movement. The generalization governing the distribution of secondary movement features is then clear:

(28) Secondary movement features can occur only on the nucleus of a syllable.

(28) correctly accounts for the distribution of secondary movement features summarized in (22)–(26), explaining the contrast between the consonant in (26) and those in (22)–(24).

The distribution of secondary movements in (17)–(21) can be explained in exactly the same way. If the segment sequences in (17)–(21) are analyzed as syllables, the contrast between Ms and Ps is accounted for in terms of their ability to function as the nucleus of a syllable:

(29) a. An M is always a syllable nucleus.
     b. A P can be the nucleus of a syllable only if it is not adjacent to an M.

(17)–(20) are thus syllables whose nuclei are Ms. (21) is a syllabic P, that is, a P functioning as syllable nucleus. The difference between the P in (21) and those in (17)–(19)

is that only the former is a syllable nucleus. This contrast between Ps functioning as syllable nuclei and those in onset or coda position correlates with their ability to have secondary movement. (28) then states the generalization governing the distribution of secondary movement features in ASL, explaining the contrast between the P in (21) and those in (17)–(19). The distribution of secondary movements in ASL thus provides striking evidence for syllable structure like that in oral languages.

The theoretical device that provides an account of the distribution of secondary movements is the syllable nucleus and the contrast between it and the onset and coda. Regardless of what formalism is adopted to represent syllable structure and this crucial contrast, any theory that accounts for this contrast in oral languages will be able to account for the distribution of secondary movements in ASL. The argument is thus independent of any particular theory or formal representation of the contrast between nucleus and onset/coda in syllable structure.

3.2. Sonority

Why does (29) hold in ASL? In oral languages (27) can be explained in terms of sonority:

(30) a. Classes of segments (or the features that characterize them) are ranked in a "sonority hierarchy."
b. Sonority peaks in a phonological string are the nuclei of syllables.[9]
c. Vowels are more sonorous than consonants.[10]

(30c) is a special case of (30a). The elements of (30) explain (27). A consonant adjacent to a vowel is less sonorous than its vowel neighbor, which will be a sonority peak and hence a syllable nucleus; the consonant will be syllabified into an onset or coda. If there is no adjacent vowel, however, a consonant higher in sonority than adjacent segments will be a sonority peak and hence a syllable nucleus.

(30) can explain (29) in parallel fashion if (30c) is replaced by (31).

(31)   In sign languages, Ms are more sonorous than Ps.[11]

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[9] (30b) states a strong tendency in oral languages to which exceptions have been found. These do not, however, detract from our ability to explain the contrast between Ms and Ps in ASL in terms of sonority any more than they detract from our ability to explain the contrast between vowels and consonants in oral languages in these terms.

[10] This is an oversimplification in that it ignores relative sonority within each of these broad categories. In addition, languages may have language-particular constraints that make segments falling below a certain point in the sonority hierarchy ineligible to be syllable nuclei, or that determine the outcome if two adjacent segments are equal in sonority. These matters need not concern us here.

[11] Oral languages distinguish many more degrees of sonority than just (30c). Glides are generally taken to be more sonorous than liquids, liquids more sonorous than nasals, and nasals more sonorous than obstruents. Further gradations in relative sonority based on the oppositions between continuants and stops, and between voiced and voiceless obstruents, have been posited, as well as gradations in relative sonority among vowels. See Clements (1990) and Selkirk (1984) for discussion. If future research brings to light a sonority hierarchy for sign languages that distinguishes many more degrees of relative sonority, the parallel between sign and oral languages in this domain will be greater than what is shown here.

The fact that a P can be a syllable nucleus only if not adjacent to an M is then explained in exactly the same way as the fact that in oral languages a consonant can be a syllable nucleus only if not adjacent to a vowel.

It may seem strange to speak of "sonority" in a sign language, especially if one believes that sonority has a uniform phonetic or acoustic correlate in oral languages. In that case, it would be difficult to imagine how this notion could play a role in sign languages. However, Ohala and Kawasaki (1984, 122) state that "no one has yet come up with any way of measuring 'sonority'," and Clements (1990) concludes that "there is reason to question whether a uniform, independent phonetic parameter corresponding to sonority can be found, even in principle." The notion of sonority, however, is justified not in terms of some invariant phonetic or acoustic property, but in terms of its ability to capture cross-linguistic generalizations about the ways sequences of segments are organized into syllables. Together with (30b), (31) does this for ASL in the same way that (30c) does for oral languages.

Is there a more abstract notion of sonority, with a less direct relation to phonetics, that can subsume both oral language sonority and the analogous property in sign languages? The relevant notion may be something like "perspicuity": in sign languages movements are more perspicuous than segments in which the hands remain in a single position, whereas in oral languages more sonorous segments are more perspicuous than less sonorous ones. In this connection, it is interesting that Clements (1990) characterizes sonority in terms of the major class features:

> "Sonority" is a composite property of speech sounds which depends on the way they are specified for each of a certain set of features. Plus-specifications for any of these features have the effect of increasing the perceptibility or salience of a sound with respect to otherwise similar sounds having a minus-specification. . . . We are able to relate the notion 'relative sonority' directly to perceptibility, since each of the acoustic attributes associated with a plus-specification for a major class feature enhances the overall perceptibility of the sounds that it characterizes.

The important point is that the relative sonority of different types of segments can be discovered from the ways they are grouped together into syllables. The fact that movements are more "sonorous" than positions in ASL accords well with the idea that sonority is correlated with something like perspicuity, perceptibility, or salience in both oral and sign languages. Here we are concerned only with one relatively gross aspect of sonority in ASL: that Ms are more sonorous than Ps. As understanding of this property in sign languages increases, it will become clearer whether the various degrees of sonority known in oral languages have analogues in sign languages and whether perspicuity is in fact the right notion to capture what this property has in common with sonority in oral languages.[12]

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[12] There have recently been several incompatible attempts to characterize sonority in ASL. Brentari (1990b,c) relates ASL sonority to "visual salience." This notion, although limited to sign languages, would

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3.3. An Argument for Sign Analogues of Vowels and Consonants

Our explanation of the distribution of secondary movements in ASL provides an argument that Ms and Ps are the sign language analogues of vowels and consonants. Like vowels, Ms occur freely as syllable nuclei, whereas Ps occur as syllable nuclei only if not adjacent to an M—just as consonants can be syllable nuclei only if not adjacent to a vowel. With respect to syllable structure, then, Ms behave like vowels and Ps like consonants. We sought to explain this in terms of the relative sonority of Ms and Ps, attributing to Ms the sonority properties of vowels and to Ps the sonority properties of consonants. The argument that Ms are vowels and Ps consonants thus rests not on their articulatory or perceptual properties, but on their patterning with respect to syllable structure. If we attribute this patterning to the relative sonority of Ms and Ps, we are led to posit (31). But does linguistic theory need both (30c) and (31)? If Ms are vowels and Ps are consonants, (31) is unnecessary; the desired results follow from (30c) alone. Formally, then, the argument based on Ms' and Ps' patterning with respect to syllable structure reduces to the fact that a theory in which Ms and Ps are vowels and consonants, respectively, need say nothing about the relative sonority of Ms and Ps; it achieves the desired results with (30c) alone. (30a–c) then work in sign languages just as in oral languages. Sign languages do not differ from oral languages with respect to any of these phenomena.

