Unit 3

Phonology

8 Meaningless linguistic elements and how they pattern

The preceding unit demonstrated that the lexicons of sign languages are rich and diversely structured, containing lexemes and bound morphemes, mechanisms of derivational and inflectional morphology, of incorporation and compounding. In all of these ways, one may naturally compare the words of sign languages with those of spoken languages. But in spoken languages, there is a level of structure beneath the word and the morpheme, a meaningless level, consisting of patterns of sounds. The form and organization of these sounds are constrained in part by the physiology of the oral–aural systems that produce and perceive them. Obviously, one would not expect to find equivalence in the formational units of a different modality. At the same time, there are principles of organization and alternation found at this level that are more abstract than those aspects of the system that can be described on the basis of physiology alone, principles which are in the domain of phonological theory. And it is here, at the level of analysis that abstracts away from the physical system to some extent, that we may look for similarities between the two modalities.

Until quite recently, sign languages were assumed to exist without a meaningless level of structure at all. As we explained in Chapter 1, it had been widely assumed that signs were essentially iconic wholes. It took the work of William Stokoe to demonstrate systematically that there is indeed a level of sign language structure that corresponds to phonology (Stokoe 1960, Stokoe et al. 1965). In particular, he showed that sign languages have duality of patterning: a meaningful level of structure, as well as a level that is made up of a list of meaningless, yet linguistically significant elements. The primary source of evidence adduced for this claim is the traditional one: minimal pairs that are distinguished by a single discrete meaningless element. Stokoe went on to show that the number of meaningless linguistically contrastive elements in the ASL system is finite and reasonably small. This discovery tells us that the human brain is determined to organize the language transmission system in a particular way, even where the physical means of transmission is radically different from that of languages in the more widespread modality. It suggests that defining phonology in terms of sound patterns is too narrow, and that the following definition is better: *phonology is the level of linguistic structure that organizes the medium through which language is transmitted.*

The study of sign language phonology has a unique contribution to make towards understanding language universals and the contribution of modality to language structure. This enterprise is valid to the extent that it is approached with the right balance of two elements: knowledge about spoken language and open-mindedness about the possibility of significant modality differences. Researchers have grappled with the challenge of finding the right balance, and, in the process, some have leaned farther to one side or the other. The result has been a substantial body of literature on sign language phonology, much of it detailed and complex, often difficult for linguists approaching this literature to probe. An additional problem is presented by the fact that sign language is, after all, transmitted in an entirely different physical modality, so that descriptions of sign language elements attributed to a phonological level, and analogies with constructs in spoken language, are sometimes quite difficult to grasp. If that's not enough, the plethora of different theories of phonological structure in sign languages, some of them partly overlapping, some of them incompatible with one another, may cause the person attempting to access the work in this field to wring his or her hands, or even to throw them up in despair.

The present unit sets three goals. One is to make the study of sign language phonology more tractable for linguists of both the spoken and sign varieties. Another is to make significant findings in sign language phonology accessible to phonologists in particular, whether or not they have any familiarity with sign language research. The third and perhaps most important goal is to show how the study of phonology in a visual-gestural language can raise unexpected questions about phonological universals and about the relation between phonetics and phonology, and, sometimes, suggest answers to them.

The study of sign language phonology forces a reexamination of concepts that are often taken for granted. When one thinks of phonological theory, one may think of such proposals as autosegmental phonology (Goldsmith 1976), hierarchical feature organization (Clements 1985), dependency relations (Anderson and Ewen 1987), syllable theory (Blevins 1995), or prosodic morphology and phonology (McCarthy and Prince 1995). But as soon as we turn our attention to language in another modality, we are reminded that even the most basic elements of phonological analysis, such as the feature, the feature class, the segment, or the syllable, are actually no more than theoretical constructs that have served us well in formulating generalizations about spoken language. There is no reason to assume that they are relevant for sign languages. If a particular

a. IDEA b. APPLE c. UGLY

Figure 8.1 Three ASL signs with different specifications for hand configuration, location, and movement

construct *is* found in the phonology of languages in both modalities, however, then that construct reflects a universal organizing principle of language at the phonological level, one that is not directly dependent on physical constraints. If a construct is found in only one modality, then it is generated by the physical design of that modality, and the discovery casts the relationship between the design and the structuring in high relief. Throughout the unit, we will briefly introduce general theoretical issues and models as they become necessary in dealing with sign language phenomena and analyses. The unit does not aim to present a comprehensive overview of all research on sign language phonology. That would be impossible in the space we have here, and utterly indigestible to boot. Nor does it presume to deal with all important issues of phonology in general. Rather, we hope to show how specific and central problems in the phonological description and analysis of sign languages have been approached, and ways in which investigators have appealed to general phonological theory in order to understand the phonology of this particular subset of human languages. The question of the universals arises naturally along the way, and is addressed explicitly in Chapter 16.

Let us begin now with a pretheoretical characterization of the sublexical structure of sign language words, providing a context for the phonological analyses that will follow in subsequent chapters. Consider the following three ASL signs: IDEA, APPLE, UGLY, shown in Figure 8.1.

The examples in Figure 8.1 are distinct from one another, and characterizing these distinctions raises key issues in sign language phonology. First we must entertain the null hypothesis and ask, should each sign be considered a holistic unit with no internal structure? Although such a view was tacitly assumed at the dawn of sign language research, had it been correct, this book would be considerably shorter. Instead, we now know that the signs in Figure 8.1 must be distinguished by analyzing their internal structure. Each has a different hand configuration, and each is signed on or near a different part of the face. Furthermore, each has a different type of movement. IDEA involves a *path movement*, from contact with the forehead outward; APPLE involves only an *internal movement*, twisting of the hand; and UGLY is characterized by internal movement (curving the finger) and path movement (from one side of the face to another) together. Is each such difference contrastive in the language? How are they to be characterized?

Working in a structuralist framework, William Stokoe demonstrated that changing a single meaningless element within a sign could produce a change in meaning; i.e., he showed that there are minimal pairs in sign language. In his 1960 monograph, *Sign Language Structure*, Stokoe provided an inventory of elements that are contrastive in ASL. He divided these elements among three categories: handshape, location, and movement.[1] Figure 8.2 shows minimal pairs that differ in handshape, location, and movement, respectively.[2] CANDY and APPLE share location (the side of the chin) and movement (rotation of the hand), but differ in handshape. UGLY and SUMMER have the same extended index finger handshape, and the same movement – closing of the finger while moving the hand from the contralateral to the ipsilateral side of the face. The two differ in location: the nose for UGLY and the forehead for SUMMER. TRAIN and CHAIR differ in movement. In TRAIN, the fingers of the dominant hand slide forward and backward on those of the non-dominant hand. In CHAIR, they move down (twice) to contact the fingers of the non-dominant hand.

While the signs shown here and in Figure 8.1 above may have iconic origins, there is a good deal of evidence that the primitives from which they are formed function like meaningless phonological elements in the language. Early psycholinguistic studies on ASL showed that errors in word-list recall tests are in the direction of formational similarities to the target words, and not semantic similarities that might be triggered by iconicity (Klima and Bellugi 1979). Those results indicate that a signer is more likely to mistakenly produce CHAIR when the target was TRAIN, than s/he is to produce TABLE, for example. CHAIR and TRAIN have nothing in common semantically, but they are a minimal pair phonologically: they are identical in hand configuration and location, differing only in type of movement. These results are similar to those of hearing subjects, who may erroneously respond with *vote* [vot] instead of *boat* [bot] (and not with *lake*).

[1] Stokoe invented different terminology than that used here. He called handshape dez (designator), location tab (tabulator) and movement sig (signifier). Similarly, rather than use the sound-based word "phoneme," Stokoe gave the name "chereme" to what he considered to be the sign language equivalent, from the Greek word *cher*, which he translated as 'handy.' These opaque terms have fallen out of use.

[2] The sign choices in Figure 8.2 are from Klima and Bellugi (1979). In the sequential view of sign language structure that we will adopt here, minimal movement contrasts are characterized somewhat differently. See Chapter 13.

CANDY APPLE

a. differing in handshape

UGLY SUMMER

b. differing in location

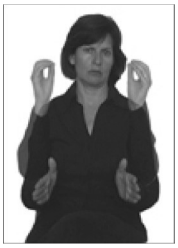
TRAIN CHAIR

c. differing in movement

Figure 8.2 ASL minimal pairs

Diachronic studies confirm the primacy of abstract phonological form over transparency of meaning. In particular, iconicity tends to be minimized in favor of arbitrariness over time, and the resulting ASL structures are phonologically simpler and more regular (Frishberg 1975). Similar diachronic findings are reported for a much younger sign language, Israeli Sign Language (Meir and Sandler 2004). More strictly phonological evidence will emerge in the chapters to follow.

Stokoe considered each of the values within the three categories he posited to be analogous to a phoneme in spoken language. The organization of these elements within a sign, however, is different in the two modalities, according to Stokoe. In a spoken word, phonemes are arranged sequentially, whereas in a sign, Stokoe's phonemes occur simultaneously.



TEACHER (ASL)

Figure 8.3 Two-handed sign with a sequence of two movements: outward and downward

Subsequent work has delved more deeply into the structure of the sign and questioned some of Stokoe's claims. It has asked whether each hand configuration, location, and movement "phoneme" is better described in terms of features, like those of spoken languages. If so, are the features randomly bundled together, or are they organized in classes? Are the major phonological elements of hand configuration, location, and movement simultaneously organized at the phonological level within a word, or does it make sense to speak of sequences of segment-like elements? If the latter, then are these units comparable to the consonants and vowels found in spoken languages?

More questions arise when we consider a suffixed sign like (ASL) TEACHER, shown in Figure 8.3. One property of interest in TEACHER is the use of two hands in the articulation of the sign. The presence of two anatomically identical articulators is unique to sign language, and raises the question of whether this characteristic leads to significant differences in the phonological structure of the two modalities. Another way in which this sign is different from the signs in Figure 8.2 is in the sequence of two movements that characterizes it, each with a different hand configuration. Clearly there is sequential structure here: the base, TEACH, is followed by the agentive suffix. But is it only at the morphosyntactic level that we have sequences, i.e., is it only morphemes and words that are sequenced? Or is there any motivation for a prosodic unit for such sequences, a unit like the syllable? Stating the question in other words, we can say that TEACHER is bimorphemic, but can we also say it is disyllabic? Consideration of prosodic structure at the level of the syllable raises the question of whether there is prosody in sign languages at higher levels of structure, such as the prosodic word, the phonological phrase and the intonational phrase.

In this unit, we will address every one of the questions just raised. The chapters will tap the work of a number of researchers, and converge on a particular picture of the phonology of sign language. We will support the claim that even morphologically simple signs have sequential segments, though the number and type of segments in a sign is severely restricted. One particularly complex phonological category that is typically realized simultaneously across the entire sign is hand configuration. Taken together, the restrictedness of sequential elements and the complexity of the simultaneous ones yield a structure that is descriptively quite different from that of spoken words, but remarkably similar from a number of key theoretical perspectives. Hierarchically organized models of the internal structure of sign language phonological categories will be presented. Finally, we will describe studies of the prosodic constituents of sign language, for which a hierarchy has also been proposed, extending from the syllable through the intonational phrase. The higher constituents of the prosodic hierarchy signal syntactic constituency, leading us up to the next and last unit on grammatical structure in sign language, unit 4, on syntax.

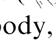
Much of the theoretical work on sign language phonology has been done on American Sign Language, and a good deal on the phonology of Israeli Sign Language and Sign Language of the Netherlands as well. The illustrations in this unit are mostly taken from American Sign Language and Israeli Sign Language. In some cases, we use the pictures to illustrate language-specific properties or rules. But unless so indicated, the choice of language was determined by technical convenience and is therefore arbitrary, and the illustrations are put forward as examples of general phonological properties of sign languages. Sign language phonologies appear to have much in common with one another at the level of complexity investigated so far (as spoken language phonologies do), and many of the claims and analyses made here may be relevant for other sign languages as well. Such purported similarities must be rigorously investigated, however, and finer grained studies must be initiated to establish differences between sign languages. We hope the present unit will provide some contexts and strategies for doing so.

9 Sequentiality and simultaneity in sign language phonology

In spoken language, segments follow one another in a sequence within a morpheme, and morphemes usually follow each other sequentially within a word. In fact, it seems so obvious that spoken words are linearly structured that discoveries of non-linear aspects to this structure in the 1970s and 1980s were considered revolutionary.

In sign language, the situation seems to be just the opposite. In the previous chapter, minimal pairs were shown in Figure 8.2 to demonstrate a phonological level of structure. The pairs were distinguished by some meaningless feature of hand configuration, location, or movement. Although minimal pairs distinguish spoken words as well, Stokoe (1960, Stokoe et al. 1965) viewed the sign language pairs as different from minimal pairs in spoken words, which are distinguished by features of a particular segment in the same linear position in the two words (e.g., the voicing feature of [p] and [b] in the minimal pair *pin* and *bin*). In Stokoe's conception of the structure of an ASL sign, the features that distinguish minimal pairs co-occur simultaneously with all other features in the sign.[1]

Indeed, when one looks at a sign, there is a feel of simultaneity about it. One reason for this may be that the iconic origin of many signs, while often irrelevant synchronically (see, for example, Chapter 6), is still retrievable, triggering the gestalt impression of the whole object or activity. Consider the sign GIVE in ASL, illustrated in Figure 9.1.

The sign looks like the act of giving something to someone, in some sense a unitary event. In the notation Stokoe developed, the sign is represented with a symbol for place of articulation (the torso, using the notation [ ]), a symbol for the handshape (, using the notation O), and a symbol for movement (away from the body, using the notation ⊥). While Stokoe et al.'s (1965) *Dictionary of ASL* adopted the convention of listing these symbols in a sequence – [ ] O ⊥ – Stokoe stipulated clearly that they were to be interpreted as occurring simultaneously.

[1] Stokoe contrasts typical signs with compounds, where sequentiality is acknowledged.

Figure 9.1 Citation form of GIVE (ASL)

But other researchers have subsequently argued that there is significant sequential structure in signs. In the GIVE example, the hand moves from one location to another. As GIVE is an agreement verb, those locations must be explicitly referred to by the morphology, indicating that each of them is linguistically significant. Nowadays, based on evidence to be presented in Section 9.2, there is a consensus that such sequential structure exists, although not all investigators are in accord about its nature and representation.

Sequential structure notwithstanding, it is also clear that sign languages have more simultaneously occurring structure in their words than spoken languages have in theirs. For example, in GIVE, there are at most three segments: the starting point, the movement, and the end-point. Furthermore, a phonologically complex category, the category of hand configuration, simultaneously characterizes the whole sign. These two properties are canonical and common to all known sign languages; the vast majority of signs share very limited sequential structure and the same simultaneous instantiation of hand configuration. The optimal model of sign language phonological structure will represent both sequential and simultaneous aspects of signs in such a way as to capture significant generalizations about its makeup and behavior.

To sum up: in spoken language, it is simultaneous or non-linear properties that are the Johnny-come-lately of linguistic analysis. In sign language, it is the opposite: simultaneous properties are self-evident, while sequential properties are the big surprise. But is this an accidental artifact of the history of the field, or does it reflect a real difference in phonological structure in the two modalities? We believe the latter to be true: signs are more simultaneously structured than spoken words. Yet sequentiality and simultaneity are a matter of degree, and the existence of both types of structure in both modalities reflects a universal property of language.

We begin this chapter by introducing non-linear theories of spoken language phonology and morphology as a frame of reference. Section 9.2

then presents some of the evidence for sequentiality of structure in signs. On the basis of this evidence, a model of phonological structure was developed that departs from that of Stokoe and represents sequential structure explicitly as sequences of dynamic and static segments. That model, the Move–Hold model of Liddell and Johnson, is presented in Section 9.3. As the model focuses especially on the sequential aspects of sign language structure, and also pays much needed attention to previously neglected phonetic detail, other things are inevitably overlooked. In particular, simultaneous aspects of structure and certain significant phonological generalizations are not accounted for. A different model builds on the insights of the Move–Hold model, while attempting to arrive at a phonologically motivated representation of both the sequential and the simultaneous in sign language phonology. The outlines of that model, Sandler's Hand Tier model, are introduced in Section 9.4, and its details presented in subsequent chapters.

9.1 Liberation of the segment: excursus on non-linear theories of phonology and morphology

A major turning point in phonological theory was the adoption of the phonological feature as the atomic element in the system, rather than the phoneme as a whole. This discovery led to a vast body of illuminating and elegant solutions to problems in spoken language phonology. For many decades, these features were viewed as anchored to segments in a sequence of cohesive bundles (see especially Chomsky and Halle 1968). The study of African tone languages, in which tones may behave independently of other features and cannot be viewed as part of a cohesive feature bundle, led to the breaking up of these bundles, and to the representation of some features on different "tiers" with the temporal freedom to move around among segmental positions (see especially Goldsmith 1976, 1990).

These non-linear theories of phonology led to new ideas about morphological structure as well, this time growing out of research on Semitic languages (McCarthy 1979, 1981), explained briefly in Chapter 3. By adopting a non-linear representation, in which the root is separated from the vowel pattern, and both are separated from the morphologically determined sequence of consonantal and vowel positions, more satisfying analyses of the phonological and morphological properties of such languages were attainable.

The early models of non-linear phonology and morphology led to crucial innovations in sign language phonology, because they posited an integration of simultaneous structure with sequential structure within words.

Thanks to Stokoe, sign language researchers were well aware that signs were characterized by simultaneous phonological structure. Some researchers assumed that the simultaneous layering of both phonological

CHRISTIAN (ASL) COMMITTEE (ASL)

Figure 9.2 Minimal pairs differing in final location

and morphological information was determined by the physical modality (e.g., Bellugi and Fischer 1972; see Chapter 16 and Unit 5). It was the discovery of sequentiality in sign language that made it possible to begin to explore the interaction of the two types of structuring in sign language phonology as well. Let's turn to the evidence for sequential structure.

9.2 Sequential structure in the sign

There are some monomorphemic signs which are distinguished by one feature at a particular temporal point in the sign's structure. For example, one version of ASL CHRISTIAN is distinguished from COMMITTEE by different final locations only, as illustrated in Figure 9.2 (example from Emmorey 2002).

Sign languages differ from spoken languages, however, in that such simple and clear examples of sequential structure in non-complex sign language words are rare. The best evidence for linguistically significant sequentiality in sign language comes from the analysis of morphologically complex forms. Let us return to the sign GIVE. When this sign is inflected for agreement with first-person subject and non-first-person object, it changes in a way that reveals independent structural elements. Specifically, the end of the sign occurs at a different location than that of the citation form. This can be seen by comparing Figure 9.1 with Figure 9.3.

As we explained in Chapter 3, most agreeing verbs involve movement from some particular location to another particular location in order to mark agreement with their referents. Thus, verbs may be modified with respect to the initial location as well as the final location, as can be seen by comparing Figure 9.3 with Figure 9.4. Regardless of how the rules for agreement are stated formally, they must make reference to the beginning and ending locations of the sign independently. The first and last locations are discretely referred to by the grammar, indicating, according to

1-GIVE-a 'I give her' (ASL)

Figure 9.3 GIVE with first-person subject, third-person object agreement

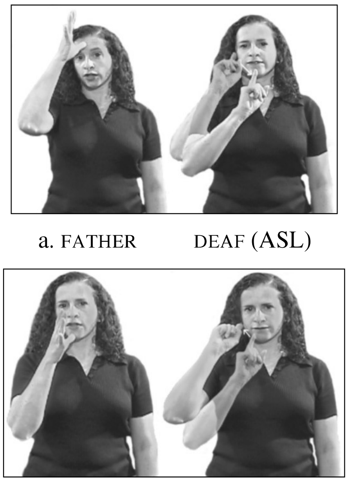
a-GIVE-b 'she gives him' (ASL)

Figure 9.4 GIVE with third-person subject, third-person object agreement

standard assumptions in linguistic investigation, that each location is a grammatical element in the language. This means that a Stokoean model, according to which there is a single location, simultaneously realized with hand configuration and movement, is inadequate. Rather, two sequenced locations must be part of the representation.

Another ASL process making crucial reference to discrete locations is metathesis, which switches the first and last locations of a sign (Liddell and Johnson 1989 [1985]). In signs in which the signing hand makes contact at two different settings within one major body area (such as the head or chest), the order of the two may be reversed, as shown in Figure 9.5. In 9.5a, DEAF follows FATHER. FATHER is signed at the forehead and the first location for DEAF is at the cheek, followed by the second location, at the chin. In 9.5b, DEAF follows MOTHER, a sign made at the chin. Influenced by this lower location, the sign DEAF begins with the chin location in this context, and ends at the cheek. Liddell and Johnson claim that the conditioning environment for metathesis is the location of the preceding sign.[2] In order to

[2] In a sociolinguistic study, Lucas (1995) claims that metathesis is not predictable on phonological grounds alone. She found that the only significant correlation between metathesis



a. FATHER DEAF (ASL)

b. MOTHER DEAF (ASL)

Figure 9.5 Metathesis of locations for the sign DEAF in different phonological environments

characterize such a process, it is necessary to refer independently to the beginning and ending of adjacent signs.

In an influential paper, in which evidence is presented for a class of derivationally related nouns and verbs (see Chapter 4), Supalla and Newport (1978) show that signs may be distinguished underlyingly by what they call the manner of movement. One such "manner of movement" is restricted to the end of the sign only, where the hands may either remain stationary in space (hold) or not (continuous). For example, the movement at the end of the ASL sign THAT'S-THE-ONE is continuous, while at the end of the otherwise identical sign, STAY, the hands are held in place.

Supalla and Newport show that the hold at the end of a sign can be added derivationally, distinguishing for example the sign for FLY (by plane), which employs continuous movement, from FLY-THERE, with a hold. While the authors make no arguments for sequential phonological structure, we may deduce that the rule for this locative morpheme glossed 'there' or 'specified

and other factors for the sign DEAF is its lexical category: if DEAF functions as an adjective, it may undergo metathesis. It is possible, however, that a finer-grained linguistic analysis – one that takes prosodic structure into account – will explain this seemingly odd result. Adjective-noun phrases are likely often to comprise a single prosodic constituent. As such constituents commonly serve as the domain for phonological rules that involve adjacent words (see Chapter 15), it is reasonable to hypothesize that metathesis tends to occur within but not across such prosodic domains. If this hypothesis is borne out, Liddell and Johnson's analysis of metathesis as a phonological process can be maintained. Brentari (1998) argues that plane of articulation is also important for the application of metathesis. In any case, some signs certainly metathesize, and the description of this process requires reference to the first and last location of a sign, i.e., to sequential structure.

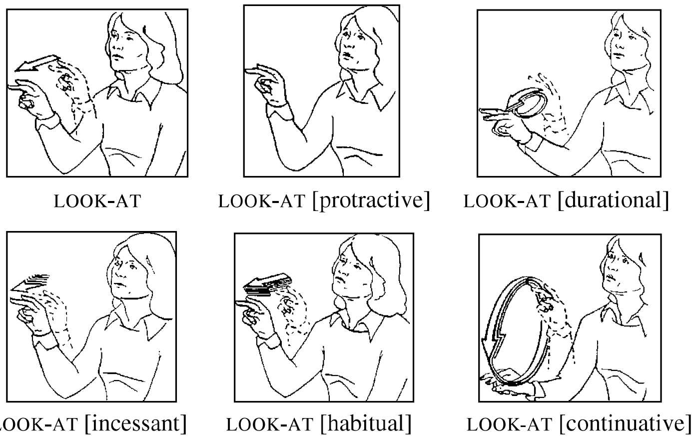


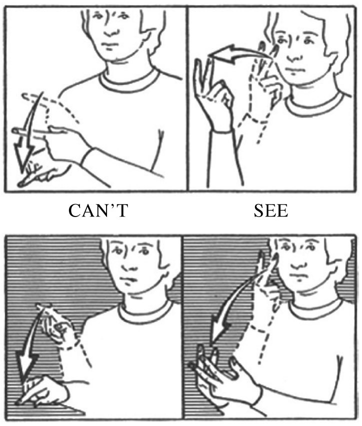
Figure 9.6 Some inflections for temporal aspect on LOOK-AT (© Ursula Bellugi, the Salk Institute)

location' must make explicit reference to the end of the sign, showing that the end is phonologically discrete.

Around the same time and, like Supalla and Newport, also working at the Salk Institute, Newkirk (1978, 1979) shows that temporal aspects such as Iterative, Durational, Continuative, Habitual, and Facilitative in ASL contrast according to features of the onset, the movement core, or the offset. Illustrations of these aspects appear in Figure 9.6, repeated from Chapter 3.

By distinguishing onset, movement, and offset, Newkirk proposes the first explicitly segmental analysis of sign language structure, one in which canonical signs have three segments. The new observation here is that not only the beginning and ending location, but also the movement between them can be seen as sequentially significant.

The Delayed Completive aspect (Brentari 1998) provides additional evidence for sequential segments in ASL. This operation productively applies to telic verbs, with some phonological restrictions, and adds the meaning, 'delay the completion of x,' where x is the base verb. The process consists of a sequence of two elements, the first of which associates to the beginning of the sign, which is also geminated (given added duration), and the second spreads over the rest of the sign. The first element is wiggling of the fingers, if the handshape of the base sign is (all fingers extended and spread). Otherwise, it is a rapidly repeated tongue wag if the base has any other handshape, an allophonic alternation described in Chapter 4. The second element consists of a mouth movement which, if pronounced as a spoken syllable, would be something like [op]. That is, at the beginning of the sign, the hands are held in their first location while the fingers wiggle or the tongue wags; then the movement and second location are executed, while the visual equivalent of the syllable [op] is articulated by the mouth.



CAN'T SEE

error error

*CAN'T SEE (ASL)

Figure 9.7 Slip of the hand *CAN'T SEE (ASL). (© Ursula Bellugi, the Salk Institute)

As Brentari points out, what is significant phonologically about this process is the temporal distribution of the Delayed Completive morpheme. The first part must co-occur with the beginning of the sign, coinciding temporally with the first location and hand configuration, and the second part, [op], is evenly distributed over the lexical movement of the sign, ending with the final location. The fact that either allomorph – finger wiggle or tongue wag – must discretely coincide with all the other features that occur at the beginning of the sign, before the hand moves, supports the claim that there is linguistically significant sequential and segmental structure to signs.

Finally, performance data also support the claim that segments exist in ASL. The example we are about to describe is from the only extensive study done to date on slips of the hand in ASL (Newkirk, Klima, Pedersen, and Bellugi 1980). In the example, illustrated in Figure 9.7, the signs CAN'T and SEE are produced so that the last segment of CAN'T, i.e., the location reached by the hand after the movement portion of the sign, is erroneously switched with the last segment of SEE.

The investigators in the error study did not notice that this is an example of a segment switch (like *hash and grass* → *hass and grash*, Fromkin 1973) because they had a simultaneous model in mind. It was one of a small number of errors pictured in Klima and Bellugi's book and its sequential nature was noticed and described in Sandler (1989). If the same error data were reanalyzed allowing for the possibility of sequential structure in signs, our interpretation promotes the expectation that other such sequential segment switching errors would be found.

How can this group of observations be incorporated into a model of the structure of the sign? The next section, 9.3, describes the first attempt to incorporate sequential structure into a phonological model. Section 9.4 deals with another model, one that represents both sequential and simultaneous structure, and that incorporates some of the constraints on that structure as well.

9.3 The Move–Hold model: sequential segments in sign language

The first detailed model of sign language structure that attempts to account for observations such as those just described is the Move–Hold model proposed by Liddell and developed together with Johnson (Liddell 1984b, 1990b, Liddell and Johnson 1989 [1985]). In effect, the Move–Hold model rejects two fundamental properties that had been introduced by Stokoe: the tripartite categorization of major phonological categories as handshape, location, and movement; and simultaneity of organization among all categories and their features. The Move–Hold model proposes a basic distinction between two types of sequentially ordered segments, a distinction that is determined by a single phonetic criterion: whether or not the hands move. If the articulating hand or hands move, then the segment is a Movement (M) segment; if they are held still, then the segment is a Hold (H) segment. Signs consist of sequences of Hs and Ms, just as spoken words are made up of Cs and Vs. In fact, Liddell and Johnson make the radical proposal that movements are analogous to vowels, and holds are analogous to consonants.

While focusing primarily on the sequential segmental aspect of sign structure, the Move–Hold model borrows certain ideas from the theory of autosegmental phonology (Goldsmith 1976), described briefly in Section 9.1 above. In particular, the idea that phonological elements may have a one-to-many or many-to-one temporal relationship to one another is adopted. While the beginning and ending segments may be characterized by different features of location, handshape, and other elements, the movement between them is often – but not always – just a straight path with no other independent features. In these cases, the movement is redundantly characterized by the same features as the surrounding "hold" segments, and serves as the anchor for a contour that phonetically results between one hold and the other. Another idea that Liddell and Johnson adopt from general phonological theory is the concept of an abstract timing skeleton to which features are associated (McCarthy 1979, 1981, Clements and Keyser 1983) The sign IDEA is illustrated in Figure 9.8. Its representation in the Move–Hold model (Liddell and Johnson 1989 [1985]) is given in (1).

IDEA (ASL)

Figure 9.8 Sign with path movement

(1) Representation of the ASL sign IDEA in the Move–Hold model (Liddell and Johnson 1989 [1985])[3]

	H	M straight	H
a. handshape	Io-		Io-
b. point of contact	PDFI		PDFI
c. proximity	c		p
d. spatial relation	-		ahead
e. major body area	iFH		iFH
f. facing of palm	PA		PA
g. surface plane	SP		SP
h. base hand	BA		BA
i. base hand plane	HP		HP

Liddell and Johnson offer new evidence for sequential structure in their work, such as the metathesis rule described above. Within their framework, the rule switches the first and last hold segments. Liddell (1984a) also shows that a certain morphological process involves deletion of one segment of the base form and insertion of the remaining features into a "frame" consisting of three segments. This process, which forms the Unrealized Inceptive form of some verbs (e.g., STUDY → 'was just about to study when . . . '), may be interpreted as a kind of templatic morphology, similar to the morphology of Semitic languages for example (McCarthy 1979, 1981). The templatic theory of sign language morphology (Sandler 1989) was introduced in Chapter 4 and is explained in more detail in Section 9.4 below.

[3] Line (a) represents the handshape: Io- means that all but the pinky are closed and the thumb is opposed and closed; (b) is fingerpad contact (of the pinky with the forehead); (c) is proximity, where c means contact and p means proximal; (d) is spatial relation, from contact with the location to a place ahead of it; (e) is the major body area location, the side of the forehead ipsilateral with the signing hand; (f) refers to the fact that the palm faces the location, on (g) the surface plane; and the base of the hand (h) is on the horizontal plane (i).

The Move–Hold model of Liddell and Johnson offers a wealth of phonetic detail, from which all subsequent research on sign language phonology has benefited. It provides thirteen features for handshapes alone, which specify a total of 150 handshapes claimed by the authors to exist in ASL. Some eighteen major places of articulation are listed as well. The result of relying on purely descriptive motivations as the Move–Hold model does is that the model overgenerates, predicting the existence of many types of signs that are in reality unattested, while leaving unexplained significant predictable properties of signs. One of the goals of subsequent work by other sign language phonologists has been to eliminate the redundancy inherent in the Move–Hold model, to arrive at a smaller set of features and distinctions. The other, related, major challenge has been to understand the inter-organization of the categories and features, and constraints on their co-occurrence.

Overgeneration is due mainly to redundant representation of features. In the sign IDEA, for example, pictured in Figure 9.8 and represented in (1), there is no change of handshape from the first H to the second H, yet a second representation of the same handshape features appears in the representation. As most signs have no change in handshape, a representation such as this one is clearly redundant. In many signs, however, there is a change in certain particular features of handshape (see Chapter 10, Section 10.2). While Liddell (1990b) considers the possibility of eliminating the second representation of handshape features, he argues that this is not possible in signs that have handshape change, because that change is not predictable – a claim which has been disputed, as we shall see. But it is not only handshape features that are redundant in the Move–Hold model. In fact, the majority of the features that characterize one hold segment are identical to those characterizing the other hold segment, and yet they are listed independently in the original Move–Hold model. This type of representation is undesirable from a theoretical point of view, as it implies that the recurrence of the same features is coincidental, rather than the result of constraints on the structure of signs, and it inaccurately predicts that any other, non-redundant combination is equally possible. In the wake of criticism along these lines, Liddell (1990b) alleviated some of these problems in a revised version of the Move–Hold model, specifying repeated features only once, and doubly associating Hs or Ms instead. However, certain key specifications argued by other researchers to be predictable, specifically, certain features of both handshapes in signs with handshape change and features of the place of articulation, are still represented twice in the Move–Hold model, associated independently to different segments. These redundancies are eliminated in the Hand Tier theory described in Section 9.4.

Dealing as it does with purely surface phenomena, the Move–Hold theory is forced to propose blanket rules of epenthesis and deletion. For example, Liddell and Johnson propose that a rule of movement epenthesis inserts a transitional movement between signs. To sign FATHER DEAF (Figure 9.5a above), for example, the hand must move from the final location of FATHER (i.e., on the chin) to the initial location of DEAF (cheek). Liddell and Johnson propose a rule to insert this movement. But such a rule is seen as redundant in phonological theory, since it is required by the physiology of the system, and no manual language could do without it.

The authors also propose a rule of hold deletion, which allows the hands to move smoothly between signs in a string, rather than holding them still at the beginning and/or end, as is done in citation forms. In the same sequence, FATHER DEAF, the final hold of FATHER and the initial hold of DEAF are both deleted. The features associated with the holds are not influenced; they remain in the signal, spreading to the neighboring Ms in the Move–Hold model. Only the stillness of the hands is deleted.

The main problem with this analysis is the assumption that the citation form is the same as the underlying form. This assumption triggered the proposal of a phonological rule that deletes a structural element that is absent more than it is present: holds only appear (a) at the beginning and/or ending of a rhythmic unit; or (b) as a result of morphological processes.

This leads to the alternative suggestion that the holds of the Move–Hold model are not underlying at all. Instead of proposing a hold-deletion rule, we assume instead that holds appear either as a rhythmic effect of prosodic chunking, or as a result of a morphologically conditioned process of gemination. By this reasoning, citation forms induce holds because they are by definition surrounded by intonational phrase boundaries (Sandler 1986, 1989, Perlmutter 1992, Wilbur 1993).[4] Morphological insertion of "holds," i.e., gemination as a morphological process, hinted at in Supalla and Newport's discussion of continuous versus hold endpoints, is returned to in Section 9.5 below on templatic morphology.

We leave the Move–Hold model for now, returning in later chapters to other insights uncovered by the model. A different model of the sequential properties of signs will be described next, one that provides a greater role for simultaneous structure than the Move–Hold model does, and attempts to provide a more constrained representation of phonological elements.

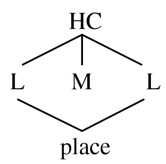
4 Prosodic constituency and phonology are the topic of Chapter 15 in this unit.

9.4 The Hand Tier model: hand configuration as an autosegment

Non-linear theories, those sketched in Section 9.1 and others that evolved later, forged a new view of the phonological structure of spoken languages. The universally available pool of phonological form is now seen as including structure that is sequentially segmented, yet still allows a degree of autonomy from that segmentation. The meaningful units of language, morphemes and words, are poured into this structure. Each such unit may have an abstract form underlyingly, and may only take on the linear properties observed on the surface when they join up with all the other elements of the word.

Advances in autosegmental phonology and morphology provide a conceptual and formal framework for exploring the relationship among sequentiality, segmentation, and simultaneity in sign languages, a framework first tapped for sign language in the Move–Hold model of Liddell and Johnson, described in the previous section. This approach led to the Hand Tier model of sign language structure (Sandler 1986, 1987b, 1989), which proposes the representation of a canonical monomorphemic sign given in (2).[5] In this representation L stands for location and M for movement. HC represents the hand configuration, which has its own complex structure, to be expanded on in Chapter 10.

(2) Canonical form of a monomorphemic sign in the Hand Tier model (Sandler 1986, 1987b, 1989)



The Hand Tier model adopts some aspects of Stokoe's original categorizations as well as elements of the Move–Hold treatment, while rejecting others. In the Hand Tier model schematized in (2), sequential segmental structure established in the Move–Hold model is maintained, as are some of the phonetic features. Movement as a sequentially represented category is also adopted.[6] But most other aspects of the representation are different. Locations replace the holds of the Move–Hold model as a major segmental category. Lengthened holding of the hand or hands

[5] The Hand Tier model first appeared in Sandler (1986). The model was motivated in detail and also modified significantly in Sandler (1989).

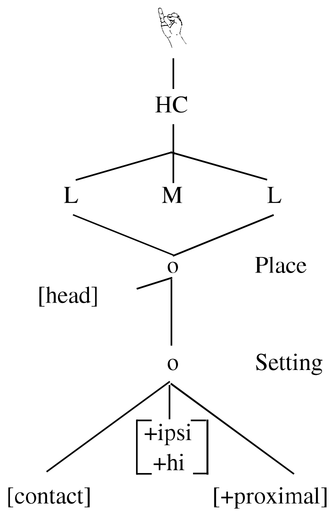
[6] The place category is associated only to the Ls and not to the M. This convention is adopted to reflect the fact that place features belong to the location category. Phonetically, place spreads to characterize the movement as well.

at some location is seen as related to prosody or to morphological structure, as described above, and not as an underlying property or category of signs. The second difference between the Hand Tier model and the Move–Hold model is the revival of Stokoe's view of hand configuration, location, and movement as the major category types. But the major categories are not simultaneously organized with respect to each other as in Stokoe's model. Instead, locations and movements are organized in a sequence, like the moves and holds of Liddell and Johnson's theory, while hand configuration typically characterizes the whole sequence simultaneously. In this way, the model captures both sequential and simultaneous aspects of sign language structure. The three major categories are not seen as containing "phonemes," as Stokoe proposed. Rather, like the major phonological categories of spoken languages, they are comprised of subclasses of features. These subclasses and the hierarchical organization they manifest are dealt with in Chapters 10–13. For now, we focus on the major categories, their interorganization within a sign, and some of the motivation for these in the Hand Tier model.

Locations stand for the starting and ending point that the hand traverses in articulating the sign. As such, there are typically two locations in a sequence. In the citation form of the sign, IDEA, for example, pictured in Figure 9.8 above, the first location is in contact with the head of the signer, and the second location is a slight distance in front of the first. The major body area, or place of articulation, is the head, and that place characterizes the whole sign, as indicated by the one-to-many association of the place category in (2) above. Unlike Stokoe's model, which characterizes the movement of the hand in a sign like IDEA with a simultaneous movement feature, 'away' (⊥), the Hand Tier model adopts the view that the beginning and ending locations must be separately and sequentially represented, in order to be accessible to the rules and other generalizations outlined in Section 9.2. The hand moves from one location to another in relation to that place of articulation. This theory of sign structure obviates the need to posit the hold-deletion rules postulated by Liddell and Johnson, and also assumes that the M epenthesis they offer as a rule applying between signs is a phonetic effect that need not be accounted for by a phonological rule.

While the hand or hands usually move from one location to another in the articulation of signs, it is generally the case that a morpheme is characterized by one and only one handshape, like IDEA, shown above in Figure 9.8. The representation of IDEA in the Move–Hold model was shown in (1) above. Compare it with a partial representation of this sign in the Hand Tier model, in (3). In advance of deeper exploration of each category later, diagram (3) is still partially schematized, and a handshape icon is substituted for representation of that complex category.

(3) Hand Tier representation of IDEA



In the Move–Hold representation, all features are doubly represented, but the only feature that changes is the location feature: the hand moves from contact with the forehead to a location ahead of and close to the forehead. The Hand Tier model attempts to eliminate the redundancy in the representation while capturing generalizations about the form of signs. Only the changing features are represented sequentially; the rest are multiply associated. The major categories of hand configuration (HC) and place are always multiply associated in this model, reflecting the fact that they are predictably instantiated simultaneously across all segments. The first location of the sign IDEA, specified by the feature [contact], means that the hand is in contact with the head; and the second, specified as [proximal], means that the hand is a short distance in front of the head.

The representation of hand configuration as a single, multiply associated category in the Hand Tier model is motivated first and foremost by the fact that most signs are characterized by a single hand configuration in which no features vary throughout the sign. Many signs are characterized by some change in the handshape, however, a characteristic that prompted Liddell and Johnson to represent each handshape in a separate segmental cell. In the sign SEND (Figure 9.9), for example, the selected fingers are closed at the beginning of the sign, and open at the end; while the opposite is true for LIKE (Figure 9.10).

The problem is that the term "handshape change" for such signs overstates the case. A closer look reveals that it is not the whole handshape that changes, but only the position of the fingers. The choice of fingers is constant, as established in Mandel (1981). Mandel's Selected Finger Constraint is given in (4).

SEND (ASL)

Figure 9.9 Sign with change in finger position: closed to open

LIKE (ASL)

Figure 9.10 Sign with changed finger position: open to closed

(4) Selected Finger Constraint (Mandel 1981)[7]
Only one group of fingers may be selected in a sign.