4. Handshape Changes

4.1. The Phenomenon

In some signs the hands switch from one handshape to another. For example, in BAWL-OUT (32), the hand changes from the S handshape to the 5 handshape. In OLD (33), the hand changes from the C handshape to the S handshape.

Handshape changes raise several problems. First, which handshapes and combinations of handshapes occur in handshape changes? Second, how are handshape changes to be represented? These problems have been addressed in different ways by Friedman (1977), Battison (1978), Liddell and Johnson (1989), Sandler (1986; 1989), Corina and Sagey (1989), Brentari (1990a,b), Liddell (1990), and Corina (1990a; in press). The prob-

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fall under the notion of "perspicuity" suggested here for both oral and sign languages. Brentari's proposal is similar to that of Coulter (1985), who has proposed that sign language sonority is correlated with relatively unrestrained manner of movement and high visual salience. Edmondson (1986) has proposed essentially the opposite, viewing sign sonority in terms of "activity restraint," so that "restraint or controlledness of activity" constitutes "perceptually salient peaks." Corina (1990b) has proposed that relative sonority in ASL is a property not of segments or features but of the major *classes* of features (movement, orientation, handshape, and location), where these feature classes are viewed as a property of the sign as a whole rather than a property of segments or other phonological constituents.

These proposals illustrate the difficulties inherent in attempts to characterize sonority. This is why I have concentrated here on distributional arguments, showing that (31), together with (30a–b) from oral language phonology, can account for the distribution of secondary movements in ASL signs.

(32)   BAWL-OUT

(33)   OLD

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s and Ps like
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ss). The prob-

lem addressed here is a different one: What is the distribution of handshape changes—
that is, where in the sign can they occur?

4.2. The Distribution of Handshape Changes

Handshape changes can occur during a movement, as in (32)–(33) and (34)–(35).[13]

(34)   Closed to open: ASK, SEND, HATE, THROW
(35)   Open to closed: TAKE, BEAUTIFUL, LIKE, LEARN, COPY, AND, OLD

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ed with relatively
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in ASL is a prop-
n, handshape, and
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rom oral language

[13] The presentation of the data in (34)–(38) reflects a somewhat oversimplified characterization of hand-shape changes as "closed to open" or "open to closed." See the references cited above for more fine-grained analyses.

Handshape changes are also possible on a P, as in UNDERSTAND (36), with a change
from the closed S handshape to the open G handshape, and (37)–(38).

(36) UNDERSTAND

(37) Closed to open: UNDERSTANDING, FINGERSPELL-TO, 11, 12, LIGHTS-
      ON
(38) Open to closed: CATCH, BITE, WET/SOFT, LIGHTS-OFF

Like secondary movements, handshape changes can occur either on an M or on a P.

4.3. Environments That Systematically Exclude Handshape Changes

As with secondary movements, handshape changes cannot occur just anywhere in a
sign. They are possible on an M regardless of its environment. Signs consisting of only
a P allow a handshape change, as in (36)–(38). However, a P that is adjacent to an M
cannot have a handshape change. (39) illustrates an impossible PM sign in which the
hands change from the closed S to the open 5 handshape on the initial P, followed by
an M during which the hands move downward. (40) is an impossible MP sign in which
the hands in the closed S handshape move downward, followed by a change to the open
5 handshape on the final P. Both these signs illustrate the impossibility in ASL of a
handshape change on a P that is adjacent to an M. Thus, no sign consists of a handshape
change while the hands are stationary in some position preceded or followed by a move-
ment. The key contrast is between Ps adjacent to an M, which disallow handshape
changes, and Ps occurring alone in a sign, as in (36)–(38), which allow them. The dis-
tribution of handshape changes within the sign is thus the same as that of secondary
movements in (17)–(21). The problem is to account for this distribution.