In SEND, all five fingers go from closed to open, and in LIKE, the selected middle finger and thumb go from open to closed. *Contra* the claims of Liddell and Johnson, the relationship between the first and second positions is largely predictable in such signs (Friedman 1977, Wilbur 1987, Sandler 1989), as we show in detail in Chapter 10, Section 10.2. We will see there that the problem of capturing the Selected Finger generalization while allowing for "handshape change" is solved by dividing the HC category into two feature classes, Selected Fingers and Finger Position. For now, suffice it to say that the Selected Finger Constraint and the simultaneous instantiation of hand configuration across a sign are represented by one-to-many association of categories in the Hand Tier model.

Another indication that HC has a somewhat independent status is the fact that hand configuration alone often functions as a morpheme. For example, classifiers generally consist of handshapes only, joining with

[7] In Chapter 10, we will revise this constraint as a constraint on the morpheme and not the sign.

a. THINK b. MARRY c. BELIEVE

Figure 9.11 Lexicalized compound (ASL)

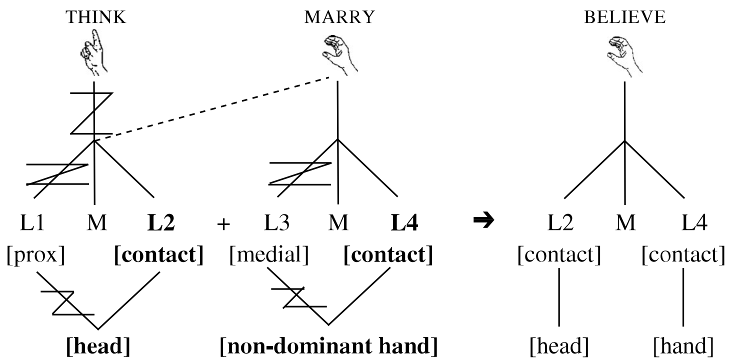
meaningful locations and movements to form classifier constructions. As we showed in Chapter 5, Section 5.2, some classifier constructions have the phonological appearance of lexical signs, while others may span several phrases. In both cases, the utterance is interpreted as predicated of the same nominal referent as long as the same primary classifier, that is, the same handshape, persists.

The generalizations about hand configuration are captured by representing the HC category autosegmentally, on a separate tier from the features of locations and movements, associated in one-to-many fashion to the L and M positions, as in (2). The representation eliminates the redundancy of listing the same hand configuration for each segment in a sign, throughout the lexicon. The phonological and morphological autonomy of hand configuration are the central motivations for the Hand Tier model (Sandler 1986, 1987a, 1987b, 1989).

In addition to capturing generalizations in the lexicon, this representation also offers a coherent account of processes in which hand configuration with all of its features behaves as an autonomous unit, i.e., as a long-distance autosegment. An example is the behavior of HC in many lexicalized compounds, which have undergone hand configuration assimilation as part of a common pattern of reduction (Frishberg 1975). First of all, some sequential segments of both members of the compound delete (Liddell 1984b, Liddell and Johnson 1986, Sandler 1987b, 1989). In addition, the hand configuration of the first member also deletes, and that of the second member characterizes the whole surface compound (Sandler 1986, 1987b, 1989). The compound THINK^MARRY = BELIEVE is an example, illustrated in Figure 9.11.

What is significant in this reduction process is that the hand configuration is not lined up temporally with the locations and movements. Rather, one segment of the first member of the compound survives, but its original hand configuration deletes, and the hand configuration of the second member spreads to characterize it. This is an example of autosegmental stability, a defining property of autosegments. In (5) is a schematic representation of the compound reduction process.[8]

(5) Compound reduction



The representation reflects the autonomy of the hand configuration from the sequential segments. It does this by representing the LML segments sequentially, allowing for the selective deletion of some of them (deletion of L1 and L3 here), and representing the HC autosegmentally, expressing the autonomous spreading behavior of this category.

Not all compounds reduce. Some maintain all segments and both hand configurations. Others, like (ASL) PRAISE, reduce in their segmental structure only, maintaining two hand configurations. In the latter, the two underlying handshapes of the member signs characterize the surface representation in this model, just as the two underlying places of the members of BELIEVE characterize that compound, seen in (5). In having two HC or two place specifications, such signs are readily distinguishable from monomorphemic signs and from reduced lexicalized compounds, each of which is represented with only one HC. The difference between simple signs and morphologically complex ones is thus clearly represented in the model.

There is some evidence that this assimilation process is synchronic as well as diachronic: some compounds, such as THINK^TOUCH = OBSESS, can optionally be signed with or without handshape assimilation.[9] The same

[8] In the Hand Tier model, the orientation of the hand is part of the hand configuration category (Chapter 10, Section 10.3). We were unable to graphically indicate orientation in (5), which is offered as an abstract schema.

[9] The observation that there is synchronic variation in the form of THINK^TOUCH = OBSESS, with and without hand configuration assimilation, is based on data videotaped in the late 1970s at the Salk Institute, which Ursula Bellugi kindly made available to Sandler.

kind of assimilation exists in ISL compounds, indicating that assimilation of this sort is not idiosyncratic but reflects basic phonological properties of signs.

The other category that remains constant throughout most signs is the major body area, called place of articulation in the Hand Tier model. Specifically, the two locations that are typically articulated by the hand are contained within a single major body area, such as the head or the trunk (Battison 1978 [1973]). We can state Battison's observation as a constraint, as in (6).

(6) Place constraint (Battison 1978 [1973])[10]
There can be only one major body area specified in a sign.

Both of these constraints are represented by the many-to-one autosegmental model shown in (2), and the full representations of each of these categories are argued for in detail in Chapters 10 and 11. Unlike hand configuration, no evidence of spreading of the place category has come to light to date.

The picture that emerges is one in which signs have sequential structure of a limited and largely predictable kind (typically, but not exclusively, LML on this analysis). But it is also one in which much of the phonological material of signs co-occurs simultaneously (in particular, the complex hand configuration category and the place of articulation). The Hand Tier model is designed to capture these generalizations through grouping features into categories, and one-to-many autosegmental associations of these categories.

As mentioned, several researchers, beginning with Liddell (1984b), have proposed that the alternation of static and dynamic segments is comparable to the alternation between consonants and vowels in spoken languages. In the terminology of the Hand Tier model, we can express this claim by thinking of the static Ls as consonant-like and of the dynamic Ms as vowel-like. This comparison is not meant to be taken literally here. It will be evaluated (and essentially rejected) in Chapter 14 on the syllable in sign language.

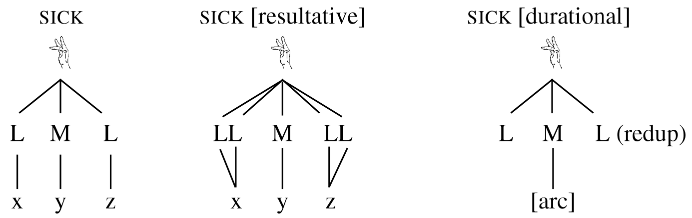
Regardless of whether or not the analogy with consonants and vowels is adopted, there does appear to be an alternation between static and dynamic parts of signs, giving signs a canonical prosodic shape. The basic prosodic shape of signs is then systematically manipulated by the morphology of sign languages, which provides prosodic templates for a variety of morphological processes. We now take a closer look at that templatic morphology.

[10] This constraint as well will be shown in Chapter 14 to hold over the morpheme rather than the sign.

9.5 The phonology of non-linear morphology in sign language: prosodic templates

As in the morphology of Semitic and other types of spoken languages, in ASL too some morphological entities are best described as abstract skeletons that mark the position, the length, and sometimes the quality of segments. The phonetic material from the root and from the inflectional or derivational morphology are the flesh and blood that are incorporated by the skeleton to give the complex word a recognizable form (Liddell 1984b, Sandler 1987b, 1989, 1990). In Chapter 4, Section 4.2, we foreshadowed the present discussion by demonstrating how material from the ASL base adjective SICK associates with the Resultative and Durational templates of the kind proposed in the Hand Tier model, which follows McCarthy's early work on Semitic languages. We repeat those representations here in (7) for convenience, with the addition of an HC icon.

(7)



To form the Resultative, the underlying specifications of the base for handshape, place of articulation, and settings are associated to the LLMLL template, much as the *k-t-b* root in the Arabic examples in Chapter 4 are associated to templates consisting of Cs and Vs. The Resultative template merely alters the timing of the base sign, by doubly associating the features of the first and last locations to additional timing slots and thereby lengthening them, creating geminates.[11] Similarly, the Durational inflection can be seen as associating a root consisting of specifications for a handshape and two locations to an LML template in which the movement is prespecified for an arc feature (Sandler 1989, 1990).[12] The underlying form of LOOK-AT and the inflected form LOOK-AT[durational] with a circular movement pattern were shown in Figure 9.6.

[11] The form with lengthened beginning and ending segments is sometimes described as "Intensive" in the literature. In the Klima and Bellugi (1979) drawing and feature description, this form maps to what those authors call "Resultative." More research to clearly motivate and distinguish the array of temporal aspects that has been reported would be welcome.

[12] In spoken languages, too, templates may be prespecified. See McCarthy (1979) and Marantz (1982).

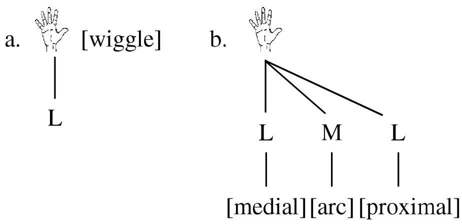
a. STUDY[citation form] (ASL) b. STUDY[durational] (ASL)

Figure 9.12 Citation and inflected forms of an underlyingly L-only sign

The introduction of more abstract and less temporally rigid structures into the universal inventory of grammatical possibilities provides the framework for a more satisfying explanation of such sign language processes.

The representations in (7) demonstrate the association to templates of signs whose underlying form is the canonical one, represented here as LML. However, some signs consist of only one L, for example, the ASL sign STUDY, shown in Figure 9.12a. This sign is produced by holding the dominant hand above the non-dominant hand, the fingers pointed toward the palm of the non-dominant hand, and wiggling. As there is no movement from one location to another, the sign STUDY only has one location, and may be represented schematically as in (8a).

(8)



When STUDY is inflected for durational it assumes a path movement from one location to another, as shown in Figure 9.12b and represented in (8b), just as the underlyingly LML sign LOOK-AT does (Figure 9.6). For each aspect, the whole complex is then reduplicated. In addition, for the durational aspect an arc feature is associated to the movement section. The transitional movement between reduplications is given features creating arcs with the opposite value for concavity to that of the M in the template. The result is the circular movement observed on the surface (Sandler 1989, 1990).

The fact that L-only bases like STUDY conform to LML templates through augmentation of their underlying form is evidence for the existence of such abstract templates (Sandler 1999b). Similar augmentation is found in Arabic, where underlyingly biconsonantal roots (e.g., *s.m.*) double their last consonant to conform to a triconsonantal template (e.g., *samam*; McCarthy 1979, 1981). In a range of other languages, extra elements occur under reduplication in order to fill out a template with more material than is present in the underlying base word (McCarthy and Prince 1986, 1993). This augmentation of the base to fit a more elaborate template is an earmark of templatic morphology.

Moreover, a model that includes sequential segments perspicuously reflects the distinction between the uninflected form of L-only signs like STUDY and DIRTY and their forms when they are inflected for temporal aspect (Newkirk 1998 [1981]). Such inflectional templates, then, are evidence for sequential structure in signs. Similarly, an LML template in which the M segment is prespecified for an arc shape lends further support to the sequential segment model, and, as we will argue in Chapter 13, to the M category it posits as well.

In a later development of the theory of prosodic morphology, McCarthy and Prince (1986, 1995) suggest that only actual prosodic constituents such as the mora or the syllable are relevant for prosodic morphology, and that the segmental level should be eliminated from consideration. Whether a purely prosodic analysis of this kind can be independently motivated in sign language remains to be seen. In either case, this type of morphology, with abstract formational templates with particular prosodic shapes, is found frequently in sign languages.

The Hand Tier analysis described here implies that all the processes previously described as "superimposition" or "simultaneous layering" of morphemes are more appropriately analyzed as non-concatenative templatic morphology of this sort. The similarity between Semitic languages and sign languages should not be overemphasized, however. Unlike the Arabic examples shown above, in which consonants and vowels have the status of separate morphemes, it is not the case in sign languages that each tier is morphologically motivated. In particular, in lexical signs, the hand configuration, location and movement "melodies" typically all belong to the root.[13] The autosegmental status of HC and place are phonologically rather than morphologically motivated. In Semitic languages, the morphological tiers conflate eventually, so that the consonants and vowels are actually sequentially ordered on the surface (McCarthy 1986). In sign language too there is reason to believe that some (but not all) autosegmental features must link to sequential positions, but the categories in

[13] The situation is actually more complicated than this. The content of locations may be determined morphologically, as in the case of verb agreement. In the classifier subsystem of the grammar, which involves polysynthetic combinations of bound morphemes rather than lexical signs, hand configuration always functions as a morpheme.

question are phonological and not morphological.[14] We return to the issue of linearization of non-linear features in the next chapter.

9.6 Conclusion

Spoken languages, long represented as strictly linear in their internal organization, are now understood to possess significant non-linear properties as well. This new understanding led to models of phonological and morphological structure that allow for a certain amount of temporal autonomy of structural units. Conceptions of the phonological structure of sign languages have the reverse history. Their phonological and morphological elements, first thought to have only simultaneous organization, are now understood to have a certain amount of linearity as well. Several diverse pieces of evidence from a number of different studies have been presented here to support the claim that signs have sequential structure: minimal pairs differing in the place features of one sequential segment; marking of verb agreement on the first and last segment; metathesis; underlying and derivational distinctions in the timing of the final location; verb aspect inflections that selectively alter locations, movements, or both; a sign error.

The theories that arose to account for temporal autonomy of linguistic units in spoken language have helped to explain the relation between linear and non-linear structure in languages of both modalities. Such models reveal that spoken languages as well as signed languages have both linear and non-linear structure, providing support for the universality of the basic insights underlying non-linear theories. But the overall architecture of languages in the two modalities is not the same. Sign languages have a good deal less sequential structure and a good deal more simultaneous structure than do spoken languages. This difference, which resurfaces throughout this unit, is surely related to modality, and as such it will be addressed in Chapter 16 and more broadly in Unit 5.

Because the Hand Tier theory has tried to come to terms with a wide range of phonological issues and sought to integrate them in a single model, that model will stay with us throughout much of the unit. Yet there are many unresolved issues, as well as a proliferation of other models that have been proposed to deal with them. The unit will reflect these as well where useful. Some of the most interesting controversies surround movement, questioning, for example, whether it has equal

[14] In the classifier subsystem discussed at length in Chapter 5, it is shown that hand configurations are independent morphemes, classifiers. This independence was one of the original motivations for placing the category on a separate tier. However, within the phonology of lexical words, the category behaves as a meaningless element with autosegmental properties, the primary motivation for the representation.

status as a timing unit with static segments, whether or not it constitutes a major class, and, if so, whether this class is like the class of vowels in spoken language. Another hotly debated topic is the role of the non-dominant hand, a dual articulator with no parallel in spoken language. These issues will be tackled in later chapters. First we take on the complex category of hand configuration, in the next chapter, replacing the icons used thus far with hierarchically organized features.

10 Hand configuration

Of the three major categories – hand configuration, location, and movement – the hand configuration category is the most complex. The hand has many degrees of freedom, and sign languages exploit this articulatory range, though subject to certain constraints. The four fingers and the thumb can be selected in various combinations in the articulations of handshapes. The fingers can bend at any joint, or at more than one joint at once. The thumb can be adducted or abducted, can contact fingertips, or can close over the fingers. In addition, the whole hand may be oriented in various directions.[1] In this chapter, we present generalizations that have been discovered about the way in which these possibilities are both exploited and constrained in sign languages, and some models that have been proposed to reflect these generalizations. A chart of some common handshapes is offered in Figure 10.1 for reference.[2,3]

We begin by presenting parameters along which lexical contrasts are made, each of which will later be shown to constitute a subcategory of hand configuration features. After these preliminaries, the chapter proceeds to construct a model of hand configuration that is motivated by the clustering of features in classes, both in underlying representations and in phonological processes. The overall structure of the model relies on the theory of feature geometry (e.g., Clements 1985, Sagey 1986, Halle 1992). The representation of the terminal features is facilitated by appealing to the theory of dependency phonology (Durand 1986, Anderson and Ewen 1987, van der Hulst 1989). As usual, we find that the strategy of holding sign language phenomena up against spoken

[1] See Ann (1992, 1993, 1996), for anatomical and physiological descriptions, and for algorithms devised to calculate ease of articulation of various handshapes.
[2] The handshape drawings in the chart and throughout the book are reprinted with permission from HamNoSys (Hamburg Notation System, Prillwitz 1989).
[3] This chart is offered for convenience and is not intended to represent the phonemic handshape inventory of any sign language. Shapes that only occur in handshape changes in the sign languages with which we are familiar are omitted. Some of those included may only function as allophones.

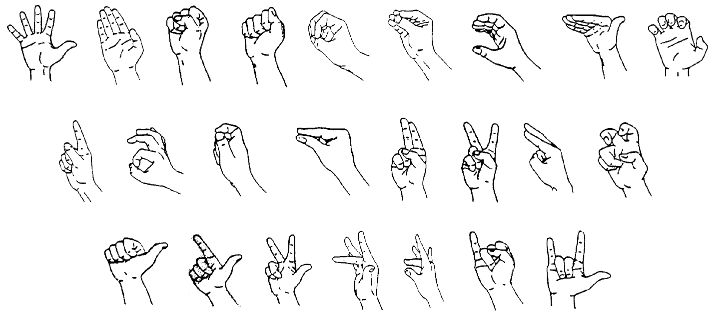


Figure 10.1 Some common handshapes

a. DANGEROUS (ISL) b. INTERESTING (ISL)

Figure 10.2 Minimal pair distinguished by different specifications for selected fingers

language models helps to illuminate both similarities and differences between the two modalities.

10.1 Parameters of contrast

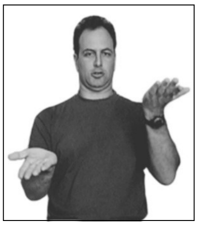
Hand configurations may contrast along several parameters. The examples in this section are from Israeli Sign Language, but the same contrasts are found in ASL and other sign languages. The most salient way in which signs may contrast is in the selection of fingers, as in (ISL) DANGEROUS, INTERESTING, shown in Figure 10.2. DANGEROUS is specified for all fingers selected, while INTERESTING is specified for pinky and thumb. Signs may also contrast for the shape or position of the fingers, as in (ISL) ALREADY, DOCUMENT, shown in Figure 10.3. In both members of this pair, all fingers are selected. In ALREADY, they are open, and in DOCUMENT, they are closed.

In addition to shape, the orientation of the hand may also be responsible for lexical contrasts (Battison 1978 [1973], Klima and

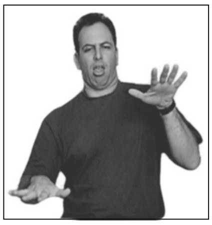
a. ALREADY (ISL)

b. DOCUMENT (ISL)

Figure 10.3 Finger position minimal pair



a. COMPARE (ISL)



b. VACILLATE (ISL)

Figure 10.4 Minimal pair distinguished by different specifications for orientation

TAKE-ADVANTAGE-OF (ISL)

Figure 10.5 Internal movement: change of finger position

Bellugi 1979). Signs minimally contrasting for orientation are pictured in Figure 10.4.[4]

Finally, the hand configuration may change in particular ways: either the finger position may change or the orientation of the hand may change within a sign, creating what is usually referred to as internal movement. Each of these two types of internal movement is illustrated in Figure 10.5 and Figure 10.6. Different types of internal movement may also create

[4] Facing is included as a category by Liddell and Johnson (1989 [1985]), who showed that it varies independently of orientation. Meir (1998a, 1998b) shows that facing plays a grammatical role in verb agreement. Facing has not been accounted for in phonological models to date.

DEAD (ISL)

Figure 10.6 Internal movement: change of orientation

WIN (ISL)

Figure 10.7 Handshape and orientation change together

a. WINE (ISL) b. FLAT-TIRE (ISL)

Figure 10.8 Minimal pair for internal movement (WINE) and path movement (FLAT-TIRE)

contrasts. The sign WIN shown in Figure 10.7 involves handshape change, as well as orientation change. It is distinct from TAKE-ADVANTAGE-OF (Figure 10.5), which involves handshape change only.

Presence or absence of internal movement may be contrastive. In Figure 10.8, we see WINE, with internal movement (opening of the index finger) and short path movement to contact the neck, and FLAT-TIRE, with path movement to contact but no internal movement.

Stokoe's (1960) phonemic ASL handshape inventory of twenty-one shapes is compiled on the basis of minimal pairs. An ambitious attempt to list all of the handshapes found in all sign languages, the HamNoSys notation (Prillwitz 1989) is useful from a phonetic point of view, but makes no claims about

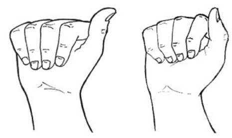


Figure 10.9 Cross-sign-language handshape differences: ASL and CSL (© Ursula Bellugi, the Salk Institute)

contrastiveness. Stokoe's phonologically based inventory may not be exhaustive for ASL, and there are certainly some shapes that exist in other sign languages, but not in ASL. Only systematic cross-linguistic research on the phonology of handshapes will ultimately enable us to speak with confidence about the pool of possible shapes available to the sign language learner.

In the oral modality, different languages have different phoneme inventories, and foreign accents often reflect different phonological structure of the same phonetic space. Aspiration of voiceless stops, for instance, can be phonemic (as in Hindi), allophonic (as in English), or non-existent (as in French). Adult speakers of each of these languages transfer their own phoneme inventories and allophonic rules to any foreign language they learn, resulting in the foreign accents we perceive. In sign languages as well, there are differences in handshape phoneme inventories and in the pronunciation of similar shapes, both across sign languages and across dialects of the same sign language. For example, Thai SL has an extended ring finger handshape that doesn't exist in ASL or ISL (Mandel 1981). Russian SL has an extended ring finger and pinky shape. In addition, casual observation indicates that shapes in different sign languages that seem the same are actually different in subtle ways. For example, Klima and Bellugi (1979) show that there is a difference between the handshape *A* in ASL and a similar shape in Chinese SL. In CSL *A*, the fingers are more tense than in the ASL version. These differences are illustrated in Figure 10.9.

Presumably, an American signer learning CSL would have a foreign accent which is partly definable by the features that distinguish similar but not identical shapes in the two languages. But most investigations to date have been based on one sign language only, and, until recently, models of handshape structure were developed on that basis alone.

Attempts to arrive at a universal inventory of underlying handshape features are confounded by two other factors which are unique to sign languages: iconically motivated shapes that may occur in only one sign, and the limited borrowing of shapes from fingerspelling alphabets (see Chapter 6, Section 6.3).[5] Some researchers (e.g., Brentari 1998) attempt

[5] Liddell and Johnson (1989 [1985]) add many shapes, to arrive at a grand total of 150 handshapes. The reason for this huge disparity appears to be Liddell and Johnson's inclusion of small variations in handshape that Stokoe and other researchers have ignored on the assumption that they are phonetic only and not contrastive. The problem may relate in part

to incorporate such shapes into their feature inventories in order to be able to represent all shapes with features. Another approach is to represent anomalous handshapes holistically, refraining from positing special features for them alone, and predicting that the resulting feature inventory will capture all and only the phonological generalizations of the language (e.g., Sandler 1989, 1995b, 1996a).

The notion of feature inventories for hand configuration is in itself a departure from the Stokoe proposal. For Stokoe, who was trained in the structuralist linguistic tradition, each hand configuration is the equivalent of a phoneme, indivisible. Generative phonologists have shown that phonemes of spoken languages must indeed be broken down into smaller units in order to give a satisfactory explanation for distinctions within and among inventories, as well as to account for the set of phonological processes that occur in the world's languages (Chomsky and Halle 1968, Jakobson, Fant, and Halle 1951). We take the position that feature theory is more explanatory than a holistic phonemic approach in sign language as in spoken language.

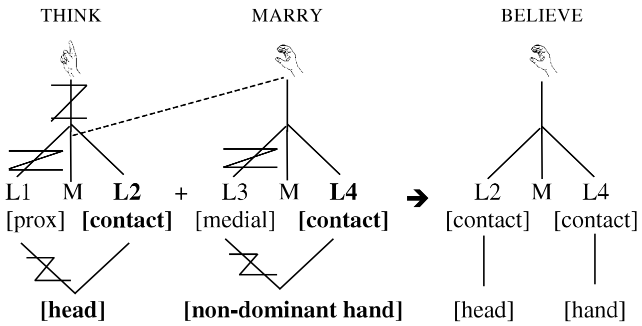
Investigations of hand configuration abound, most of them seeking to define handshapes using a set of features, and numerous inventories have been proposed. Unfortunately, we cannot begin to do them all justice here.

Our goal is to isolate and account for central generalizations about the category of hand configuration. We do so by appealing to phonological theories developed on the basis of spoken language which account for similar phenomena. Facts about the behavior of the fingers, their position, and the orientation of the hand within signs and in phonological rules find an explanation in the theory of Feature Geometry, according to which features are hierarchically organized in classes corresponding to physical articulators. Another robust generalization is that some handshapes are more marked than others according to the definition and range of criteria set out in Jakobson (1968 [1941]). The theory of Dependency Phonology is concerned with reflecting the relative markedness of phonological elements, as well as with parsimony in the feature inventory, and we appeal to that theory as well. The question of whether or not the two approaches can be integrated coherently within general phonological theory will not be resolved here. In the new science of sign language phonology, each approach makes a significant contribution.

A basic generalization about the hand configuration category is its temporal autonomy from locations and movements exemplified by assimilation in compounds, discussed in Chapter 9 and illustrated in Figure 9.11. We repeat the schematic representation of that process here for convenience. As shown in (1), the entire category of hand configuration undergoes total assimilation, and some of the locations and movements independently delete.

to iconic motivation inherent in some handshapes, which causes subtle variants of basic shapes. This issue has yet to be resolved, but serious consideration of the effect of iconicity on the phonology of Sign Language of the Netherlands appears in van der Kooij (2002).

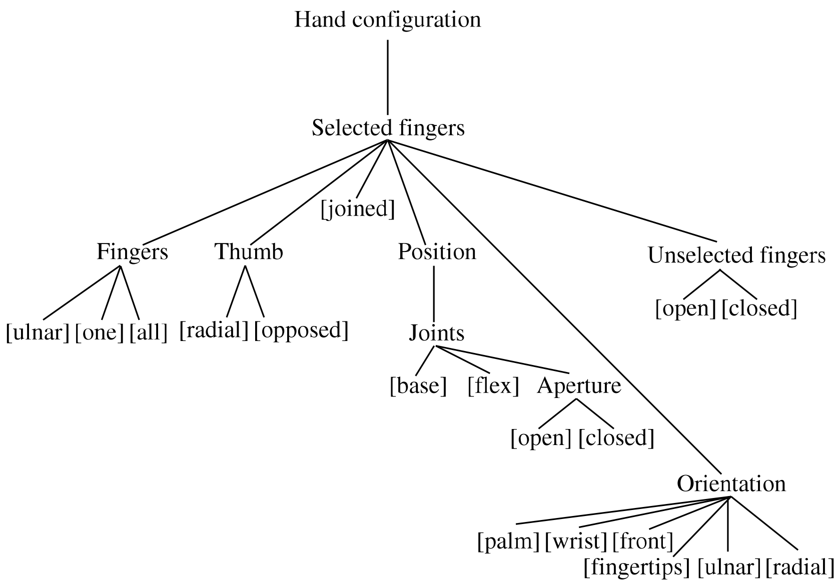
(1) Autonomy of hand configuration



The present chapter aims to break down the category of hand configuration into its features and motivate a particular hierarchical organization of the classes into which those features are organized.

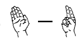
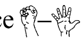
The central claims of the model to be supported are these: (1) hand configuration is made up of both the shape and the orientation of the hand; (2) the shape consists of finger selection and their position; and (3) orientation is a subclass of handshape, i.e., of selected fingers (Sandler 1987b, 1989). Other aspects of the model shown in (2), to be elaborated here, are drawn from Sandler (1995c, 1996a), van der Hulst (1995), Crasborn and van der Kooij (1997), and van der Kooij (2002).

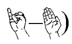
(2) A hierarchical model of hand configuration features (based on Sandler 1989, 1995c, 1996a)



We now proceed to take the model apart and put it together again, beginning with handshape (selected fingers) and finishing with orientation. The relation between these two categories in an assimilation process motivates their representation and completes the hierarchy.

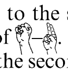
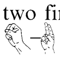
10.2 Hierarchical representation of feature classes: handshape

Let us begin with a division of the category of handshapes into two subcategories first proposed by Mandel (1981). Mandel observes that any morpheme has only one set of selected fingers, but that these fingers may change their position within the morpheme. In other words, while a morpheme may be characterized by internal movement in which the handshape changes, this is restricted to a change of position, and not of selection of fingers. A sequence such as  may not occur within a morpheme.[6] But the sequence  occurs commonly, as in the ASL sign SEND, pictured in Figure 9.9 above. This important observation motivates a model of handshape in which there are two categories: selected fingers and finger position.[7]

Liddell and Johnson (1989 [1985]) present some signs that are purported to counterexemplify Mandel's generalization. Words such as JOB (characterized by the handshape sequence ) include two groups of selected fingers. Sandler (1986, 1989) rejects the claim that these are counterexamples, on the following grounds: these are fingerspelled borrowings from English orthography (Battison 1978 [1973]); orthography is an arbitrary symbol system for representing language in a different modality; in spoken language, borrowed sounds often go beyond native phoneme inventories (e.g., [x] sometimes used in English for *Bach*); and the selected fingers constraint remains strong in the native lexicon. According to the latter view, a good phonological model should make perspicuous precisely which forms are well behaved and which are exceptional; i.e., it should favor phonological generalizations over a purely descriptive taxonomy.[8] But how can we represent the generalization that selected fingers must remain constant across a sign while their position

[6] Numbers and fingerspelling are excluded from these generalizations. In numbers, each finger is an icon or a symbol for a digit, so that the finger combinations are arithmetic rather than linguistic. Fingerspelling is a borrowed system dictated by orthography, which is itself parasitic on spoken language, and does not reflect the natural properties of sign language.

[7] Another argument for the separation between selected fingers and finger position is the fact that they can be affected independently in slips of the hand (Newkirk et al.1980, Sandler 1989).

[8] Another type of sign that Liddell and Johnson claim is a counter example to the selected finger generalization is signs like (ASL) THROW, which they claim consists of . Sandler (1989) argues instead that the first handshape is actually a closed version of the second both phonetically and phonologically – i.e., only two fingers go from closed to open and the others are unselected – making the sequence:  and in keeping with the selected finger generalization.

may change, if the two belong to the same phonological element, namely, the hand configuration?

Non-linear theories of phonological structure in spoken language, introduced in Section 10.2.1, liberated features from their strict segmental straitjackets. Later developments went further, and allowed for a multidimensional conception of sound structure in which each feature is autonomous, whether or not it has the broad scope of features such as tone. In this view, all assimilation rules are represented as multiply connected lines that associate the assimilating feature to various positions in a string. And all deletion rules simply delink the feature from the string; i.e., they cut the association lines. As we will show shortly, these theoretical innovations influenced sign language research, making it possible to capture certain generalizations in a principled way.

10.2.1 Feature geometry in spoken language phonology

Though features are potentially autonomous, they often cluster together in classes. According to the theory of Feature Geometry, the classes are motivated by the physical architecture of the vocal tract as well as by the behavior of features in rules, especially assimilation rules (e.g., Clements 1985, Sagey 1986, Halle 1992). In particular, features that tend to cluster together in rules – such as place features – are represented as a class that may assimilate as a group. In Chapter 1, the example was given of nasal consonants that assimilate the place of articulation of a neighboring segment, whatever it is, without losing their nasal quality: *can* becomes [kæm] before *be* and [kæŋ] before *go*. Hierarchical Feature Geometry models capture the generalizations that all oral place features involve articulators in the oral cavity, and that they may assimilate together, by grouping them together as a class. In the case of [ŋ] resulting from the assimilation of the place features of [g] in *go* to the [n] segment of *can*, the rule will automatically assimilate both the [high] and [back] features responsible for velar consonants, while leaving the [nasal] specification unaffected, as shown in example 1 in Chapter 1.

10.2.2 The geometry of selected fingers and finger position

We now turn to the representation of handshape in sign language, in the context of the theory of feature geometry, following the Hand Tier model introduced in Chapter 9 (Sandler 1987b, 1989).[9] To take the anatomy as a starting point, one might consider Mandel's separation of the selection

[9] Other hierarchical models are proposed in Ahn (1990), Corina (1990a), and Corina and Sagey (1989). Space does not permit a comparison here, but see Corina and Sandler (1993) for an overview.

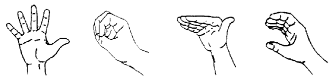
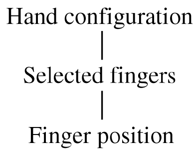


Figure 10.10 Four finger positions: open, closed, bent, curved

of the whole finger or fingers from the position of those fingers, i.e., the extension or flexion of the joints. ASL may select a single finger, a combination, or all fingers together. The position of the fingers may be considered a separate category because whatever fingers are selected, they must all be in the same position; i.e., they must all extend or bend at the same joints. All are open, all bent, all curved, or all closed, each illustrated in Figure 10.10 for shapes in which all five fingers are selected.

In terms of phonological behavior as well, there is a separation of the two feature classes, selected fingers and finger position. In a morpheme with handshape change, it is only the position that changes, as we have seen. Position may also be altered by morphological rule, for example by wiggling or flicking the fingers; but these rules may not affect the selection of fingers (Battison 1978, Mandel 1981, Sandler 1989). Taken together, these facts motivate a feature hierarchy in which the selected fingers node dominates the position node, as in (3).

(3) Hierarchy of selected finger and finger position features (Sandler 1987a, 1987b, 1989).



By design, whichever position feature is specified must characterize all the selected fingers that are specified. Also, if the selected fingers node spreads (i.e., assimilates) or deletes, then the position features must go along. Yet position features are predicted to potentially behave independently.[10]

There is some evidence from ASL that this prediction is correct. In the Unrealized Inceptive (Liddell 1984a), the second handshape deletes; i.e., both the selected finger and the position features delete. Under other circumstances, only the position feature is affected. In particular, some signs with handshape change have variants without the change (Corina

[10] Corina and Sagey (1989) independently propose a hierarchical model of handshape. In their model, each finger dominates position features independently, a representation motivated by cases of individual finger assimilations between words. Since such assimilations are postlexical, we assume here that the representation motivated by them is not underlying in the lexicon.

1990a). This means that one finger position deletes, but the selected finger specification persists throughout the sign. For example, the sign UGLY is specified for the index finger only, and the position is first open, then curved, as the hand moves across the face. In the variant, the hand, index finger selected, traverses the same path across the face, but only the curved position surfaces. As the model also predicts, processes affecting the selected finger specification but not the position are not attested.

10.2.3 The representation of internal movement

There are two broad types of movement in sign languages: path movement, from one location to another; and internal or local movement, i.e., change of handshape or change of orientation. In the case of handshape change, illustrated in Figure 10.5 above, only position features may change; selected finger features remain constant. This was presented in the previous section as a motivation for the representation of handshape with the feature classes of selected fingers and finger position.

The Hand Tier model that we have been describing represents internal movement by branching at the finger position node, or at the orientation node, as shown in (4).[11] This branching creates a contour transition between the two states represented on each branch, comparable to contour tones in tone languages (Sandler 1987b, 1989).

(4) Representation of handshape contour

position		orientation	
[open]	[closed]	[radial]	[ulnar]

There is a constraint on the sequences of handshapes, given in (5), originally proposed in Sandler (1989) and refined in Brentari (1990).

(5) Handshape Sequence Constraint (HSC)
If there are two finger positions in a sign, then one must be open or closed.

The HSC means that there cannot be a sequence in which at least one position is not either open or closed. In other words, sequences such as open–closed, or bent–open are okay, but the sequences *bent–curved and *curved–bent are ruled out. The feature [closed] is interpreted as involving contact between the thumb and the fingers; i.e., thumb involvement is redundant.

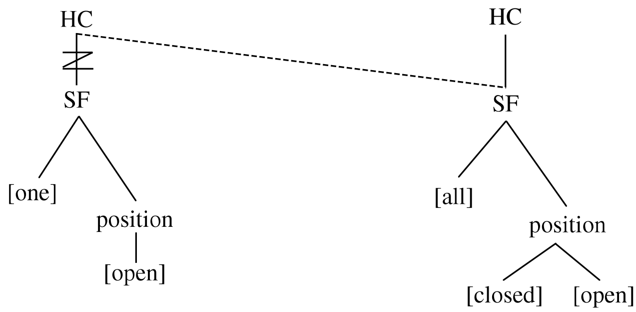
[11] See Corina (1993) for a proposal that handshape changes be represented with the contour features [opening] and [closing], rather than with branching position nodes.

a. MIND b. DROP c. FAINT (ASL)

Figure 10.11 Independent members of a compound (MIND^DROP) and the compound (FAINT) with selected fingers and Finger position assimilation

Evidence for the representation of internal movement as part of hand configuration comes from assimilation under compounding in ASL. Total assimilation of hand configuration includes features of finger position, unitary or contour, independently of the L and M segments. For example, in the compound MIND^DROP = FAINT, the HC from DROP spreads to the beginning of the compound in the same total assimilation process schematized in (1) above. As FAINT has handshape-change-internal movement ( – ), both finger positions spread with all other hand configuration features. Figure 10.11 illustrates this compound, and (6) shows a partial representation of the spreading process.

(6) Total hand configuration assimilation in FAINT



The geometry of handshape (i.e., the selected fingers category) has now been laid out. Before dealing with the terminal features in Section 10.4, we now complete the overall architecture of hand configuration by placing the category of orientation in the model.

10.3 Orientation and the hand configuration hierarchy

In a sign, the hand articulator is characterized not only by its shape, but also by its orientation. Battison (1978) notices that orientation is sometimes contrastive, as shown in Figure 10.4, and proposes it as a fourth major phonological category. The discovery that orientation is contrastive can be separated from the claim that it constitutes a major category, however, since any distinctive feature is, by definition, contrastive. Orientation might function instead as a part of the hand configuration category, an idea that is suggested by an error study (Newkirk et al. 1980), in which handshape substitutions included orientation as well (Sandler 1989). Since the patterning together of handshape and orientation is not required on phonetic grounds, such substitutions indicate that orientation and handshape are indeed phonologically related.

In fact, there is independent phonological motivation for the idea that orientation is a phonological subcategory of hand configuration, and not, as Battison suggested, an independent category on a par with hand configuration, location, and movement. The evidence consists of the behavior of orientation under assimilation. In ASL compounds, orientation alone may assimilate without the fingers and their position, but if the fingers and their position assimilate, then orientation is not independent – it must assimilate as well (Sandler 1987a, 1987b, 1989). This observation prompts the representation of orientation as subordinate to the selected finger node.[12]

A good example is the compound OVERSLEEP (from SLEEP^SUNRISE), introduced in Chapter 1. In one variant, only orientation assimilates, as illustrated in Figure 10.12.

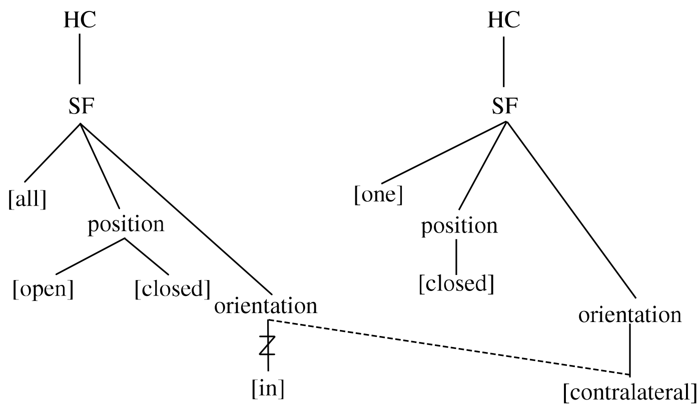
a. SLEEP (ASL) b. SUNRISE (ASL) c. OVERSLEEP (ASL) orientation assimilation

Figure 10.12 Independent members of compound and partial assimilation form

[12] In the original model, orientation was subordinate to a handshape node, making it a sister of the position node. That representation is motivated by different considerations that complicate the discussion and is less desirable for reasons of perspicuity, so we opt for the representation shown here.

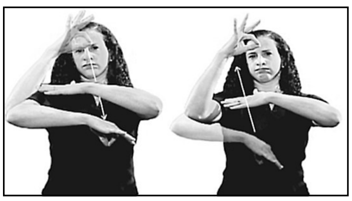
The partial assimilation process of orientation only is represented in (7), where only the HC category (and not the location and movement categories) is shown for simplicity. The feature representation is transparent and somewhat oversimplified in advance of the discussion of features in the model.

(7) Assimilation of orientation only in OVERSLEEP



Partial assimilation, assimilation of orientation only, characterizes one version of this compound. In another attested version, selected fingers may assimilate, but if they do, then their position and the orientation of the hand assimilate as well, resulting in total assimilation, as illustrated in Figure 10.13.

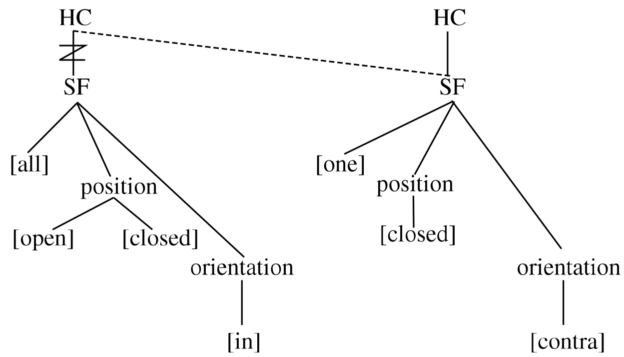
Here, the selected finger node spreads, taking along all the other features of hand configuration, as shown in (8). These data motivate the representation of hand configuration in the Hand Tier model shown here, which allows total hand configuration assimilation (selected fingers, finger position, and hand orientation) to be represented simply as spreading of the highest node in the hierarchy dominating all the other features.



OVERSLEEP (ASL)

Figure 10.13 Total assimilation of handshape and orientation

(8) Total hand configuration assimilation in OVERSLEEP

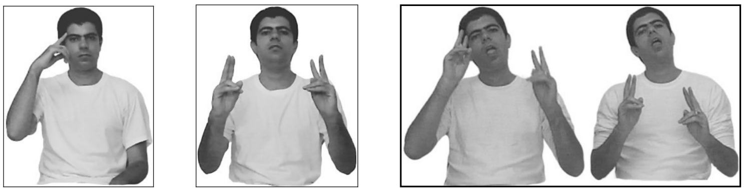


What is striking about this pattern is that it is not required by the phonetics. It is phonetically quite easy to assimilate the selected fingers and their position without orientation. In fact, such assimilation occurs postlexically (see Chapter 16, Section 16.1). But in assimilation processes at the lexical level shown here, selected fingers do not assimilate without orientation in ASL.

Most of the documented cases of assimilation of this kind involve lexicalized compounds, raising the question of whether the structure argued for is synchronically relevant (Perlmutter 1996). There are three reasons for thinking it is. First, even if such assimilation processes were not synchronically productive, they could still point to structural properties that are synchronically relevant. In English, there is a small group of lexicalized alternations involving plurals of certain words ending in *f*: *wife*, *wives*; *knife*, *knives*; *half*, *halves*; *calf*, *calves*. This process is not synchronically productive, as we can see from *fife*, *fifes* (**fives*); *staff*, *staffs* (**staves*), but it is structure preserving, deriving words whose sounds and sound combinations exist in English, and it relies on a feature that still functions as distinctive in English: voicing. In other words, the stem allomorphy is frozen in the lexicon and not productive, but the feature contrast that it relies on is still relevant, and both the base and derived forms are synchronically well formed. In the same way, lexicalized compounds can lend insight into phonological structure even if the phonological processes involved in forming them were no longer productive. Considering how few truly phonological processes there are in ASL, it is a useful strategy to exploit any evidence we can find in order to understand the phonological structure of the language.

But in fact, there is a good reason to believe that this process is not dead. Recordings of the compound THINK^TOUCH = OBSESS support this model as synchronically relevant.[13] The compound THINK^TOUCH = OBSESS has

[13] This analysis of compounds (Sandler 1987a, 1987b, 1989) relies on Salk Institute data collected in the 1970s.



a. MIND b. STOP (suspend) c. MIND^STOP = DAYDREAM

Figure 10.14 Total HC assimilation in an ISL compound

three synchronic variants, one with orientation only assimilation, one with total handshape assimilation, and one with no assimilation. Crucially, there is no variant attested for this or any other compound in which only handshape assimilates without orientation (Sandler 1987a, 1987b, 1989).

Furthermore, lexicalized compounds in Israeli SL behave the same way: if handshape assimilates, orientation does as well. The lexicalized compound DAYDREAM from MIND^STOP, given in Figure 10.14, illustrates this.

This supports the claim that the type of feature organization shown in (2) may characterize all sign languages – just as spoken language feature geometry is claimed to be universal for all spoken languages.[14] In the original Hand Tier model, orientation refers to the palm of the hand, and the features are defined accordingly. A different proposal for orientation features derived from a relation between handpart and place of articulation will be presented in Section 10.4.2.

The feature geometry model is in the spirit of the spoken language models in grouping features together by articulator (Sagey 1986). The fingers, finger joints, and palm of the hand are each articulator nodes, and all together belong to the hand articulator. Such a representation is arguably more explanatory than one in which the feature groupings bear no relation to the anatomy of the system.

10.4 Terminal features

Having established the architecture of handshape feature categories, we now move on to the features themselves. For two reasons, the theory of Dependency Phonology has provided a useful framework for dealing

[14] We have not noticed any examples of partial (orientation-only) assimilation at the lexical level in ISL, and therefore cannot yet confirm that handshape dominates orientation in that language. However, the ISL total assimilation data do confirm that orientation and handshape group together, i.e., that they are both dominated by the higher hand configuration category.

with handshape features. First, the theory admits only unary and not binary features, and second, it aims to reflect relative markedness directly in the representation (Durand 1986, Anderson and Ewen 1987, van der Hulst 1989). Each of these principles facilitates the expression of generalizations about handshape.

There are two principles of dependency phonology that are appealed to in the model of hand configuration we espouse. One is the idea that the simplest and most useful theory of phonological features is one in which features are unary, not binary as in the classical generative model. The second principle holds that relative markedness should be reflected by relative complexity in the representation: the simpler the representation the less marked the form, and vice versa.

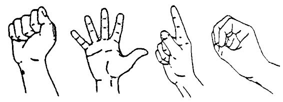
10.4.1 Unariness and markedness in handshapes

Researchers have proposed feature-based hierarchical models of handshape that can represent all the shapes of all sign languages (e.g., Corina and Sagey 1989, Sandler 1989). But certain robust generalizations are missed by these models.

First, no evidence has been provided for minus values of the binary features used in handshape specifications. A sign may be characterized for index finger, but if a sign is specified for pinky, for example, then the notion of non-index fingerness is superfluous. Other criteria for constructing a feature theory are parsimony and perspicuity. Here, too, we fail to find advantages for binary features in the representation of sign language phonological form. Sandler's (1989) model of the location category proposes binary values for pairs of features which, when combined, can yield a third specification for free, just as [-hi,-lo] yields "mid" in spoken vowel systems. But the absence of processes that refer to the lack of some feature encourages us to seek other equally parsimonious ways of specifying phonological properties, and the representation in (2) models such a system.

The second generalization about handshapes that is supported by several disparate types of evidence, but that is not reflected in the models presented so far, is this: certain handshapes consistently behave as less marked than others. The term "markedness" is used in a variety of ways in linguistics. For discussions within the theory of dependency phonology, the reader is referred to Durand (1986) and Anderson and Ewen (1987). In connection with hand configuration, we refer to Jakobson's theory of markedness, which posits the following cluster of properties for elements that are relatively *less* marked: they are frequent cross-linguistically, easier to produce, acquired early by children, and resistant to loss in aphasia (Jakobson 1968 [1941]). A summary of the evidence for an unmarked set of handshapes given in (9) is from Sandler (1995c, 1996a). These generalizations are mainly from the literature on American Sign Language, but ISL is reported to have the same set of unmarked shapes based on such properties as frequency and the shape of the non-dominant hand in two-handed signs (see (2) and (3) in Chapter 12), and a subset of these shapes is reported to be an unmarked set in Sign Language of the Netherlands (Harder and Schermer 1986).[15]

(9) Evidence for this set of unmarked handshapes:



1 The unmarked shapes are "maximally distinct, basic geometrical shapes" (Battison 1978).
2 They are the easiest to articulate motorically (McIntire 1977, Woodward 1978, Klima and Bellugi 1979, Mandel 1981, Whittemore 1986, Ann 1993, Greftegreff 1993).
3 They are the most frequently occurring shapes in ASL and in other sign languages (Battison 1978).
4 They are the first to be acquired by children (McIntire 1977, Boyes-Braem 1981, Siedlecki and Bonvillian 1997).
5 When the non-dominant hand is involved in a sign but is not in the same shape as the dominant hand, its shape is restricted to one of the unmarked shapes (Battison 1978). (See footnote 16.)
6 These shapes are less restricted in terms of how they may contact the body or the other hand than are the other shapes (Battison 1978).
7 Aphasics make fewest errors on these shapes (Whittemore 1986).

[15] We include both  and  in the unmarked list here, but the two are probably not contrastive in unmarked contexts (e.g., non-dominant handshape in h2-P signs [see Chapter 12], acquisition substitutions, etc.). If this is the case, only one of them should be included in the list. Battison includes . As the latter shape sometimes alternates allophonically with , we've chosen to leave it out pending further evidence that the distinction is relevant for markedness. Battison also includes the shape  among the shapes that may occur independently on the non-dominant hand, and classifies it as an unmarked shape. However, as Mandel (1981) points out, this shape occurs in signs in which the dominant hand makes contact in the opening made by the non-dominant hand (e.g., VOTE, TEA). That is, the underlying shape in such signs is the closed shape, , and the curved shape is allophonic.  is also included by Battison. In the analysis presented here, this handshape, when specified, is more marked than , because it requires the feature [joined]. Here too, we list only the unmarked spread-finger shape, hypothesizing that in the unmarked contexts the two are not contrastive.

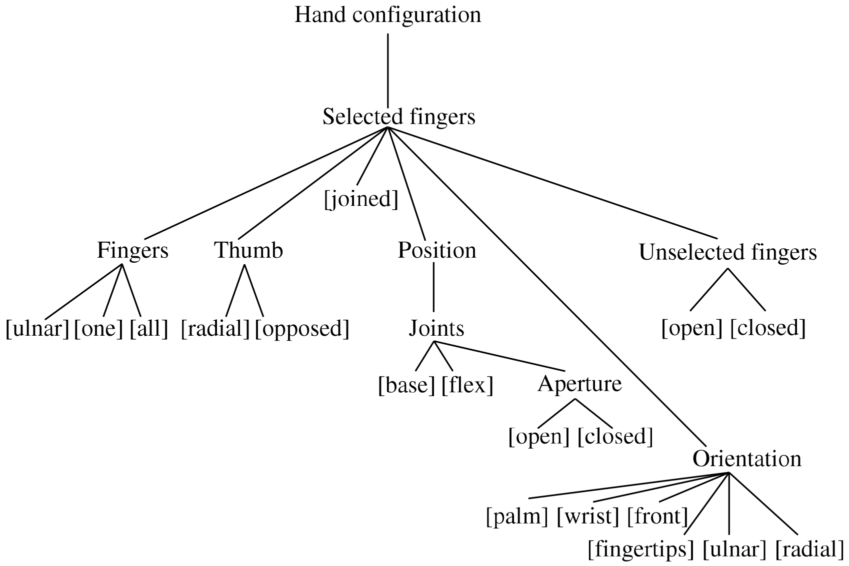
8 These are the shapes most likely to be substituted for other shapes by children (McIntire 1977) and by aphasics (Whittemore 1986).

A principled way of constraining the representation of handshapes, then, is to seek a model that reflects relative markedness in terms of relative complexity, and ignores irrelevant phonetic detail. The theory of Dependency Phonology (Anderson and Ewen 1987) provides the underpinning for the dependency hand configuration model (Sandler 1995c, 1996a), in which the main opposition for selected fingers is determined by whether the hand is relatively pointy (one finger) or relatively broad (all fingers) in appearance. Finger positions are relatively open or relatively closed. Features expressing these characteristics are proposed and representations of handshapes combine the features and their head-dependency relations in various ways, resulting in a model in which relative complexity of representation corresponds to the relative markedness of the handshape. This model does away with individual representations of each finger and each position found in other models, proposing instead only two features for fingers and two features for positions.

These two features are either alone in a representation or enter into different dependency relations with each other. The number of features and their structural relationship with each other reflect the relative markedness of the handshape. Shapes with only one feature in each category and therefore no dependency relations comprise precisely the class of unmarked shapes. Sandler's dependency model of features was strongly influenced by a general theory of sign language structure that is developed in van der Hulst (1993, 1996). We will have more to say about van der Hulst's dependency model in connection with the non-dominant hand (Chapter 12) and movements (Chapter 13). The revised model of hand configuration, repeated in (10), is based on Sandler's (1995c, 1996a) proposal, but also incorporates improvements from work by van der Hulst (1989) and van der Kooij (2002). For example, van der Hulst (1995) refines the representation by splitting finger position into joint selection and aperture, a change we have adopted. We also adopt here the straightforward selected finger feature labels [all] and [one] proposed by van der Kooij (Brentari, van der Hulst, van der Kooij, and Sandler 1996, van der Kooij 2002).[16]

[16] The thumb feature [radial] is intended for signs in which the thumb is selected non-redundantly, like (ASL) CIGARETTE-LIGHTER or (ISL) PEN. The thumb feature [opposed] helps to distinguish (ASL) FORBID from LATER, for example. Addition of either of these features and the Thumb node with it adds markedness to a sign. For detailed argumentation for the model, see Sandler (1996a).

(10)



Only specified nodes are activated; nodes that dominate default specifications are not included in representations. The default features are called upon in underlying representation only when required to interact in a dependency relation in order to represent very marked shapes. This requirement simplifies representations and also reflects relative markedness: the more nodes represented, the more complex the handshape.

An example of a node that is rarely activated is the Unselected Fingers node. According to Corina (1993), in most ASL signs, the position of the unselected fingers is redundant. While selected fingers may occur in any of four positions, the fingers not selected – the unselected fingers – are more constrained: they must be either open or closed, and, in most cases, the position is predictable. The redundancy rule Corina proposes is shown in (11).

(11) Unselected Fingers Redundancy Rule (Corina 1993)
If specified fingers are closed, unspecified fingers are open; otherwise unspecified fingers are closed.

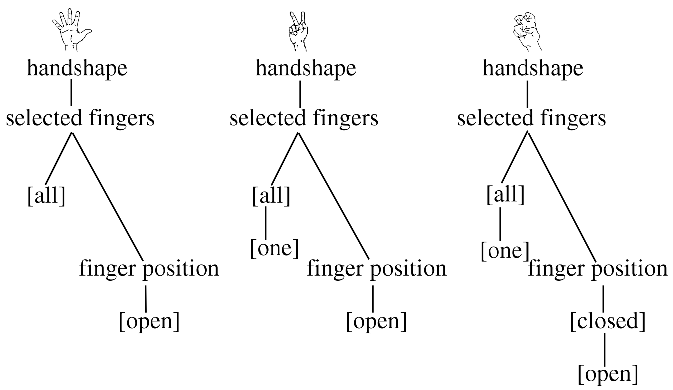
The "otherwise" part of the rule is interpreted as follows: if the selected fingers are anything except closed – if they are open, curved, or bent – then the unselected fingers are closed. In the spirit of suggestions in Mandel (1981), van der Kooij (1998) suggests that this bifurcation of foregrounded and backgrounded fingers may be considered a type of phonetic enhancement. By assuming an extreme position that is as different as possible from that of the selected fingers, the unselected fingers make the selected fingers more perceptually salient.[17]

The model includes a node for the position of unselected fingers, although their position is usually redundant. There are two cases in which the positions of unselected fingers is not redundant: and . In , the middle finger is selected and bent, and the unselected fingers should be closed according to the redundancy rule in (11) but they are open instead. In , the index is selected and closed (through fingertip contact with the thumbtip), and the unselected fingers are expected to be open . While such a shape exists and is even more common than , the latter also exists. Unselected finger position must be specified for these configurations, indicating correctly that they are marked shapes.

Returning to Battison's unmarked shapes , the first thing we now notice is that only two selected finger specifications are involved, each of them maximally simple: [all] and [one].

The examples in (12) illustrate the way this model works, by giving representations for the unmarked shape , the somewhat more marked shape , and the still more marked shape . The unmarked shape has only one feature under the selected finger node and one under the finger position node. The marked shapes have combinations of features in dominance relations to one another. The handshape, which selects the index and middle fingers, is represented with [all] as head and [one] as dependent. The bent position is represented with [closed] as head and [open] as dependent.

(12) Representations of less and more marked shapes (from Sandler 1995c, 1996a)



We follow van der Hulst (1995) in representing dependency relations among features in tree structures (instead of using the punctuation

[17] Similarly, if the fingers are in the unmarked spread position, the feature [joined] does not appear in the representation. The thumb node is also usually redundant and therefore not represented (see Sandler 1995c, 1996a, for details).

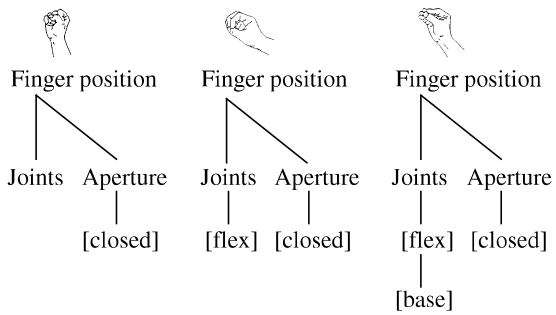
convention of Durand 1986). In our model, this means that structures in which features are subordinate to other features (and not to feature classes as in Feature Geometry) are interpreted as feature complexes according to the conventions of Dependency Phonology.

The unmarked shape  has the simplest possible representation: one selected finger feature and one position feature. The more marked shape  has two selected finger components: [all] and [one] in a dependency relation. The most marked shape  has the same complex selected finger representation plus a combination of finger position components, [closed] and [open]. The model represents other more marked shapes with the additional categories of thumb and unselected fingers, used when these articulators are in a configuration that is other than the default.

The resulting model preserves the original feature-geometric tree structure as far as the relationship of the categories to each other is concerned; only the level of the terminal features themselves is different, now proposing unary features organized in dependency relationships. Feature Geometry represents the relationship between physical articulators and the way in which features that are produced by those articulators function in forms and rules of languages. Dependency Phonology representations reflect feature groupings according to their patterning in languages, as in Feature Geometry, but the relationship of the features to their articulators is not a motivating factor. Rather, Dependency Phonology representations aim to reveal relative markedness, as well as head-dependent relations that are argued to characterize all phonological structure, and to restrict the feature inventory by allowing combinations of a very small set of unary primitives. Because of advantages offered by both theories, we adopt this mixed model of handshape for now, and recommend future investigations of the consequences of a hybrid model such as this. For models of sign language phonology that are constructed entirely according to the principles of Dependency Phonology, see van der Hulst (1993, 1996) and van der Kooij (2002).

We are now in a position to return to finer details, for example, distinguishing the following three shapes, all represented as all five fingers selected ([all]), and a [closed] position: . A solution to this problem is proposed by van der Hulst (1995), who further refines a suggestion in Uyechi (1996 [1994]) that separates flexion at the base joints (the joints closest to the hand body) and the non-base joints (the other two joints). In van der Hulst's model in the Dependency Phonology framework, the finger position node is split to include joint selection (which articulates bending and curving) and aperture (which articulates opening and closure). Representations of finger position for these three shapes in van der Hulst's model are shown in (13). The selected finger specification for all three examples is [all].

(13) Three closed handshapes (from van der Hulst 1995)



The categories Joints and Aperture are in a dependency relation with each other: Joints is the head, represented with a straight line, and Aperture the dependent, represented with an angled line in van der Hulst's model. A model that provides separate features for Joints and Aperture has the advantages of unambiguously spelling out the first and last shape in signs with handshape change, and of limiting all handshape changes to changes of aperture. Here as above, the more marked shapes have more complex representations.

10.4.2 Orientation features

The observation that the orientation of the palm can be minimally contrastive (Battison 1978) prompted phonologists to take the category seriously, and there is a place for it in all models. The articulatory status of orientation as well as assimilation facts in lexicalized compounds motivate a model in which orientation is a member of the hand configuration category, as explained in Section 10.3. In addition to features of orientation, so-called "facing" features have also been argued for (van der Hulst 1993, Liddell and Johnson 1989 [1985]) to refer to the part of the hand that faces the location toward which the hand moves. Verb agreement must refer to facing because some part of the hand faces the syntactic object, as we saw in Meir's (1998a) analysis, described in Chapter 3, Section 3.2. Two questions require answers with respect to this parameter: what are the features of orientation, and is orientation distinct from facing?

These questions relate to the broader question of where redundancy lies. From a phonetic point of view, specification of handshape, place of articulation, orientation, facing, and the part of the articulating hand that makes contact with the place of articulation (in signs in which the hand contacts the body) will make all necessary contrasts. However, if only some of these features must be specified and the others are redundant, then the redundant features do not belong to the underlying representation. But which features are redundant? Asked differently, which features, if specified, consistently predict the values of other features?

Figure 10.15 AT-THAT-MOMENT (ISL)

Let's take the ISL sign AT-THAT-MOMENT, pictured in Figure 10.15, as an example. In this sign, the handshape is ; the palm orientation is down, facing is the selected fingertips, handpart of contact is also selected fingertips, and place of articulation is the non-dominant hand.

If the shape of the hand, the orientation and the place are specified, then facing and handpart of contact are redundant. That is, if the palm is oriented downward, the location is the non-dominant hand, that location is specified for the feature [contact], and the handshape selects the fingers that it does, then both the direction in which the hand is facing and the handpart making contact are predictable. Alternatively, if the handpart making contact and the location are specified, then the orientation of the palm and the facing are predictable. What, then, should be specified in underlying representation?

A recent proposal takes a step toward solving the problem. According to Crasborn and van der Kooij, working on SLN, orientation is a relative notion, realized relative to the other elements mentioned in the previous paragraph (Crasborn and van der Kooij 1997, Crasborn 2001, van der Kooij 2002). They explain that restricting orientation to the palm is the wrong approach, as it forces independent specification of the facing handpart and the point of contact. However, if orientation is reinterpreted as that part of the hand that relates to the place of articulation, then the old classes of orientation, facing, and point of contact can be reduced to one, which they call relative orientation. The features Crasborn and van der Kooij propose are the following: [palm], [back], [wrist], [front], [fingertip(s)], [ulnar], and [radial], adopted in the representation in (2)/(10) above. They propose that only relative orientations be specified in the hand configuration subtree, and that these are interpreted in relation to handshape and location features which must be represented for independent reasons. The rest falls out from redundancy and phonetic interpretation rules, which they leave to future research.[18]

[18] Brentari (1998) also proposes that orientation is a relative notion, interpreted from a combination of handpart and plane of articulation. See the representation in Chapter 13, example (10).

In support of their proposal that relative orientation should be represented in terms of a part of the hand in relation to the place of articulation is the following observation: the relative orientation value (i.e., the relation between handpart and location) is sometimes more robust – more resistant to alternation – than either the finger position or the orientation of the palm. An example in which relative orientation is more robust than finger position is in the SLN sign PEOPLE, a sign in which the fingertips contact the body. In the citation form of the sign, the handshape is . But the sign is often pronounced with a curved handshape . Regardless of finger position, the relative orientation [fingertips], interpreted together with the place of articulation on the body, remains constant. Exemplifying the latter observation, that relative orientation is more robust than orientation of the palm, is the SLN sign IDEA, in which the fingertip must always articulate at the forehead, but the palm orientation may vary.

The analysis has yet to be fully worked out in order to make the right predictions about how orientation and facing interact with verb agreement. This is an important test of any model, as the direction in which the hands are facing is part of the verb agreement morphology (see Chapter 3, Section 3.2). Crasborn and van der Kooij suggest that it is the second location in the agreeing form that somehow determines the relative orientation. That is, the part of the hand that faces the second location is specified as the relative orientation feature. For example, in the ASL sign LOOK-AT, the handshape is , the palm is oriented downward, and the fingertips lead the hand toward the locus of the object referent; i.e., they point toward the locus. The relative orientation specification is presumably [fingertips], interpreted in relation to the second locus of the sign. However, in this particular sign and others like it the wrist is also morphologically accountable; it must be oriented toward the locus of the subject, i.e., the first location of the sign, distinguishing YOU-LOOK-AT-ME from SHE-LOOKS-AT-ME, for example. Future research is also needed to specify how to interpret the surface form from the underlying representation.

10.4.3 Phonetic redundancy and other predictable properties

A model cast entirely in the dependency framework is offered in van der Kooij (2002).[19] The frequency of shapes in the lexicon, which needs to be tallied in order to determine relative markedness, is calculated in a computerized database – the SignPhon database of Sign Language of the Netherlands (SLN). Van der Kooij's is the first phonological handshape study we know of that uses such a database, which includes 3,000 signs.[20]

[19] An early version of the model initiated by van der Kooij, developed in an unpublished working paper (Brentari et al. 1996), is adopted with some revisions in Brentari (1998).
[20] The SignPhon website is http://www.leidenuniv.nl/hil/sign-lang/signphon2.html

In an effort to represent only those features which are contrastive in SLN, thereby eliminating features that are predictable, van der Kooij proposes a set of redundancy rules (called Phonetic Implementation Rules or PIRs). The model simplifies underlying representations by positing rules to derive surface forms. For example, PIRs are proposed to specify thumb features such as [adducted, abducted, crossed (= restraining)] according to the selection and position of the other fingers, and the presence and type of internal movement (van der Kooij 2002). Noting that flexion of the base joints depends on the articulatory context, she proposes the phonetic implementation rule in (14). The rule is clearly phonetic, as it is gradient.

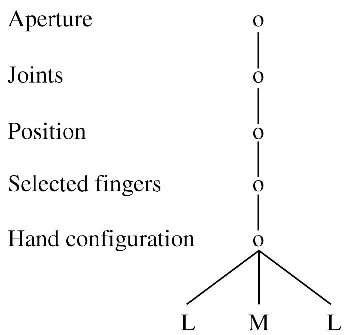
(14) A Phonetic Redundancy Rule (van der Kooij 2002, p. 127)
Base joints are flexed if a combination of the specification of a part of the hand and a specified location (i.e., the relative orientation) requires it for articulatory reasons.

A radical step is taken in van der Kooij's theory. She attributes to iconicity a significant role in the specification of handshapes. Staying with the example of base joints, their position may also be determined by the shape of the object depicted by the sign. If the object is a ball, for example, the base joints are not flexed, as flexing would make the resulting shape angular instead of round. To account for such conditions, van der Kooij proposes Semantic Implementation Rules. This idea, which is influenced by Boyes-Braem (1981), is beyond – even incompatible with – phonology as we know it, and we will return to it in Unit 5.

10.5 Where is hand configuration in the overall phonological model?

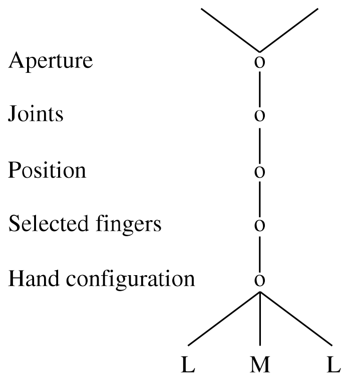
In the model under consideration, hand configuration is conceived of as a complex category with long-distance autosegmental properties. As such, the whole category associates in one-to-many fashion to the segments on the LM tier, exemplified schematically in example (15).

(15) Linking of hand configuration to the LM tier



This representation is self-explanatory for most signs. If a sign has hand-internal movement, as shown in example (10) with a branching Aperture node, linking becomes a bit more complex.

(16) Underlying representation of a sign with hand-internal movement

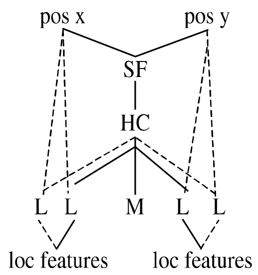


This representation is somewhat abstract, differing from the surface representation in the actual temporal realization of each member of the aperture (or orientation) contour. On the surface, the first and second branches of the contour are articulated with the first and second locations, respectively. In the sign SEND (Figure 9.9) for example, the closed finger position is co-temporal with the first location, and the open finger position is co-temporal with the second location. But this is problematic: is the HC category, including finger position and orientation, temporally autonomous of the LM tier? Or are the contour features in signs with two positions or orientations linked to the timing tier? The answer is: both.

Position is part of the selected finger category, so it spreads with it, whether there is one aperture or two. The representation is explanatory, because the position of the fingers is directly related anatomically to the fingers themselves, it characterizes all selected fingers in the same way, and position spreads with the fingers, in compound reduction, for example, as we have seen. Yet on the surface, each finger position in a sign with handshape change does end up aligned with a different timing slot. On this evidence, one might expect the temporal linking of features to occur only at the surface, perhaps in phonetic implementation.

This leads to indeterminacy, however, since some processes require the two features making up a contour to be associated to the first and last timing slots before phonetic implementation. For example, when the ASL Resultative inflection (Klima and Bellugi 1979), which geminates the first location segment, applies to a sign with internal movement, the first finger position geminates too.[21] This can only happen if the first and last positions are lined up with the first and last locations, as shown in (17). The point at which this linking occurs must be "after" compounding, so that assimilation can affect all HC features without reference to the timing tier, but "before" aspectual inflections occur.[22] The schematic representation in (17) shows only the relevant position features (strictly speaking, aperture features) that create an internal movement contour, labeled pos x and pos y.[23]

(17) Linking of finger positions and spreading for Resultative



10.6 Summary and conclusion

The hand has many degrees of freedom, but it does not exploit them all when it acts as an articulator in a linguistic system. Instead, its configuration is subject to constraints. The main constraint on hand configuration operating at the level of the morpheme is that only one group of fingers may be selected. An additional phonological constraint is that all selected fingers must be specified for the same position in native handshapes of the sign languages we have studied. If there are two finger positions in a sign, one must be either fully open or fully closed, another constraint on the structure of hand configuration. Finally, the unselected fingers may also be either open or closed, and their position is usually predictable from that of the selected fingers.

21 Finger position features must be interpretable as aligned to the first and last location in order to undergo "negative incorporation" as well. This process is exemplified in Chapter 14, on syllables.

22 This explanation is couched in a theory entailing rule ordering and the ordering of lexical levels. A constraint-based approach might instead posit different constraints and rankings to achieve the survival of different parts of the structure of HC under compounding and aspectual inflection.

23 The solution chosen in (17), in which features align themselves without breaking down the feature geometry, is simpler than that suggested in earlier work (Sandler 1993d). However, such double linking of phonological material is admittedly ad hoc, and the theoretical and empirical implications should be investigated.

The investigation of hand configuration illuminates some of the similarities between spoken and signed languages, and reveals differences as well. We focus here on similarities, leaving differences for the final chapter in this unit, Chapter 16.

In both modalities, phonological categories are comprised of distinctive features, and these features are classed in groups. Hierarchical organization of feature classes is also shown to be universal. The theory of feature geometry launched by Clements (1985) seeks to encode the insight that anatomical architecture and phonological architecture are synchronized. At first glance, this seems unsurprising; after all, phonology is carried by physical articulators in a much more direct way than is, say, syntax. However the link between physical structure and phonological structure becomes more interesting when the latter is distinguished from phonetics. To quote Hayes (1999), "There is a considerable gap between the raw patterns of phonetics and phonological constraints." Both modalities have systematic rules of assimilation that are phonological rather than phonetic in the sense that they involve whole categories of features and are discrete rather than gradient.

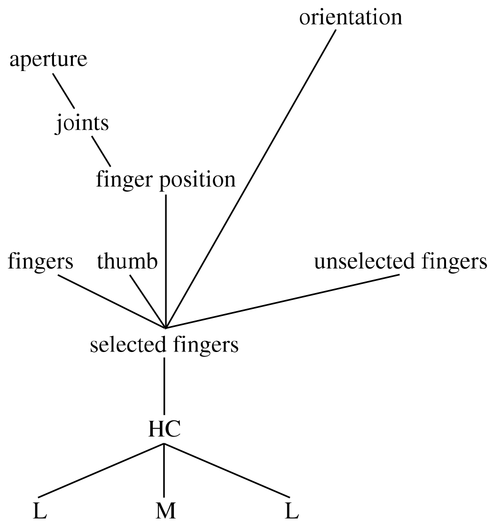
In the hand configuration assimilation that occurs in compounds, the category of orientation is shown to be subordinate to handshape (selected fingers). Involving as it does the direction in which the hand is turned, orientation is anatomically part of the hand, motivating a representation in which it is dominated by a higher structure in HC, proposed in the Hand Tier model to be the selected fingers category. However, from a purely phonetic point of view, the selected finger specification is independent of the orientation. There is no phonetic barrier to the assimilation of fingers independently of orientation, a type of assimilation that actually occurs postlexically between pronominal clitics and their hosts (see Chapter 15, Section 15.1).[24] Yet in the lexical phonological process of compounding, assimilation of the finger selection category carries along the orientation category, encoding an anatomical relation phonologically.

Finally, the study of sign language handshapes gives renewed credence to Jakobson's notion of markedness, which links relative complexity or difficulty with other properties such as frequency, distribution, the course of acquisition, and the course of language loss. The relative markedness of handshapes is captured in a model of terminal features that relies on the theory of Dependency Phonology.

[24] Even gradient assimilation of a single finger in signs that select more than one finger can occur on the surface (Corina 1993), a fact that supports a distinction between phonology and phonetics. We will return to this idea in Chapter 14.

A model of the overall architecture of the hand configuration category emerges from the investigation in this chapter, offered in (18). The model shows only feature classes and not terminal features.

(18) The architecture of hand configuration



The category of hand configuration is represented as multiply associated to locations and movements because there is only one per morpheme, and because it exhibits a degree of temporal autonomy as explained in Chapter 9, and demonstrated again in (1) in this chapter. The other two major categories, location and movement, are elaborated in Chapters 11 and 13.

11 Location: feature content and segmental status

The designation of location as a major phonological category in sign language is unquestioned. Clear evidence is presented in Chapter 8, where the ASL minimal pair UGLY, SUMMER, distinguished only by some feature of location, is illustrated in Figure 8.2b. Like hand configuration, the location category is made up of subcategories with different characteristics. In particular, the major body area (such as the head) remains constant within a morpheme, while different subareas (such as the forehead or the chin) may have two different specifications in that domain (Sandler 1989). This categorization, too, is widely accepted. There is, however, one area of controversy with respect to locations that may be stated in terms of the following two views: (1) locations are a sequential segment type (as consonants are in spoken language); or (2) locations are a category on a par with hand configuration in a single feature hierarchy (like the place features of a segment in a Feature Geometry model). In this chapter, we will demonstrate the category-internal organization about which there is a consensus. We adopt the Hand Tier framework to represent it, making certain changes from the original model. The more controversial issue and what is at stake in it are laid out in the conclusion to the chapter. As this issue is related to the notion of syllables in sign language, it will be taken up again in Chapter 14.

11.1 Two classes of location features

A robust generalization with respect to locations is that there is only one major body location per morpheme (Battison 1978, Stokoe 1960). Yet the hand moves to articulate a sign, with the result that in some sense it articulates two locations, the beginning and the ending locations. For example, in the ASL sign IDEA, repeated in Figure 11.1 for convenience, the major body area is the head, while the beginning and ending locations are: (1) in contact with the forehead and (2) at a small distance in front of the forehead, respectively.

There are two different ways to account for these facts. One is to propose that there is only one location in a morpheme, and that the

Figure 11.1 IDEA (ASL)

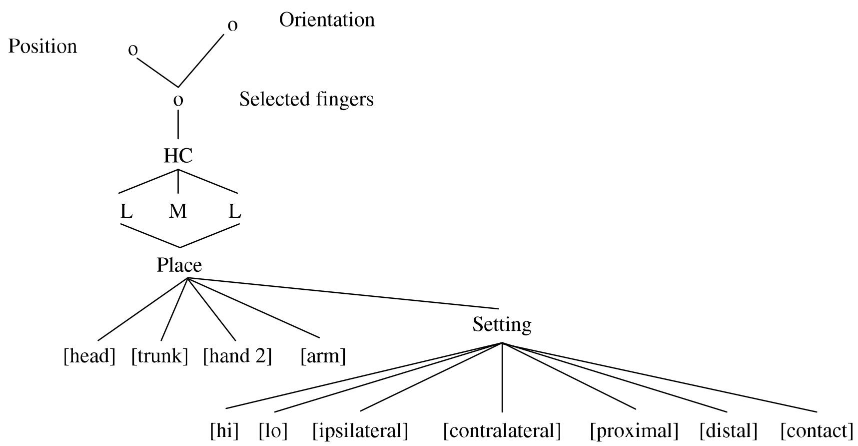
Figure 11.2 DEAF (ASL)

hand moves in some direction with respect to it, i.e., that there is a direction or path feature, such as 'toward' or 'away' (Stokoe 1960, Brentari 1990, 1998). The other is the position we adopt here, representing IDEA with two distinct locations (Liddell and Johnson 1989 [1985], Sandler 1989). One reason for our choice is that it provides a unified representation for signs like IDEA and signs like DEAF, repeated in Figure 11.2. DEAF, like IDEA, also has the head as its major body area. But here the first location is at the cheek, while the second is at the chin. Both signs are represented with the same LML structure.[1]

In order to capture the generalization that there is only one major body area, this model divides the location category into two features classes: place, which is the major body area, and setting (Sandler 1989). The place category includes the unary features [head], [trunk], [non-dominant hand], and [arm]. As there is only one per morpheme and usually only one per sign, place is multiply associated, as shown in (1). Place is a category of location, and as such it is associated to the L segments in representations. Its features spread to the intervening M phonetically. The bare bones of the hand configuration category are shown here as a reminder of the rest of the structure. There is a single class of setting features that may characterize any place – in the same way that the same finger position features (e.g., [open] or [closed]) can characterize any specification of selected fingers.

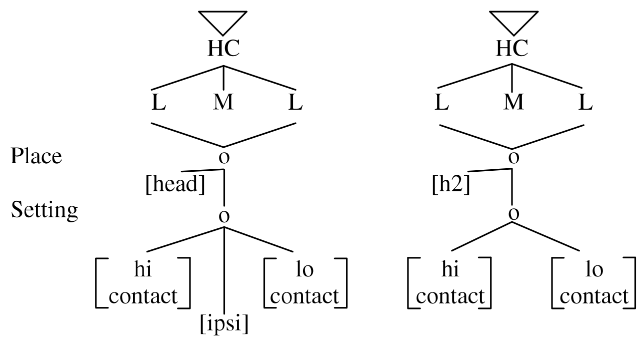
[1] The Hand Tier representation offered here contrasts with both Liddell and Johnson's Move–Hold model and Brentari's Prosodic model (Brentari 1998), which both assume IDEA and DEAF represent two different types of signs with distinct types of representations.

(1) Representation of the place category



The features [hi, lo, ipsilateral, contralateral, proximal, distal, contact] are binary in the original model (Sandler1989), in which "mid" or "central" or "medial" settings are represented as [-hi, -lo], [-ipsi, -contra], and [-prox, -dist], respectively, following spoken language binary feature theory. Here we make the assumption that all features are unary, and that the values "mid," etc., are to be represented through combinations of unary features in dependency relations instead, as explained in the previous chapter. HEAD and LIST are illustrated in Figure 11.3, and partially represented in (2). Instead of positing settings like "ipsilateral temple" and "chin" for the sign meaning HEAD in ASL, and "fingers" and "heel" of the non-dominant hand for the sign meaning LIST, the same height features are used to characterize both signs: [hi] and [lo]. [h2] stands for the non-dominant hand, the place feature of LIST. This analysis and representation significantly cut down and constrain the location feature inventory and feature combinations.

(2) Distinct place features for HEAD and LIST

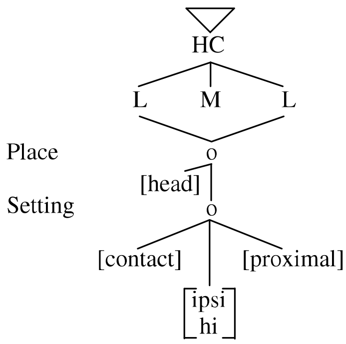


a. HEAD (ASL) b. LIST (ASL)

Figure 11.3 Signs with distinct place features and the same setting features: [hi] and [lo]

A sign like IDEA, illustrated in Figure11.1, is of similar form. The main difference is that only one of the settings involves contact with the place; the other is a short distance in front of it, as partially represented in (3).