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(39)   (Impossible Sign)
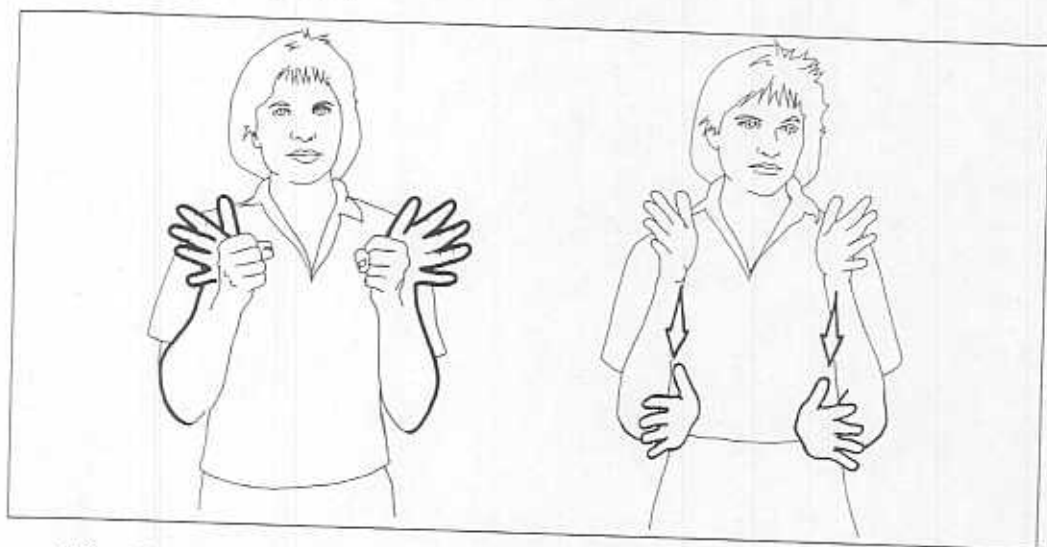
(40)   (Impossible Sign)
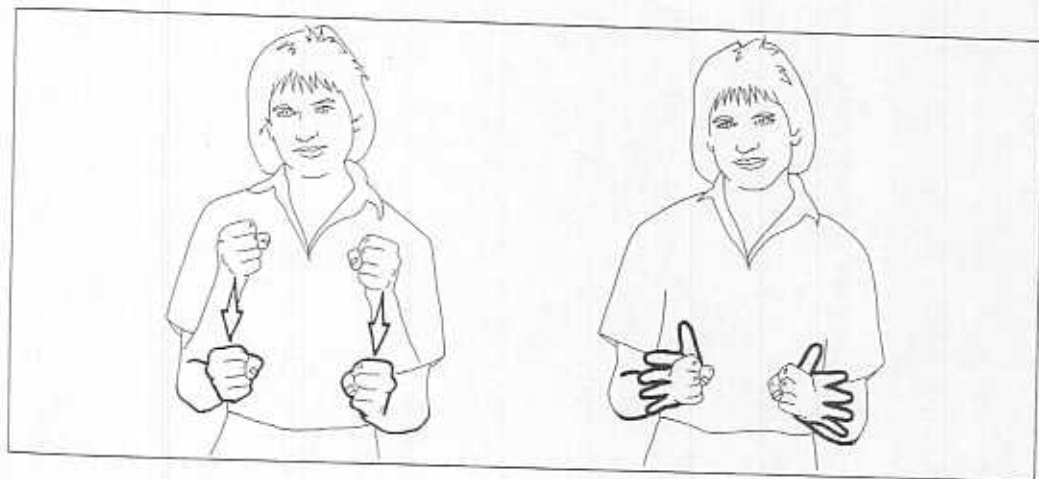
4.4. An Explanation

The explanation here is the same as for secondary movements. The syllable structure posited to account for the distribution of secondary movements—based on (27)—can account for the distribution of handshape changes as well. The constraint is as follows:

(41)   A handshape change can occur only on the nucleus of a syllable.

Given (27), an M is always a syllable nucleus and hence able to support a handshape change. A P that occurs alone in a sign, as in (36)–(38), is also a syllable nucleus and

hence able to support a handshape change. But a P that precedes or follows an M will be an onset or a coda and hence unable to support a handshape change.

5. The Prosodic Domain of Handshape Features: Some Contrasts Explained

5.1. The Representation of Secondary Movement Features and Handshape Features

The syllable structures posited here are supported by the demonstration that both secondary movements and handshape changes occur only on syllable nuclei. This result, together with the analysis of handshape changes as a form of secondary movement in Friedman (1977), Klima et al. (1979), Wilbur (1987), and Sandler (1989), could easily lead one to conclude that handshape changes and secondary movements have the same kind of phonological representation. I now argue that this is incorrect.

Secondary movement features and handshape features have different domains. The domain of secondary movement features is the segment, whereas handshape features have a prosodic domain: the mora (see section 5.4).[14] How is this difference in these features' domains to be represented phonologically?

In current theories of feature geometry being developed by Mohanan (1983), Clements (1985), McCarthy (1988), and others, the fact that secondary movement features have segmental domains can be captured by representing them somewhere in the feature geometry beneath individual segments' root nodes so that there is no direct association between secondary movement features and prosodic structure; the association between them is *indirect*, mediated by the root node. Features on the handshape tier, however, are linked directly to prosodic structure; I argue below that they are linked not to syllables but to morae. This correctly represents handshape features' suprasegmental domains. The representation of handshape in ASL is thus analogous to that of tone in tone languages, since tone features (like ASL handshape features) have suprasegmental domains.

A key element of the present proposal lies in the contrasting representations for secondary movement and handshape features. In other respects it shares certain features with other proposals.[15] What is new here are the linking of handshape features to morae in the prosodic representation and the arguments for this representation based on the

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[14] ASL handshape is thus a "prosody" in the sense of Firth (1948) and subsequent research in Firthian "prosodic analysis." The Firthian term *prosody* refers to phonological elements associated with units of structure larger than the segment: phrases, words, syllables, or parts of syllables.

[15] Like the present proposal, Sandler (1986; 1987; 1989; 1990; in press) treats handshape differently from other feature classes. Sandler also proposes a feature geometry for ASL. Corina and Sagey (1989) and Corina (1990a; in press) develop a segment-internal representation of handshape under which handshape contours are contour segments, analogous to affricates in oral languages. Although Liddell and Johnson (1986; 1989), Liddell (1990), and Brentari (1990a,b) represent handshape autosegmentally, their representations do not reflect the major distinction between handshape and other feature classes that is essential to the proposal advanced here. A second dimension along which proposals differ concerns the domain of handshape features. In the work of Corina, Corina and Sagey, Liddell, and Liddell and Johnson, handshape features have a segmental domain; in Sandler's work they have a morphemic domain; and Brentari's work is like the present proposal in giving handshape a prosodic domain, which Brentari takes to be the syllable rather than the mora, as argued here. See Perlmutter (1992) for discussion of the domain of handshape features.

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contrasting behavior of secondary movement and handshape features under the rule of Mora Insertion in phrase-final position (Perlmutter (1991b)).

To make the arguments explicit, it is necessary to make some further assumptions about phonological representations. I adopt the moraic theory of Perlmutter (1991b), assuming that the root nodes of the melodic units corresponding to Ms and Ps can be directly linked to elements of the prosodic representation (with no intervening segmental skeleton with M-slots and P-slots, as would be posited in a sign language analogue of Clements and Keyser's (1983) CV phonology), and that the feature complexes of Ms and Ps can be distinguished by a major class feature.[16] No claim is made that theories of the syllable that posit a skeleton consisting of segmental slots cannot account for the data presented here. The key point is the direct association of features on the handshape tier with (morae in) the prosodic representation. With these minimal assumptions about ASL phonological representations it is possible to account for some surprising contrasts in which handshape features play a prominent role.