(3) Place representation of IDEA

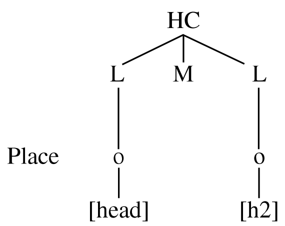


The model also shows which features are invariant across a morpheme, and which are not: the parameter that has different specifications in each location (i.e., the height, laterality, or distance features) branches from the setting node. In HEAD and LIST, the height features branch; in IDEA, the distance features branch. Setting features that are invariant like [ipsi, hi] in IDEA do not branch. But note that in HEAD and LIST, [contact] is not represented as branching, despite the fact that each location is characterized by contact. This is in order to distinguish signs with two contacts like these from signs with continuous contact across movement as well, like CLEAN, represented in Chapter 13, Figure 13.7.

The representation here, in which place is constant and setting features may branch, is essentially a mirror image of the HC representation, in which the selected finger node is constant, while its dependents, finger position or orientation, may branch. And as with those categories, the branching features must link to the L timing units because they may truncate independently of the major place feature under certain morphological operations, such as compound reduction (discussed in Chapter 9, Section 9.4) or negative incorporation (discussed in Chapter 14, Section 14.5).

In bimorphemic signs, such as compounds, with two major body areas, each location has its own place specification.[2] Because of the place constraint introduced in Chapter 1, stating that a morpheme may have only one place of articulation, any sign represented with two places of articulation is revealed to be bimorphemic. An example is BELIEVE, formed from THINK and MARRY, and illustrated in Chapter 9, Figure 9.11. In simplified form, emphasizing the individual place specifications, BELIEVE is represented in (4). Although this reduced compound has only one HC specification (as a result of assimilation) and only one movement, and therefore has the general appearance of a canonical monomorphemic sign, the presence of two place specifications gives away its bimorphemic origin.

(4) Representation of Place in the lexicalized compound, BELIEVE



This model makes two testable predictions: (1) that finer setting distinctions (such as a setting somewhere between the ipsilateral temple and the center of the forehead) will not be minimally contrastive within a sign language and (2) that features such as [high], [ipsilateral], etc. will figure in phonological processes, to the exclusion of specifications such as "cheek" or "chin" that are posited by other models.

The first prediction, while promising because we know of no counter-evidence, remains to be thoroughly tested on a variety of sign languages. There is some suggestive evidence for the second prediction, that processes will refer to features of laterality or height rather than to specific phonetic settings like cheek or chin. The evidence comes from metathesis in ASL (Liddell and Johnson 1989 [1985]), a process which also supports the division of locations into two categories, place and setting. As discussed in Chapter 9, Section 9.2, metathesis works in the following way. Signs that are characterized by contact on two different settings within the same place of articulation fit the structural description for this process. An example is the

[2] The model shown here is different in some respects from the original Hand Tier model. In particular, settings are subordinate to place here, while they were sisters in the earlier model. This change is in the spirit of van der Hulst (1993), which proposes that setting is a dependent of place, and it is compatible with the feature geometry approach of the Hand Tier model, in the sense that settings are a refinement of place.

sign for DEAF, from the sentence, FATHER DEAF ('father is deaf'), shown in Chapter 9, Figure 9.5. In this sequence, DEAF is signed in its citation form. If a sign such as this one is preceded by a sign closer to the second setting (here, the ipsilateral side of the chin), such as MOTHER, then the two settings are reversed.

Metathesis also applies to signs made elsewhere on the body, such as the chest. An example is the sign COMMITTEE, shown in Chapter 9, Figure 9.2. In citation form, it is normally signed by making contact first on the contralateral side of the chest, and then on the ipsilateral side. If this sign occurs after a sign articulated on the ipsilateral side of the chest, such as VOLUNTEER, then it may metathesize. Metathesis is triggered by signs that make contact at high and low settings on a place as well, such as DEAF or HOME. However, the two settings must be on the same place of articulation. The process does not occur if the two settings are on different places of articulation, such as the (lexicalized) compound MAN, which contacts the head and the trunk.

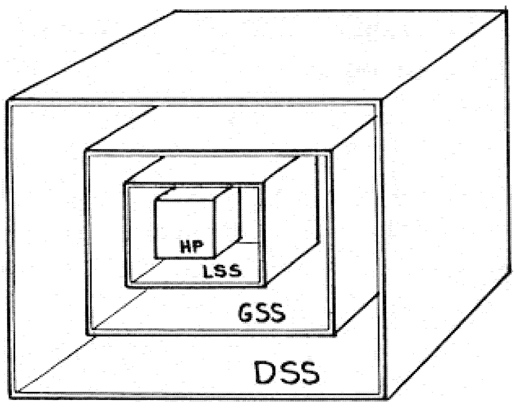
To clarify the advantage of this model, consider first the fact that signs can metathesize whether they are made on the head or the trunk, provided the settings are [high], [low], or [contralateral], [ipsilateral]. In order to state the process in the most general way, to account for metathesis of DEAF and COMMITTEE with the same rule, the metathesis rule should refer to these settings, and not to specific (phonetic) locations like cheek or chest. More support for the use of a single set of setting features is seen in Negative Incorporation; described in Chapter 14, Section 14.5, and footnote 12 in that chapter.

Furthermore, the metathesis rule is constrained to apply only where the contacts are made within the same body area. This is evidence that major body areas are seen by the phonology as distinct from settings, a distinction later adopted by other models as well (Brentari 1998, van der Hulst 1993, 1996). Finally, the rule as it applies in ASL requires the sign to have two locations with [contact], providing evidence for the existence of this feature. The metathesis rule, then, provides evidence for several aspects of the model: the separation of place from setting; the dominance of place over setting in the hierarchy; the use of the same setting features dominated by different places of articulation to characterize different locations; and positing [contact] as a phonological feature.

11.2 A 3-D hierarchy of signing spaces

A novel and intriguing approach to location is introduced in Uyechi (1996 [1994]). That work proposes that the visual phonology of sign languages is inherently different from the auditory phonology of spoken languages, and should be investigated entirely on its own, without the contamination of theories based on spoken language. Uyechi proposes that there are three different signing spaces, inhabiting a nested structure. Local Signing Space (LSS) is the space occupied by the hand in a lexical sign. For example, the ASL sign LOOK-AT requires specification of a particular position and orientation of the hand in local signing space. Morphological specification of the spatial path, as in verb agreement, is represented in Global Signing Space (GSS). To sign 'I look at you,' for example, the Global Signing Space must indicate the spatial relation of the hand with respect to the signer and the addressee. At the discourse level, where areas of space can be used to designate different discourse topics, and where the whole body may shift its spatial perspective to indicate different points of view, another space obtains: Discourse Signing Space (DSS). If the signer assumes the point of view of a third person looking at another third person, for example, the body shift must be represented in Discourse Signing Space. Schematically, these spaces are seen as nested in a three-dimensional hierarchy, as shown in (5).

(5) Hierarchy of signing spaces (Uyechi 1996 [1994])



The notion of three independent yet interdependent spaces is compelling on the intuitive level. It reflects the fact that the articulating hand retains the features of LSS when it is implanted in GSS, and both the hand and the articulating arm retain their spatial features as they are implanted in DSS.

This conception of the space utilized in signing highlights a unique problem in the phonological treatment of locations in sign languages. Notice that only the Local Signing Space is required to be represented as part of a sign in the lexicon. Global Signing Space and Discourse Signing Space are only relevant for the syntactic and discourse levels. But these locations in space are unlike the syntactic aspects of words in spoken language, such as agreement markers, or discourse-related elements, such as anaphoric pronouns – all of which are represented phonologically in the same way as any other form in the oral modality. The locations of the verb agreement or classifier systems in sign language defy phonological characterization, as they can be designated at any point in the signing space. It seems that the best we can hope for is a representation that designates a linear position for locations where this is predictable (as in verb agreement; see Chapter 3), and leaves the precise locations to the interpretive devices like coindexation. Uyechi's model is instructive in distinguishing differences in the use of space at different levels of the grammar, and in revealing their interaction in the physical system. The linguistic use of space is discussed further in Unit 5.

11.3 Summary and unresolved issues

This chapter adopts a phonological view of locations that originated with the Hand Tier model: that the location articulated in a sign is a major phonological category, comprised of two subcategories, place of articulation and setting. As setting is a refinement of place, the two are represented hierarchically (following van der Hulst 1993; see footnote 2). The constraint that a morpheme may only have one place specification is represented by association of the place category to both (or all) locations. These place and setting features belong to a superordinate category in this model, locations, which are sequentially represented on a timing tier with movements.

The notion that there are two categories of features comprising locations – place features and setting features – has been incorporated into other models (Brentari 1998, van der Hulst 1993). One way in which these models differ from the Hand Tier model presented in this chapter is that they do not represent movement as a sequential position separating the two locations, a difference we will examine in Chapters 13 and 14. One aspect of locations is not likely to be resolved by any phonological model, and that is the specification of locations whose articulation is not related to a part of the body, but to referential loci in space. Such loci, assigned to Global Signing Space and Discourse Signing Space in Uyechi's model, were shown to be important in the verb agreement and classifier systems (Chapters 3 and 5). They involve a potentially infinite number of points in space established for different referents in a discourse. This use of location is modality specific – and universal within the sign language modality – and will be addressed in Unit 5.

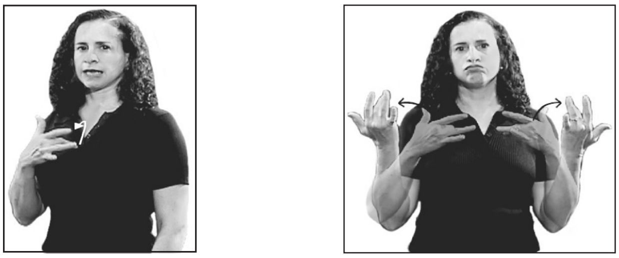
With discussions of hand configuration and location behind us, we are now equipped to turn our attention to an element which is claimed by some researchers to belong to each of those two categories: the non-dominant hand.

12 The non-dominant hand in the sign language lexicon

A striking difference in the transmission system of languages in the two modalities is the existence of two anatomically identical articulators in sign languages: the two hands. Spoken languages have no such potential. On the assumption that the human organism will make full use of its articulatory system, within the relevant modality, in the service of communication, one would expect that both hands would be used in sign language. And indeed they are. But do they function linguistically as two independent articulators in the words of sign language, resulting in a significant phonological difference between the two modalities? Researchers are in agreement that the answer to this question is "no." The physiological existence of a second articulator generally does not mean that there are two completely independent articulators in the formation of words in the sign language lexicon. Rather, the non-dominant hand (h2) is always in some sense subordinate to other structural elements at the phonological level. This is the most important discovery about the non-dominant hand, as it offers novel insight into the relationship between phonetics, phonology, and the lexicon. What we see is a potential articulator with many degrees of freedom that behaves in a highly restricted way in the words of sign language lexicons.

But the non-dominant hand behaves quite differently within words than it does at other levels of structure, such as discourse and prosody. At the end of the chapter, we suggest that the seemingly anomalous articulator of sign languages conforms to aspects of grammatical organization that are not anomalous at all.

An independent question that is harder to answer is the one to which much of this chapter is devoted: does the non-dominant hand have two distinct phonological roles in sign language words, or only one? Is it sometimes an articulator and sometimes a place of articulation, as Stokoe asserted, or is it always essentially an articulator that is subordinate to the primary articulator, the dominant hand? Although the answers that have been proposed are more complicated than the question, and controversial as well, the debate over h2 is well worth considering, for three reasons. First,



a. FEEL b. THRILL

• •• ••• ••• One-handed versus symmetrical two-handed signs (ASL)

the main opposing positions are clearly spelled out and supported, and can be compared to each other directly. Second, the two models examined here reveal the way in which distinct phonological theories can influence sign language analysis. Finally, considering the two views raises interesting questions about the relation between phonetics and phonology. One theory, the one that we ultimately adopt, claims that while h2 is phonetically unitary, it has two distinct phonological roles. The other claims that h2 is a single element, both phonetically and phonologically.

••• • •• •• ••••• •• • • • •

According to Stokoe's (1960) original analysis of the phonological components of ASL, there are descriptively two main types of two-handed signs. In one type, both hands articulate, and in the other, only one hand articulates. That is, the distinction is made on the basis of whether or not the non-dominant hand *moves* in the underived form of the sign. Compare THRILL, a two-handed sign, with FEEL, which is one-handed. The two signs are illustrated in Figure 12.1. According to the two-role theory, in signs in which both hands move, such as THRILL, h2 is a duplicate articulator, performing the same phonological role as h1. We will call signs like THRILL h2-S (symmetry) signs.[1]

In signs in which only h1 moves, h2 performs the phonological role of place of articulation. We refer to signs of this type as h2-P (place) signs.[2] In Figure 12.2 compare TOUCH, which has h2 as place of articulation, with SICK, in which the head is the place of articulation.

[1] Despite their similarity, FEEL and THRILL are *not* a minimal pair distinguished by use of one versus two hands. In FEEL, the dominant hand moves from a midpoint on the torso to a higher point, maintaining contact with the body. In THRILL, the hands start at about the same location as FEEL, but then they lose contact with the body and describe an arc shape outward while changing their orientation. In fact, signs minimally distinguished by number of hands are exceedingly rare across sign languages.

[2] Different types of two-handed signs have been called many things in the literature. We hope that the transparency of the labels we choose in this book offsets the potential confusion that the plethora of different terms might otherwise cause.

a. SICK b. TOUCH

• •• • •• • • •• [head] and [h2] as places of articulation (ASL)

In order to understand these various roles of h2, let us consider two overall conditions on two-handed signs observed by Battison (1978 [1973]). Battison formulated the constraints on the non-dominant hand paraphrased in (1)–(2).

(1) The Symmetry Condition
states that (a) if both hands of a sign move independently during its articulation, then (b) both hands must be specified for the same handshape, the same movement (whether performed simultaneously or in alternation), and the specifications for orientation must be either symmetrical or identical.

(2) The Dominance Condition
states that (a) if the hands of a two-handed sign do not share the same specification for handshape (i.e., they are different), then (b) one hand must be passive while the active hand articulates the movement and (c) the specification of the passive handshape is restricted to be one of a small set: A,S,B,G,C,O.[3]
(Battison 1978 [1973], pp. 34–35)

This formulation leaves out the set of signs like ISL ALREADY (Figure 8.3) in which the non-dominant hand has the same handshape as the dominant hand, but it is passive – signs which Battison calls Type 2 signs. The two-role model categorizes such signs simply as h2-P signs, since they behave phonologically just like any other signs in which h2 does not move. Under this analysis, the Symmetry Condition is assumed to refer to h2-S signs and the Dominance Condition to refer to h2-P signs. If this is the case, however, the Dominance Condition requires revision, as follows in (3).

(3) Revised Dominance Condition
In signs in which h2 is passive (i.e., does not move), h2 must either be unspecified underlyingly, or it must be characterized by an unmarked handshape.

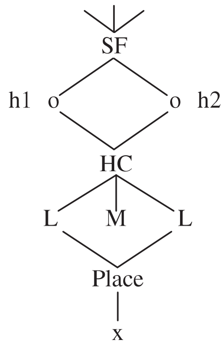
[3] The shapes that Battison designates as unmarked, based partly on the Dominance Condition, are A,S,B,G,C,O: . We've narrowed the list of unmarked shapes down to . See Sandler (1995b, 1996a) and Chapter 10, footnote 15 for an explanation.

Under the condition in (3), it is assumed that an underlyingly unspecified h2 takes on the shape of h1 by a redundancy rule (Sandler 1989, 1993a).

The argument about how to represent h2 is not about whether two general types exist at the descriptive level; no one disputes that. What has become a source of controversy is whether the non-dominant hand is playing two distinct roles phonologically, and therefore should be represented in different ways in models of sign language phonological structure, or whether it is fundamentally a single element from a phonological point of view, deserving of only a single representation.

The basic dichotomy of Stokoe is adopted in the Hand Tier model (Sandler 1989, 1993a). In the two-role view, the diagnostic for categorihood is whether or not h2 is active. In h2-S signs (like THRILL, Figure 12.1b), h2 is represented as an additional node in the HC hierarchy, essentially copying all the features of h1, and associating to all the same locations and movements. The representation in (4) requires h2 to have the same handshape as h1, and to articulate in the same way.[4]

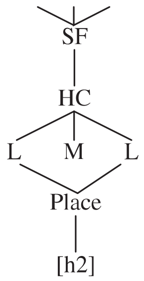
(4) Hand Tier representation of h2-S signs (Sandler 1989, 1993a)



In h2-P signs (like TOUCH, Figure 12.2b), in which h2 functions as a place of articulation, h2 is simply represented as such, as the feature of place, just like the head or the trunk, as shown in (5). If its shape is different from that of h1, it must be specified. Otherwise it is left unspecified and a redundancy rule will copy the shape of the dominant hand.

[4] Blevins (1993) supports Sandler's (1989, 1993a) two-role view, but proposes a change in the model for h2-S signs, according to which h2 is a dependent of h1 rather than a sister to it. Like Brentari (1990, 1993), Blevins argues that h2 is weaker than h1, and that it is phonologically dependent on it, as h2 does not occur by itself in lexical signs, and it is synchronized with h1 if both hands move. She proposes the dependency representation for h2-S signs only, agreeing with Sandler that in h2-P signs, h2 is represented as a place of articulation.

(5) Hand Tier representation of h2-P signs (Sandler 1989, 1993a)

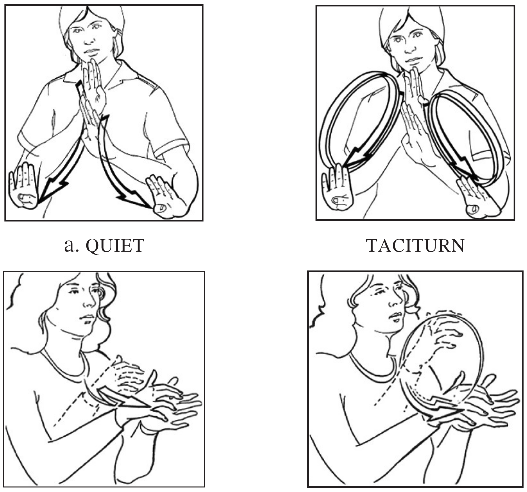


Some of the arguments for this model follow. Unless otherwise indicated, the arguments are from Sandler (1993a).

1. The Symmetry and Dominance Conditions on h2 ((2) and (3)) treat the non-dominant hand differently, depending on whether it moves (h2-S) or not (h2-P).
2. As Perlmutter (1991) points out, signs in which h2 functions as a place of articulation (h2-P signs) normally may not be specified for any other place of articulation. Signs in which h2 functions as a symmetrical articulator (h2-S signs) must have a place specification.[5]
3. Under morphological operations, h2 behaves like h1 in h2-S signs and like places of articulation in h2-P signs, as predicted by the model. For example, under inflection for Characteristic Adjective (Klima and Bellugi 1979, Padden and Perlmutter 1987), the non-dominant hand behaves differently, depending on whether the sign is one-handed, h2-S or h2-P.[6] The rule forms adjectives meaning 'characteristically X' from plain adjectives by reduplicating the movement of the sign in the following way. If the sign is underlyingly one handed, then it becomes h2-S, with the two hands moving in alternating fashion. If it is underlyingly h2-S, then the movement of the two hands does not become alternating. If it is underlyingly h2-P, then h1 reduplicates its movement, but h2 remains stationary, like any other place of articulation. Figure 12.3a shows QUIET, an h2-S sign. In the derived characteristic adjective, TACITURN (Figure 12.3b), both hands move the same way, as predicted from the representation in (4), as both hand (h) nodes are associated with the same L and M slots and their features. The sign ROUGH, shown in Figure 12.3c, is an h2-P sign. When it inflects for characteristic adjective to form CHARACTERISTICALLY CRUEL, shown

[5] Perlmutter (1991) presents a view of h2 that is similar to that of Sandler (1989, 1993a). The main difference is that Perlmutter proposes a different set of features for h2 in h2-P signs with the goal of including each feature set for h2-P as a different place of articulation. Since the handshapes available to h2-P are precisely the unmarked subset of those that may characterize h1, the Hand Tier model is able to capture this generalization without increasing the inventory of phonological features. It does so by using the same features for both hands.

[6] The Characteristic Adjective derivation is described in Chapter 4, Section 4.1.1.

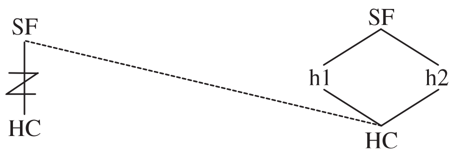


Characteristic Adjective formation (ASL) (Figure 12.3a reprinted with permission from Padden and Perlmutter 1987; Figure 12.3b © Ursula Bellugi, the Salk Institute)

in Figure 12.3d, only h1 moves, which is also predicted by the model, reflected in (5), where h2 is a place of articulation and not an articulator.[7]

4. In lexicalized compounds in which hand configuration assimilates (discussed in Chapter 10, Section 10.2), h2 assimilates together with h1 only in h2-S signs, but not in h2-P signs. For example, in FAINT, in which the second sign is an h2-S sign, the two hands assimilate. Assimilation of FAINT (pictured in Figure 10.11) is represented schematically in (6).

(6) Representation of hand configuration assimilation from an h2-S sign (FAINT)

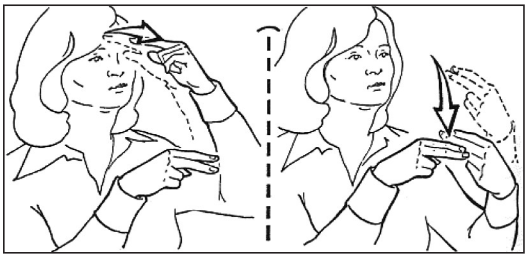


But in SLEEP^SUNRISE = OVERSLEEP, pictured in Figure 10.12, in which the second sign is an h2-P sign, only h1 assimilates. In this as in all h2-P signs, h2 is a static place of articulation. As the two-role theory predicts, h2 does not assimilate with h1 under compound reduction because it is represented under the place node (see (7)).

7 Note that the non-dominant hand behaves the same in the Distributive inflection allomorphy described in Section 4.1.3, further supporting the Hand Tier two-role model.

a. BLACK

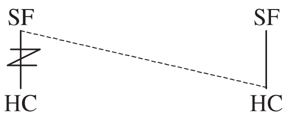
b. NAME



c. BLACK^NAME

• •• • •• • • •• BLACK^NAME = BAD-REPUTATION (ASL) © Ursula Bellugi, the Salk Institute)

(7) Representation of hand configuration assimilation from an h2-P sign (OVERSLEEP)



5. Another rule, h2 anticipation (Liddell and Johnson 1986, Sandler 1989, 1993a), causes h2 in h2-P signs like BLACK^NAME to be present in the signing space at the beginning of the compound, as can be seen in the picture in Figure 12.4c. This spreading is different from the assimilation rules shown in (6) and (7), since in anticipation, h2 does not assimilate any features from the first sign; it only changes its temporal scope, appearing in the signing space while the first member of the compound is signed by h1.[8]
6. There are a few attested compounds in which the second member is an h2-S sign, while the first is one-handed; in these compounds the first sign becomes h2-S instead of one-handed – i.e., the symmetrical two-handedness of the second sign spreads to the first member. An example is SLEEP^CLOTHES = NIGHTGOWN in ASL. This spreading of two-handedness does not occur in compounds whose second member is a h2-P sign.

[8] In Chapter 15, we will see evidence from ISL that the domain of the anticipation rule is larger than the compound.

7. Weak Drop,[9] a process by which h2 is deleted from a sign (illustrated in Chapter 16, Figure 16.1), is far more common in h2-S signs than in h2-P signs, in adults (Battison 1974) and in children acquiring ASL (Siedlecki and Bonvillian 1993). The latter researchers attribute the stability of h2 in h2-P signs to the salience of place of articulation generally in the signing of young children, supporting the claim by the two-role model that h2 in h2-P signs is a place of articulation and not an articulator.

[illegible]

The opposing position views h2 as a unified category with a single representation. Its proponents (Brentari 1990, Brentari and Goldsmith 1993, van der Hulst 1993, 1996) suggest that h2 is always in some sense a weaker version of h1, and that the representation should reflect this. This theory of h2 is also motivated phonologically, but relies on a different set of arguments. The strongest of these follow, from Brentari (1998) unless otherwise indicated:

1. In any type of two-handed sign, h2 may always either have the same shape as h1, or one of a subset of the shapes that may characterize h1. This is taken to be evidence for a general dominance relationship between the two hands (Brentari and Goldsmith 1993, Brentari 1998).[10]
2. There is a relatively large number of h2-P signs in which h2 has the same shape as h1. Indeed, it is only when h2 = h1 that h2 may have a marked handshape in h2-P signs. The argument is that this redundancy must have something to do with the fact that the hands are phonologically related to each other, even when only one is articulating.
3. There are five ASL signs which are known to have changed diachronically in a way that supports a relationship between the two hands in h2-P signs. These signs have remained h2-P signs, but h2 has assumed the handshape of h1. While the two-representation model of Section 12.1 can represent this change, that model does not predict that there should be interaction between the two hands in this way.
4. There are three signs in ASL which have changed diachronically from h2-S to h2-P signs; i.e., h2 historically behaved as a symmetrical articulator, with the same handshape as h1 and mirrored movement, but over time, h2 lost its movement and became a place of articulation. An example given in (Brentari 1998) is the sign DEFEAT.

[9] The process of h2 deletion was first described in Battison (1974) and was later given the name Weak Drop in Padden and Perlmutter (1987), where its interaction with morphological rules was investigated.

[10] This observation led to the proposal that h2 is a syllable coda (Brentari 1990, 1993).

5. One type of sign (e.g., SHOW) is somewhere in between the two types described above as h2-S (like THRILL, pictured in Figure 12.1b and represented in (4) above), and h2-P (like TOUCH, pictured in Figure 12.2b and represented in (5)). Though otherwise like h2-P signs, in the sense that h2 has a different configuration from that of h1 and one that is unmarked, SHOW-type signs involve uninterrupted contact between the two hands, so that h2 moves with h1, and does not remain stationary as in more typical h2-P signs. This suggests that movement of h2 does not clearly distinguish two distinct types of two-handed signs.
6. Brentari (1998) shows that a clear distinction between h2-S and h2-P signs cannot be made on the basis of Weak Drop. It is the particular lexical feature specifications of a sign that determine whether or not the rule of Weak Drop applies, and not whether the sign is h2-S or h2-P. The following types of signs may *not* undergo weak drop.[11]

   a. Signs with alternating movement (by definition, these are also h2-S).
   b. Signs with continuous contact between the two hands (h2-S or h2-P).
   c. Signs with *both* contact between the two hands at any point in the sign, *and* an orientation in which the two hands face each other (h2-S or h2-P).

7. It has been suggested that two of the processes affecting h2 in compounds, HC assimilation (represented in (6) and pictured in Figure 10.11), and h2 anticipation (pictured in Figure 10.13) may be reducible to a single process, in which h2 spreads regressively, regardless of whether the input is h2-S or h2-P (van der Hulst 1996).

Let us look at a model of h2 under this view, and then go on to further evaluate the two theories of h2. The representation proposed in van der Hulst (1996) reflects his one-role analysis, in accord with the empirical observations of Brentari (1990) and Brentari and Goldsmith (1993), and also determined by the overall theory of sign language structure that he adopts. Van der Hulst proposes that the type of structural relationship holding between the two hands that best explains their interaction is one of dependency: h2 is a dependent of h1 in all two-handed signs.[12] His theory of the structure of signs is guided by general principles of Dependency Phonology (Anderson and Ewen 1987) and by his view of the nature of head-dependent relations in all human languages (Dresher and van der Hulst 1998). Specifically, van der Hulst proposes that linguistic structures (morphosyntactic or phonological) are best represented in tree structures, in

[11] See Unit 5 for a suggestion that there are also semantic conditions on weak drop.

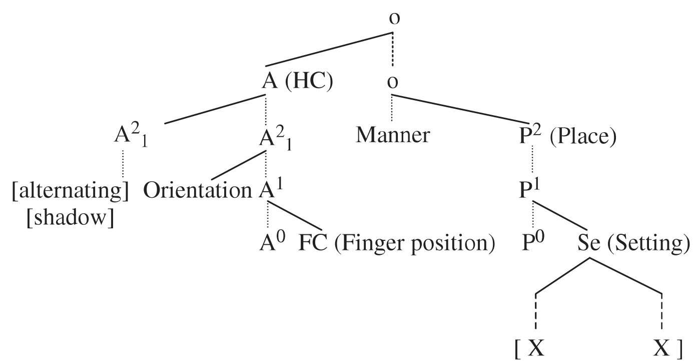
[12] Van der Hulst's dependency view has something in common with that of Blevins (see footnote 4), but he extends the dependency relation to all two-handed signs, h2-S and h2-P, whereas Blevins adopts Sandler's view that h2-P signs are in a different category.

which the character of non-terminal constituent nodes is determined by one of its daughters, which is called the head of the constituent. This is familiar from syntax, in which Noun Phrase nodes necessarily dominate nouns, for example. His theory further claims that each element of structure within a tree has two branches (i.e., is binary branching, van der Hulst 1989).

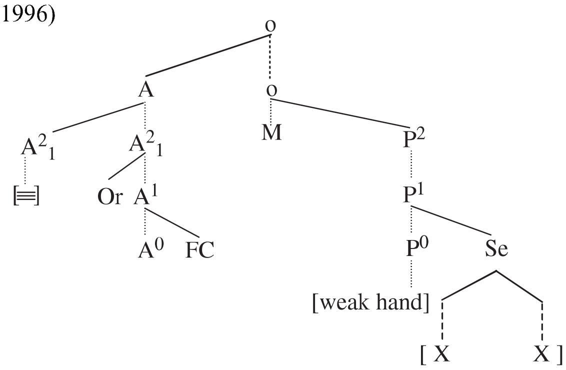
The theory is further developed in Dresher and van der Hulst (1998), in which it is claimed that there is a typology of asymmetries between heads and dependents. The relevant type of asymmetry for treatment of the non-dominant hand in his view is that in which the head and dependent are elements of basically the same type (like, e.g., two syllables forming a foot), but one is dominant. This dominance is reflected in the relative complexity of the two elements: the head is more complex than the dependent. In the case of syllables in a foot, the head is the stressed syllable (often more complex in its segment or timing structure); and in the case of the two hands, the dominant hand is more complex. The lack of complexity of h2 is expressed in the fact that h2 is limited to either copying the properties of h1, or to allowing a small unmarked subset of handshapes (Brentari 1990, 1993). Dresher and van der Hulst support the analogy with heads and dependents within a foot with the observation that the handshapes that may occur on h2 in h2-P signs are a subset of those that may occur on h1, just as the vowels that may occur in weak (dependent) syllables are a subset of those that may occur in strong (head) syllables.

This theory, developed on the basis of spoken language, provides the foundation for a model of the phonological structure of signs in general (van der Hulst 1993) and for that of two-handed signs in particular (van der Hulst 1996). Provided in (8) are representations of h2-S ("balanced" two-handed) and h2-P ("unbalanced" two-handed) signs, respectively, in the dependency model, slightly simplified. In the first representation, explanatory terms are added in parentheses for clarity.

(8) a. Dependency model representation of h2-S ("balanced") signs (van der Hulst 1996)



b. Dependency model representation of h2-**P** ("unbalanced") signs (van der Hulst 1996)



We cannot provide a detailed discussion of this model and its motivations here, as it would take our eye off the h2 ball, the topic of this chapter. Instead we describe only the general architecture of the model and then focus on the representation of h2.

This model represents a typical sign as branching off from a single root node at the top of the tree. The two main branches of structure are place (P) and hand or articulator (A). As the hand is more likely to spread or change in a sign, a property typical of dependents, it is hypothesized that hand is dependent, and place is the head. Manner (M) corresponds to movement in other models, and is deemed equivalent to spoken language manner features such as [continuant]. The model does allow for sequential timing units, however, represented as X slots with which phonological elements are aligned. Here, the settings are aligned with sequential X slots to create a path movement.

Let's now focus on the representation of the non-dominant hand. In both h2-S signs and h2-P signs, h2 is represented as a dependent of h1. In h2-S signs, the two hands (A) are coindexed, indicating that they are essentially the same in shape and articulation. In h2-P signs, h2 may optionally be further specified for its own handshape features, and the place branch of structure also specifies that h2 is the place of articulation. That is, in h2-P signs, the non-dominant hand is represented in two different places in the hierarchy, once as an articulator (A), and once as a place (P).

[illegible]

While each theory has points in its favor, each has undesirable consequences as well. We synthesize here what we see as advantages and disadvantages for each theory and its claims (see also van der Hulst and Sandler 1994), and go on to argue in favor of only one of them in Section 12.4.

The main advantage of the two-role (HT) theory is that it reflects the generalization attested to by the grammar that there are basically two types of two-handed signs, and that h2 behaves differently in each type. In h2-S signs (h2 has the same shape and same movement as h1), it behaves like h1 in the morphophonology, e.g., in processes like Characteristic Adjective and different types of spreading in lexicalized compounds. In h2-P signs (where h2 often has a different configuration from h1 and is normally static), h2 behaves like any place of articulation, remaining static and not affected by morphophonological processes affecting h1.

The disadvantage of the two-role model is that it does not predict that there will be any phonological interaction whatsoever between the two hands in h2-P signs. We have seen that there is such interaction, though marginal, diachronically. A few h2-P signs in ASL have become h2-S signs, and the handshape of several h2-P signs which were once different from the shapes of h1 have taken on the same shape as h1 over time. It is reasonable to hypothesize that many of these signs were originally asymmetrical in handshape and changed over time, a situation which appears anomalous in the two-role representation.

The advantages and disadvantages of the one-role theory are the mirror image of those of the two-role theory. The main advantage of the one-role theory (Dependency model of van der Hulst and Prosodic model of Brentari) is that it does reflect the fact that h2 may be influenced by h1 regardless of the type of two-handed sign it occurs in, i.e., even when h2 functions as a place of articulation.

In only one case has it been argued (by van der Hulst) that the actual phonological behavior of h2 in the distinct sign types might be collapsed – in the assimilation of h2 in compounds where the second member is an h2-S sign, and the spreading h2 in compounds where the second member is an h2-P sign. But this suggestion fails on closer examination. First, the details of the spreading are quite different in the two processes: one results in assimilation of handshape and orientation (shown in Figure 10.13); the other does not affect hand configuration at all, instead affecting only the timing of the appearance of h2. Not even the Dependency model can represent these two phenomena in a single coherent rule. In addition, the particular rule of hand configuration assimilation that assimilates orientation together with handshape applies only to compounds. The spreading behavior of h2 in h2-P signs is a different rule, applying at a higher prosodic level, as we show in Chapter 15, Section 15.2.

Another disadvantage of the one-role model is that it is actually a closet two-role model which forces a redundant representation of h2 in h2-P signs. In the representations in (8)b, h2 appears both under the articulator node and under the place node. This is disadvantageous insofar as it makes the unmotivated prediction that h2 will normally behave both like h1 and like a place in the same sign.

Each of the two main schools of thought captures complementary generalizations, and neither offers an account of all of the data. We suggest that the reason for this complementarity in the two theories is a battle between the phonetics and the phonology of sign languages. Phonetically, there are two anatomically identical articulators, whose activity is motorically coordinated (Blevins 1993). This leads to certain symmetries, such as the existence of h2-S signs in the first place, assimilation of shape between the two hands, and diachronic overlap of function, emphasized in the Prosodic and Dependency one-role models. But phonologically, the system allows only one major articulator, possibly due to some abstract organizing principle that is at work regardless of physical modality (see Gijn et al. in press). The Hand Tier two-role model reflects the relevant generalization: when h2 is an articulator, it must be largely redundant; elsewhere, it's not an articulator at all. We view the generalizations motivating the two-role model – i.e., the behavior of h2 in lexical rules – as more phonological in nature, while those motivating the one-role model – e.g., diachronic interaction between the two hands – as reflecting the phonetics of the system. For these reasons, we opt for the two-role theory and the Hand Tier representations in (4) and (5) as a phonological model of h2.

What is missing is a detailed and well-motivated *phonetic* model of the sign in sign language that is phonologically informed, along the lines of the model of spoken language developed by Browman and Goldstein (1989). Such a model, and the research required to develop it, will help to better understand the interaction of the two hands.

This interesting disagreement should not obscure the consensus view that h2 is not an independent phonological element within the ordinary words of the ASL lexicon. That is, despite the fact that signed languages have at their disposal two anatomically identical articulators, the phonology of the *words* of the language only exploits one major articulator: the dominant hand. Considering the fact that spoken language has only one major articulator, the tongue, this generalization about sign language may reveal a fundamental modality-free organizing principle (Perlmutter 1991).[13,14]

[13] Spoken languages have additional articulators (e.g., the lips and the pharynx; see McCarthy 1988), but the tongue is certainly predominant.

[14] The model of Liddell and Johnson is an exception, however, as it implies that h2 is an independent articulator, and therefore misses the generalization that the behavior of h2 is far more constrained than that of h1.

At the beginning of the chapter, we mentioned the assumption that the human organism is likely to make full use of the articulatory system at its disposal – predicting that both hands would be exploited by the system. And, despite the modest role of h2 in the lexicon, this expectation does not go unfulfilled. In fact, the non-dominant hand performs important tasks elsewhere in the grammar of sign languages: at the levels of discourse and of prosody. An example of the former is the role of h2 in classifier constructions, where it has morphemic status and phonological independence from the dominant hand (see Chapters 5 and 15, respectively). Within this system, the non-dominant hand may represent some referent with respect to which the dominant hand can interact throughout a whole chunk of discourse (see Chapter 6, Section 6.1). Even outside the classifier subsystem, the non-dominant hand can act like a secondary dominant hand for certain discourse effects, maintaining the hand configuration of a lexical sign that simultaneously backgrounds some aspect of a discourse. In such cases, the signal is carrying more than one word (or classifier morpheme) simultaneously.[15] The second grammatical role played by the non-dominant hand outside the lexicon is in the prosodic system. There, it delineates prosodic constituents at two levels of the prosodic hierarchy. This function of h2 is examined in detail in Chapter 15.

By contrasting the active role of h2 in other areas of the grammar with the redundancy that it exhibits in words of the lexicon, we arrive at an interesting hypothesis (Sandler 2002). The predictability and redundancy of h2 in sign language words may provide a perceptual cue to wordhood within the language, offering a significant advantage for language acquisition and for language processing.

[15] Other interesting ways in which h2 behaves independently at the level of discourse are discussed in Padden (1988 [1983]), Frishberg (1985), Zimmer and Patschke (1990), Brentari and Goldsmith, (1993), and in Emmorey and Falgier (1999).

13 Movement

All signs have movement in them – either a path made by the hand or hands as they go from one location to another, a change in handshape, a change in orientation, or some combination of these (Wilbur 1987, Stack 1988, Brentari 1990). In the classifier subsystem (introduced in Chapter 5), there is a sizeable inventory of movements, and a rich array of combinatory possibilities, both simultaneous and sequential. In words of the lexicon, the main focus of this chapter, the inventory of path movements is far more limited, and the possibilities for their combination strictly constrained. Yet they are part of the system, not only phonetically, but phonologically and morphologically as well, and many models of sign language phonology treat movement as an important phonological property of signs (e.g., Stokoe 1960, Liddell and Johnson 1989 [1985], Sandler 1989, 1993d, Brentari 1990, 1998, Perlmutter 1992, Wilbur 1993, 1999a). These investigators are in agreement about the importance of movement, but not about the way in which it is integrated into the phonology of sign language, and the following questions remain unresolved: how is movement instantiated in a sign, and how should it be represented in a model of sign language? Do movements constitute a sequential segment type, or do they characterize the sign as a whole? Are they like vowels, carrying the sonority of the sign language syllable?

The issue is especially interesting because movements, especially path movements, are often redundant; i.e., they are often no more than straight paths between two locations. This redundancy has even led some researchers to make different claims, either that movement is non-existent at the underlying level altogether (Nagahara 1988, Stack 1988, Hayes 1993, Uyechi 1996, Osugi 1997) or that it should not be considered a phonological primitive (Miller 1991, van der Hulst 1993, Channon 2002a, 2002b). Following Ahn (1990) and Wilbur (1993), van der Hulst (1993) proposes that all features that define the type of movement present in a sign belong to the category Manner, represented as characterizing the whole sign rather than as a sequential segment. Channon (2002a, 2002b) also refrains from representing movement as a segment type. In fact, her model takes the extreme position that the canonical monomorphemic sign has no internal sequential structure, that it is unisegmental.

The position to be supported here is that movements do exist as a phonological category, that their sequential position should be reflected in the representation, and that they define the sign language syllable. The first two of these issues are dealt with in this chapter; the syllable and the comparison of movements with vowels are taken up in Chapter 14. We begin by describing some common movements, and then provide some arguments for movement as a phonological category. After that, evidence for the sequential status of movements will be presented, completing the arguments for the model we adopt. A different model is then described, one that also assigns an important role to movement, but that motivates a non-sequential representation of the category – Brentari's Prosodic model. That model, which integrates all types of movement into one of the two major branches of structure in the sign, is contrasted with the LML model we adopt here. A summary and conclusion provide a transition to the next chapter, which focuses on syllables.

13.1 The movement category: preliminary description

The main kinds of movement found in lexical signs are path movement and internal movement. The latter can be broken down into handshape change and orientation change. These types and their combinations are illustrated in Figure 13.1. The examples are from ISL, but are typical of ASL and other sign languages as well.

The shape of path movements can be straight, arc, or, in ASL, '7,' the last used almost exclusively for initialized city names. Circling movement is considered a movement type by some researchers; others analyze circles as consisting of a sequence of arcs with different values for concavity (Sandler 1989, 1990, Corina 1990b). Different types of handshape and orientation changes result in an inventory of internal movements, such as hooking, flattening, releasing, squeezing, rubbing, twisting, nodding, circling, and swinging (Stack 1988, van der Hulst 1993).

Another kind of internal movement, called secondary, oscillating, or trilled,[1] involves uncounted rapid repetition of handshape or orientation change, or else finger wiggle.[2] Like the other kinds of internal movement, secondary movement may also occur either together with a path movement, or by itself, as shown in Figure 13.2.

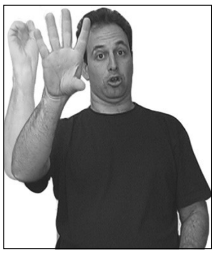
[1] The term "trilled movement" was coined by Padden and Perlmutter (1987), who include in this category not only trilled internal movements as we do here, but uncounted, rapidly repeated path movements as well.

[2] Signs with secondary movement (rapidly repeated handshape change or orientation change) and no path movement (BIRD in Figure 13.2) are decidedly more common in ASL than in ISL, where they are hard to find at all. Finger wiggle is also more common in ASL than in ISL.

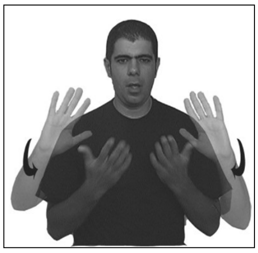
AT-THAT-MOMENT (ISL)
a. Path movement

TAKE-ADVANTAGE-OF (ISL)
b. Handshape change

DEAD (ISL)
c. Orientation change



SEND (ISL)
d. Path movement plus handshape change

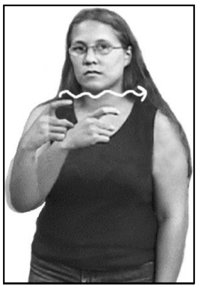


FAST (ISL)
e. Path movement with orientation change

Figure 13.1 Movement types

BUG (ASL)

a. Secondary movement: rapidly repeated finger curving



WORM

b. Secondary movement with path movement

Figure 13.2 Secondary movement with and without path movement

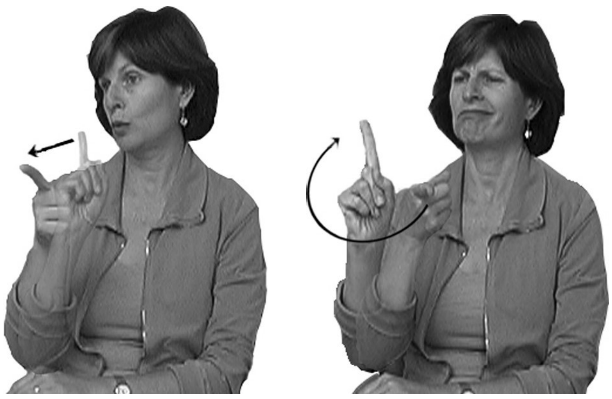
Perhaps the most fundamental argument for the significance of movements is this: signs are not well formed without them (Wilbur 1987, Stack 1988, Brentari 1990). This is important because of the surprising fact that it is phonetically possible to pronounce many, perhaps most, signs without their flowing straight or arc movements, and even to do so in a sequence, connecting them only with transitional movements in between. Normally, only one or two features of the setting, [hi]/[lo], [proximal]/ [distal], or [ipsilateral]/ [contralateral], distinguish the first location from the last, so that the meaning of the sign would probably be retrievable if one setting is deleted and with it the sign's movement. Such movementless signs can be strung together into sentences, connected only by phonetic transitional movements, and can even be quite intelligible, though annoying to signers (p.c., Ted Supalla). No natural sign language we know of makes general use of such signs. The movements in the signs of natural sign languages are an intrinsic part of the sign. Phonetically, these movements are different from transitional movements, and phonologically, they carry both lexical and morphological contrasts.

13.2 Evidence for a movement category

One way of determining the nature of the movement within a sign phonetically is by comparing it with transitional movements between signs. A measure that has been applied is the tracking of handshape change in signs that have both path movement and handshape change, and comparing that change to transitional handshape changes occurring during the movement between signs. This measure determined that the timing of the handshape change in ASL is systematically more evenly distributed across the co-occurring path movement within signs than between them (Brentari and Poizner 1994, Brentari, Poizner, and Kegl 1995). These findings provide phonetic evidence for distinguishing lexical from transitional movement. According to Brentari (1998), this result also unifies handshape change and path movement in a single movement category, a point to which we will return.

There is phonological evidence for lexical movements as well. The next several arguments are from Sandler (1996b). First, movement features can be contrastive. The ASL minimal pair YOU and INSULT, for example, illustrated in Figure 13.3, is distinguished by movement features. Partial representations of these signs are given in (1). As we explain below, the feature [straight] is the unspecified default movement feature.[3]

[3] In addition to the shape of the movement path, there are other small differences in the articulation of YOU and INSULT, such as the direction in which the fingertip is facing and the orientation of the hand. These features are all clearly connected phonetically



YOU INSULT

Figure 13.3 Two ASL signs distinguished by path movement features

(1)

```
  YOU          INSULT
L  M  L       L  M  L
   |             |
   |             |
[straight]   [convex arc]
```

A minimal pair in ISL distinguished by arc shape is NEXT-YEAR (concave) and THIS-YEAR (convex), pictured in Figure 13.4. Single movement in a sign is sometimes contrastive with lexically specified double movement, as in (ISL) LUCK (single movement) and LOAN (double movement), shown in Figure 13.5.

Another argument for a movement category in ISL specifically comes from the behavior of movement features under inflection for multiple agreement. ISL verbs specified for any feature belonging to the class of movement features, [arc, tense, restrained], are subject to a constraint that blocks the multiple agreement inflection (Sandler 1996b). [arc] is a shape feature; [tense] means muscle tension in producing the movement; [restrained] refers to shortened and doubled movement, and is specified in all signs that are lexically (not morphologically) reduplicated (like (ISL) LOAN above).

ISL verbs that take singular agreement marking also take multiple agreement marking, characterized by a horizontal arc, as illustrated for the sign SUPERVISE in Figure 13.6a and 13.6b. This process takes place *unless* the verb base is specified for a movement feature, like the sign GUARD in Figure 13.6c, specified for [restrained] movement. That is, GUARD is an agreeing verb (see Chapter 3, Section 3.2), but does not take the multiple marking because it is underlyingly specified for a movement feature. Since both the blocking features and the blocked feature ([horizontal arc]) are features that characterize movements, it can be argued

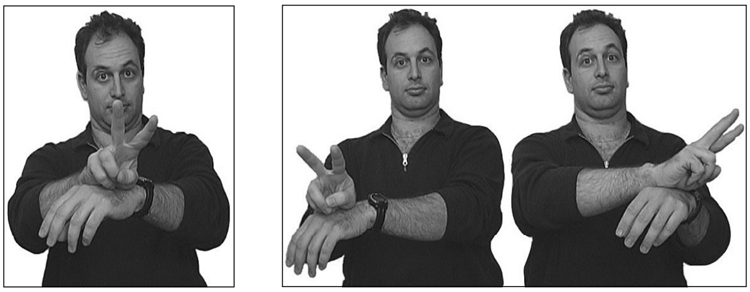
(see Chapter 10, Section 10.4.2 for relevant discussion), but a fully satisfactory analysis of their interrelation and (under-) specification awaits further research.

a. NEXT-YEAR (concave) (ISL) b. THIS-YEAR (convex) (ISL)

Figure 13.4 Minimal pair distinguished by arc shape

a. LUCK (one movement) (ISL) b. LOAN (two movements) (ISL)

Figure 13.5 Minimal pair distinguished by number of movements



a. SUPERVISE (uninflected) b. SUPERVISE-ALL (multiple form)

c. GUARD (uninflected)

Figure 13.6 Evidence for a movement category: lexical double movement in GUARD blocks the multiple form that the relevant constraint here refers to a phonetically unified movement category (Sandler 1996b).

While the multiple form on signs specified for movement, like GUARD, is blocked, it is possible to pronounce it, either by rearticulating the specified movement across the horizontal arc, or by coalescing the two types of movement together, which result in more complex path movements. Apparently, it is this complexity of movement that is being avoided. These arguments are based on ISL, but there is some indication that ASL behaves the same way. ASL multiple agreement takes a similar form to that of ISL, and, while not all movement features have been checked in verbs of that language, Padden (1988 [1983]) reports that one of them, the feature [arc], blocks multiple agreement inflection in ASL, as it does in ISL.

Further research on all proposed movement features is called for. But the weight of the evidence presented suggests that these generalizations must be stated on a phonological movement category of some type, arguing against proposals that deny the existence of such a category.

Phonologists who accept this view have proposed different types of representations to accommodate it. There are essentially two camps: those who think that movement should be associated with a sequential position in representations, and those who do not.

13.3 Representation of movement as a sequential segment

Models that propose a sequential position for movements are the MH model (Liddell and Johnson 1989 [1985]), the Hand Tier model (Sandler 1989), and the Moraic model (Perlmutter 1992, 1993). These researchers adopt the sequential theory of sign language structure described in Chapter 9, Section 9.2. In all three models, there are two major segment types, those that move (Ms in all three models) and those that don't (holds, locations, or positions, respectively). There are differences among the models in the way in which an element qualifies as a segment, especially a non-movement segment, and we abstract away from those differences here.

One argument for representing movement as a sequential segment type is the distribution of the feature [contact]. This feature may occur on either location segment (creating either an initial contact or a final contact sign), on the movement segment of a sign (creating a so-called brushing movement), or on all segments (for so-called continuous contact), as illustrated in Figure 13.7 and represented in (2).[4] This distinction

[4] See Channon (2002a) for a discussion of the distribution of [contact] within a monosegmental model of the sign.

a. NUDE
Contact during movement

b. SHINY
Contact on first location

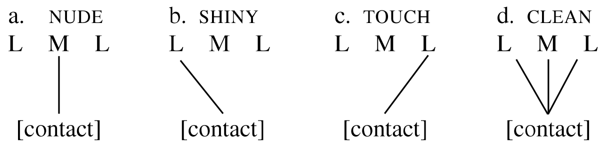
c. TOUCH
Contact on second location

d. CLEAN
Contact on all segments

Figure 13.7 ASL signs with discrete contact on one location segment, a movement segment, or all segments

is argued to support both the existence of a sequential movement segment as well as a sequential representation of movements and locations (Sandler 1989).

(2) Representations of signs with contact on:
a. the movement segment (NUDE)
b. the initial location (SHINY)
c. the final location (TOUCH)
d. all three segments (CLEAN)



Another argument for the validity of a movement category is the fact that movements must be referred to by morphological operations. For example, in Israeli Sign Language, the movement segment is geminated (temporally lengthened) in the intensive form of verbs and adjectives, as represented in (3a) (Sandler 1993b), resulting in a movement that is longer in duration. In the same language, the final location is lengthened in the continuative form, shown in (3b), resulting in a geminated location, i.e., a hold.

GO-UP-IN-FLAMES (ASL)

Figure 13.8 A sign with path movement and secondary movement (reprinted with permission from Perlmutter 1993)

(3) Gemination in two ISL forms

a. Movement in Intensive

```
L  M  L        L M M L
   |      →     \ /
  [F]           [F]
```

b. Location in Continuative

```
L  M  L        L  M  L  L]redup
      |    →           \|
     [F]               [F]
```

In ASL as well, characteristics of movements are contrastively altered in the temporal aspect system (Klima and Bellugi 1979, Newkirk 1981) and in certain adjectival derivations. For example, the feature [arc] is added (among other changes) to the movement segment to derive Characteristic Adjectives as well as the Durational and Continuative aspects (Sandler 1990, 1993d).

The distribution of secondary movement under phrase-final lengthening, described by Perlmutter (1992, 1993), provides another argument in favor of an M segment. He observes that secondary movement, such as rapid repetition of handshape change or wiggling of the fingers, co-occurs with the path movement in any syllable that has a path movement, as in GO-UP-IN-FLAMES, Figure 13.8. But signs without path movement may also be characterized by secondary movement. The wiggle or other secondary movement is associated with the static location in such signs as GERMANY, shown in Figure 13.9.

Under phrase-final lengthening, accounted for by mora insertion in Perlmutter's analysis, the secondary movement persists on the lengthened segment in signs with no path movement (P(osition)-only, using Perlmutter's notation), but not in PMP (LML) signs.[5]

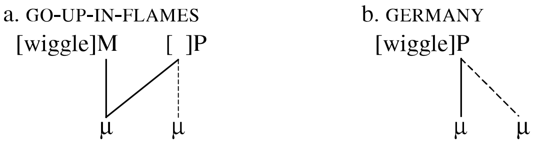
[5] Perlmutter represents GO-UP-IN-FLAMES as MP. According to the analysis of location in Chapter 11, this sign has the form LML (equivalent to PMP in Perlmutter's model). This difference does not affect the point made here, because in both representations, the sign ends with a non-movement segment.

GERMANY (ASL)

Figure 13.9 A sign with secondary movement only (reprinted with permission from Perlmutter 1993)

According to the analysis, this behavior can be explained by associating secondary movement with the M segment in signs like GO-UP-IN-FLAMES, and with the P segment in signs like GERMANY. The process is shown in (4).

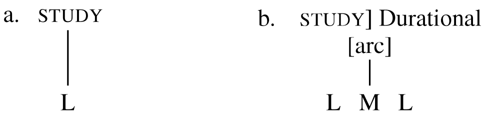
(4) Phrase-final lengthening (adapted from Perlmutter 1992)



These phenomena are made clear by a sequential representation that includes movements.

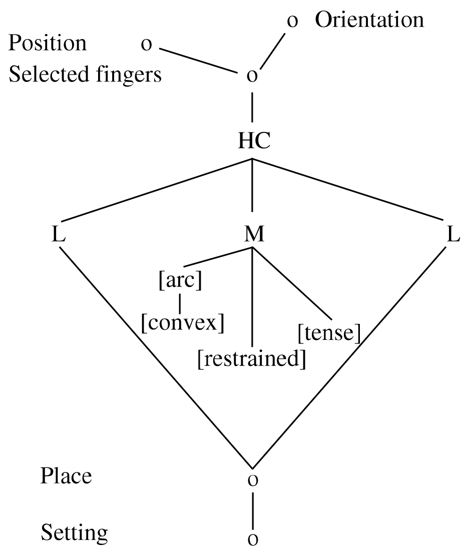
Finally, some temporal aspects in ASL augment signs that have no internal movement underlyingly to fill an LML template in which the movement is prespecified with an arc movement, as illustrated in Chapter 3, Section 3.3. Such signs, like STUDY or DIRTY (formally similar to GERMANY) when not inflected for aspect, have finger-wiggle-internal movement but no path movement, and they are represented with only one L segment, as shown in (5)a. Under continuative, they take the form in (5)b.

(5)



The evidence presented indicates that there is such a thing as a movement category and that typical signs have path movements situated sequentially between two locations, as shown in (6). In the spirit of Sandler (1995c, 1996a) and the model set out in Chapter 10, Section 10.4, we leave out two default features from the representation: [straight] and [concave]. We assume that [straight] is the default path shape, so that a sign with a straight path movement will have no feature represented. If [arc] is the shape, we assume that [concave] is the default arc shape. The marked feature [convex] is represented as a dependent of [arc].

(6) Path movement in the Hand Tier model



13.4 Another proposal: movement as prosody

The Prosodic model of sign language phonology views movement as the principle determinant of class membership within a sign, but unlike the Hand Tier model, the Prosodic model denies it any sequential position in the representation (Brentari 1998). In the theory behind the Prosodic model, movements are considered very important, providing necessary salience to the sign. Brentari offers additional phonological arguments for a category that unifies path and internal movement. One is the uniform behavior of internal and path movement in the morphological process of Delayed Completive. In Chapter 9, Section 9.2, it was shown that the Delayed Completive morpheme is a sequence of two elements: first, finger wiggle (or tongue wag), and second, a mouth movement corresponding to the spoken syllable *op*. The wiggle or wag is aligned with the first segment or timing unit of the base sign, while the mouth movement distributes itself over the lexical movement of the sign – crucially, regardless of whether that movement is path or hand internal.

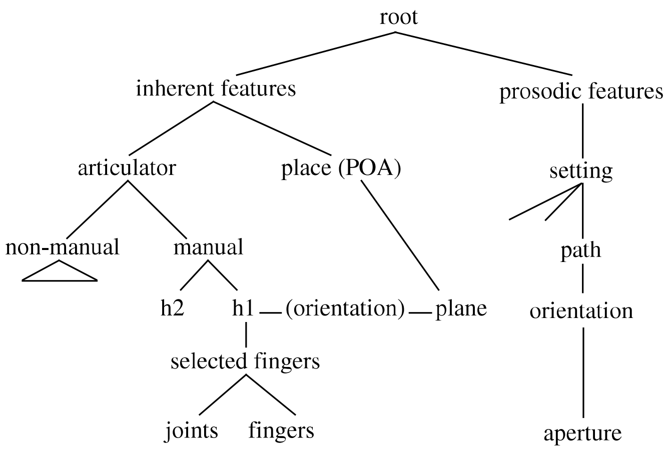
This is compelling evidence for sequential structure as well as for a movement category that includes both path and hand-internal movement, especially in light of the fact that either type of movement is sufficient for the well-formedness of a sign. The theory behind the Hand Tier model also recognizes path and internal movement as a single category, but does not represent it in a unified way in the model. The Prosodic model adopts the position that movement should be represented as a unified category.

In order to unify the representation of movement, Brentari's Prosodic model divides the phonological features of ASL into two major categories: (1) inherent features, all features that characterize the whole sign and have no internal sequencing or other dynamic quality; and (2) prosodic features, those that result in movement on the surface. In some cases, following Wilbur and van der Hulst, movement falls out from sequencing of features. Specifically, there are the finger position handshape features, orientation features, and setting features of location. The two features that do not involve sequencing in the Prosodic model but are still considered prosodic features are the path features of direction (toward or away from the place of articulation) and of tracing (following some other path with respect to the place of articulation, such as the arc path traced by the hand in neutral space in front of the body, in the ASL sign RAINBOW).[6]

The representation proposed in the Prosodic model is shown in (7). For clarity, we have chosen a partial representation, including only main feature classes but not including either smaller classes (such as joints and fingers under the h1 articulator node) or terminal features (such as [all] under the finger node). The main innovation of the Prosodic model is the division made in the model between static ("inherent") and dynamic ("prosodic") properties of signs.

[6] Brentari (1998) proposes the following movement features for ASL: [direction], [tracing], [pivot], [repeat], and [alternating]. Behind Brentari's feature inventory lies a different analysis of the underlying properties of signs from that of Sandler's Hand Tier model. For example, the inventory proposed by Brentari includes a [direction] feature, motivated by an asymmetry in movement under reduction in compounding. Some simple path movements do not delete in compounds, while other phonetically identical ones do. On this basis, Brentari argues that the signs that reduce (often but not always signs with final contact) have no underlying movement and that the surface movement in such signs is epenthetic. Those signs that block reduction in compounds are assigned the movement feature, [direction]. See Brentari (1998) for motivation of movement features in the Prosodic model. In the Hand Tier theory, all movements along a path are represented the same way: as setting changes.

(7) The Prosodic model with branching setting features for one type of path movement (adapted from Brentari 1998)



In this model, categories and their features are separated from the movement that they articulate. Place is segregated from setting in different branches of structure; inherent orientation from orientation change,[7] and finger position (joints, fingers) from handshape change (aperture change). Articulators and their configurations are thus segregated from the movements they make. A further characteristic of this model is that path movement is seen as independent of setting change, a point we will return to below.

One of the ways in which signs are made more prominent serves as a central motivation for the model. Under certain discourse conditions, path movement and hand internal movement can be added to one another and/or substituted for one another.[8] In general, to make the movement of a sign more prominent, e.g., for public signing or emphasis, a larger movement is made by producing the movement from a joint closer to the body. For example, a sign whose citation form involves movement at the elbow will substitute movement at the shoulder for more prominence. Movement at either joint results in path movement, so the observed path movement in itself does not constitute an argument in favor of collapsing the two. But a sign that involves movement at the wrist, which can articulate an orientation change, a kind of internal movement, can also be enhanced by substituting movement at the elbow, changing such a sign into one with path movement instead.

[7] In the Prosodic model, orientation is conceived of and represented in two ways. Inherently, it is seen as a relation between hand part and the plane of articulation. It is also represented in the prosodic branch with features such as [supination], [pronation], etc., if there is an orientation change in the sign being represented.

[8] Some of these alternations were first observed and analyzed by Corina (1990a, 1996).

a. UNDERSTAND (ASL)

b. UNDERSTAND ('enhanced') (ASL)

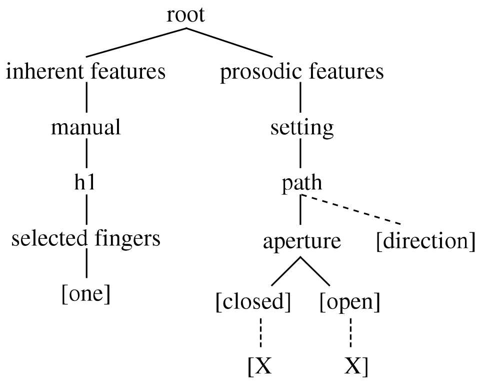
Figure 13.10 Process adding path movement to internal movement for emphasis

Alternatively, a sign that in citation form involves movement at the elbow, can be made less prominent under certain discourse conditions, reducing to movement at a joint more distal from the body instead, such as the wrist, resulting in a visibly smaller sign. In the latter case, path movement becomes internal movement, or, in other words, a change in orientation or handshape features may replace a change in setting features, while all other features are kept constant. Since these alternations appear to be systematic, it follows that these changes involve the same sort of features – movement/prosodic features – and Brentari argues that the representation ought to be able to reflect the fact that the features belong to one and the same category, while facilitating statement of the rules involved in the alternations.

For example, the (ASL) sign UNDERSTAND is shown in Figure 13.10 in its citation form (a) and in its more prominent form (b). In citation form, there is an opening handshape change and no path movement. In the emphatic form, a path movement is added. To achieve this, an association line is added, linking a direction feature to the path node.[9] Extrapolating from Brentari's model and discussion, we assume the process would look like (8). The Prosodic model recognizes sequential structure, adopting van der Hulst's two X timing slots for anchoring the branching features.

[9] Direction features are also used to represent verb agreement in the Prosodic model (Brentari 1998).

(8) Addition of path movement by associating a [direction] feature in the Prosodic model



A set of translation statements is expected to be worked out, which will govern relative prominence operations, saying, for example, that an opening handshape change is made more prominent (enhanced, in Brentari's terms) by a path movement away from the place of articulation. In this example, the model succeeds in unifying path and internal movement features, both within the representation of lexical forms, and in its ability to express the relationship between more and less prominent signs. The example of relative prominence shows that the relationship between path and internal movement features and their interaction are natural within this model, all represented in the prosodic category, an advantage for the model.[10]

The segregation of prosodic and inherent features from one another is not without cost; that is, the internal organization of categories like hand configuration and place is disrupted in the Prosodic model, which divides up the pie primarily on the basis of movement. In order to evaluate the model, both its motivation and the implications of its organization of feature categories must be gauged.

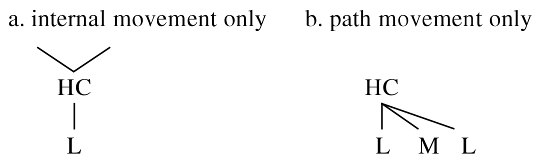
13.4.1 Discussion

The Prosodic model represents both path and internal movement in the same branch of structure. This is a plus for the model, as there are good arguments for considering movement to be a unified category. The two types of movement are not formally integrated in the Hand Tier model, which represents internal movement as branching structure in the hand configuration category, and path movement as an M position on the

[10] Whether or not this relative prominence is a matter of sonority, as Brentari claims, is a separate question. We will argue in Chapter 14, Section 14.6 that it is best understood not as sonority but as the sign language equivalent of loudness.

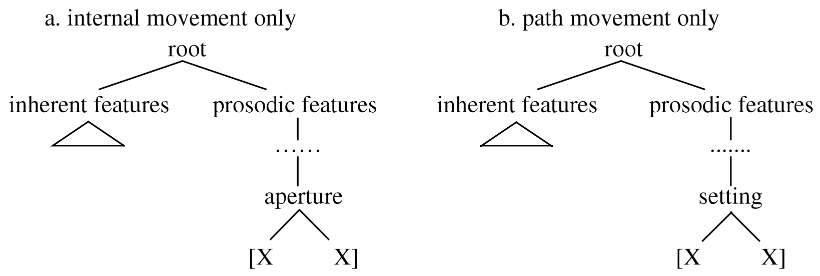
segmental tier, as shown in (9).[11] A sign with both path and internal movement is a combination of these; it has LML structure as well as a branching finger position or orientation node.

(9) Two Hand Tier representations



In the Prosodic model, each type is represented under the prosodic features branch of structure, as shown in (10).

(10) Two Prosodic model representations



We now consider Brentari's empirical arguments for unifying path and internal movement structurally. The distribution of the two parts of the Delayed Completive morpheme is presented as one argument. While Brentari does not offer a representation of this process, she explains that the wiggle or wag would associate to the first X slot. But the unelaborated non-manual node in the Prosodic model, appearing as it does in the inherent branch of structure, makes the wrong predictions about the Delayed Completive. As an inherent feature, the *op* non-manual unit in Delayed Completive is predicted to characterize the whole sign instead of just the attested second syllable. Therefore, at least until the non-manual component is worked out, the representation of the Delayed Completive cannot be considered an advantage of the Prosodic model and does not help us choose between the two models.

[11] The representation of signs with internal movement but no path movement in (5a) and (9) is true to the original Hand Tier model. In a paper on a sonority cycle in ASL, Sandler (1993d) makes a change in the model, proposing that not only signs with path movement have an M segment, but that signs with some types of internal movement and no path movement do as well, contra the earlier Hand Tier model. We hesitate to accept that revision here, because it obscures the distinction between signs with and without path movement. Also, as there seems to be a conspiracy in favor of path movement (see Chapter 14), we wish to leave that distinction encoded in the representation for clarity, as in (9).

Another phenomenon that figures prominently in motivating the Prosodic model is the range of alternations created by generating the movement at different joints, in other words, differences in the size of the movement. We will argue in Chapter 14 that these alternations are phonetic, and that they are directly comparable to loudness in spoken language. On that interpretation, they do not reflect a phonological property, and therefore do not constitute an advantage for the Prosodic model.

The most convincing argument in favor of unifying path and internal movement is that each of them makes a sign well-formed, constituting something like a syllable nucleus. In this regard, the Prosodic model offers the aesthetic advantage of putting both types of movement in the same branch of structure. And if movement defines the syllable, a claim we support in the next chapter, then there should be some way to identify this movement, whether it is internal or path, and the introduction of a prosodic branch of structure is a way to do this. This choice has consequences, however. It results in a bifurcation of the categories of hand configuration and place. What is the effect of this organization?

The inherent features of handshape (in the articulator category of the inherent branch of structure in the Prosodic model shown in (7)) include those that distinguish open and closed finger positions by specifying the relevant joints and whether or not they are flexed. In signs with handshape change, the prosodic features specify the same properties with the features [open] and [closed]. There is a certain amount of redundancy here, and with it a missed generalization: that it is the finger positions that change in handshape change.

Another generalization that does not find expression in the Prosodic model is the unity of handshape change with handshape in phonological processes. For example, recall that under total hand configuration assimilation, selected finger, finger position, and orientation features all spread together. Where there is internal movement, represented by branching position or orientation features in both models, then that movement assimilates as well, as in the sign MIND^DROP = FAINT (see Figure 10.11). The Hand Tier model represents assimilation of this kind simply by spreading at the hand configuration node, as shown in example (6) of Chapter 10, Section 10.2.3. This process can't be represented in a unified way by the Prosodic model because the relevant features are in two different branches of structure: the inherent finger and joint specifications are under the inherent feature branch, while the [closed][open] handshape change features are under the prosodic feature branch.

According to common representational conventions, the organization of the Prosodic model raises the expectation that the prosodic features should spread or be affected as a group. This expectation does not appear to be borne out, although they do interact with one another in the "enhancement" effects, to which we have promised to return in the next chapter. In this sense, the Prosodic model implicitly rejects the central motivation for feature geometry, and with it, the phenomena that it explains. According to the theory of feature geometry, grouping features in a single branch of structure predicts that they are affected together in rules and/or constraints. The explanatory power of the theory lies in the linkage between the anatomical organization of the articulators and the phonological behavior of the features they control (Clements 1985, Sagey 1986). That is, the features assume an organization that mirrors that of the physical structures that articulate them, and their spreading and deletion as a group confirms both the class status and the hierarchical organization among classes so represented (see Chapter 10, Section 10.2). The geometry of hand configuration in the Hand Tier model achieves this theoretical goal, as argued at length in Sandler (1989). The fact that generalizations such as these are lost in the Prosodic model is a drawback.

Finally, by representing movement as a branch of structure, the Prosodic model rejects the notion that M is a type of sequential segment, as claimed by Sandler, following Liddell and Johnson. The primary generalizations captured by the sequential movement representation of models like the Hand Tier model are prosodic. First, positing an M segment makes perspicuous the timing differences introduced by various morphological operations. As shown in (3) above, ISL morphology distinguishes between gemination of movement and gemination of location. Second, as we explain in more detail in the next chapter, ASL (at least) clearly favors an LML structure in its signs (Sandler 1989, 1993d, 1999b). Other structures – that is, signs with internal movement only and no path movement, represented as just L, as well as longer signs with more than one syllable – often expand or reduce in the direction of the canonical LML template, as we will show in Chapter 14. This distinction is encoded by the Hand Tier model with an M timing slot for each path movement, but is obscured in the Prosodic model.

Another argument for LML structure is the distribution of [contact]. The feature may characterize the first location, the last location, or the movement, or it may alternatively characterize all three, in signs with so-called "continuous contact," as shown in example (2) of Section 13.3 above.[12] Representing contact on the first location in SHINY and the last in TOUCH is a perspicuous representation of the temporal distribution of this feature. Similarly the most coherent representation of signs like NUDE, in which the contact takes place during the movement from one

[12] Van der Kooij (2002) suggests that the feature [contact] may be eliminated from the phonology in Sign Language of the Netherlands. This does not seem to be an option for ASL, which refers to [contact] (a) in distinguishing the sign types presented in this chapter (Sandler 1989), (b) in determining allophonic variation of handshapes (Wilbur 1987), and (c) in predicting which elements will delete under compound reduction (Liddell and Johnson 1989 [1985]).

location to another, is simply to specify the feature [contact] on the movement segment, as the Hand Tier model does.

Because of the coherence of the feature geometry, the ability to distinguish path movements from other movements, the perspicuous representation of the distribution of [contact], and the possibility of representing movement length and other movement features needed for prosodic templates, the Hand Tier representation is adopted here.[13]

13.5 Movement in words is constrained

Before leaving the topic of movement, we wish to draw attention to an instructive contrast between the restricted role assumed by movement in words of the sign language lexicon and its form and use in more expressive aspects of sign languages, like classifier constructions and poetry. We suggest that this difference is another indication of the special status of words.

The classifier subsystem (Chapter 5) exploits a rich variety of movement shapes, such as upwards arc, pivot, and zigzag, as well as movement manners, which manipulate speed, size, and rhythm – each argued to have morphemic status in ASL. These possibilities are finite and constrained according to Supalla (1982, 1986), but both the primitives and their combinations are far more numerous than the movements of lexical signs.

In poetry, the movement parameter is also used in a versatile way for artistic effect. For example, consider a haiku performed in sign language in the film, *The Human Language*.[14]

Since my house burned down,
I now have a clear view
Of the rising moon.

In presenting the poem, the signer signs the burning down of her house by violent whirling motions which gradually diminish and fade like the fire itself. Expressing hope and wonder in the face of this devastation, she then signs MOON-RISE very slowly, denoting the rising of the moon over the now flattened landscape. Without these possibilities for producing a wide range of movement shapes and rhythmic variations, sign languages lose some of their expressive power.

However, once movement assumes a role that is phonological, rather than either morphological or poetic/affective, its inventory is drastically reduced (see also Wilbur, Klima, and Bellugi 1983). This bifurcation is reminiscent of the behavior of the non-dominant hand (Chapter 12). There we explained that when h2 behaves as a morpheme or an

[13] See Miller (1996) for a treatment of rhythmicity of movement in LSQ.
[14] Apparently, the sign language haiku was adapted from an English one by Bob Holman (http://www.poetrysociety.org.holman.html). The sign language version appears in *The Human Language, Part I.* A film series by Gene Searchinger.

independent sign in classifier constructions and for special discourse purposes, it has many degrees of freedom. But when it assumes a phonological role within words, it is far more restricted. We now see that movement too is much more constrained and exhibits more redundancies in lexical signs than in other kinds of expression. While sign languages take advantage of iconic and other motivated forms of expression afforded by the modality, in what we will call "non-lexical" subsystems (Chapter 16), they are still subject to the imperative of language to clearly identify its central unit, the word.

In the next chapter, we deal with the phonological distinctions between the word, the morpheme, and the syllable, and the role of movement in these constructs.

14 Is there a syllable in sign language?

The opposition between relatively static elements and relatively dynamic elements in signs was first reported in the work of Newkirk (1998 [1981]), and the idea that ASL signs have a formal unit like the syllable can be traced back to Chinchor (1978). The first comprehensive model to encode such a distinction is that of Liddell (1984b). That model, developed in Liddell and Johnson (1989 [1985]), makes the radical claim that there is a sequentially organized static–dynamic alternation that can be compared to consonants (holds) and vowels (movements), leading to the concept of a sequentially organized syllable in ASL, adopted also by Sandler (1989) and Perlmutter (1992). Others conceive of a sign syllable that is simultaneously organized, one that is projected from, and organized in relation to, a dynamic element (Brentari 1990, Corina 1990b). The notion of sonority has also been employed in describing syllables of sign language (e.g., Brentari 1990, 1998, Corina 1990b, Perlmutter 1992, Sandler 1993d).

But is use of the terms "syllable" and "sonority," "consonants" and "vowels" with regard to sign language merely metaphorical, or should we understand the analogy with those concepts in spoken language to be direct, and therefore approachable through the general assumptions of linguistic theory? We will show first that there is such a thing as a syllable that is distinct from the morpheme and the word. We'll then argue that "syllable" as a formal concept does have an analogue in American Sign Language, but that both its phonetic and its phonological properties are quite different from those of spoken language. Considering the notion of sonority as visual salience, we find some distributional evidence to suggest that it plays a role in the form of signs. However, we show that a direct comparison with sonority in spoken language is premature and probably untenable, given the radically different properties of the transmission systems in the two modalities. Despite these differences, or, more interestingly, because of them, we conclude with the suggestion that further linguistic and experimental investigations of the syllable and visual salience in sign language will move us closer to a comprehensive theory of phonology.

This chapter focuses almost exclusively on ASL. Comparison with other sign languages awaits future research.

14.1 The sign language syllable: preliminary description

Syllable-based generalizations in spoken language rely on such factors as the organization of sounds around a sonority peak and the assignment of relative stress. In sign language, movement has been likened to a syllable peak. But there is a strong tendency for each sign to contain only one movement. This raises two questions: whether the two concepts, the word and the syllable, are even distinguishable, and whether it makes sense to talk about relative stress in a sign language word. Moreover, the property of sonority is grounded firmly in the anatomy and physiology of the vocal tract and acoustics, and it typically organizes sequences of consonants on either side of the most sonorous element in the syllable unit. Now, no matter how sequential one's theory of sign language phonology, there can never be any clusters of static elements (i.e., holds or locations), because the physiology of the system requires the hand to move in between. And, as we show in Section 14.6, the physical properties of the production and perception system are so different from those of spoken language as to make any meaningful comparison of sonority in the two modalities extremely difficult.

Against these odds, a number of investigators have devoted serious thought to the notion of a syllable in sign language that is defined in terms of movement. A central observation that has figured in this work is the requirement described in the previous chapter, that a sign must have at least one movement in order to be well-formed, even if this movement is a default straight path movement. This observation alone would not argue for a defining role for movements in syllables, though, since both hand configurations and locations are also obligatory in well-formed sign words. Two additional ideas, together with the obligatoriness of movements, lead to the suggestion that movements may be the nuclei of sign language syllables. One is the possibility that movement is more visually salient than stasis, just as the nucleus is the most auditorily salient element in a spoken syllable. The other idea was presented in Chapter 13: most signs are pronounceable, and many are intelligible, *without* movement – a generalization which does not hold of the other two major phonological categories – and yet the movements are still required for well-formedness. This reasoning has led to the proposal that one movement (or more than one movement occurring simultaneously) constitutes a syllable nucleus (Chinchor 1978, Coulter 1982, Wilbur 1982, Liddell and Johnson 1989 [1985], Sandler 1989, Brentari 1990, 1998, Perlmutter 1992).

Let us assume the definition of a syllable given in (1).

(1) Definition of a sign language syllable (Brentari 1998, p. 205)
a. The number of sequential phonological movements in a string equals the number of syllables in that string. When several shorter dynamic elements co-occur with a single dynamic element of longer duration, the single movement defines the syllable.
b. If a structure is a well-formed syllable as an independent word, it must be counted as a syllable word-internally.

The mention of shorter and longer dynamic elements in (1a) refers to secondary movement: finger wiggle or rapidly repeated handshape or orientation change. If any of these occur on a path movement, they don't count as individual syllables; rather, the number of path movements determines the number of syllables. An implication of (1a) is that if a single path movement co-occurs with a single internal movement, then that unit also counts as one syllable. Only if movements occur in a sequence can we count more than one syllable. Reference to "phonological movements" is intended to exclude transitional movements between signs and between reduplications of a sign.

The literature on syllables and sonority in sign language is confusing, in part because the conclusions of different researchers often have different empirical bases. We will try to present a coherent picture of some of the results and arrive at some useful generalizations. We gather support for the following claims:

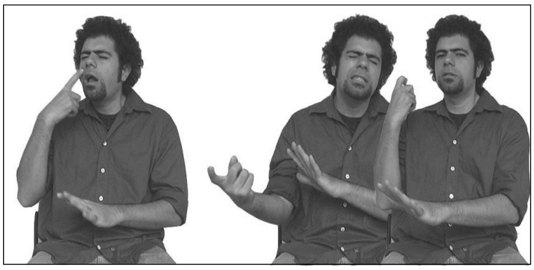
(2)
i. there is a prosodic unit that organizes the timing of phonetic gestures
ii. there are constraints on the content of this unit
iii. it is referred to by rules
iv. there is distributional evidence for the following saliency hierarchy: path movement > internal movement > location

We will also argue that the analogy that has been proposed between movements and vowels is too strong, and that certain phenomena that have been attributed to relative sonority in sign language are better understood as relative loudness instead.

Before pursuing the question of whether syllables exist in sign language and what their properties might be, it is useful to consider the basic characteristics of syllables in spoken language as a frame of reference.

14.2 Theoretical background: the syllable in spoken language

Evidence for syllables in spoken language comes from phonetics and psycho-linguistics, in addition to standard linguistic patterns. Syllables are organized according to the relative sonority of segments; speech errors respect the onset-nucleus-rhyme structure of the syllable, as well as the number of syllables in a word; and many phonological generalizations require reference to the syllable and its constituents.



EXTRACT-INFORMATION (ISL)

Figure 14.1 Movements coordinated in the second syllable

14.3 The sign language syllable as a timing unit

The canonical syllable in sign languages, defined as in (1), consists of a simple path movement from one location to another; we have seen many examples of this form. If internal movement – change of handshape or change of orientation – occurs in addition to the path movement, then the first shape or orientation co-occurs temporally with the first location, and the second with the last. Another movement element that is temporally organized by the syllable is non-manual movement, e.g., by the eye or mouth. We are not referring here to adverbial mouth movements, which span whole predicates or larger discourse stretches, nor to co-occurring mouthings of spoken language that are superimposed on signs and may also span longer prosodic constituents (see Chapter 15). Rather, it is those mouth movements that are lexically specified for individual signs that are organized temporally by the syllable. The native sign language lexical mouth movements we are now focusing on have been reported in many sign languages (see Boyes-Braem and Sutton-Spence 2001), and also exist in ISL. They typically consist of a gesture made by the mouth, which, if whispered or voiced, would be perceived auditorily as a CV or VC syllable (Woll 2002). Lexically specified mouth movements are temporally distributed over the syllable in the same way that the specifications of internal movement are.