5.2. The Contrast between Handshape and Secondary Movement Features under Mora Insertion

A key contrast between handshape and secondary movement features can be seen clearly under the effects of Mora Insertion, a rule that inserts a mora in phrase-final position in signs ending in a P:

(42)   *Mora Insertion*

$$\sigma$$

$$\mu \qquad \mu$$

$$[\quad]_P \quad \#\#$$
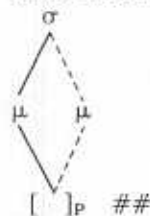
As argued in detail in Perlmutter (1991b), Mora Insertion correctly predicts the distribution of short holds in phrase-final position. By adding a mora to signs ending in a P, it gives the final P a mora of its own. Since morae are timing units, such a P is realized as a short hold. Mora Insertion also predicts length alternations in signs consisting of only a P such as GERMANY (46). These signs are monomoraic syllables that, in phrase-final position, get another mora by Mora Insertion. They are therefore dominated by two morae in phrase-final position but by one mora elsewhere, which accounts for their realization as long holds in phrase-final position and as short holds elsewhere.

The contrast between handshape and secondary movement features can be seen in

[16] Since Ms are path movements and Ps are not, this feature might be called [±Path]. Nothing essential to the argument hinges on this. I make no further assumptions about the phonological features in these melodic units or their feature geometry, except for the key assumption that secondary movement features are not directly linked to prosodic representations, whereas features on the handshape tier are.

a sign such as GO-UP-IN-FLAMES (43), which consists of an MP sequence signed with the 5 handshape. The presence of the final P can be seen in GO-UP-IN-FLAMES in phrase-final position; the hands' upward movement is followed by a hold that results from Mora Insertion.

(43) GO-UP-IN-FLAMES

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The key fact is that although the fingers wiggle during the hands' upward movement in GO-UP-IN-FLAMES (43), this movement is followed by a hold *without finger wiggling* during which the 5 handshape is maintained. Finger wiggling does not continue during the final hold, as in the incorrect form (44).

(44) (Incorrect Form)

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Two questions must be answered. First, why do the fingers wiggle during the movement but not during the final hold? Second, why is the 5 handshape maintained during the final hold? An explanation is provided by phonological representations in which secondary movement features are melodic features of individual segments, whereas handshape is represented on a separate autosegmental tier directly linked to prosodic structure.[17]

GO-UP-IN-FLAMES (43) has the representation in (45). The secondary movement feature for wiggling, which I call "[W]", is a feature of the M segment;[18] the final P could not have this feature without violating (28). Handshape, however, is represented on a tier directly linked to prosodic structure, like tone in oral languages.

(45) $[W]_M$ $[\quad]_P$

$$\mu \qquad \mu$$

[HS:5]
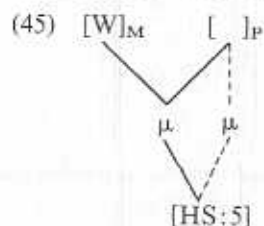
The inserted mora associates with the handshape tier. Since association lines cannot cross (given the Autosegmental Well-Formedness Condition of Goldsmith (1976) and subsequent research in nonlinear phonology), the only root node with which it can associate is that of the P in final position. Crucially, it cannot be associated with the root node that dominates the [W] wiggling feature. The representation in (45) thus predicts that in GO-UP-IN-FLAMES (43), there will be finger wiggling during the first mora but not during the second. And this is correct: the fingers wiggle during the hands' upward movement to their final position (the first mora), but not while they remain there (the second mora). The representation in (45) and the prohibition on crossing association lines together explain the contrasting behavior of handshape and secondary movement features: the inserted mora can associate with handshape features but not with secondary movement features.[19]

The contrasting representations of secondary movement and handshape features

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[17] If separate morphemes are represented on separate tiers, as in McCarthy (1986) and much other work, numerous cases in ASL would require the autosegmentalization of handshape features in underlying representations because handshape realizes separate morphemes, for example, for classifiers in verbs of motion and location (Supalla (1982; 1986; 1990)), size and shape specifiers (Supalla (1986)), "incorporated" numerals (Liddell et al. (1984)), case in pronouns (Perlmutter (1991a)), and others. On the phonological representation of certain morphemes in ASL, see Johnson and Liddell (1984).

[18] I treat this and other secondary movement features as privative, but the argument would be unaffected if they are binary. In that case the melodic unit constituting the M in (45) would contain the feature [+W] and that of the P would include the feature [−W].

[19] Liddell (1990) gives what is essentially the same argument, but developed in a CV-type framework with Movement (M) and Hold (H) as the two basic segment types. Here the argument is based on feature spreading onto morae inserted by Mora Insertion; neither Mora Insertion nor morae have any status in Liddell's framework. Thus, two very different approaches embedded in different conceptions of ASL phonological structure have both reached the conclusion that handshape and secondary movement features must be represented differently.

mean that secondary movements and handshape contours occur on syllable nuclei for different reasons. Secondary movement features are segmental features and are restricted to syllable nuclei by (28). Handshape contours occur on syllable nuclei because each contour is associated with a mora dominating the syllable nucleus and is realized over that mora. (41) can therefore be eliminated from the grammar.

The fact that the second handshape in a handshape change spreads onto inserted morae also bears on the analysis of handshape changes. An "edge effect" that supports the contour representation of handshape changes, it is similar to the edge effects in handshape spreading discussed by Corina (1990a). It also argues against analyses such as those of Friedman (1977), Klima et al. (1979), Sandler (1989), and Wilbur (1987) that treat handshape changes and secondary movement alike and thereby fail to explain the fact that in signs like GO-UP-IN-FLAMES (43), secondary movement features do not spread onto inserted morae, whereas handshape features do.[20]

5.3. The Contrast between Syllable-Internal and Syllable-Final Segments under Mora Insertion

It might be thought that there is some inherent difference between secondary movement and handshape features that could account for this contrast without different representations. For example, it might be claimed that secondary movement features are inherently incapable of spreading, whereas handshape features spread. To see that no such hypothesis can be maintained, consider the contrast between GO-UP-IN-FLAMES (43) and GERMANY (5), repeated here as (46). GERMANY (46) consists of just a P, with the representation in (47) in phrase-final position.

(46) GERMANY

[20] An anonymous referee correctly points out that recent research (Sandler (1989), Liddell (1990), Stack (1988)) has brought out similarities between handshape changes and certain secondary movements that are essentially repeated oscillations between two handshapes. For these cases an analysis is needed that both captures these similarities and accounts for the differences explained here. On the other hand, certain secondary movements (such as finger wiggling and circling) do not seem to be analyzable as oscillations between two handshapes. That is why I use finger wiggling and circling to illustrate secondary movements.
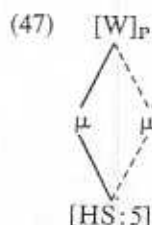
(47) $[W]_P$

$$[HS:5]$$

Since (47) presents no problem with crossing association lines, the mora added by Mora Insertion can associate with both the representation of the 5 handshape on the handshape tier and the P's root node, which dominates the wiggling feature. The representation in (47) thus predicts that in GERMANY (46), *both* finger wiggling and the 5 handshape will be present throughout the sign, and that is how GERMANY (46) is executed. The form in (48), parallel to GO-UP-IN-FLAMES (43), is incorrect.