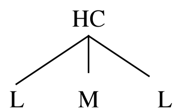
The ISL sign meaning 'to get information out of someone' illustrates both aspects of timing within a syllable: internal movement and non-manual movement. This sign consists of the EYE sense prefix (see Chapter 4, Section 4.2) and a second sign with no independent meaning, together glossed as EXTRACT-INFORMATION. The complex word, shown in Figure 14.1, is disyllabic, consisting of an (epenthetic) movement from the eye to a point in space in front of the signer, and another path movement to a point closer to the signer. In the second syllable, two kinds of movement are synchronized with the path movement toward the signer. First, there is a hand-internal movement in which the index finger goes from an open (extended) position to a curved position. Second, there is a mouth movement in which the corners of the mouth are pulled back, exposing the teeth, and then relaxed. The internal handshape movement and the mouth movement are clearly coordinated with the path movement of the second syllable only, and not with the whole word.[1]

Such synchronization within a syllable might not be significant if it were not for the contrast it presents with the transitional movements that occur between signs. Brentari measured handshape changes that occur within a sign syllable with those that occur on transitional movements. She found that within a syllable, the transition between the two handshapes is evenly distributed over the path movement, as mentioned in Chapter 13. This contrasts with handshape and orientation changes that occur during the transitional movement between signs, which are only about 40 percent as long as the transitional path movement, and are not linked temporally with the beginning and ending of that path movement (Brentari and Poizner 1994, Brentari et al. 1995, Brentari 1998).

14.4 Distinguishing the sign language syllable, the morpheme, and the word: constraints on structure

In Unit 2, we equated the concept "sign" with "word," and from a morphosyntactic point of view the analogy is apt. In terms of syllable content and structure, though, there are differences between the signed word and the spoken word. In many spoken languages, the prosodic form of words can vary greatly, consisting of one or many syllables, which are simple or complex, open or closed, as the following examples from English show: *go*, *cri.mi.no.lo.gists*. But in all sign languages that we know of, most words correspond to the same phonological template, repeated in (3) (Sandler 1989, 1993d, 1999b).

(3) The canonical form of the sign



According to the definition of a syllable in (1), this means that most words consist of a single syllable because there is only one movement. Saying that LML is canonical means that, although there are many signs with internal movement only, the typical sign has a path movement, represented by M.

[1] Woll (2002) suggests that the structure and timing of these lexical mouth movements point to a common rhythmic base for spoken and signed syllables.

There are constraints on this LML form, but since a syllable usually corresponds to a word and a word may also be monomorphemic, it is not immediately apparent whether these constraints hold on morphemes, words or syllables. So, it is important at the outset, in our pursuit of the sign language syllable, to distinguish these three kinds of structures – the morpheme, the word, and the syllable.

We will approach the issue from the point of view of constraints on structure and the domains over which those constraints hold. Most of the constraints we refer to here are either inviolable or would be very highly ranked in an Optimality framework (McCarthy and Prince 1993, Prince and Smolensky 1993). By looking mostly at constraints that cannot be violated within their domains, we may clearly distinguish different levels of structure. As the phonology of sign language is still in its infancy, we can take nothing for granted, and must use the clearest possible means to determine the viability of structures such as the morpheme, the syllable, and the word, whose independent existence is usually a foregone conclusion in spoken languages. Throughout the discussion that follows, it will be useful to keep in mind the definition of the syllable, which stipulates that any path movement constitutes a single syllable regardless of whether or not internal movement occurs with it simultaneously, and that internal movement alone may also constitute a syllable.

We summarize the generalizations we will be making with respect to words, morphemes, and syllables in Table 14.1.[2]

14.4.1 Constraints on the syllable

Let's begin with the syllable. A constraint that holds exclusively on syllables – and not on morphemes or words – limits finger positions and orientations to a maximum of two within this domain (Wilbur 1993, Uyechi 1996 [1994], Brentari 1998). Such a sequence results in internal movement, which is timed with the beginning and end of the syllable, as described above. A different kind of internal movement is called secondary movement or trill, and it involves either rapid repetition of these two finger positions or orientations throughout the sign, or finger wiggle.[3] There are very few signs in ASL or ISL that have both handshape and orientation change with or without path movement. If these languages are representative, then under the hypothesis

[2] The first work to systematically distinguish the syllable, the morpheme, and the word is Brentari (1990). That approach is revised and extended in Brentari (1998). Some but not all of the generalizations cited here are compatible with Brentari's. Unfortunately, a detailed comparison would exceed the scope of this work.

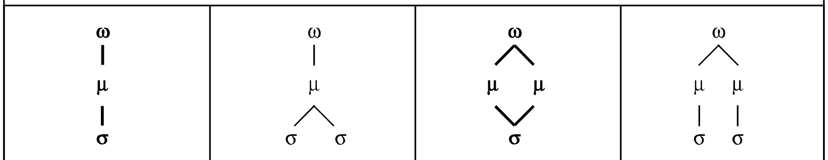
[3] The term "trill" is used differently by different authors, some of whom include uncounted rapid repetitions of path movements in the category (footnote 1 in Chapter 13). We assume here that only internal movement may be trilled.

Table 14.1 *Distinguishing the word (ω), the morpheme (μ), and the syllable (σ) in ASL*

Word	Morpheme	Syllable
Hand Configuration Assimilation domain	Selected Finger Constraint (5)	Hand Configuration Binary Branching Constraint (SHCC) (4a)
	Place Constraint (6)	Timing Constraint (definitional) (STC) (4b)

Non-isomorphism between syllable, morpheme, and word:
(a) words may be monosyllabic but multimorphemic (e.g., a-GIVE-b with subj-obj agreement);
(b) words may be disyllabic but monomorphemic (JOT-DOWN)

All of the following forms are attested:



monomorphemic monosyllabic words	monomorphemic disyllabic words	**bimorphemic monosyllabic words**	bimorphemic, disyllabic words

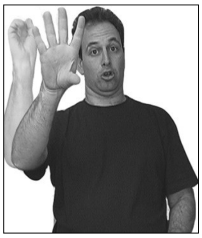
that handshape and orientation both belong to the hand configuration category (Sandler 1987a, 1987b, 1989), we may restate the constraint on finger positions and orientations as follows:

(4) Syllable Structure Constraints

a. Syllable-level Hand Configuration Constraint (SHCC)
The hand configuration category may dominate at most one binary branching constituent (finger position or orientation) within a syllable.

b. Syllable-timing constraint (STC; preliminary formulation)
   i. The two branches of (a) are temporally aligned with syllable edges.
   ii. Lexically specified non-manual movements are temporally aligned with syllable edges.

So, a word like (ISL) SEND, repeated in Figure 14.2, has open and closed finger positions, and these are aligned with the beginning and end of the path movement, i.e., the locations. Similarly, a sign specified for a non-manual movement like (ISL) EXTRACT-INFORMATION shown in Figure 14.1 has internal or mouth movements that are aligned with the beginning and end of the path movement of the second syllable.



SEND (ISL)

Figure 14.2 Sign with a sequence of finger positions: closed and open

A monomorphemic word in ASL may have more than two finger positions, as does DESTROY, with the finger positions open to closed and closed to open. By definition, this word is disyllabic. This shows that constraint (4a) holds within the syllable and not the morpheme. There is only one binary branching finger position structure in each syllable of (ASL) DESTROY, as constraint (4a) prescribes. The timing of the handshape change satisfies constraint (4b): each position is temporally aligned with the first and last timing slot. This example also demonstrates that the syllable and the morpheme are not isomorphic: the ASL word DESTROY consists of a single morpheme, but it has two sequential handshape changes, each aligned with a path movement, and therefore two syllables.

The constraints on syllables are essentially the definition of the syllable, and an attempt to motivate the constituent solely through definitional constraints would be circular. Independent evidence is provided for the phonological significance of a syllable unit in Section 14.5.

14.4.2 Morpheme structure constraints

We now move on to the morpheme. The Selected Finger Constraint described in Chapter 10, Section 10.2 (Mandel 1981) – stating that only one selected finger specification is allowed – is a constraint on the morpheme, not on the syllable or the word. Mandel's constraint above is revised in (5) to refer to the morpheme instead of the word (Sandler 1989).[4]

(5) Revised Selected Finger Constraint (Sandler 1989)
There can be only one specification for selected fingers in a morpheme.

The disyllabic word DESTROY observes the Selected Finger Constraint – selecting all five fingers throughout – even though it is disyllabic, because it is monomorphemic. That the Selected Finger Constraint operates on

[4] As explained in Chapter 10, the Selected Finger Constraint may be violated by fingerspelled borrowings from English orthography.

SEE + ZERO 'not see at all' (ASL)

Figure 14.3 Two selected finger specifications in two morphemes of one word

THINK^MARRY = BELIEVE (ASL)

Figure 14.4 Monosyllabic compound sign with two selected finger specifications

the morpheme and not on the word is shown by the fact that neither words with linear affixes nor compounds are constrained by it. For example, the ASL suffixed sign SEE-ZERO, illustrated in Unit 2 and repeated in Figure 14.3, is a single word that has two morphemes and two selected finger specifications, and . That the SFC is not a constraint on the syllable can also be seen from those compounds which reduce to one syllable (one path movement) but maintain their two handshapes. As seen in the partial assimilation variant of the compound THINK^MARRY = BELIEVE, shown in Figure 14.4, which keeps its two distinct handshapes and , a single syllable may have two selected finger specifications if it is bimorphemic. We conclude, then, that (5) is correct as a condition on the morpheme.

Similarly, the place constraint mentioned in Chapter 11 (Battison 1978 [1973]) – stating that only one place of articulation (major body area) is allowed in a sign – is a constraint on the morpheme, as claimed in Sandler (1989), shown in the revised constraint, (6).

(6) Revised Place Constraint
There can be only one place of articulation per morpheme.
(Sandler 1989)

Both of these constraints hold in the disyllabic monomorphemic word, DESTROY, but neither holds in compounds (lexicalized or not), even if

JOT-DOWN (ASL)

Figure 14.5 Disyllabic monomorphemic sign with different finger positions in each syllable

they are monosyllabic. The ASL compound BELIEVE shown in Figure 14.4 above reduces to a single syllable, but maintains its two distinct places of articulation, the head and the non-dominant hand.

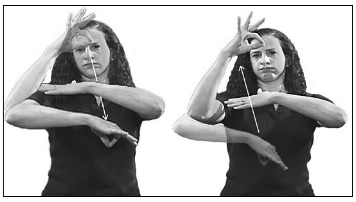
The specification of the non-dominant hand is also determined at the level of the morpheme, rather than the syllable or the word. Interestingly, the behavior of the non-dominant hand in monomorphemic, disyllabic words is compatible with the two-role theory described in Chapter 12, Section 12.1. In the disyllabic monomorphemic sign DESTROY, a symmetrical h2-S sign, h2 acts as h1 does, articulating the same single selected finger specification and the same open–closed, closed–open finger positions as h1. That is, there are two hand-internal movements on each hand, one per syllable. In the disyllabic monomorphemic sign JOT-DOWN, shown in Figure 14.5, in which h2 is a place of articulation (in an h2-P sign), h1 articulates two different finger positions, one in each syllable, but h2 can only have one specification, constrained by the place constraint in (6) stipulating a maximum of one place of articulation per morpheme.[5] DESTROY and JOT-DOWN also show that a word may be monomorphemic and disyllabic. The selected finger and place constraints are constraints on morpheme structure, and h2 abides by those constraints according to its role in a given morpheme.[6]

[5] JOT-DOWN is interpreted here as disyllabic because there are two movements to contact with the hand, each characterized by a different handshape. The two handshapes share the same selected fingers specification as required by the SFC on morphemes. The same sign would be monosyllabic if the handshape change occurred during a single movement.

[6] Brentari (1998) argues that the prosodic word governs specification of h2, and not the morpheme as we claim. Specifically, on the basis of lexicalized compounds that have only one specification for h2, Brentari proposes that there is a limit of one h2 specification per prosodic word. Her consultants judged the specially invented compounds presented to them, with two different h2 specifications, to be unacceptable. However, grammatical novel compounds such as PRACTICE + VOTE with h2  + h2  falsify that claim. (Thanks to Carol Padden for the example.) We speculate that the rejection by Brentari's

MAN^MARRY = HUSBAND (ASL)

Figure 14.6 Hand configuration assimilation in a reduced monosyllabic compound



SLEEP^SUNRISE = OVERSLEEP (ASL)

Figure 14.7 Hand configuration assimilation in an unreduced disyllabic compound

14.4.3 The word

We move on to the morphosyntactic word. One way in which the grammar identifies the constituent "word" is in stating the rule of HC assimilation in compounds, illustrated and analyzed in Chapter 10. The domain of this rule is neither the morpheme nor the syllable, but the word. Compounds are by definition single words comprised of two or more base words. Partial and total assimilation of hand configuration in compounds takes place within the compound word (across the two members of the compound). As indicated in Chapters 9 and 10, compounds may reduce to a single syllable, but this is certainly not obligatory, and hand configuration assimilation may take place regardless of whether or not the compound loses a syllable. For example, total hand configuration assimilation occurs on the reduced monosyllabic compound (MAN^MARRY =) HUSBAND in Figure 14.6[7] and on the unreduced disyllabic compound (SLEEP^SUNRISE =) OVERSLEEP in Figure 14.7.[8] This shows that the domain for the rule is the word.

More evidence that the morpheme, the syllable, and the word are clearly distinguishable comes from other kinds of morphologically

consultants was not due to a phonological constraint, but rather due to the fact that the compounds that were used as examples (e.g., WORD + HELP, 'thesaurus') were too semantically opaque to be accepted as novel compound forms.

[7] Note that HUSBAND is homophonous with BELIEVE.

[8] In the discussion of hand configuration assimilation, we do not distinguish between the morphosyntactic word and the prosodic word. Prosodic words are discussed in Chapter 15.

complex words. A verb marked for subject and object agreement such as ASL ASK, shown in Chapter 3, Figure 3.4, is typically monosyllabic but trimorphemic, as shown in the representation in (7) in the following section. Temporal aspect marking, also discussed in the following section, may add a morphemic movement feature to a verb marked for agreement, adding another morpheme without disturbing the monosyllabic nature of the base.

We concur with Brentari (1990), then, that syllables, morphemes, and words are distinguishable. Still, we feel that we would be missing a generalization were we to ignore the fact that words often overlap with syllables. Apart from full reduplications, sign language words, be they morphologically simple or complex, are usually monosyllabic (Coulter 1982, Wilbur 1987). That is, most words take the first or the third form, shown in boldface, in Table 14.1 above. It has been suggested that this tendency is a conspiracy, in the sense that it is a prosodic form that signs seem to settle on, regardless of their morphosyntactic structure (e.g., Sandler 1993d, 1999b). We discuss this conspiracy in the next section, making the supposition that if a conspiracy exists, there must be something to conspire about. We then go on to provide phonological evidence for the syllable explicitly.

14.5 The monosyllable conspiracy and other syllable level generalizations

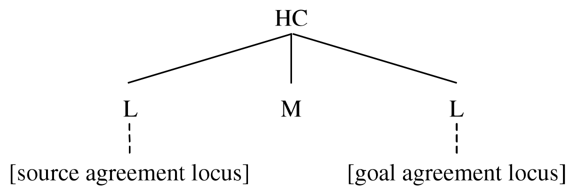
Most phonologists consider the best evidence for the existence of theoretical constructs, such as the syllable, the feature, or the feature class, to be the behavior of that element in the grammatical processes of a language or languages. In particular, if the statement of rules or constraints in a language must make reference to the proposed element, especially if there is more than one independent process that must refer to it, then the existence of that element is supported. The syllable was not given much credence in Chomsky and Halle's *Sound Pattern of English* (1968), in which generalizations were stated on sequences of segments, morphemes, and words. It was only when researchers such as Kahn (1976) demonstrated clearly that many independent generalizations are best accounted for by assuming the syllable as an independent element of structure that this construct was legitimized in generative phonology. In sign languages, we have seen that syllables can be defined phonetically as in (1), and that they have certain phonotactic constraints on their structure, shown in (4). Is that where the story ends? Or does the morphophonology have further use for the syllable?

Here we provide three independent pieces of evidence from ASL to support the claim that the syllable is a bona fide phonological construct in that language, over and above the structural constraints in (4) above. These are (1) the tendency of morphologically complex signs to be monosyllabic; (2) word-level stress; and (3) final syllable reduplication.

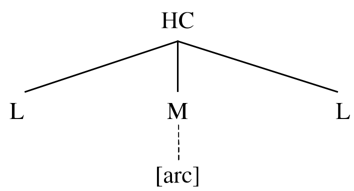
14.5.1 The monosyllable conspiracy

The tendency of morphologically complex words to be monosyllabic (Sandler 1989, 1993d, 1999b) is one way in which the grammar is telling us that the syllable unit is real. The first indication of this conspiracy is reflected in the so-called simultaneity of many of the morphological processes in sign languages, i.e., the combination of morphemes without adding sequential structure. Common and productive processes such as verb agreement and verbal aspect morphology are clear examples. Verb agreement, whose morphological properties are described in Chapter 3, can be described phonologically as associating an agreement morpheme with the first and last locations of a sign, as shown schematically in (7). Durational aspect involves associating an arc specification with the M segment, as shown in (8), and then reduplicating the whole form. In fact, a word may be inflected for both verb agreement and temporal aspect, as sketched in (9).

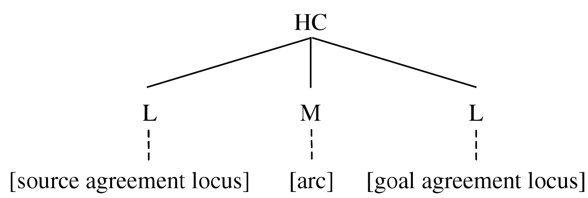
(7) Verb agreement (Sandler 1989)



(8) Durational aspect (Sandler 1990)



(9) Verb agreement and durational aspect



In these and many similar morphological processes, morphemes such as [arc] are added without adding sequential movements, resulting in morphologically complex bases that are monosyllabic.[9] Other templatic

[9] We exempt the total reduplications that are typical of temporal aspect morphology from the syllable count, and return to them in Section 14.5.2.

a. WANT (ASL)

b. DON'T-WANT (ASL)

Figure 14.8 Negative incorporation – reduction to a monosyllable

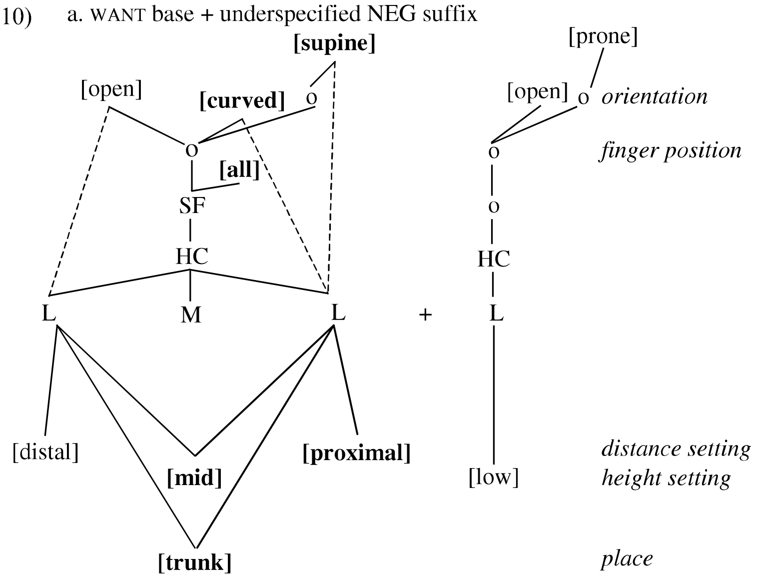
morphological forms that add timing slots to form geminates without adding syllables are shown in Chapter 13, example (3).

When classifier constructions lexicalize and become words (see Chapter 6), they too become monosyllabic. Since classifier constructions may constitute more than one syllable and even more than one intonational phrase, it is striking that the lexical items that evolve from them are overwhelmingly monosyllabic.

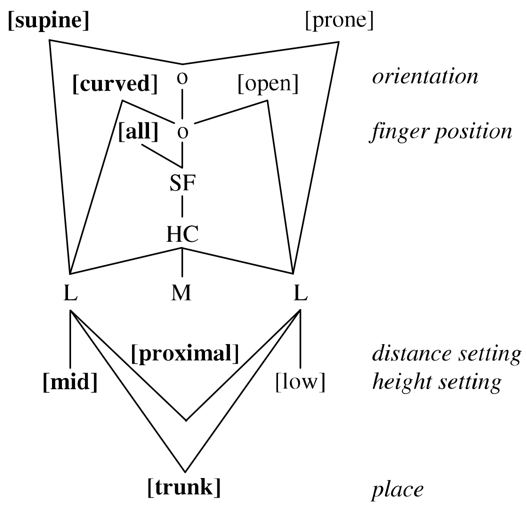
Even processes that are by their nature sequential may result in truncation to produce the favored monosyllabic words. One example is the process known as negative incorporation (Woodward 1974) shown in Figure 14.8. These forms involve suffixing a location that is lower than the last location of the base sign and that is specified for a prone orientation and an open finger position. Adding the additional location sequentially would result in a disyllabic sign, as the hand moves to the lower position and adds the additional open finger position: LML + L → LML(M)L. But disyllabicity is prevented by truncation: the first location and handshape are deleted. The process is shown for the sign DON'T-WANT in (10) (following Sandler 1989). The representations are schematic, suppressing some of the hierarchical structure and using transparent feature specifications for clarity. Those features of the base that will characterize the derived sign are printed in bold. The suffix is lexically underspecified, bearing only the features represented, features of finger position, palm orientation, and setting, but not specified for selected fingers or for place. The latter specifications are spread from the base sign.[10]

[10] The negative incorporation process supports the Hand Tier model of locations presented in Chapter 11, since the setting features such as [low] behave independently of the place features. In WANT/DON'T-WANT, the place is [trunk], while in KNOW/DON'T-KNOW,

(10) a. WANT base + underspecified NEG suffix



b. DON'T-WANT surface form



The result, in which the movement is the default straight movement necessarily intervening between two locations, is the canonical LML monosyllabic form. Similarly, we have seen that in both of the sign languages with which we are familiar, ASL and ISL, compounds may reduce when they are lexicalized, and that a common type of reduction

the place is [head]. Negative incorporation always results in a final setting that is lower than the first, but articulated with respect to the place that is lexically specified for the specific base sign.

is the elimination of one of the movements, resulting once again in monosyllabic forms: LML + LML –> LML. Examples are ASL MAN^MARRY = HUSBAND, pictured above in Figure 14.6, and ISL MIND^STUCK = DAYDREAM, pictured in Chapter 10, Figure 10.14. All of these processes point to a conspiracy of monosyllabicity.

It is likely that the monosyllables we see are due to an output constraint in the form of an LML syllable template (Sandler 1989). This suggestion is compatible with the proposal of Miller (1991) that the negative incorporation form results from right-to-left syllabification. Further support for Miller's suggestion can be seen in the fact that total hand configuration assimilation in compounds also preserves the right HC at the expense of the left. The details of how and under what circumstances signs reduce to monosyllables remain to be investigated, and a constraint-based approach like OT in which constraints are ranked and may be violated suggests itself for future research in this area. In any case, the fact that we see such monosyllables so pervasively supports the syllable as a valid prosodic organizing unit in sign language phonology. We'll deal with the distinction between the syllable, the morphosyntactic word, and the prosodic word in Chapter 15, on prosody.

14.5.2 Stress

We now turn to stress, a system that crucially involves the relative prominence of syllables. Although most lexical signs are indeed monosyllabic, not all of them are. In fact, all novel compounds and many lexical compounds are disyllabic, and we may look to the stress patterns in such forms for further linguistic support for syllables. Researchers have claimed that compounds in ASL have regular stress patterns. First, disyllabic compounds have been described (by Klima and Bellugi 1979) as having what may be interpreted as a weak–strong stress pattern, where stress is characterized as increased muscle tension and increased speed.[11] The discussion in Klima and Bellugi (1979) describes the relation between the first and second sign in compounds, and not syllables explicitly. However, many of their examples are uncontroversially disyllabic, consisting of a sequence of two path movements (e.g., BLACK^NAME 'bad reputation' shown in Chapter 12, Figure 12.6; THRILL^INFORM 'news, entertainment'), so it is reasonable to interpret their description as applying to disyllabic feet. In particular, the first sign is always weakened (losing repetition, shortening in duration and displacement, and

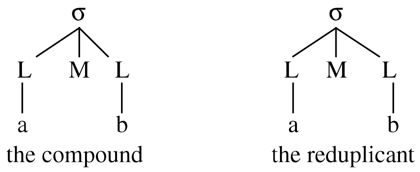
[11] The judgments about word-level stress are impressionistic, as are most phonological treatments of spoken language stress. Wilbur and her colleagues have measured stress instrumentally; see Wilbur and Schick (1987) and Wilbur (1999a) for an overview. These studies have concentrated on phrase-level stress (prominence) and stress used for emphasis or focus.

weakening in stress), and the second sign either remains normally stressed or receives additional stress. ASL words that are lexically reduplicated such as NAME or CHAIR – a type described with the feature [restrained] in the ISL data in Chapter 6 – are described in Coulter (1990) as stressed on the first syllable, i.e., on the first iteration of the base.[12] These stress assignment rules, then, must refer to the last or first syllable of a word. Finally, bidirectional words, whose movement is from one location to another and back again ($L_1ML_2ML_1$), like PLAY-PIANO, have been described as having equal stress on both syllables (Supalla and Newport 1978, Wilbur 1999a), distinguishing them from unidirectional reduplicated words like FINGERSPELL ($L_1ML_2(M)L_1ML_2$), whose stress is on the lexical movement and not on the epenthetic return movement. While a full analysis of these different stress patterns on different types of ASL words has not yet been undertaken, it is clear that in order to contrast these three different patterns, it is necessary to refer to the syllable.[13] This is evidence that the phonology of ASL recognizes the syllable unit.

14.5.3 Final syllable reduplication

Another process that makes reference to the syllable is morphological reduplication. Unlike underlying reduplication found in monosyllabic words like NAME, which has exactly one reduplication (two iterations), morphologically introduced reduplication may involve three or more iterations. Many of the temporal aspects described for ASL (Klima and Bellugi 1979), in particular those expressing duration or iteration, involve total reduplication of the base. When ASL compounds are reduplicated, the reduplicated element is the final syllable (Sandler 1987b, 1989). If the compound is reduced and monosyllabic, like MIND^DROP = FAINT (shown earlier in Chapter 10, Figure 10.11), then the whole form is reduplicated, as schematized in (11).

(11) FAINT [reduplicated]

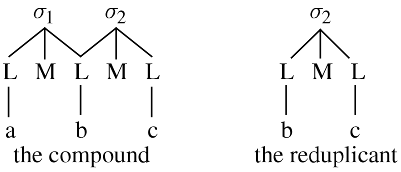


[12] Lexically reduplicated words are represented with the feature [restrained], and not by a sequence of syllables in Sandler (1996b), as mentioned in Chapter 6. In any case, on the surface these signs are disyllabic by our definition, and it is at that level that the stress pattern is revealed.

[13] See Miller (1996) for an analysis of stress and prosody in LSQ.

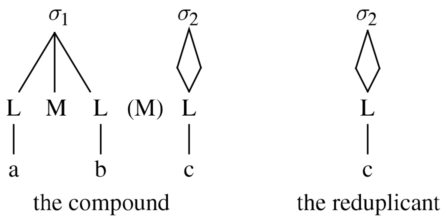
However, if the compound is disyllabic, like SLEEP^SUNRISE = OVERSLEEP, shown in Figure 14.7, then only the final syllable is reduplicated, as schematized in (12).

(12) SLEEP^SUNRISE = OVERSLEEP [reduplicated]



It doesn't matter whether the last syllable has path movement only or internal movement only; each type of movement is regarded as a syllable nucleus by this reduplicatory process. The second member of the compound WRONG^HAPPEN = ACCIDENT has internal movement only, specifically, orientation change. It is that syllable that gets reduplicated, and not the whole compound, as shown in (13). In the representation of ACCIDENT, the M in parentheses is epenthetic, and the branching structure above the L in the second syllable schematically indicates a handshape change. As the reduplication rule refers to the last syllable regardless of its structure, this supports the existence of the construct "syllable" (Sandler 1989).

(13) ACCIDENT [reduplicated]



We now have both phonetic/phonotactic and phonological generalizations about the prosodic unit consisting of a single movement (which may be complex, i.e., consist of two or even three simultaneous movements), commonly called a syllable in the sign language literature, and summarized in Table 14.2.

The table illustrates both phonetic and phonological evidence for a unit that is prosodically defined and distinct from the morpheme and from the word, an interesting discovery in itself. It is reasonable to call such a unit a syllable for two reasons: (1) it is defined prosodically, in terms of movement which is hypothesized to be visually salient and (2) it shows some effects that are typical of a prosodic unit at the same level in spoken language, specifically, behavior regarding stress and reduplication. At the same time, we have already seen some significant differences. Two of the ubiquitous characteristics of the spoken language

Table 14.2 *Evidence for a syllable unit in sign language*

Sign language syllable generalizations
Hand Configuration Binary Branching Constraint (4a)
Timing Constraint (definitional) (4b)
Final syllable stress in ASL compounds
Initial syllable stress in lexically doubled words
Final syllable reduplication for temporal aspect in ASL compounds
Non-isomorphism
a. A single syllable may be monomorphemic, bimorphemic, or multimorphemic.
b. Words may consist of two or more syllables (though they are usually monosyllabic).

syllable are the asymmetry between onset and coda, and the complex category, rhyme, consisting of nucleus and coda. For example, onsets are more obligatory than codas cross-linguistically; the set of consonants that may characterize the coda is a subset of those that may occur in the onset (Goldsmith 1990); and the rhyme constituent alone may determine syllable weight and stress assignment. The only asymmetry we are aware of in sign language syllables has to do with signs with handshape change in which one finger position is open. In LSQ, and most likely in other sign languages as well, if the first handshape is closed, then it is typically characterized by thumb restraint, while if it is the last handshape that is closed, there is not necessarily thumb restraint (Miller 1991). Otherwise, no asymmetries have been attributed to onset and rhyme in the sign language syllable, a clear difference from spoken language.

Another difference from spoken language is in the nature of the two sequentially organized categories that have been proposed to characterize the sign language syllable. The sequential model as first introduced by Liddell and Johnson explicitly draws an analogy between static elements (holds in their model, locations in the Hand Tier model) and consonants, and between dynamic elements (movements) and vowels. Other researchers have followed suit. On more careful consideration, it appears that this analogy is either too sweeping or else only trivially viable, for the following reasons. (1) While spoken languages often have consonant clusters, there are no location clusters. (2) In a typical CVC syllable of spoken languages, there is not necessarily any similarity between the first and last consonant. In fact, in many languages, there is a strong tendency for consonants to have different places of articulation within a morpheme (McCarthy 1988). In sign language, the two locations in a typical syllable always share many features, especially place of articulation (see Chapter 16). (3) While some spoken languages have small vowel inventories, we know of no spoken language in which most vowels are default vowels like the straight path movements of sign language. (4) Spoken languages vary in terms of the number and types of consonants and vowels that constitute the onsets, nuclei, and rhymes of syllables (see footnote 1). Apparently, sign languages universally have the same syllable structure. More differences emerge from an examination of sonority, which we undertake in Section 14.6.

The phonetics of the spoken syllable offers some insight into the differences between spoken and signed syllables. MacNeilage (1998) and Davis and MacNeilage (1995) argue that the basic shape of syllables in spoken language is determined by the oscillation of the mandible (jaw). Although there are other articulators, such as the tongue and the lips, the authors claim that the "frame" for the consonant and vowel alternations in syllables is provided by the repeated raising and lowering of the mandible. They also bring evidence from infant babbling to suggest that the distribution of particular consonants and vowels is influenced by the same mandibular oscillation. Clearly, the sign unit we have been describing is different. As Meier (2002b) observes, there is no single predominant oscillator in sign languages. The hand is sometimes compared to the tongue as a primary articulator, but that analogy cannot be extended to actual phonological behavior in relation to other elements within the system. This is because the places of articulation that the hand must reach are often not anatomically contained within the same coherent unit as the hand in the way that the tongue is connected to the jaw and contained within the mouth. In particular, though the hand often articulates at some point on the body, it also commonly articulates at points in space, and these seem to be determined by spatial and perceptual factors more than by any constraints imposed by the physiology of the articulatory system. From a physical point of view, then, we must conclude that there are no significant similarities between the spoken syllable and the syllable of sign language. This also means that phonological generalizations that result from physical properties of syllables and their primitives will not be the same in the two modalities. So it seems that there are clear modality differences at this level of structure (see Wilbur 1999a). Implications of these differences are considered in the conclusion to this chapter.

14.6 Sonority in sign language

Another property that has been appealed to in defining the sign language syllable is sonority. As we've explained, in spoken languages, it is the relative sonority of sounds that establishes the peak (nucleus) of the syllable and organizes other sounds around it. If sonority is the property that lends salience and well-formedness to a syllable, and relative sonority organizes the phonetic material within the syllable, then this leads to the hypothesis that in sign language, movement of any kind is sonorous

(Brentari 1990). In spoken language, syllables are organized in terms of the *relative* sonority of their component parts. What evidence is there for relative sonority and its role in sign language?

We review a number of investigations into sonority in sign language, beginning with approaches that are most compatible with the sequential structure that we have been favoring throughout. The question asked is whether the sequential alternation between static and dynamic elements in sign language that Liddell and Johnson originally posited is related to sonority. We then consider, and argue against, other approaches which view sonority as a simultaneous property of the whole sign.

While all the studies reported have yielded interesting generalizations, the claims of different researchers are often incompatible or conflicting. There are three reasons for this. One is that each study relies on a different model of sign language phonology. Another is that they rely on different empirical data. The third reason, a more fundamental one, is that none of the treatments has been informed by an understanding of salience in a visually perceived language, simply because of a lack of experimental research in this domain. Our survey of the various theories and their empirical bases leads us to suggest that some of the phenomena attributed to relative sonority in sign language are more likely to have other explanations, such as articulatory reduction or relative loudness.

We hypothesize that the requirement for movement on the one hand, and the restricted nature of the sign language syllable and canonical word on the other, are indeed related to visual "sonority" or salience. But we also conclude that progress in phonological research on sign language sonority can only be made if conducted in tandem with empirical experimental investigations into salience in these languages.

14.6.1 Sonority in a sequentially organized syllable

Perlmutter (1992) follows Liddell and Johnson (1989 [1985]) and Sandler (1989) in arguing for sequences of static elements, which he calls "positions" (comparable to locations), and dynamic elements, called "movements" (similar to the movements of the other sequential models). As mentioned in Chapter 13, Perlmutter observes that secondary movement, such as rapid repetition of handshape change or wiggling of the fingers, co-occurs with the path movement in any syllable that has one. He claims that secondary movement co-occurs with a location only if there is no path movement in the sign. Schematic representations are shown in (14).

(14) Secondary movement distribution

```
 [wiggle]        [wiggle]
    |               |
  L M L             L
```

In this representation, we use Ls instead of the Ps or positions of Perlmutter's model, for continuity. Assuming that secondary movement always co-occurs with a syllable nucleus, the conclusion offered is that a position (≈ location) can only be a syllable nucleus if it is not adjacent to a movement. The generalizations in (15) and (16) are derived from this distribution of secondary movement:

(15) Secondary movement features can occur only on the nucleus of a syllable.
(Perlmutter 1992, p. 417)

(16) A P can be the nucleus of a syllable only if it is not adjacent to an M.
(Perlmutter 1992, p. 417)

The sonority hierarchy proposed is simply that movements are more sonorous than positions: M > P (≈ M > L). The analysis implies that a P will be a nucleus if it can't be syllabified with a nearby M, and that secondary movement will then (and only then) have no choice but to be realized on the P. In a sense, Perlmutter uses the distribution of secondary movement as a diagnostic for the relative sonority of Ps and Ms.

The Delayed Completive aspect described in Chapter 9, Section 9.2, presents a problem for this analysis. It shows that there are signs in which a secondary movement does occur on a location that is adjacent to a path movement, contrary to (16). It demonstrates that secondary movement may define a syllable nucleus even if it is adjacent to an M, as in the sign RUN-OUT-OF] Delayed Completive, represented schematically in (17), in which the syllable nuclei [wiggle] and the M segment are shown in bold. That sign inflected for Delayed Completive aspect is not ill-formed, as Perlmutter's analysis predicts; it is simply disyllabic according to the definition offered in (1) above.

(17) Delayed Completive

[wiggle]
/\
L L **M** L

This means that secondary movement isn't a diagnostic for sonority; instead it manifests sonority, constituting a syllable nucleus. If it co-occurs with a movement, then the two types of movement together constitute a single syllable nucleus. If it co-occurs with a location, then the secondary movement alone is the nucleus.

Sandler (1993d) further pursues the idea that movement is related to sonority, and that movement segments are more sonorous than the static type, a claim with roots in Liddell and Johnson's and Sandler's early work, and adopted also in Blevins (1993).[14] Following Corina (1990b)

[14] Blevins' (1993) sonority scale for ASL is path movement > nonstatic articulator (= internal movement) > static articulator > location hold. Sandler's scale is similar, except for "static articulator," i.e., a secondary classifier morpheme held in place. Classifier

and Brentari (1990), Sandler assumes that sonority in sign language corresponds to visual salience. Observing the overwhelming preponderance of LML structure over signs with L-only plus internal movement, she surmises that path movement is preferred over internal movement as a syllable nucleus because it is more sonorous (salient) than internal movement.

Not only are morphologically simple signs typically L M L – i.e., signs that move from static L to sonorous M and back to static L – but, as demonstrated in Section 14.5, morphologically complex signs are as well. Morphological operations that involve simultaneous structure (like verb agreement) as well as those that alter sequential structure (like compounds reduced under lexicalization, and negative incorporation) tend to surface as LML syllables, i.e., as syllables with one path movement, as we have seen. Temporal aspect templates, illustrated in Chapter 13, Section 13.3, and Section 14.5 above, tend to have LML form, so that bases with no path movement (such as DIRTY, STUDY, etc.) are augmented to fit the template with path movement. Sandler (1993d) suggests that this LML conspiracy is guided by a constraint preferring a rise–fall sonority cycle (in the sense of Clements 1990) in the sign language syllable. Such phenomena are used to argue for the following sonority hierarchy, motivated primarily by the relative degree of movement.

(18) (Partial) sonority hierarchy adapted from Sandler (1993d)
path movement > internal movement > locations > contacting locations

14.6.2 Other theories of sonority

Two other proposals about relative sonority are reviewed briefly here. We will argue that each proposal uncovers significant generalizations, but that these generalizations are not likely to be related to sonority.

The first researcher to introduce the concept of relative sonority in sign language is Corina (1990b). He adopts a simultaneous model rather than a sequential one, and argues that there are no sequentially organized sonority differences in sign syllables. But Corina does propose a simultaneously instantiated sonority scale in ASL, shown in (19), on the basis of interesting alternations that he observes.

(19) Sonority hierarchy according to Corina (1996)
Movement sequence > full handshape change or orientation change > location change (i.e., path movement) > partial handshape change

First, he studies signs like (ASL) ASK, that are lexically specified for both path and internal movement, but in which one of these two movements is

constructions are not taken into consideration in Sandler's sonority scale or other work on the phonology of lexical words because these constructions are not words, and exhibit generally anomalous phonological behavior (see Chapter 5).

optionally deleted. In such signs, he finds that internal movement survives while path movement may delete. On that basis, he argues that internal movement is more sonorous than path movement, the opposite conclusion from that of Sandler (1993d).

An alternative explanation for Corina's observations suggests itself: the tendency of the hand-internal movement to survive in the signs Corina cites is due to lexical retrievability. On this view, the internal movement cannot delete because it carries so much information about the sign that the sign would not be recognizable without it. This suggestion is compatible with the fact that path movements add little information that is not predictable to the sign, as explained in Chapter 13, so that deleting them barely reduces retrievability of many signs. Relative retrievability is a phenomenon that can be studied empirically under experimental conditions, and resolution of the opposing views awaits such research.

Another observation made by Corina (1990b, 1996) is that some types of handshape change always co-occur with secondary movement; i.e., they are always rapidly repeated. The type of handshape-change signs that behave this way are precisely those in which neither of the shapes in the sign is open or closed; instead, the two positions are curved and bent, like ASL BUG, shown in Figure 14.9. Corina's claim is that such partial handshape changes are not sonorous enough and that they must therefore be rapidly repeated several times in order to reach a minimum sonority threshold.

Here too, an alternative analysis is at least equally plausible. Notice that the handshape changes in question are precisely those that seem to violate the Handshape Sequence Constraint (Chapter 10, example (7)). That is, neither of the shapes is open or closed. The alternative analysis now becomes clear: it is the rapid repetition that creates the partial handshape change, and not the other way around. Under such an analysis, signs like BUG are underlyingly specified for open and bent handshapes, thus satisfying the HSC, and they are specified for rapidly repeated movement as well.[15] The rapid repetition has the phonetic effect of preventing the hand from opening all the way.