(48) (Incorrect Form)
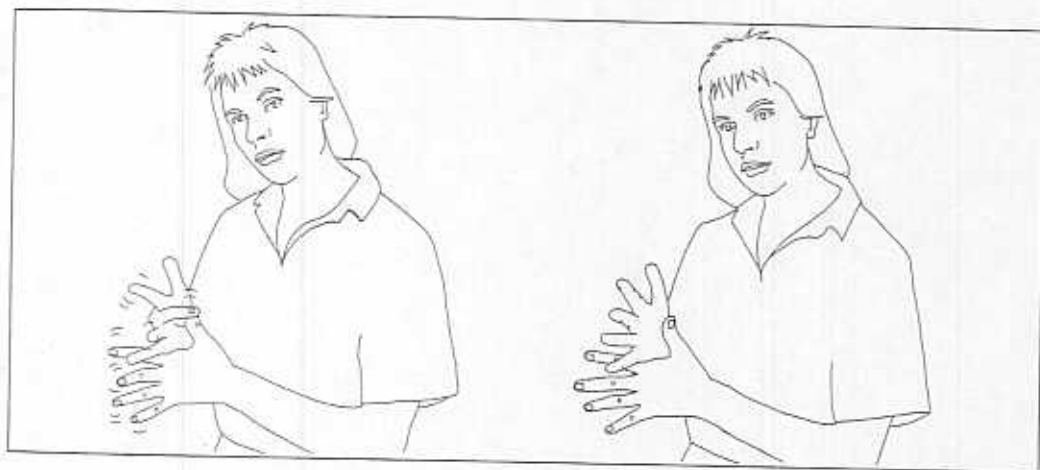
In (48) the fingers wiggle during the first mora but not during the second. Although this is what we find in GO-UP-IN-FLAMES (43), in GERMANY (46) this is impossible. GERMANY (46) must be executed with finger wiggling throughout. This shows that in GERMANY (46), *both* finger wiggling and handshape spread onto the inserted mora. The reason finger wiggling does not spread onto the inserted mora in GO-UP-IN-FLAMES (43) is not that secondary movement features are inherently incapable of spreading, but that association of the inserted mora to the M segment with the [W] feature in (45) would cause association lines to cross. The contrast between the spreading secondary movement feature in (47) and the nonspreading secondary movement feature in (45) is due to the fact that although both syllables are in phrase-final position, the former is a feature of a syllable-final segment, whereas the latter is a feature of a syllable-internal segment. Under the analysis proposed here, this contrast follows directly from the prohibition on crossing association lines in autosegmental representations.

5.4. The Mora as Handshape-Bearing Unit: The Timing of Handshape Changes

When followed by another sign in the same phonological phrase, a syllable with a hand-shape change such as (32), (33), or (36) is pronounced with roughly equal time on the two handshapes. In phrase-final position, however, much more time is spent on the second handshape. Why is this? Given that more time is spent on a sign in phrase-final position, why does this "extra time" go to the second handshape rather than being apportioned more or less equally between the two handshapes?

The linking of handshape features to morae, the representation of handshape changes as contours, and Mora Insertion in phrase-final position provide an explanation. The first two guarantee that in a monomoraic syllable with two handshape representations on the handshape tier, these representations will be associated with the mora. Since the two handshape representations share a mora, they will be realized with roughly equal time for each handshape. In phrase-final position, however, Mora Insertion results in the representation in (49).[21]

(49) [HS1]   [HS2]

$$\mu \qquad \mu$$

([ ]_P) [ ]_M [ ]_P
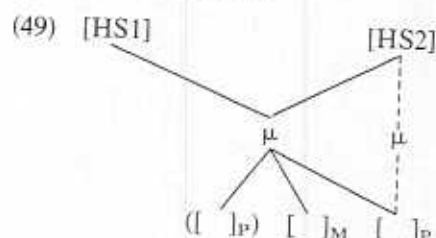
Since association lines cannot cross, the inserted mora can be associated only with the second handshape, not with the first. Since morae are timing units, (49) correctly predicts that the handshape contour (the change from HS1 to HS2) will occupy roughly half the sign's duration, whereas HS2 will occupy roughly the second half. The fact that the "extra time" a syllable gets in phrase-final position goes entirely to the second handshape in a contour is thus explained.

The timing of handshape changes in phrase-final position provides evidence that the mora and not the syllable is the handshape-bearing unit in ASL. If handshape features were associated with the syllable node, we would have representations such as (50).

(50) [HS1]   [HS2]

$$\sigma$$

$$\mu \qquad \mu$$

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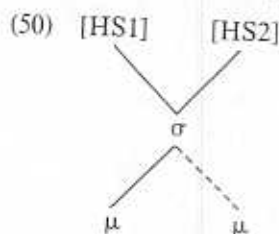
[21] For notational convenience the initial P is dominated by the mora, but nothing essential to the argument hinges on this.

With handshape features associated with the syllable node, the insertion of a mora in phrase-final position would lengthen the entire syllable, with a roughly equal division of time between the two handshapes. However, the "extra" duration due to Mora Insertion goes to the second handshape. This argues for the representation in (49) over that in (50) and hence for association of handshape features with the mora rather than the syllable.[22]

5.5. Mora Insertion versus Phrase-Final Lengthening

The phenomena discussed above bear on the analysis of the lengthening in phrase-final position accounted for in Perlmutter (1991b) with a phonological rule of Mora Insertion (42) that adds a mora in phrase-final position if the phrase ends in a P. An alternative analysis of this phenomenon would identify it with phrase-final lengthening in oral languages—a phenomenon that results in added length on a syllable in phrase-final position, generally realized as additional length on the syllable nucleus. Affecting both long and short vowels, such lengthening is independent of contrastive vowel length and therefore is usually thought to be a phonetic rather than phonological phenomenon.

The lengthening observed in phrase-final position in ASL, however, differs from phonetic phrase-final lengthening in oral languages in ways that argue that it is phonological (rather than phonetic) and best accounted for by a phonological rule of Mora Insertion. First, what lengthens is not the syllable nucleus but the final P, which is accounted for by adding a mora in final position. This can be seen clearly in MP and PMP syllables where the additional length is not on the M (the syllable nucleus) but on the final P. This is even clearer if the syllable has a handshape contour like those discussed in section 5.4. The additional length is not split between the two handshapes, but goes onto the final handshape, as predicted by (49). Second, and most telling, the contrast between handshape features and secondary movement features in signs like GO-UP-IN-FLAMES (43) in phrase-final position supports the analysis of this phenomenon as insertion of a mora in phonological representations. Analyzing it as phonetic lengthening would fail to explain why a form such as (44) is impossible. If this lengthening is due to a phonological rule of Mora Insertion, however, the impossibility of signs like (44) is due to a universal well-formedness condition on phonological representations—the impossibility of crossing association lines, as seen in (45). This argues that the phenomenon is phonological.

6. On the Distribution of P-Syllables in Lexemes

Although most ASL lexemes are monosyllabic,[23] two types of evidence for disyllabic lexemes have been found: the presence of two distinct M-segments (Perlmutter (1991b))

[22] It is not clear how these facts would be accounted for under Brentari's (1990b) analysis, which associates handshape features with the syllable node, or under Corina's (in press) analysis, which treats handshape contours as segments and rejects a contour representation.

[23] Coulter (1982) claimed that ASL signs are monosyllabic, with the exception of compounds, reduplicated signs, and loan signs from fingerspelling.

and the distribution of handshape sequences and contours (Perlmutter (1992)).[24] As pointed out in these works, an ASL lexeme can have at most two syllables. Syllables with an M as nucleus occur in both monosyllabic and disyllabic lexemes. Not discussed in the literature is the distribution of P-syllables in lexemes, which is more restricted.

If a P-syllable could precede a PM-syllable or follow an MP-syllable in a lexeme, we would find lexemes of the following form:

(51) a. PPM
b. PPMP
c. MPP
d. PMPP

These sequences would be realized as signs like those shown to be impossible. For example, if the final P in a lexeme of the form (51c) had the finger wiggling feature [W], the representation would be as follows:

(52)
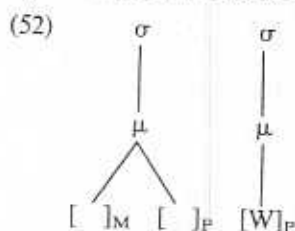
Except for [W], the two Ps have the same features. (52) would yield a sign like (13), which is not a possible ASL lexeme. Similarly, the other lexeme types in (51) would yield impossible signs and must be ruled out.

Further, ASL has no lexemes consisting of two P-syllables. Such lexemes, which would have the form in (53), must be ruled out.

(53)
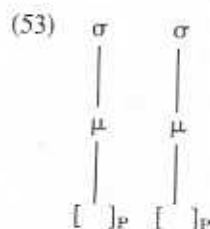
[24] This differs from some earlier work that assumed without argument that each articulatory movement constitutes a separate syllable—an assumption that can lead to extraordinary conclusions. For example, Wilbur (1987, 62) reports that Wilbur and Nolen's (1986) study of stressed versus unstressed signs found that "the number of syllables per sign was significantly greater for the stressed than the unstressed versions." Evidence is presented in Perlmutter (in preparation) that the signs in one relevant class are monosyllabic. Under this analysis, what Wilbur and Nolen interpreted as an increased number of syllables under stress is simply increased duration. Wilbur and Nolen's conclusion brings out one consequence of assuming that a single articulatory movement necessarily constitutes an M segment or a syllable. Wilbur (1990, 105) brings out another conse- quence of this assumption: "the number of syllables is not fixed for a given sign but varies in accordance with the phonological effects of neighboring signs, stress, rate of signing, morphological inflections, and historical etymology."

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The impossible lexemes in (51)–(53) have something in common: in each a P-syllable occurs in a disyllabic lexeme. These lexemes could be ruled out by a constraint on lexical entries:

(54)   If A is a lexical entry containing a P-syllable, A is monosyllabic.

(54) states the observed restriction. Is (54) needed in the grammar, or can its effect be made to follow from a more general constraint? I now explore the second possibility.

Though the impossible lexemes in (51)–(53) each have a P-syllable in a disyllabic lexeme, there is something else they have in common: PP sequences. Instead of (54), we could state a constraint ruling out lexical entries with PP sequences:

(55)   *PP

(55) rules out sequences of two root nodes dominating the feature that distinguishes P-melodies from M-melodies (cf. fn. 16). Given the evidence that P-segments are consonants, (55) incorporates the claim that ASL lexemes do not allow consonant clusters.

Like (54), (55) correctly rules out the impossible lexemes in (51)–(53). (55), however, also rules out a class of lexemes that (54) does not: those in which an MP- or PMP-syllable precedes a PM- or PMP-syllable:

(56)   . . . MPPM . . .

The fact that such lexemes are impossible in ASL argues for (55) over (54).

Since (55) is stated on entries in the lexicon, it allows PP sequences resulting from juxtaposition of signs in sentences.[25] I know of no cases where PP sequences would arise word-internally through affixation of melodic material.

In sum, (55) correctly accounts both for the fact that P-syllables occur only in monosyllabic lexemes and for the impossibility of the segment sequences in (56), incorporating the claim that the constraint is phonological. A P-syllable in a disyllabic lexeme would have to be adjacent to an M or a P. If a P is adjacent to an M, it will be syllabified as an onset or coda, as shown in section 3; it cannot be the nucleus of a separate syllable. If it is adjacent to a P, (55) is violated. P-syllables consequently cannot occur in disyllabic lexemes.

This completes the explanation of why the signs in (12)–(15) and (39)–(40) are impossible. All these signs involve a secondary movement or handshape contour on a P. They could arise in any of three ways, but all are ruled out. First, such signs could result from representations like those in (51) and (52), with a syllabic P adjacent to an onset

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[25] Some scholars (e.g. Liddell and Johnson (1986; 1989), Sandler (1989; 1990), and Wilbur (1987; 1990)) have posited M-Epenthesis rules that insert a movement to break up such PP clusters (or their equivalents in other segmental frameworks), but it is argued in Perlmutter (1990) that such apparent "movements" are not M-segments and do not figure in phonological representations. Sandler (1990, 34), who posits L (Location) as a segment type quite similar to P, sees the nonexistence of LL clusters in her framework as due to the fact that "it is not physically possible to articulate a sequence of distinct locations without movement in between." I have argued here, however, that the constraint that blocks PP sequences rules out a significant class of impossible lexemes in ASL that Sandler's analysis does not.

or coda P. These representations, however, are ruled out by (55). Second, they could result from PM or MP sequences in which the P is a syllable nucleus, but these are impossible because a consonant adjacent to a vowel is syllabified as an onset or coda (see section 3). Third, if they result from tautosyllabic PM or MP sequences, their representations would have secondary movement or a handshape contour on an onset or coda. The former is ruled out by (28), which governs the distribution of secondary movement features, and the latter by the direct association of features on the handshape tier with morae in the prosodic representation, which results in handshape contours' being realized on syllable nuclei. The ill-formedness of signs like (12)–(15) and (39)–(40) in ASL is thus accounted for.