Support for this alternative comes from signs with internal movement that are demonstrably not underlyingly specified for rapidly repeated movement but that gain such movement through morphological derivation. For example, DOUBT, produced with the handshape sequence open  and then bent , may be derived to form the adjective DOUBTFUL by adding rapidly repeated handshape change (Liddell 1990b). In the

[15] For different representations of secondary movement, see Sandler (1989, 1993d), Corina (1990b, 1996), Liddell (1990b), Perlmutter (1992), Brentari (1993, 1998), van der Hulst (1993).

BUG (ASL)

Figure 14.9 Sign with secondary movement and partial handshape change

process, according to the illustrations provided by Liddell, the fingers do not reach the fully open shape, but rather phonetically articulate two degrees of bent shape instead. We are suggesting that the same may be true of signs like BUG. That is, such signs actually do conform to the HSC by being underlyingly specified for one shape that is fully open, and, in words like BUG, are underlyingly specified as well for rapidly repeated movement. The effect of this movement is to phonetically reduce the handshapes.

We now turn to a different theory of relative sonority, one that we mentioned in the previous chapter in our discussion of the Prosodic model. The theory of sonority adopted in that model is motivated by variations in signs that are made under circumstances in which signers want their signing to be perceived at greater distances, such as on a stage (Brentari 1998).[16] Under those circumstances, signers may substitute an underlying movement with a movement made at a joint that is closer to the body (substituting the shoulder for the elbow, for example), creating a larger movement. Brentari's proposal suggests that this joint substitution is a form of phonetic enhancement.[17] The citation forms of UNDERSTAND and its enhanced form were shown in Figure 13.10. As explained, Brentari argues that such substitutions unify all movements into one phonological class, regardless of how they are produced, a claim independently motivated and one we find compelling.

She also makes a different claim based on the same observation, a claim that we challenge: that the degree of proximity to the body of the joint responsible for a given movement determines the sonority of that movement. The hierarchy in (20) is proposed on that basis.

[16] Rapidly repeated movement, variously called trills, trilled internal movement (TIM), or secondary movement, are not included in these alternations.

[17] Brentari cites Stevens and Keyser's (1989) theory of phonetic enhancement. Their theory, however, relates to relative markedness of features belonging to different categories, where the relation between enhancement and sonority is indirect and partial. We interpret Brentari's use of the term enhancement in a more straightforward way, as simply increasing the relative visual salience of a movement.

(20) Brentari's (1998) sonority scale[18]
shoulder joint > elbow joint > wrist joint > base-of-finger joints > middle finger joints

We will argue that the alternations she describes are analogous to loudness rather than sonority. Distinguishing the two in sign language reveals an important difference between the two modalities.

14.6.3 Sonority versus loudness

The phenomenon under consideration has been observed before, notably by Uyechi (1996 [1994]). She uses as an example the chant in the famous 1988 demonstrations at Gallaudet University[19] in favor of hiring a Deaf president: DEAF PRESIDENT NOW. She compares the very large signs used in that chant with the way in which the signs would be produced in an imaginary police state where it was forbidden to openly express such an opinion. The differences are similar to those that Brentari attributes to sonority. Uyechi's loudness explanation seems to us to be the more straightforward interpretation of the observations of different sized signs, that "bigger" signs are shouted and "smaller" ones are murmured!

This interpretation is supported by Crasborn's (2001) study of SLN (Sign Language of the Netherlands) phonetics. He conducted an experiment in which signers of SLN were asked to sign to each other across a large room in one condition, and sitting very close to each other in another. The subjects made adjustments similar to those Brentari describes, and the types and degrees of adjustments made under different conditions varied across signs and signers, as is expected for phenomena that are not phonological in nature.

The challenge in sign language becomes one of distinguishing between a linguistic property (sonority) and a non-linguistic property (loudness). Loudness in spoken language depends on the intensity of the sound source, specifically, the rate at which the lungs collapse and push the air through the vocal cords. The faster the rate at which the air is pushed through, the greater the amplitude of vocal cord vibration, and the louder the perceived sound. Loudness is a matter of degree; differences in loudness are gradient – both in terms of physical properties and in terms of the way loudness differences are used and interpreted in the system.

Sonority in spoken language is quite different. After the lungs push the air through the larynx, the configuration of the vocal tract filters the resulting sound in such a way as to enhance certain frequencies and their

[18] In Brentari's scale, the base-of-finger joints have the technical name, metacarpal, and middle-of-finger joints are called interphalangeal. We use the more transparent terminology here.
[19] Gallaudet University is a university for Deaf students in Washington, DC.

harmonics at the expense of others. The amount of sonority a sound has is determined mostly by how open the mouth is, i.e., by the filter rather than by the source. The configurations of the oral cavity filter the sound, so that a more open mouth permits more energy to radiate from it, hence more sonority. Vowels are more sonorous than consonants, and the vowel [a] is more sonorous than the vowel [i].[20] And this is true regardless of the amplitude of vocal cord vibration, i.e., regardless of whether you shout or murmur, whether you are declaiming from a stage or intimately confiding in a friend.

While relative sonority is phonetically scalar just as relative loudness is, sonority is a linguistic property, encoded in language in a way that is discrete. Different amounts of sonority are encoded in the discrete phoneme inventory of a language; there is no gradient continuum of [a] sounds; rather [a] is distinct from other vowels in any phoneme inventory, corresponding to a particular configuration of the vocal tract. Similarly, all of the sounds in a language are typically treated by the phonology of that language as either plus or minus sonorant; the relation is binary and not scalar. Relative sonority is relevant for syllabification in spoken language. But here too, sonority is distinguished from loudness. Sonority is relative across sounds, not within sounds. Specific phonemes do not alter their relative sonority value in the way that any sound can be altered for loudness.

In sign language, the closer to the body the articulating joint is, the larger the perceived signal – the "louder" it is visually. And, according to Crasborn's findings, differences observed for sign language loudness are gradient, like loudness in spoken language. Loudness spans three kinds of internal movement (middle finger joints, base-of-finger joints, and wrist joint) and two kinds of path movement (elbow and shoulder).

Irrespective of both sonority and loudness, the difference between internal and path movement is a discrete one within the phonology. Signs are underlyingly specified for a particular path or internal movement, and not for any variant along a continuum from path to internal. For example, FLAT-TIRE and WINE in ISL, shown in Figure 14.10 are very similar, but WINE has only internal movement while FLAT-TIRE has only path movement.

The grammar does not recognize incremental distinctions between joints of relative proximity. According to Sandler's sonority hierarchy shown in (18), this two-way distinction between path and internal movement is the only one within the movement category that might be relevant for a sign language counterpart to sonority.

[20] Thanks to John Kingston for helping us understand the phonetics of sonority and loudness.

a. FLAT-TIRE (ISL) path movement — b. WINE (ISL) internal movement

Figure 14.10 Minimal pair for path and internal movement

We have tried to draw a distinction between sonority and loudness in sign language. Why should this be such a challenge in sign language, while the two are clearly distinct in spoken language? Here we get to a fundamental problem in finding an analogue to sonority in sign language.

14.6.4 Sonority summary: assessing the relation between visual salience and linguistic sonority

As mentioned, the source of energy in spoken language is the lungs, and the filter responsible for creating different sounds is the vocal tract. The acoustic signal that results is created by sound waves as they emerge from the vocal apparatus, displacing the air, which sets up vibrations in the auditory system, and the signal is then interpreted as sounds of language. Syllables organize themselves around the element with the most sonority. More energy at the source (the lungs) results in loudness regardless of the configuration of the filter (the vocal tract); the source and the filter are independent physically, and have independent effects, i.e., loudness on the one hand and sonority on the other.

In sign language, the situation is quite different, because the configurations of the articulatory system are perceived directly. We are not in a position to speculate about the relation between manual articulation, the resulting visual signal, and its perception. But it seems clear that this relationship is qualitatively different from the source-filter-signal-perception relationship that exists in spoken language. This difference should not be taken lightly, and exploring it will lead to a deeper understanding of phonetics and phonology in each modality.

As there is no obvious distinction between source and filter in sign language, the *physical* difference between linguistic salience (sonority) and loudness is harder to pinpoint in this modality than it is in the spoken modality. Nevertheless, this does not mean that distinguishing the two is hopeless. Rather, we look to linguistic patterning as the key. The gross distinction between internal movement and path movement is encoded linguistically as two different categories of movement, and it seems that the greater salience of syllables with path movement makes it the preferred type in the system. Gradient differences created by degrees of proximalization at any of five joints is interpreted non-linguistically, as loudness.

Clearly, the concept of a syllable in sign language, its internal organization, and the relative salience of its components are areas requiring more experimental work.[21]

14.7 Syllables and sonority: conclusion

Our approach to sign language research is one that takes full advantage of linguistic description and linguistic theories that have been developed on the basis of spoken language. We take this approach because we think it is reasonable to expect human language to conform to certain organizing principles regardless of physical modality. At the same time, the extent to which sign language and spoken language are alike is still an empirical question whose answer must not be taken for granted if we are ever to achieve a comprehensive theory of language (Sandler 1993c, 1995b). The construct "syllable" and the property of sonority are instructive here.

The syllable is a unit determined partly by the physical properties of the production and perception systems, and as such there are significant differences between syllables in the two physical modalities. But the syllable is also a prosodic unit referred to directly by the phonology, e.g., in rules of aspiration in spoken language or thumb restraint in sign language, and rules of stress and reduplication in both. These grammatical parallels justify a relatively direct analogy in the two modalities, and even use of the same label, *syllable*.

At the same time, the properties and internal organization of signed and spoken syllables have very little in common with those of the spoken syllable, and should be studied in their own right. For instance, the property of sonority is so intrinsically tied to the modality of production and perception as to render any direct comparison across language modalities difficult. Yet the patterning of the system does offer us some hints about where to look for relative salience in sign language.

The evidence in this chapter and the previous one suggests the syllable types shown in (21) below. The LML structure on the left is a sign with path movement like (ISL) FLAT-TIRE shown in Figure 14.10a, and the L-only structure represented schematically on the right with two finger (or orientation) positions in (21) is like (ISL) WINE shown in Figure 14.10b).[22]

[21] Some experimental work has already been undertaken, but space considerations do not permit discussion of it here. See, for example, Grosjean (1981), Clark and Grosjean (1982), Emmorey and Corina (1990), an interpretation of some studies by Kingston (1999), and Corina and Hildebrandt (2002).

[22] Other researchers propose a greater variety of syllable types (e.g., Liddell and Johnson 1989 [1985], Perlmutter 1992, Brentari 1998). Our investigations and analyses yield a sparer inventory. Unfortunately, space does not permit a comparison here.

(21) Sign language syllable types

The difference in salience in these two syllable types might be compared to the difference in sonority between the two syllables in the English word, *rhythm* [rɪðm̩]. The first syllable nucleus, with a full vowel, is more sonorous than the second, containing a nasal consonant as nucleus. Unlike spoken language, though, there is no conclusive evidence in sign language that different degrees of sonority determine the organization of elements within the syllable.

We've mentioned two observations suggesting that signs with path movement (LML) may be more "sonorant" or salient than those with internal movement only (L). First, they are far more common in the lexicon, and second, under derivation and inflection, signs tend to be augmented or reduced to the LML form rather than reduced to L. Most other arguments for sonority were shown to fall through or to be explainable with equal plausibility by other factors.

The differences in organization between spoken and signed languages at this level of analysis raise important theoretical issues about the relation between the biology of language and linguistic form. If the manual/corporal-visual modality is responsible for the form of syllables in sign language, then the oral–aural modality is responsible for the form of syllables in spoken language. This implies that constraints on spoken syllables are not an arbitrary set, supplied to language by UG. Instead of taking them as given, we stand to reach a deeper understanding of those linguistic constraints by motivating them, through investigation of the physical channels in which they are produced and perceived. (See, e.g., Hayes 1999 for a relevant discussion of phonetically grounded constraints in spoken language.)

Similarly, the details of the interaction between production, perception, salience, and sign language form must be determined by experimental work in tandem with more linguistic research. As those details begin to emerge and to be compared with the spoken language system, our understanding of phonology will be considerably advanced.

We now turn our attention to higher levels of prosody, the description of which is more tractable: the prosodic word, the phonological phrase, and the intonational phrase.

15 Prosody

In spoken language, the flow of speech is not a steady unbroken stream, nor is it uttered monotonally. Instead, it is broken up into rhythmic chunks; some of its elements are more prominent than others; and it is characterized by meaningful excursions of pitch, called intonational tunes. This prosodic pattern is such an integral and systematic part of language that it enables newborn babies to notice when a speaker changes from one language to another, even when the segmental information is filtered out of the signal, leaving only prosodic properties (Mehler, Jusczyk, Lamberz, Halsted, Bertoncini, Amiel-Tison 1988). We intend to show that central properties of the prosodic system are common to languages in both modalities, spoken and signed.

Prosody is often thought of as an area of phonology, and that is understandable, under the broad definition of the term *phonology* proposed in Chapter 8: *phonology is the level of linguistic structure that organizes the medium through which language is transmitted*. This broader definition implies that the realm of phonology includes material above the word as well, encompassing, for example, the phrase, the utterance, or even the discourse. However, many linguists maintain that prosody comprises a separate component of the grammar, independent of other levels of linguistic analysis, because it has units and rules for their distribution and combination that are specific to the prosodic component. This prosodic component systematically interacts with all other components – with phonology, syntax, semantics, discourse, and pragmatics.

Research has motivated a hierarchy of prosodic constituents (Selkirk 1984, Nespor and Vogel 1986). The hierarchy shown in (1), adapted from Nespor and Vogel,[1] ranks prosodic constituents, from smallest to largest. These constituents exist alongside morphological and syntactic constituents, but are often not isomorphic with them. For example, *Jane's* in the sentence *Jane's singing* is two morphosyntactic words, *Jane* and *is*, but a single prosodic constituent – one syllable. The non-isomorphism of

[1] We have omitted the clitic group, which has proved controversial in spoken language research, and subsume it with the prosodic word.

prosodic constituents with morphosyntactic constituents is one of the strongest arguments that prosody is an independent component of the grammar, and cannot be relegated exclusively to an interaction between syntax and phonology without mediation.

(1) Prosodic hierarchy
mora < syllable < foot < prosodic word < phonological phrase < intonational phrase < phonological utterance

In earlier chapters, we have dealt with the prosodic unit, syllable, and with prosodic templates employed by the morphology. The discussion of prosody in the present chapter will move up to higher levels of the hierarchy: to the prosodic word, the phonological phrase, and the intonational phrase.

Our goal here is to describe the elements that go into the prosodic system in sign languages, and in this way to demonstrate that sign language grammar has a prosodic component. We'll also take a close look at the claim that sign language has intonation, expressed on the face. The discussion lays the groundwork for investigations of non-manual elements in connection with syntax, to be explored further in Unit 4. As intonation is part of prosody, and prosody is related to syntax, it is not surprising that some scholars have attributed to facial expression an explicitly syntactic role. We will suggest instead that the function and distribution of the relevant facial articulations correspond more closely to an intonational system.

15.1 The Prosodic Word

Just as morphemes and syllables are not isomorphic, morphosyntactic words and prosodic words are not always the same thing. It's very common, for example, for unstressed function words to group together with a nearby word prosodically, to form one prosodic word. Examples in English are contractions formed with auxiliaries like *Bill is* → *Bill's*. In many languages, like French, pronouns cliticize onto verbal hosts: *je aime* → *j'aime*. In these examples, the function word loses its syllable nucleus altogether, so that it would be ill-formed if pronounced as a full syllable; instead, it attaches prosodically to the host. In ISL, and apparently in ASL as well, there is also a distinction between morphosyntactic and prosodic words. In particular, pronouns can cliticize to lexical words, losing some of their phonological integrity, and forming one prosodic word together with the host. We will describe two such phenomena.

It has been noticed that in ASL, the handshape of pronouns can assimilate to that of a neighboring sign (Corina and Sandler 1993). This phenomenon has also been reported for Quebec Sign Language (LSQ – Parisot 2000), as well as for Danish Sign Language (Engberg-Pedersen

a. I (ISL) b. I-READ (ISL)

Figure 15.1 Cliticized pronoun and host with handshape assimilation

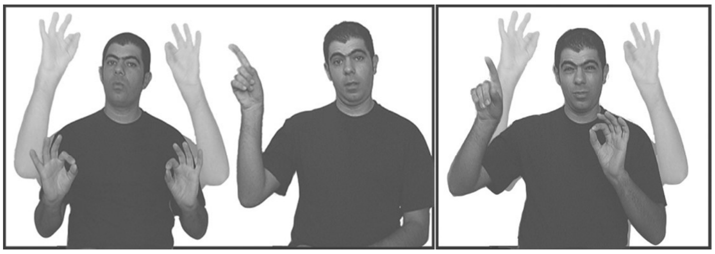
1993). It occurs in ISL as well for personal, possessive, and deictic pronouns, and has been attributed to cliticization (Sandler 1999b, 1999c). In Figure 15.1, the pronoun 'I' takes on the handshape of the verb READ.

It is clear that cliticization of a function word to a host is involved, rather than a more general phonological assimilation rule, since it is always the case that the pronoun is the word that loses its underlying handshape, and never the neighboring full lexical word. Pronouns are typically unstressed in all languages, and are commonly cliticized. Given relative freedom of word order in ISL, assimilation can be either progressive or regressive; it is the lexical status of the words that determines the direction, and not the word-level phonology.

Another type of pronoun cliticization, coalescence, has also been observed in ISL (Nespor and Sandler 1999, Sandler 1999b, 1999c). In this type, in which the host is a two-handed h2-S sign, the host and pronoun reduce to a single syllable. Specifically, the non-dominant hand completes the full lexical sign, but the dominant hand only signs half of the host sign, and then signs the pronoun clitic while h2 completes the host. The sequence of two movements of the dominant hand is simultaneous with the single movement of the non-dominant hand, which creates a monosyllabic envelope for the newly formed prosodic word (see Chapter 14, example (1) for a definition of the sign language syllable). The coalescence process is illustrated in Figure 15.2. Figures 15.2a and b illustrate the signs SHOP and THERE uttered independently. In Figure 15.2c we see that the dominant hand switches from SHOP to THERE in "midstream," while the dominant hand simultaneously completes the sign SHOP.

The prosodic words formed by assimilation and coalescence are different from lexical words in some ways and similar to them in others. Let us examine the two cliticization processes more closely.

The handshape assimilation pictured in Figure 15.1 produces a single handshape specification for the host and clitic. The resulting form conforms to the Selected Finger Constraint (Chapter 14, Section 14.4),



a. SHOP b. IX 'there' c. SHOP-IX

Figure 15.2 Independent signs and cliticized host plus pronoun

rendering a surface form that bears a certain resemblance to a monomorphemic sign. However, this assimilatory process violates a constraint encoded in the hand configuration hierarchy presented in Chapter 10, Section 10.3, and results in an anomalous form. According to that hierarchy, if handshape assimilates, as in compounds, then orientation assimilates as well. This means that complex lexical words like compounds can have the same orientation on the two member signs with two different handshapes, through orientation assimilation. But it also means that assimilation can't result in the same handshape on the two member signs with two different orientations.[2] Yet in host plus clitic forms like I-READ, just such a form is created: handshape assimilates (→ one handshape), while orientation does not (→ two orientations).

The prosodic words formed by the other type of cliticization, coalescence, shown in Figure 15.2 (SHOP-IX), also serve to make the prosodic word so formed more like lexical words. Like most lexical words, the prosodic envelope provided by the non-dominant hand is monosyllabic (see Chapter 14, Section 14.5). But, like assimilation, this process is also non-structure preserving, in this case violating the Symmetry Condition on the behavior of the non-dominant hand (see Chapter 12, example (1)). In morphemes in which both hands move, the Symmetry Condition requires the two hands to have the same shape, path, and movement. It seems that this constraint holds not only for the morpheme, but for the syllable and the morphosyntactic word as well – we know of no counterexamples at any of these levels of structure. But as Figure 15.2 shows, in the prosodic word, the dominant hand changes its shape from to , while the non-dominant hand remains throughout, and the dominant hand changes its movement trajectory in mid-word, while the non-dominant hand completes the full movement of the host, SHOP.

[2] Monomorphemic, disyllabic lexical words, like ASL COOK, may have two different orientations of the hand with the same handshape, but these orientations are always mirror images of each other, e.g., supine and prone, and always signed with respect to the same place of articulation, here, h2. In cliticization, which is postlexical, these constraints are violated.

The explanation for these apparent violations is this: clitic formation is a postlexical process, occurring not in the lexicon – not through a process of word formation – but rather "later," at the point where words are strung together in sentences. Such a form is permitted because the assimilation process that creates it is postlexical and therefore may be non-structure preserving, as are many postlexical processes generally (Kiparsky 1982, 2002). In English, for example, a geminate [t:] may occur in *night time* although English does not have lexical length distinctions, and lexically prohibited consonant clusters occur freely in connected speech as well. In the same way, the prosodic words formed by handshape assimilation as in Figure 15.1 (I-READ) are non-structure preserving, but permitted postlexically.

The discussion leads us to three conclusions about these cliticized prosodic words in ISL: they are not isomorphic with morphosyntactic words; they are non-structure preserving; at the same time, they take on certain characteristics that make them more like lexical words.[3]

15.2 The Phonological Phrase

The constituent in the prosodic hierarchy that is above the Prosodic Word is the Phonological Phrase. According to Nespor and Vogel (1986), this unit is projected from syntactic phrases according to an algorithm that starts with a phrasal head belonging to a major lexical category: Nouns, Verbs, or Adjectives. Once constructed, phonological phrases can be restructured or merged, especially if they are short. Phonetically, this prosodic constituent is identifiable by minor rhythmic breaks. For example, the square brackets divide the following sentence into phonological phrases that would be likely to occur at a normal to slow rate of speech: *[The very tall] [construction worker] [carefully walked] [under the ladder]*. In English, the rhythmically prominent or strong position in the phonological phrase is the last stressed syllable in the phrase.[4]

To further support their claim that the prosodic hierarchy includes phonological phrases, Nespor and Vogel provide evidence that is independent of phonetic rhythmicity. The evidence consists of phonological rules in several languages that have the phonological phrase as their domain. For example, the Italian rule of *Raddopiamento Sintattico* (RS) applies only within phonological phrases. RS is an external sandhi rule

[3] A constraint competition analysis of these facts is suggested in Sandler (1999b), in which the Symmetry Condition, the Selected Finger Constraint, and Monosyllabicity are in competition, and the constraints have different rankings lexically and postlexically.

[4] According to Nespor and Vogel's theory, the direction in which phonological phrases are formed from the head, and the position of prominence within them, are predicted by the direction of syntactic recursivity – i.e., the word-order properties – of the language.

(i.e., a rule of assimilation across a word boundary). The rule geminates a consonant at the beginning of a word after a lexically stressed syllable: *p* and *l* after the stressed *é* of [*é **p**iú **l**oquace*] shown underlined and in boldface in (2a). But if a phonological phrase boundary separates the consonant from the stressed syllable, as in (2b), then RS does not apply and the consonant *p* of [*piú attentamente*] does not get lengthened, because the preceding stressed [*ó*] is in a different phonological phrase.[5]

(2) a. [Il tuo pappagallo]$_P$ [é **p**iú **l**oquace]$_P$ [del mio]$_P$
'[your parrot] [is more talkative] [than mine]'
b. [Guardó]$_P$ [piú attentamente]$_P$ [e vide]$_P$ [che era un pitone]$_P$
'[He looked] [more carefully] [and saw] [it was a python]'

A study of prosodic constituents in ISL (Nespor and Sandler 1999) has shown that there are phonological phrases in that language. This investigation coded and analyzed thirty elicited sentences, each signed by three signers, providing a corpus of ninety sentences. The rhythmic phonetic cues that mark the end of phonological phrases are: hold (freezing the signing hand or hands in their shape and position at the end of the sign), pause (relaxing the hands briefly between signs), or reiteration of the last sign. Nespor and Sandler's findings suggest that the end of the phrase is the prominent position in the phrase.

The study also discovered that the surface number of iterations of a sign is often determined by position in a phrase. The lexical representation of signs usually specifies a single iteration. But some signs have two, a distinction that may be contrastive (see Figure 13.3). In Chapter 13 on movement, the feature [restrained] was used for signs with two iterations, i.e., signs that are reduplicated once lexically.[6] If a sign that is underlyingly marked for the feature [restrained], i.e., reiterated once, occurs in a weak position in a phonological phrase (i.e., not phrase finally), it is often signed only once, losing the reiteration that occurs in citation form. However, if a sign that is underlyingly non-reduplicated occurs in the prosodically strong position at the end of the phrase, it often is reduplicated, even as many as three times (four iterations).[7] In an investigation of the phonology of the sign language of Quebec (LSQ), Miller (1996) finds that reduplication is influenced by prosodic context in that sign

[5] Phonological phrases with a small number of words in them can be restructured into a neighboring phrase (Nespor and Vogel 1986).

[6] Lexical reduplication and phrase-final reiteration are each distinct functionally and distributionally from morphological reduplication that occurs for example in temporal aspect inflection.

[7] Laura Downing points out that a citation form is in a phonological phrase, implying that all signs should potentially be reiterated in citation form. However, this is not the case: the lexical distinction between single and double movement is observed in citation form but may be neutralized by higher level prosodic cues. A possible explanation rests on Nespor and Sandler's (1999) suggestion that reiteration marks prominence. As prominence is a relative property, it requires the presence of more than one word in order to surface.

language as well, suggesting that this may be a general property of sign language prosody.[8]

Phonological phrases in spoken language are marked not only by phonetic cues but by phonological processes, like RS in Italian. In ISL as well, a rule of external sandhi provides further evidence for the domain in that language – it is a rule of Non-dominant Hand Spread (NHS). Specifically, if there is a two-handed sign within a phonological phrase, the non-dominant hand can anticipate or perseverate the triggering sign by articulating the configuration and location of that sign. This spreading extends to the beginning and/or end of the phonological phrase, while the dominant hand articulates other signs. Crucially, the researchers found that NHS stopped at the boundary of the phonological phrase. Example (3) is divided into two intonational phrases (each labeled with an I subscript), the first containing three phonological phrases, and the second containing two phonological phrases. Each phonological phrase (labeled with φ) was marked by a characteristic phonetic cue – hold, pause, or reiteration of the last sign.

(3) [I-TELL HIM]$_{\varphi}$ [BAKE CAKE]$_{\varphi}$ [TASTY]$_{\varphi}$]$_{I}$ [[ONE FOR ME]$_{\varphi}$ [ONE FOR SISTER]$_{\varphi}$]$_{I}$
'I told him to bake a tasty cake, one for me and one for my sister.'

Unlike Italian RS, NHS does not involve sequential segments. Rather, the spread of the non-dominant hand from the triggering two-handed sign is simultaneous with the signing of other words by the dominant hand.

Figure 15.3 illustrates NHS in an excerpt from (3). The illustration shows the signs BAKE and CAKE with NHS. Also shown are the sign HIM in the phonological phrase that precedes BAKE CAKE, and the sign TASTY in the phonological phrase that follows it. In this example, the non-dominant hand from the sign BAKE spreads to the end of the phonological phrase by remaining in the same configuration as in the source sign, BAKE, throughout the next sign, CAKE, which is a one-handed sign. The end of the phonological phrase is marked by a hold – holding the hand in position at the end of the last sign. Precisely at the onset of the next phonological phrase, [TASTY]$_{\varphi}$, the sandhi stops, and the hand assumes a neutral shape. In the actual signing of this sequence, the change in the handshape and location between HIM and BAKE, and the rapid retraction of the fingers to a neutral position between CAKE and TASTY, are both perceptually salient (Sandler, in press).

NHS is an optional process, and does not always occur. Unlike hold, pause, and reiteration of the last sign, NHS is not a phonetic cue to a phonological phrase boundary. Instead, it is a rule of external sandhi

[8] If reiteration is influenced by prosodic position in ASL as it is in ISL and LSQ, this could explain why the underlying distinction between nouns and verbs in noun/verb pairs (Supalla and Newport 1978; Chapter 4, Section 4.1) was not discovered earlier.

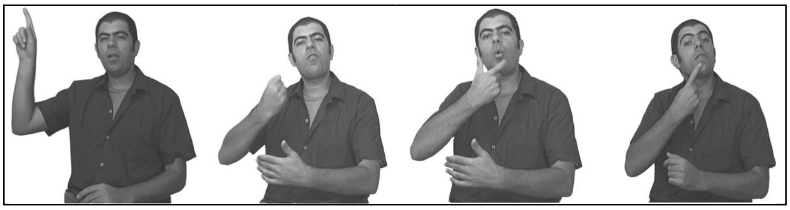


Figure 15.3 Non-dominant Hand Spread in the phonological phrase

which, by stopping at the phonological phrase boundary, is argued to provide further evidence for the existence of that constituent. What is important in the context of prosodic constituency is what the boundaries of NHS are when it does occur. In order to be convinced that the domain for the rule is the phonological phrase, we must rule out two other factors that might explain why the spread of the non-dominant hand stops where it does: the occurrence of another two-handed sign before or after the phonological phrase boundary, or the co-occurrence of a phonological phrase boundary with an intonational phrase boundary. When sentences with such co-occurrences were removed from consideration in two studies involving a total of seven signers and about eighty sentences, there were still no examples of h2 spreading beyond the phonological phrase boundary (Nespor and Sandler 1999, Sandler and Dachkovsky 2004). Therefore, the domain of the sandhi rule must be the phonological phrase boundary, and the rule provides evidence for the existence of this constituent.

15.3 The Intonational Phrase and intonation in sign language

At the next higher prosodic level, that of the Intonational Phrase, even more obvious prosodic breaks occur. Parentheticals, non-restrictive relative clauses, topicalizations and other extrapositions, vocatives, expletives, and tag questions form intonational phrases in many languages (Nespor and Vogel 1986). The salience of this break is due to clear rhythmic cues – IPs are typically separated by pauses and often by breaths – and also due to the distribution of intonational contours, to which we will return shortly. Sign languages have intonational phrases and intonational tunes as well, the latter expressed through facial expression. In ISL as in spoken languages, clear prosodic breaks were found for such syntactic constituents as those listed above. For example, when the elicited sentences in (4) were signed, they were broken up into intonational phrases in the expected way.

(4) Intonational phrases in ISL

a. Parenthetical

[DOGS THOSE]$_I$ [(YOU) KNOW]$_I$ [LIKE EAT COOKIES]$_I$

'Dogs, as you know, like cookies.'

b. Non-restrictive relative clause
[BOOKS HE WRITE PAST]$_I$ [I LIKE]$_I$ [DEPLETE]$_I$
'The books he wrote, which I like, are sold out.'

c. Right-dislocated element
[THEY TIRED]$_I$ [PLAYERS SOCCER]$_I$
'They're tired, the soccer players.'

d. Topic
[CAKE]$_I$ [I EAT-UP COMPLETELY]$_I$
'The cake, I ate up completely.'

Pronouncing the English translations of sentences (4a-d) above will give you a feel for the intonational phrase in spoken language, whose boundaries typically fall where the commas are. The breaks separating the intonational phrases in these ISL sentences of the Nespor and Sandler corpus had the following characteristics: they were marked by a change in head or body position and an across-the-board change in all aspects of facial expression. They were also optionally characterized by eyeblink. Eyeblinks often characterize phrase boundaries in American Sign Language as well (e.g., Baker and Padden 1978, Wilbur 1994b, Wilbur 1999a). The phrases described in the ASL studies appear to correspond to the Intonational Phrase (and not to the lower level Phonological Phrase).[9] This suggests that when eyeblinks occur, they are a reliable indicator of intonational phrase boundaries in sign languages generally, as breaths are in spoken language.

Comparison of the same sentences in different sign languages suggests that the change in head and body position together with facial expression at intonational phrase boundaries is common cross-linguistically (Sandler and Dachkovsky 2004). But one study indicates there may be some cross-linguistic variation in prosodic marking. Boyes Braem (1999) describes rhythmic side-to-side body sways for structuring certain kinds and levels of discourse in Swiss-German Sign Language, a cue not reported in other languages. Her work also shows that body sways of late learners differ from those of early learners on a range of measures, implying that the system is indeed linguistic.

In ASL and ISL, the ends of intonational phrases are prominent. In ISL, the last word in intonational phrases typically has more reiterations and larger signing than the last word in phonological phrases. In a study of prominence in American Sign Language, Wilbur and Zelaznik (1997) used an instrumental tracking device to determine prominence. They found that the final position in the intonational phrase was characterized by highest peak velocity, which they interpreted as prominence.

[9] For a comparison of methods and findings of Wilbur and those of Nespor and Sandler, see Sandler (1999a).

Intonational phrases in spoken languages are an important domain for intonational tunes (Pierrehumbert 1980). Intonational tunes impose a wide range of meanings on spoken utterances. In some languages, such as Hebrew, intonation may distinguish a declarative sentence from a yes/no question, as exemplified in (5) below. There is no syntactic difference between the two in these languages; only intonation distinguishes them.

(5) Hebrew intonational minimal pair

a. Yoni halax laxanut.
Yoni go-3^{rd}-sg-m.-pst to-def-store
'Yoni went to the store.'

b. Yoni halax laxanut?
Yoni go-3^{rd}-sg-m.-pst to-def-store
'Did Yoni go to the store?'

Within intonational phrases, the pitch accents fall on relatively prominent elements, and the boundary tones come at the edge, together forming the phrase's melody. The pitch accents and boundary tones themselves have meanings, and have been referred to as morphemes (e.g., Hayes and Lahiri 1991). This means that they have the dual function of delineating prosodic constituents and adding meaning to utterances. While dramatic pitch excursions tend to occur at intonational phrase boundaries, smaller changes at phonological phrase boundaries may also occur, effecting subtle nuances of meaning. Furthermore, intonational tunes in some languages have been analyzed as componential, building up complex meanings through sequences of meaningful tones and tone combinations.

An example from Bengali (Hayes and Lahiri 1991) given in (6) illustrates some of these properties. The $L^* H_P L_I$ tune is the focus tune, consisting of an L^* pitch accent – that is, an accented low pitch – followed by an H (high) phonological phrase boundary tone and an L intonational phrase boundary tone. The focus tune has the effect of emphasizing the part of the sentence on which it falls. The succeeding H tone is a continuation rise, indicating that more information follows. As we can see here, phrasal tunes are componential.

(6) [jodio ram [harlo,$]_P$ $]_I$ (o k^hub b^halo k^helec^{h}ilo)
L^* H_P L_I H_I
'Although Ram lost, (he very well played).'

We now return to sign language. The corpus examined in the prosody study of Nespor and Sandler, in addition to coding the behavior of the hands, coded each non-manual element of the face independently: eyebrows, eyes (upper and lower lids), cheeks, mouth, head position, similar to the system devised by Baker and Padden (1978). A (different-colored) line was drawn opposite the facial articulator label, and extended across the glosses of the signs with which they co-occurred. An example is given in (7).

a. WRITE b. INTERESTING

Figure 15.4 Complete change in non-manual markers in two adjacent intonational phrases in ISL

(7) Prosody coding (Nespor and Sandler 1999)

	[[BOOK-THERE]$_P$	[HE WRITE]$_P$]$_I$	[[INTERESTING]$_P$]$_I$
brows	up ________	________	down ________
eyes	squint ________		droop ________
mouth		'O' ________	down ________
tongue			
head	tilt ________	________	
mouthing	'*book*' ________		'*interesting*' ________
torso	lean ________	________	
hold	=		
reiteration	−1	×3	×4
pause			
speed			slow
size		big	big

The findings were consistent. The lines in that corpus were systematically discontinued at the intonational phrase boundary. In the example in (7), there are two phonological phrases in the first intonational phrase: BOOK THAT and HE WRITE, and one phonological phrase in the second intonational phrase, INTERESTING. The first IP is interpreted as the topic and the second as the comment (see also Rosenstein 2001). Although there is some small difference in non-manual articulation between the first two phonological phrases (in particular, there is a squint on the first phonological phrase only, and a non-neutral mouth shape only on the second), *all* facial configurations and the head and body positions change at the intonational phrase boundary in this example, and throughout the Nespor and Sandler corpus. This change is clearly indicated by the fact that all the lines on the coding sheet break between intonational phrases. Pictures of the two adjacent signs on either side of the intonational phrase boundary in this example, WRITE and INTERESTING, are given in Figure 15.4.

The fact that facial expressions coincide with intonational phrases is one of the motivations for the claim that they correspond to intonation, a claim we will support further in the next section.

15.4 Superarticulation: facial expression as intonation

It has long been known that facial expression and other non-manual markers play a significant linguistic role in sign languages.[10] Liddell (1978, 1980) presented the first detailed analysis of these markers in ASL. In that groundbreaking study, he demonstrated that yes/no questions, sentence topics, negated constituents, relative clauses, and other structures have characteristic facial expressions and head postures. He also examined the interaction between the scope of non-manuals and the scope of the constituent, finding that they were coextensive. His investigation provided evidence for word-order properties of ASL, to be presented in Chapter 18. Liddell also distinguished non-manual signals of emotional states such as surprise or anger from grammatical signals, pointing out that the emotional ones are more gradient, a claim confirmed in Baker-Shenk (1983). Analyses of the upper face/head and body positions in ASL showed that specific non-manual articulations mark questions, relative clauses, topics, conditionals, WH-questions, and rhetorical questions (Baker and Padden 1978; Baker-Shenk 1983; Liddell 1978, 1980). Baker-Shenk (1983), Liddell (1986), Wilbur (1994b), Wilbur and Patschke (1999), and Bahan (1996) subsequently have identified functions for additional components. Together with all researchers since Liddell, we concur that non-manual signals are grammatically significant. But unlike Liddell and some recent researchers such as Neidle et al. (2000), we do not claim that facial expression is a direct reflection of syntax. Instead, we support the position taken by Reilly, McIntire, and Bellugi (1990b), and Wilbur (1991), that facial expression corresponds to intonation. We present evidence for this claim here, and take up the issue again in connection with WH-questions in Chapter 23.

In this discussion, we refer only to facial expression that corresponds to intonation, and not to other uses of facial expression such as lexical marking or adverbials, which were mentioned in Chapter 4.[11] To avoid the pitch-based label, "intonation," we call the intonational system of sign language *superarticulation*, and we use the term *superarticulatory arrays* for the combination of articulations corresponding to tunes (following Sandler 1999c).

[10] See, for example, Stokoe (1960), Baker and Padden (1978), Liddell (1980), Reilly, McIntire, and Bellugi (1990a), Nespor and Sandler (1999).

[11] We also exclude iconic mouth gestures (Sandler 2003) from our purview here, as they are argued to be the sign language equivalent to co-speech gesture, and therefore outside the formal linguistic system.

Studies of ISL have demonstrated that certain facial expressions consistently bear certain meanings in that language (Nespor and Sandler 1999, Sandler 1999c, Sandler and Dachkovsky 2004, Dachkovsky 2004) as they do in ASL. As in spoken language intonation, superarticulatory meaning is broad, and gains more specific interpretation through its interaction with the meaning of the text with which it is associated. Furthermore, like the tones comprising intonational tunes in spoken languages, these superarticulations may combine componentially with one another to give complex meanings. Finally, grammatical facial expressions in sign language can be distinguished from emotional facial expressions, just as linguistic and paralinguistic intonation in spoken language are distinguishable from each other. In the sections that follow, we will illustrate each of these characteristics.

15.4.1 Superarticulation is linguistic

Superarticulatory arrays similar to those that mark yes/no questions and WH-questions in ASL (Baker and Cokely 1980, Liddell 1980), in British Sign Language (Sutton-Spence and Woll 1999), Sign Language of the Netherlands (Coerts 1992), Danish Sign Language (Engberg-Pedersen, 1993), and many others, are found in ISL as well (Nespor and Sandler 1999, Sandler 1999c, Sandler and Dachkovsky 2004). Typical yes/no questions in ISL are marked by brow raise, wide eyes, and a forward head position – Action Units 1, 2, 5, and 57 in the Facial Action Coding System of Ekman and Friesen (1978). Typical WH-questions are marked by lowered brows (AU 4) and head forward (AU 57). A common systematic facial expression in ISL is a kind of squint used to mark shared information (lower lid contraction, AU 7). What appears to be the same superarticulation with the same interpretation is reported for Danish Sign Language (Engberg-Pedersen 1990). These superarticulatory arrays are illustrated in Figure 15.5

Finer grained superarticulatory arrays have also been found in ISL. For example, factual and counterfactual conditionals are distinguished by different superarticulatory arrays in that language, discussed in the next section.