7. What Constitutes a Well-Formed Syllable in ASL?

This article has taken some steps toward answering the question of what constitutes a well-formed syllable in ASL.[26] Syllables whose nucleus is an M are well formed, regardless of whether there is a preceding or following P. This yields the four syllable types PMP, MP, PM, and M, illustrated by (1)–(4). The prohibition on PP sequences rules out syllables with P clusters as onset or coda.

P-syllables present a more complex picture. Descriptively, the facts are relatively straightforward:

(57)   A P-syllable is well formed if the P has secondary movement, if there is a handshape change on the associated handshape tier, or if there is an orientation change.[27]

There are no well-formed lexical items in ASL that consist of just a P without either secondary movement or a handshape change or orientation change. Such a sign would be realized with the hand(s) held in a single position, without path movement, secondary movement, a handshape change, or an orientation change—like GERMANY (5) without finger wiggling or like UNDERSTAND (36) without a handshape change.

How is a grammar of ASL to account for this? One solution would invoke sonority, positing that Ps with secondary movement or a handshape or orientation change are more sonorous than Ps without either. The grammar would then posit a cutoff point for syllable nuclei, requiring that a segment have the sonority of Ps with secondary movement or handshape or orientation change—or greater—in order to qualify as a syllable nucleus. This would be the ASL analogue of restrictions in oral language grammars

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[26] For discussion of earlier research on the syllable in ASL, see Wilbur (1990).

[27] GERMANY (5) illustrates a P-syllable with secondary movement, and UNDERSTAND (36) illustrates one with a handshape change. P-syllables with orientation changes, not discussed here, are discussed by Brentari (1990b; 1991).

An anonymous referee points out that Stack (1988) notes the constraint in (57) and integrates it into a more general theory prohibiting signs in which "nothing happens." The referee also suggests that Stack may have been the first to propose an M-Epenthesis rule of the type sketched below. Since I have not had access to Stack's thesis, I was unaware of her proposals.

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concerning which consonants rank high enough in sonority to qualify as syllable nuclei. Invoking sonority in this way is only one of various possible solutions to the problem of characterizing the class of P-segments that can serve as syllable nuclei in ASL.[28]

However this problem is resolved, there is an important class of exceptions to (57). The sign LOOK-AT (58) consists of an MP sequence: the hand (in the V handshape) makes a short forward movement to a position where it is briefly held.

(58) LOOK-AT

In a morphologically derived form of (58), usually translated as STARE, there is no movement: the hand (in the same handshape and orientation as in (58)) is simply held in a single position. STARE is thus a well-formed syllable consisting of just a P without either secondary movement or handshape or orientation change, counterexemplifying (57).

All the counterexamples to (57) have something in common: they are morphologically derived. Since (57) holds for nonderived lexical items in ASL, the problem is how to rule out syllables violating (57) while allowing them only in morphologically derived forms. This question is left open here.

Interestingly, there seem to be lexical items whose underlying representations violate (57) and therefore cannot be syllabified, but which undergo phonological rules that make syllabification possible. An interesting class of these have the following properties:

(59) a.   They are realized as MP sequences.
     b.   Their phonologically distinctive features are not features of the M.
     c.   No features of the M show up in morphologically related forms.
     d.   The M can be analyzed as epenthetic.

[28] For a different approach to this problem, see Brentari (1991).

This cluster of properties can be illustrated with the numbers from one through nine. Each has a distinctive handshape and is realized by a short outward movement in "neutral space" in front of the signer, followed by a short hold if the sign occurs in phrase-final position. This is the usual realization of MP sequences (Perlmutter (1991b)). The short outward movement seems to be predictable for a significant class of signs articulated in "neutral space" and can therefore be analyzed as epenthetic. Further evidence that the M is not present in the underlying representation comes from the fact that no features of an M segment show up when numerals are incorporated in nouns meaning 'week', 'month', 'hour', and so on (Liddell et al. (1984)). Under this analysis, ASL uses M-Epenthesis as a "repair strategy" to produce an MP syllable, which enables the underlying P, which otherwise could not be syllabified, to surface as a well-formed syllable.[29]

This analysis is also viable for a number of lexical signs. For example, LOOK-AT (58) can be analyzed as a P in its underlying representation. M-Epenthesis yields an MP syllable: a short movement to a final position. Here, too, no features of the M segment show up in the derived forms of LOOK-AT (58) that have been characterized as "aspectual" (Klima et al. (1979, 293)). The form glossed as STARE above has no movement at all, whereas the movement in other morphologically derived forms is determined by the morphological template for each derived form; they are not realizations of stem features.[30] Similarly, the sign KNOW is realized as an MP sequence (MH under Liddell's (1984b) analysis) whose M does not show up in the negated form DON'T-KNOW. LOOK-AT (58) and KNOW are but two examples of the many MP signs profitably analyzed as underlyingly Ps with the M due to epenthesis.

Finally, the singular pronouns are amenable to the same kind of analysis. They are realized as MP syllables: a short movement followed by a short hold if they appear in phrase-final position. Orientation is contrastive:[31] the hand (in the G handshape) points toward the signer in the first person singular pronoun, points toward the addressee in the second person, and has a third orientation in the third person. Orientation features realize person features and must be represented underlyingly. The M can be analyzed as epenthetic, the direction of movement in these forms being predictable from orien-

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[29] Brentari (1990b,c) develops the idea that M-Epenthesis is a repair strategy in this sense. M-Epenthesis rules of one kind or another have been posited by almost all researchers on ASL phonology.

[30] These are analyzed and discussed by Liddell (1984a), Johnson and Liddell (1984), Liddell and Johnson (1989), Sandler (1989; 1990; in press), and Brentari (1990b), among others.

[31] Here I fill in some details of the analysis of ASL pronouns sketched in Perlmutter (1991a):

  (i)   Person is realized by orientation.
  (ii) Case is realized by handshape in singular and plural forms. (In the dual pronouns, the K handshape realizes number.)
  (iii) Singular pronouns result from M-Epenthesis.
  (iv) The arc movement in second and third person plural forms is a plural suffix unspecified for handshape, location, and orientation features.

This suffix also appears on the plural forms of what Padden (1988) calls "inflecting verbs." See Corina (1990a) for discussion and analysis of this suffix.

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tation.[32] Evidence that the M is epenthetic comes from the fact that it does not show up in the second and third person plural pronouns, which involve affixation of the plural suffix (an arc movement) that also appears suffixed to verbs to indicate a plural object.[33] Under this analysis, the singular pronouns have underlying representations that cannot be syllabified but are "repaired" by M-Epenthesis. Thus, the numerals from one through nine, the singular pronouns, and certain lexical signs such as LOOK-AT (58) and KNOW have underlying representations that cannot be syllabified but are "repaired" by M-Epenthesis, which makes them MP-syllables that satisfy the constraints on well-formed syllables in ASL.

In brief, Ms qualify as syllable nuclei, whereas Ps' ability to do so is more restricted, as indicated in (57). Some signs' underlying representations cannot be syllabified but are "repaired" by M-Epenthesis. Two important problems remain for future research. First, how is (57) to be formalized? Second, how is the grammar to account for the fact that certain morphologically derived forms qualify as well formed although they are exceptions to (57)?

8. The Modality-Specific, the Language-Particular, and the Universal

The novel descriptive generalizations on which this article is based concern the distribution of secondary movements and handshape contours in ASL. They can always occur on Ms, but on Ps only when not adjacent to an M. Consequently, lexemes such as (12)–(15) and (39)–(40) are impossible. The distribution of secondary movements and handshape contours has been accounted for under the hypothesis that ASL signs have syllable structure like that in oral languages: Ms are more sonorous than Ps, and sonority peaks are the nuclei of syllables (which may have an onset and/or a coda). Ms can always be syllable nuclei, but Ps can only if not adjacent to an M. Since secondary movements and handshape contours can occur only on syllable nuclei, they cannot occur on a P

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[32] In this respect the singular pronouns differ from the numerals discussed above. For both sets of forms the direction of the epenthetic movement is predictable, but for the numerals it is always outward, regardless of the orientation. For the numerals from one through five the palm faces inward for counting (e.g., THREE CHILDREN), where the numeral precedes the head noun, but outward in telling time and giving ages, where the numeral follows the head:

(i)   TIME THREE 'three o'clock'
(ii) OLD THREE 'three years old'

Regardless of the orientation, the epenthetic movement is outward:

(iii) I HAVE THREE CHILDREN, YOUNG+COMPAR OLD THREE.
'I have three children; the youngest is three years old.'

In the first occurrence of THREE the palm faces inward, in the second it faces outward, but in both cases the epenthetic movement is outward.

[33] The first person plural pronouns (plain and possessive) are different in that they include specification of two contacts with the body. The arc movement in the first person plural pronouns (which might be epenthetic) is thus different from that in the second and third person plural pronouns, which is the realization of the plural suffix.

adjacent to an M. The explanation of their distribution provides evidence not only for syllable structure, but also for a difference in relative sonority between Ms and Ps that shows them to be sign language analogues of vowels and consonants. These theoretical constructs have all been motivated by evidence internal to ASL.

A secondary result of this article concerns two contrasts that appear under Mora Insertion. First, in syllables ending in an MP sequence, handshape spreads to added morae but secondary movement does not. Second, syllable-final secondary movement spreads to added morae, but syllable-internal secondary movement does not. These contrasts have been accounted for by positing different phonological representations for secondary movements and handshape contours, secondary movements being represented as features of individual segments whose association with prosodic structure is mediated by the root node, whereas handshape features are represented on an autosegmental tier directly linked to elements of the prosodic representation.

Finally, it has been shown that the only lexemes in which syllabic Ps occur are monosyllabic. A constraint ruling out PP sequences, together with independently motivated devices, accounts for this distribution and also rules out other impossible lexemes.

How much of what has been posited is modality-specific, how much is particular to ASL, and how much is universal? To distinguish the modality-specific from the language-particular with any degree of certainty, it would be necessary to know a great deal more about the phonology of other sign languages than is presently known. Nonetheless, it is worth examining this article's results in the light of these questions both to see what may be modality-specific or language-particular and to see where there is evidence for true linguistic universals that hold for both oral and sign languages.

Whatever is modality-specific must be characteristic of sign languages in general, distinguishing them from oral languages as a class. Ms and Ps as segment types and the representation of handshape on a tier directly linked to prosodic structure may be in this category. Since the very notions "movement," "position," and "handshape" are couched in terms specific to sign languages, they seem not to be candidates for universality. To determine whether all sign languages have Ms and Ps as segment types and represent handshape in the same way will require research into the phonological structure of a wide range of sign languages.

One device posited here seems likely to be a language-particular constraint of ASL: the lexical prohibition on PP sequences. Given the argument for identifying ASL Ps with oral language consonants, ASL is like an oral language that does not allow consonant clusters in lexical entries. Since oral languages differ in this respect, this seems likely to be a language-particular constraint of ASL rather than a property of sign languages in general. Research on other sign languages is needed to determine whether it is.

Most striking is the fact that most of the devices posited here are common to ASL and oral languages and therefore appear to be true linguistic universals. ASL has analogues of vowels and consonants that differ in relative sonority, suggesting a broader

notion such as "perspicuity" of which "sonority" in oral and sign languages would be special cases. Like the words of oral languages, signs consist of syllables with sonority peaks as syllable nuclei. Representations with an autosegmental tier directly linked to prosodic structure, needed for handshape in ASL, are formally like those needed for tone in oral languages. The fact that these devices are needed in ASL phonology provides strong support for their universality.

Proposed universals of language must be tested not only for languages that readily provide evidence for them, but also—most importantly—for the languages where they are least likely to hold. The aspect of oral languages' structure that would seem least likely to be shared by sign languages concerns their phonology—in particular, the organization of the sound stream into syllables that reflects segments' relative sonority. Evidence has been presented that ASL signs are organized into syllables like those of oral languages, and that these obey universal principles of phonological organization in which a sign language analogue of sonority plays a role. This is striking evidence for the universality of these aspects of linguistic structure.

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