The meanings attributed to these arrays are independent of the sentences they are articulated on, like the "morphemes" of spoken language intonation. This independence is exemplified by the fact that the superarticulations may combine with sentences whose syntax or lexical meaning do not match directly. For example, while prototypical WH-questions are accompanied by the articulatory array shown in Figure 15.5b, sentences that are WH-questions syntactically may be accompanied by different facial expressions if their pragmatic intent is not that of a WH-question. Conversely, the typical WH facial expression

Figure 15.5 Three grammatical superarticulatory arrays in ISL

may accompany strings that are not syntactically WH-questions, if the pragmatic intent is to ask a WH-question. We will provide examples of this dissociation in Chapter 23, where we present more specific arguments in support of our position that grammatical facial expressions in sign language are best understood as intonational "tunes." The next section demonstrates that meanings of superarticulatory arrays are built up componentially.

15.4.2 Superarticulation is componential

Coulter (1979) was among the first to identify component pieces of non-manual articulations, and to ascribe potential functions to them in ASL. Superarticulatory arrays can combine to form more complex arrays with more complex meanings in ISL as well (Nespor and Sandler 1999, Sandler 1999c). For example, in that language, a WH-question about information designated as shared is marked by a furrowed brow (WH) plus squinted eyes (shared), shown in Figure 15.6.

Current work on ISL is showing that even arrays often interpreted holistically may be complex, i.e., that each individual action unit makes a contribution to meaning.[12] For example, brow raise in that language can co-occur with yes/no questions, factual conditionals, adverbial clauses, relative clauses and topics.[13] Dachkovsky (2004) proposes that brow raise conveys the general meaning of prediction. In these structures, it predicts that the first part of the utterance is going to be followed by some relevant information or consequence. In simple yes/no questions, the brow raise can be interpreted as predicting that a response will follow. Both yes/no and WH-questions are characterized by a forward head position (AU 57). Wilbur and Patschke (1998) suggest that the forward head position that occurs in these structures in ASL as well indicates inclusion of the addressee, a suggestion that is also compatible with the ISL data.

[12] A micro-component analysis of this sort might account for Reilly et al.'s (1990a) interesting finding that children master the non-manual components of the ASL conditional array bit by bit between the ages of 5 and 8, rather than all at once.

[13] Wilbur and Patschke (1999) and Wilbur (2000) isolate brow raise in ASL, a component in a large number of superarticulatory arrays, and provide an analysis predicting its occurrence on syntactic grounds. See Chapter 22 for discussion.

Figure 15.6 WH-Q plus shared information: componential facial expression

Similarly, lower-lid squint (AU 7) in ISL occurs, often with various other superarticulations, on topics, relative clauses, parentheticals, and counterfactual conditionals, contributing to each array the same general meaning: designating the information so marked as shared between the interlocutors for the purpose of the utterance.

Dachkovsky (2004) analyzed counterfactual conditionals in ISL, sentences such as *If Ilan had more self-confidence, he would have passed his driver's test*. The first clause in such sentences is characterized by raised brows and lower-lid squint. Each superarticulation makes an independent contribution to the meaning, at once sharing with the addressee the knowledge that the event did not occur, and predicting the information in the next clause, i.e. what would have happened otherwise. This analysis demonstrates that the meanings associated with each action unit in the system are broad, gaining specificity and adding subtlety by combining with each other and with the meaning of the sentences they characterize. Intonation works like that.

15.4.3 The physical instantiation of intonation versus superarticulation

Superarticulation in sign language and intonation in spoken language, then, have three principal characteristics in common: (1) their functions, which are illocutionary, semantic, and pragmatic, (2) componentiality, and (3) the prosodic constituents that provide their domain: the phonological phrase and especially the intonational phrase. But the physical instantiation of tunes and arrays in each system is strikingly different, both in terms of the number of independent articulators that convey the tunes/arrays, and in terms of temporal distribution with respect to each other and to the co-occurring text.

In spoken language, the only intonational source is the vocal cords, which can vibrate at faster or slower frequencies resulting in higher or lower pitch. Intonational tunes are produced by changes in the frequency at which the vocal cords vibrate (the fundamental frequency or F_0) and are perceived as pitch excursions. Because only one articulator is involved, each tone is produced independently, and tunes consist of sequences of these tones. Although a range of tones is implemented in this system phonetically, from a phonological point of view it is sufficient to distinguish only the two extremes, H (high) and L (low), and to account for the rest by rules of implementation (Pierrehumbert 1980). The sequences of individual H and L tones that comprise tunes typically are arranged at particular points of the text: on the stressed syllable of the head of focused constituents (see Selkirk 1984) and at phonological and intonational phrase boundaries (Beckman and Pierrehumbert 1986). While the tones occur simultaneously with particular syllables (hence the traditional term, "suprasegmental"), the syllables themselves are arranged in a sequence, and even tones falling on a single syllable also follow one another in a sequence.

In sign language, the physical system is quite different. There are several independent articulators – the brows, the upper and lower eyelids, the cheeks, the lips – and each articulator can perform more than one articulation. For example, the brows may rise or lower and the eyelids may contract or widen. The result is a system with a larger potential inventory of articulatory possibilities than spoken language intonation has. Whether or not this results in a richer intonational system is an empirical question. But one aspect of the physical instantiation is clearly different in the two modalities: the temporal instantiation of tones/superarticulations with respect to each other and in relation to the text. Instead of a linear sequence, the arrangement in sign language is simultaneous. Superarticulatory arrays typically co-occur with the entire prosodic constituent they characterize, and not only with the stressed syllable of a focused or boundary word as in spoken language, so that there is nothing in sign language that directly corresponds to pitch excursions, nor has the equivalent of a pitch accent been isolated. Furthermore, the superarticulations themselves within each array – i.e., whole "tunes" – co-occur simultaneously.

15.4.4 Grammaticization and language specificity of superarticulation

All humans use facial expression when they communicate, and many of these expressions are universal (Ekman and Friesen 1975). How otherwise could we explain our ability to communicate attitudes and emotions to people with whom we have no common language? Or to empathize with people in news reports or characters in movies who speak different languages and come from cultures very different from our own? As communication through facial expression is universal, it should not be at all surprising that deaf people, for whom the visual medium is primary for communication, use facial expression as well. However, it should be clear by now that the use of facial expression in sign language is different. What is an idiosyncratic means of communication, one that may occur independently of language or as a supplement to it, has been grammaticized into a conventional system in sign language.

In an attempt to track the process of this grammaticization in ASL, Janzen argues that the yes/no question facial expression (raised brows and head tilted forward) evolved from a universal questioning expression, and that topic marking in that language evolved in turn from the yes/no non-manual configuration (Janzen 1998, 1999, Janzen and Shaffer 2002).

Evidence for the nonlinguistic source may be seen in a situation in which a person holding a drink makes eye contact with someone and then holds up the drink while raising his/her eyebrows. The interlocutor understands this to mean, 'Do you want a drink?' According to Janzen, this facial expression forms the basis of a conventional non-manual marker in ASL.

In Janzen's analysis, topics are seen as information from the interlocutors' shared world of experience, either new or old in the discourse. The meaning of the topic marker is associated with one of the meanings of yes/no questions: *Do you know x*?... This overlap in meaning is claimed to underlie the further grammaticization of topics from yes/no questions. The phonetic difference between yes/no questions and topic marking in ASL is the direction of head tilt: forward for yes/no questions and backward for topics. Janzen cites Wilbur and Patschke's (1998) explanation mentioned above: the forward head tilt on yes/no questions indicates inclusion of the addressee, while the backward head tilt found on the otherwise similar topic marking is interpreted as exclusion of the addressee.

An approach like Janzen's can explain why certain basic superarticulatory arrays, like yes/no questions, seem to be widespread across sign languages, and reveals another similarity between this system and spoken language intonation. In spoken language, for example, yes/no questions are nearly universally marked by a high tone (rising pitch) (Bolinger 1986, 1989). One explanation that has been offered for this universality is that certain pitch patterns evolved from purely biological factors and are now innate (Ohala 1984). Subsequently, such patterns are grammaticized (Gussenhoven 1999). A similar explanation for the grammaticization of universal facial expressions is suggested in Campbell, Woll, Benson, and Wallace (1999). In both modalities, the emotional or non-linguistic system exists alongside the grammatical intonation system. But if that is the case, how can we tell them apart?

15.4.5 Linguistic and nonlinguistic superarticulation

While differences between emotional or paralinguistic intonation and linguistic intonation in spoken language are not obvious, the two can

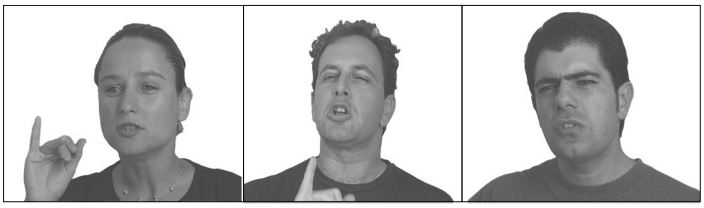


Figure 15.7 Grammatical "shared information squint" for three signers on the same phrase: 'Yossi's brother' in the utterance 'I just got a fax. Yossi's brother was killed in an accident.'

be distinguished. First, paralinguistic intonation reflects emotion and is therefore idiosyncratic, while linguistic intonational tunes have meaningful pragmatic functions and are conventionalized (Ladd 1996). Second, paralinguistic intonation is gradient. One can express more or less excitement, sadness, etc. by the degree of pitch excursion. Linguistic intonation, in contrast, is discrete and categorical (Gussenhoven 1999). The interpretation of a yes/no question melody does not depend on the mood of the asker, and small differences in the contour of a linguistic tune do not correspond to incremental changes in meaning or illocutionary force.

Signers use facial expression in both non-linguistic and linguistic ways, another parallel with intonation of spoken language. Linguistic use of superarticulation is conventionalized, while paralinguistic non-manual articulations are idiosyncratic. Furthermore linguistic superarticulation is distributed across prosodic constituents discretely. Its onset is abrupt (Baker-Shenk 1983); and it does not begin before the constituent or continue after it (Baker-Shenk 1983, Sandler and Dachkovsky 2004). In all of these ways, linguistic superarticulation is different from nonlinguistic use of facial expression.

An utterance signed by three signers in a study of superarticulation in ISL illustrates the difference clearly (Sandler and Dachkovsky 2004). The elicited utterance is, *I just got a fax. Yossi's brother was killed in an accident*. In this utterance, the string *Yossi's brother* was characterized by the "shared information squint" (AU 7) superarticulation, shown in Figure 15.7. The onset and offset of this grammatical superarticulation were synchronized within three video frames of the onset and offset of the prosodic constituent established by manual signs in the string. (There are 25 frames per second of PAL videotape.)

But each signer produced a different array of facial articulations and head positions on the rest of the sentence, idiosyncratically reflecting different kinds, nuances, and intensities of emotion. Furthermore, these arrays, exemplified in Figure 15.8, were not synchronized with the signed text, instead beginning or ending up to 17 frames from the constituent boundary, and optionally crossing intonational phrase boundaries.

Figure 15.8 Idiosyncratic emotional facial expressions characterizing other parts of the same utterance

The distinction between linguistic and non-linguistic facial expression is supported by acquisition and aphasia studies as well. Anderson and Reilly (1998), Reilly and Bellugi (1996), and Reilly, McIntire, and Bellugi (1990a) provide evidence that affective (non-linguistic) and grammatical (linguistic) facial expression are acquired differently by children, and Corina, Bellugi, and Reilly (1999) report case studies on signers with brain lesions which indicate that the linguistic and non-linguistic uses of facial expression are represented in different hemispheres of the brain.

15.5 Nonisomorphism

Although phonological and intonational phrases often correspond to syntactic constituents like the phrase or the clause, they are not strictly isomorphic with them. Rate of speech or signing, length of the syntactic constituent, and other factors have a clear influence on prosodic constituency. The two forces of syntax and rhythmicity in language don't always pull in the same direction, so that syntactic and prosodic constituents are not fully isomorphic, as shown in the excerpt from the children's story in (8).[14]

(8) Syntactic constituency vs. prosodic constituency
Syntactic: [This is [the cat that killed [the rat that ate [the malt]]]]
Prosodic: [This is the cat] [that killed the rat] [that ate the malt]

If the syllable were isomorphic with the morpheme, or the phonological phrase with the syntactic phrase, then there would be no need to posit a separate level of prosodic constituents in the grammar. Is such non-isomorphism found in sign language?

In Chapter 14, we presented evidence from sign language for non-isomorphism between the syllable, a prosodic unit, and the morpheme and the word, morphosyntactic units. In Section 15.1 above, we showed that the prosodic word and the morphosyntactic word are not one and the

[14] The example is taken from *The House that Jack Built*, a children's story compiled recursively into one long sentence.

same. Evidence is presented in the Nespor and Sandler study for non-isomorphism at the phonological and intonational phrase levels of structure in Israeli Sign Language. Specifically, syntactic units which project their own prosodic constituents may be restructured and incorporated into nearby constituents if these syntactic units are short, or if the rate of signing is fast.

Especially compelling evidence of the dissociation between syntax and prosody can be found in the superarticulation system. This runs counter to a good deal of current research on ASL syntax, which relies on the assumption that facial expressions are explicit syntactic markers determined entirely by the syntax. We've provided a number of arguments here that the system is intonational instead, and will provide evidence of the dissociation between syntax on the one hand, and the rhythm and intonation of prosody on the other, in Chapter 23.

15.6 Summary, conclusion, and future research

Like all human behavior, communication among humans is subject to rhythmicity. It appears that language recruits this rhythmicity to interpret constituents that are not inherently rhythmic in nature, such as words, clauses, sentences, utterances, and higher discourse segments. This results in a prosodic system in which a hierarchy of prosodic constituents corresponds to morphosyntactic constituents to some extent, but not fully. Intonation superimposes itself upon this combination of syntactic structuring and rhythmic accentuation, systematically adding particular kinds of semantic information to the message. The existence of a prosodic system is a linguistic universal.

This chapter has served to substantiate the claim that prosody exists in sign language, and that it has certain key features in common with the spoken language system. But we have just begun to understand the structure of the sign language prosodic system in general, and of the intonational system in particular. How should intonational meanings best be characterized? How are they distributed and associated with the text? How are they interpreted? Is there an underlying system of intonational tunes that is altered by phonological and phonetic rules to produce the surface arrays, as has been demonstrated for spoken language (Pierrehumbert 1980; Gussenhoven 1984)? What are the prosodic differences across sign languages? Neither instrumental tracking and transcribing of this system in sign language, nor experimental work on its perception and interpretation, have yet been done. Our work is cut out for us.

16 Phonology: theoretical implications

In this unit, we have taken apart the phonological elements that contribute to making a sign and examined each of them in detail. Now it is time to put them back together again and to look at the system from a somewhat broader perspective. First, we attempt to draw together areas of consensus among researchers with regard to the phonology of sign language. Still unresolved issues emerge at every turn, which point the way to future research.

From this broader perspective, the overall architecture of the phonological component comes into view, and with it the relation of that component to the rest of the grammar. We will review some of the differences between the phonological patterning of words in the lexicon and phonological patterning at the level of phrases and sentences. This bifurcation is found in spoken languages as well, and may be considered universal.

At the same time, sign languages have a third level of structure to draw on, one that we will call *non-lexical*, which is particular to the modality. At this level, the dividing lines between phoneme and morpheme on the one hand, and form and meaning on the other, are blurred, as are certain constraints on structure. But the contrast between lexical and non-lexical does not erode the imprint of linguistic structure on sign language; on the contrary, it places it in high relief.

The last topic is that of the differences between the two modalities. We review the differences between signed and spoken phonologies, and consider the implications for our understanding of language in general.

16.1 Consensus and unresolved issues

Within each aspect of sign language phonology, areas of consensus and of disagreement can be found. Let's begin with the major phonological categories. There is across-the-board consensus on the centrality of Stokoe's categories of hand configuration and location (regardless of what these categories are called and how they are represented in each model). There is broad agreement on the centrality of movement as well, though there are some voices of dissent, mainly over how it should be represented. Most models of sign language phonological structure now accept sequentiality, whether it is a sequence of static and dynamic segments (Liddell 1984b, Liddell and Johnson 1989 [1985], Sandler 1986, 1989, Perlmutter 1992), or a sequence of abstract timing units with which only the non-dynamic endpoints ultimately associate (van der Hulst 1993, Brentari 1998). The notion of a sign syllable, defined as a movement unit, is very widely accepted.[1]

Another area of consensus is the division of handshape features into the categories of selected fingers and positions (Sandler 1987a, 1987b, 1989, 1996a, Corina and Sagey 1989, Corina 1990a, Perlmutter 1992, van der Hulst 1993, Brentari 1998). The hierarchical representation proposed in Sandler (1987a, 1987b, 1989) is also widely accepted.

The claim that orientation is a subcategory of hand configuration (Sandler 1987a, 1987b, 1989) remains unrefuted so far and is also incorporated into the DP model (van der Hulst 1993, 1996) – although other models are either not fully compatible with it (e.g., Brentari 1998) or do not reflect it (Liddell and Johnson 1989 [1985], Perlmutter 1992). Taken together, the models of the handshape category support the view that phonological features are grouped in classes that are hierarchically organized (Sandler 1987a, 1987b, 1989, Corina and Sagey 1989).

An area of healthy dispute is the phonology of the non-dominant hand, but even here there is significant consensus. All researchers agree that the non-dominant hand is a subordinate category and not a "separate but equal" articulator in the lexical representation of signs (see Chapter 12 for details and references). This is a significant claim, since it implies that languages with two anatomically identical potential articulators (sign languages) are like languages with only one (spoken languages). Each modality has only one primary articulator at the phonological level: the hand and the tongue. The area of dispute is essentially whether the non-dominant hand plays two different subordinate roles in the phonology, or only one.

The models of the phonological structure of sign language vary, sometimes dramatically. This is to be expected in a new field attempting to define language in a different modality. Even so, consensus has been reached on several key issues, as we have shown. A clear exception is sonority.

Though a number of investigators have explored the notion of sonority or visual salience in sign language, and have claimed that it plays a role in the syllable, it is not possible to draw firm conclusions. Nearly every investigation has a different empirical basis, leading to disparate claims that are difficult to compare with one another. The reason suggested

[1] An exception is van der Hulst (1993), who suggests that what is considered a syllable by other researchers is instead a rhyme, and that the transition between signs provides the onset.

(Chapter 14, Section 14.6) is that the importance of modality cannot be marginalized here, and oral sonority cannot be fruitfully compared with visual salience at this stage. Experimental research is needed to assess the property in sign language, how it is perceived, and what effect it has on the structure of the sign.

16.2 The architecture of the phonological component: lexical, postlexical, and non-lexical

We would like to aim the camera at a comfortable distance now in order to compare the phonology of the lexicon with phonological processes that occur "later," when words are inserted into sentences. The addition of morphemes changes the phonology of signs in the trivial sense that they are pronounced differently than their morphologically simple counterparts. Such changes in the phonological form of words that are the result of morphological processes are often described as part of the lexical phonology. Other phonological changes that occur whenever the phonological conditions are met (including across words), without reference to morphological structure or operations, are not part of word formation, and are assigned to the postlexical level, where words are put together in sentences (Kiparsky 1982, 2002).[2]

A model of grammar that is divided into lexical and postlexical levels has certain characteristic features, and interesting implications as well. First, lexical-level processes must be structure-preserving, in the sense that they may not result in the creation of forms that do not belong to the underlying inventory of phonological elements or that violate well-formedness constraints. Second, lexical processes may only apply within words. Postlexical processes, on the other hand, may be non-structure-preserving, and they may apply between words. An important implication is that all lexical processes are ordered before all postlexical processes. The ordering metaphor, as Goldsmith (1990) calls it, reflects the fact that word formation is in some sense independent of sentence formation. When sentences are formed from words, then the contact between the words may result in alternations that can be different in kind from those that may only occur within words. In particular, they may fail to respect lexical phonological and morphological constraints.

From a functional point of view, the distinction between lexical and postlexical phonological alternations makes sense. Communication is not significantly impeded by postlexical processes which create ambiguities or other confusions, because sentence context is so good at resolving these potential problems.

[2] In phonological theory of spoken language, there is no longer a unanimous consensus concerning the lexical/postlexical distinction. See Kiparsky (2002) for a defense of the distinction in the context of Optimality Theory. As we show here, respecting this distinction allows us to state several interesting generalizations about sign language.

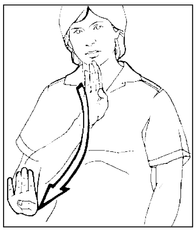


Figure 16.1 QUIET (ASL) with Weak Drop (reprinted with permission from Padden and Perlmutter 1987)

16.2.1 Lexical and postlexical phenomena in sign language

Some clear arguments are made for a similar architecture in ASL in an article by Padden and Perlmutter (1987), where they show that a lexical morphophonological process must occur before a postlexical phonological process. The lexical process in question derives characteristic adjectives from plain adjectives. The formational change involved is as follows: if the input is a one-handed sign, then the Characteristic Adjective is formed by adding the non-dominant hand, making the derived form two-handed, and producing reduplicated, alternating movements, as shown in UNDERSTAND and its corresponding Characteristic Adjective, FLEXIBLE, shown in Chapter 4, Figure 4.2. If the input is two-handed, the surface form is different: the whole sign is reduplicated, but with synchronized rather than alternating movement, as shown in Chapter 12, Figure 12.3b.[3]

Now that the phonology of the lexical rule is clear, we turn to the postlexical phonological process involved: Weak Drop. It deletes the non-dominant hand from two-handed signs. For example, the underived sign QUIET, shown in its citation form in Figure 12.3a, is shown in Figure 16.1 after the application of Weak Drop.

Since the conditions for application of Weak Drop are entirely phonological, having nothing to do with morphological processes, it is assumed to be postlexical. As such, it is predicted to apply after morphological operations, if the architecture of sign language grammar is similar to that of spoken language. Indeed, Padden and Perlmutter showed that Weak Drop must apply after Characteristic Adjective formation, and may not apply before. Were Weak Drop to apply before Characteristic Adjective formation that derives TACITURN from QUIET (see Figure 12.3b), then

[3] The description of Padden and Perlmutter requires some modification. If the input sign is two-handed and symmetrical (h2-S), then the derived form is reduplicated and synchronized, as the authors state. However, if the input is two-handed but h2 is a place of articulation (h2-P), then h2 remains stationary like any other place of articulation, while h1 alone reduplicates the sign's movement (Sandler 1993a). In addition to being necessary for deriving the correct surface form, the additional distinction required by the rule provides support for the Hand Tier model that suggests two different representations for h2 (see Chapter 12, Section 12.1).

the input to Characteristic Adjective would be one-handed, and the rule would then produce alternating movement. Instead, the architecture of the grammar prevents such forms from occurring.

More evidence for a postlexical level in sign language comes from cliticization in Israeli Sign Language, discussed in Chapter 15, Section 15.1. Both cliticization processes must be postlexical because they occur in the syntax, where function words combine with content words to form phrases and sentences. In addition, they are non-structure-preserving, forming prosodic words that violate lexical well-formedness constraints (Sandler 1999b). In the syllable coalescence process, both hands begin to sign the lexical host sign, and the non-dominant hand completes it while the dominant hand changes its path half-way through, and signs the pronoun (see Figure 15.2). This form violates the Symmetry Condition (stated in Chapter 12, example (1)), which says that if both hands move, they must have the same hand configuration and the same or symmetrical movement. Syllable coalescence is therefore non-structure-preserving: no lexical process produces such forms.

The other ISL cliticization process, handshape assimilation (Figure 15.1), is also non-structure-preserving, but in a different way. It disrupts the lexical representation in which orientation is subordinate to handshape, and must therefore assimilate together with it (see Chapter 10, Section 10.3). So far, we have seen no counterexamples to this proposed hierarchical structure of handshape and orientation in any lexical processes of ASL or ISL, and even the error data of Newkirk et al. (1980) confirm its robustness. However, in the non-structure-preserving postlexical process of cliticization, the integrity of the relationship between selected fingers and palm orientation is violated in both sign languages. An even more obviously non-structure-preserving assimilation reported in ASL (Corina and Sandler 1993) involves coalescence of handshape, such that the resulting form has two different selected finger specifications simultaneously. In particular, the sign HAVE in the sequence HAVE IX (where HAVE specifies all fingers bent and contacting the chest, while IX (index) is a pronoun specified for extended index finger only), undergoes single-finger assimilation. The middle, ring, and pinky fingers are all curved and making fingertip contact with the chest, while the index finger only is extended, assimilated from IX. Once again, this must be postlexical, as the assimilation occurs across words. Such facts support the claim that sign language grammars, like those of spoken languages, are structured into lexical and postlexical components. Finally, the external sandhi rule of Non-dominant Hand Spread (Chapter 15, Section 15.2) results in non-structure-preserving configurations in which there may be two places of articulation simultaneously present in the signal. In the example shown in Figure 15.3, BAKE CAKE, the place of articulation for BAKE, the non-dominant hand, co-occurs with the place of articulation for CAKE, the chin.

16.2.2 A non-lexical level in sign language

In addition to the lexical and the postlexical, sign languages are unique in possessing linguistic structures that we might call "non-lexical."[4] In particular, the classifier system, described at length in Chapter 5, consists of underspecified morphemes of hand configuration, location, and movement, the same elements which are meaningless phoneme-like units within lexical words. While most of the elements that comprise classifier constructions must be in the lexicon, their combination does not result in "words," and that is why we are including them under the heading of non-lexical. Instead, these morphemes combine to form complex predicates.

The non-lexical forms that result apparently enter into grammatical subsystems with different properties from those of ordinary words and sentences. For example, we showed in Chapter 5 that classifier constructions often consist of strings of complex predicates with a single classifier argument which span any number of intonational phrases. Such constructions may translate as a sequence of propositions. The non-dominant hand can simultaneously represent an additional argument in such constructions, adding to their complexity and to their departure from lexical form. The gestural roots of these languages and the fact that they are perceived visually afford them kinds of expression that are simply not available to the aural–oral modality.

From the point of view of phonology, what is interesting about these forms is that they do not obey the phonological constraints of the lexicon. For example, each hand may articulate a different classifier morpheme in a single construction, in violation of the Dominance and Symmetry conditions on the non-dominant hand (Chapter 12, examples (1) and (2)). Similarly, movement patterns are permitted in this system that do not occur in lexical signs (Chapter 13). The classifier subsystem provides a basis for more creative uses of language in story telling and poetry, also subsumed under the category of "non-lexical." Using the basic principles of the subsystem, nonce forms may be created that are immediately understandable (see Sutton-Spence and Woll 1999, Sandler and Lillo-Martin 2001; and Chapters 5 and 6). The building blocks of both lexical and non-lexical systems may be selectively interpreted and combined in the service of metaphor (Wilcox 2000, Taub 2001). Forms in the non-lexical system may exhibit gradience (e.g., the use of movement in the poem described in Chapter 5), typically not exploited in linguistic systems, the forms of which are instead discrete.

In fact, even the lexicon itself is not hermetically sealed against non-lexical influences. Since many words in the lexicon originated as classifier

[4] Non-lexical should not be interpreted as non-linguistic. See Chapters 5 and 20 for morphological and syntactic analyses of the classifier subsystem, a linguistic system which we analyze as non-lexical.

constructions, the lexicon may "leak" when such words are reanalyzed into their component classifier parts (Figure 6.2). In Chapter 5, this was described as a sign language special kind of backformation, a phenomenon that is reflected in the phonology too. For example, it has the effect of violating a constraint that holds at the level of the phonological phrase. If there is a two-handed sign that undergoes this kind of backformation, where each handshape is reanalyzed as a classifier rather than a meaningless phonological element, then the non-dominant hand may spread across phonological phrase boundaries, which is otherwise prohibited (Chapter 15, Section 15.2).

The pervasive presence in sign languages of both lexical and non-lexical systems, and the clear formal dichotomy between these systems, do not, in our view, point to a non-linguistic explanation for sign language structure. On the contrary – the clarity with which the two are formally distinguished, i.e., the strict constraints on phonological form of the morpheme and the word (Chapter 14), make the identification of a *word* in sign language straightforward.

Consider the significance of this result. The existence of the word is a necessary condition for any language, and its identification is essential for acquisition and for processing. In these languages that also have a non-lexical component, the formal constraints on words, and by extension the clear distinction between words and nonwords, provide a significant advantage for acquisition and processing of the words and sentences of sign languages.

What we are calling the non-lexical system, manifested productively in the classifier subsystem and exploited for special effect in story telling and poetry, offers an auxiliary type and range of expression that are unique to the modality.

16.3 Universals and modality effects in both modalities

What can we learn about language from the phonology of signed languages? In some very significant ways, signed languages are surprisingly like spoken languages at the phonological level of structure, supporting the view that there are phonological universals regardless of language modality. At the same time, there are significant differences. These differences should not be dismissed as "modality effects," but instead they should motivate us to look more closely at the role of the physical system in the shaping of phonological structure in *both* modalities (see also Sandler 1995a, in press, Lillo-Martin 2002). Let's be more specific about universals that emerge from comparison of the phonology in the two modalities, noting the differences that are revealed as we go.

The first universal is the existence of a sublexical level of structure that is meaningless, discrete, finite, and systematically organized. Given the different modality, it is not at all obvious a priori that sign languages would have this level of structure. Nor is it necessarily to be expected that the elements of this component may be altered in rule-governed ways under certain morphological and/or phonological-contextual conditions. In other words, it is a significant discovery that sign languages, like spoken languages, have phonologies, and the properties just listed are indeed universals of human language. Considering the likelihood that sign languages certainly evolve from an iconic base, it is all the more remarkable that this abstract level of structure inevitably arises. This tells us that human minds create this kind of system wherever they get together to make language.

In each language modality, certain features are common across languages, and are frequently referred to by constraints and rules, while others are less active in phonological systems. This observation leads to the (Jakobsonian) notion of markedness, a notion which is clearly exemplified by the distribution and behavior of handshapes and of the interaction between the two hands. A comparison of the relative markedness of phonological elements in the two modalities may provide deeper insight into the nature of phonological markedness in general, its relation to articulation, and its influence on phonological systems.

The internal organization of features reveals another interesting similarity between the two modalities. In particular, there is compelling evidence in both modalities that features cluster into categories that correspond to their articulators, and that these categories are organized hierarchically (see especially Chapter 10). At each level of the hierarchy, the features subordinate to it behave as a group. If the evidence accrued so far is representative, then these aspects of the organization of features and feature categories appear to be universal.

The features themselves are of course different. While distinctive features apparently exist in any natural language, and may be considered a universal property, the quest for a universal set of them must now be conducted according to modality. This discovery should not elicit the complacent response that some things are simply "modality effects." If the set of features required to describe sign languages is a function of modality, then the set of features required to describe spoken languages is also a function of modality. If each modality carves out a different set of features, then the set arrived at must therefore somehow be *explained*, motivated on the basis of production, perception, and processing constraints, rather than assumed to be simply innately specified. Articulation-based constraints on the system may also be approached in this way.

In all natural languages, the phonetic features define natural classes of sounds. Since the features are different in the two modalities, it follows that the natural classes must necessarily also be different. Just as spoken languages have processes or constraints affecting all stop consonants or all vowels, for example, sign languages have processes or constraints affecting all handshapes or all movements.

Languages in both modalities have sequential structure, but there are big differences in the nature of that structure. Spoken languages show variation along the following parameters: the makeup of syllables (e.g., whether clusters are allowed in the onset or the rhyme, and if so, what kinds); the minimal and maximal length of words; stress patterns among syllables. Sign languages appear to have very few options. A signed word generally consists of one syllable; there are no clusters; whatever word-level stress pattern may exist must be very simple, since there are so few words with more than one syllable (apart from fully reduplicated forms and compounds).

The simplicity of the sequential structure in sign languages in no way precludes complexity of word structure, however. As explained in Unit 2, sign languages have complex morphology. Morphological complexity in sign languages strongly tends to be templatic, incorporating morphological material non-linearly, and resulting in sequential form that is monosyllabic and simple. We will return to this unusual combination of morphological complexity, non-linear structure, and sign language universals in Unit 5.

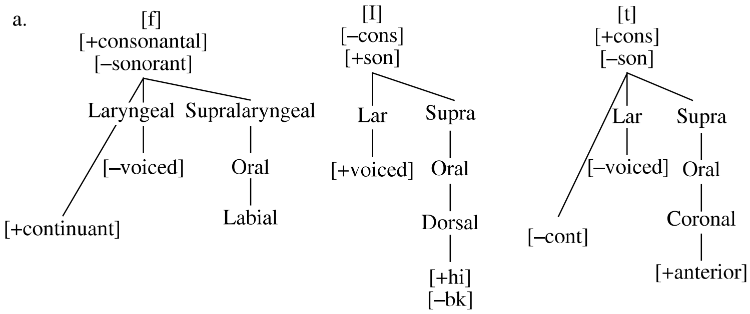
Non-linear phonological structure exists in all languages, but here too we have striking modality differences. Ignoring for now the fact that all features bear a relationship with segments that in some sense is not strictly linear (cf. feature geometries), let us consider only those elements that are dramatically non-segmentalized, those with long-distance scope and spreading effects, such as tones in tone languages, or nasality or vowel features in harmony systems. Comparing these with the sign language elements that have similar scope, we see some big differences. Unlike spoken language autosegments, which typically consist of one or two features, the hand configuration autosegment of sign languages is the most complex element in the whole system, consisting of several hierarchically organized classes of features (Sandler 1987a, 1987b, 1989, 1995c). The other element that has scope over the whole sign is the place of articulation (major body area), which, though not as complex, is visually very salient in a word. In fact, very few features are actually sequenced in any signed word. In spoken words, the opposite is true: most features are sequenced. Also, only a subset of spoken languages even have long-distance autosegments, while the phonological structure of sign languages seems universally to be characterized by long-distance features of hand configuration and place of articulation.

Compare representations of the English word *fit* (1a, b), with the ASL sign, IDEA (2a, b). The word *fit* is represented using a feature geometry in the spirit of Halle (1992), and then with SPE-type feature matrices. The ASL sign IDEA is represented using a feature geometry in the spirit of Sandler (1989), and also with feature matrices.[5]

[5] In the Halle (1992) model, the features [stiff, slack] are intended to account for voicing (Halle and Stevens 1971). Here we use the more common feature, [±voiced].

(1) English *fit*

a.

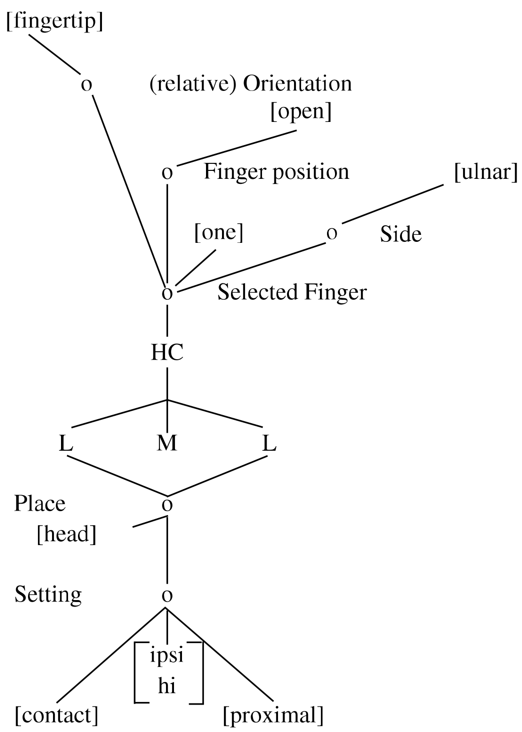


b.

[f]	[I]	[t]
[+cons]	[–cons]	[+cons]
[–son]	[+son]	[–son]
[+cont]		[–cont]
[–voiced]	[+voiced]	[–voiced]
[+labial]	[+high]	[+coronal]
	[–back]	[+anterior]

(2) IDEA (ASL)

a.



b.

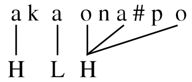
x	x	x
Location	Movement	Location
one	one	one
ulnar	ulnar	ulnar
open	open	open
fingertip	fingertip	fingertip
head	head	head
ipsi	ipsi	ipsi
high	high	high
contact		proximal

The English word *fit* has three segments, like the ASL sign IDEA. Few features and values are the same in the three segments of *fit*, and fewer of them are predictable from the features in the other segments. The only feature value that is fairly predictable given a word with three segments is that the second segment is likely to be a vowel. In ASL IDEA, almost all the features are the same in the three segments. Apart from what might be considered major class features, location and movement, only the features [contact] in the first segment and [proximal] in the last segment differ. While it is not predictable which features will be different, it is predictable that in a monomorphemic sign with three segments, only two (setting features) or at most four (two setting and two finger position or orientation features) will be different. Whether each segment is a location or a movement is also predictable.

These examples illustrate why the overall impression in spoken language is one of sequentiality, while in sign language the overall impression is one of simultaneity. In the English word *fit*, there are no features that have scope over more than one segment phonologically. In the ASL sign IDEA, almost all of them do.

If we think of the hand configuration category as a long-distance autosegment as Sandler proposes, and compare it with tones, prototypical long-distance autosegments in spoken language, we again see a difference. Consider the Shona word, *ákàónápó*, 'he saw there.' This word has three tones, the last of which has scope over three vowels. Unlike the hand configuration category, which is very complex, the tones of Shona are simple, consisting of one feature only. Even vowel harmony generally involves one or two features at most.

(3) Shona *ákàóná#pó* 'he saw there' (data from Odden 1980, cited in Kenstowicz 1994)



So, while the formal properties of linearity and of non-linearity are common to both spoken and signed languages, the relative centrality of each in the phonological organization of each modality is different.

A numerical comparison of features and their organization in Halle's spoken language model and in Sandler's sign language model (as revised here) is useful. The number of feature classes is similar: nine in spoken language and ten in sign language. But there is a big difference in the number of features. Spoken language has eighteen features while sign language has thirty (of which fifteen are hand configuration features).

We might speculate that the reason for this difference is related to the relative amount of sequentiality in the two modalities. Each modality must have the potential to produce a great number of lexical contrasts. In spoken language, this can be achieved through different configurations of sequentially arranged phonemes. In sign languages, sequentiality is limited and simultaneity favored by the modality. In order to create a similar number of lexical contrasts with far fewer sequential positions available, a larger number of features may be required.

This idea is compatible with the results of a study of ten languages conducted by Nettle (1995) in which he compared the number of contrastive segments in the inventories of ten languages to the mean number of segments in the words of each language. He found that as the number of segments in a language increases, the mean word length decreases. The languages at the two extremes were Nahuatl and !Xu. Nahuatl has an inventory of 23 segments and a mean word length of 8.69, while !Xu has 119 segments and a mean word length of 4.02.

A comparison of segment inventories in signed and spoken languages is not very meaningful, because of the differences we have seen here in the nature of the sign segment compared to that of spoken language, and the number of contrastive segments in any given sign language has not been calculated. But a comparison of feature inventories is instructive. Both language modalities are presumably structured in such a way as to accommodate a large vocabulary of distinct words. In sign languages, the small number of sequential distinctions in a sign – i.e., both the small number of segments in a typical sign and the small number of feature distinctions across them – may be compensated for by a larger number of features.

That the organization of phonological elements in words tends to be more simultaneous in sign language than in spoken language has a direct effect on phonological rules. Relatively few rules that are purely phonological, like aspiration in English or final devoicing in Russian, have been discovered in sign languages. By purely phonological, we mean rules that are not triggered by the morphology. We suggest that the apparent dearth of purely phonological rules is due to the relative lack of sequential structure in sign words. It is precisely under morphological and syntactic processes in sign language that concatenate morphemes and words – i.e., linear affixation, compounding, and cliticization – that significant sequential structure arises within words. As soon as such concatenation does occur in sign languages, a plethora of concomitant phonological effects arises: hand configuration assimilation, orientation assimilation, truncation, coalescence, selected finger assimilation. These effects only arise under morphological operations and cliticizations because it is primarily under those circumstances that phonological elements are conjoined linearly.

Finally, the existence of prosodic structure is a language universal, regardless of modality. Investigations conducted to date demonstrate that sign languages have prosodic constituents that are similar to those of spoken language, and that they also have the equivalent of intonational systems. The main differences discovered so far are in the phonetic makeup and scope of the primitives of intonation. The high and low tones of intonational tunes are sequential in spoken language, while the configurations of the face and body features that comprise superarticulation in sign language are simultaneous. The way in which these markers are superimposed on the text is different too. In spoken language, the pitch excursions of intonational tunes co-occur with syllables, typically at constituent boundaries, while in sign languages superarticulatory arrays co-occur with the entire prosodic constituent with which they are associated.

Research on sign language phonology leads to two conclusions, which are also important directions for future research in this relatively new field: (1) there are universal properties of phonological organization common to natural language in radically different physical modalities, but (2) there are substantial areas in which the physical production and perception systems mold the phonology of *both* modalities. Clearly, this conclusion has implications for our conception of phonological universals, and for how we "do" phonology as well. If modality effects in sign language are isolated by comparing them with spoken language, then the mirror image of these properties are precisely the modality effects of spoken language. This should lead us to ask not only what phonology is like, but why it should be as it is.

Unit 4

Syntax