

3. Phonology

1. Introduction
2. Structure
3. Modality effects
4. Iconicity effects
5. Conclusion
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Abstract

This chapter is concerned with the sub-lexical structure of sign language phonology: features and their organization into phonological units, such as the segment, syllable and word. It is organized around three themes – structure, modality, and iconicity – because these themes have been well-studied since the inception of the field and they touch on the reasons why the consideration of sign languages is essential if one wishes to understand the full range of possibilities of the phonology of natural languages. The cumulative work described here makes two main arguments. First, modality affects the phonological representation in sign and spoken languages; that is, the phonological structure represents the strengths of the phonetic and physiological systems employed. Without a comparison between sign and spoken languages, it is easy to lose sight of this point. Second, iconicity works with phonology, not against it. It is one of the pressures – like ease of perception and ease of production – that shape a phonological system. This interaction is more readily seen in sign languages because of the availability of visual iconicity and the ease with which it is assumed by phonological structures.

1. Introduction

Why should phonologists, who above all else are fascinated with the way things *sound*, care about systems without sound? The short answer is that the organization of phonological material is as interesting as the phonological material itself – whether it is of spoken or sign languages. Moreover, certain aspects of work on spoken languages can be seen in a surprising new light, because sign languages offer a new range of possibilities both articulatorily and perceptually.

In this chapter the body of work on the single sign will be described under the umbrella terms *structure*, *modality*, and *iconicity*. Under the term *structure* is included all the work that showed that sign languages were natural languages with demonstrable structure at all levels of the grammar including, of course, phonology. Much progress has been achieved toward the aim of delineating the structures, distribution, and operations in sign language phonology, even though this work is by no means over and debates about the segment, feature hierarchies, contrast, and phonological operations continue. For now, it will suffice to say that it is well-established crosslinguistically that sign languages have hierarchical organization of structures analogous to those of spo-

ken languages. Phonologists are in a privileged place to see differences between sign and spoken languages, because, unlike semantics or syntax, the language medium affects the organization of the phonological system. This chapter deals with the word-sized unit (the sign) and phonological elements relevant to it; phonetic structure and prosodic structure above the level of the word are dealt with in chapter 2 and chapter 4 of the handbook, respectively.

Taken together, the five sign language parameters of Handshape, Place of Articulation (where the sign is made), Movement (how the articulators move), Orientation (the hands' relation towards the Place of Articulation), and Non-manual behaviors (what the body and face are doing) function similarly to the cavities, articulators and features of spoken languages. Despite their different content, these parameters (i.e., phonemic groups of features) in sign languages are subject to operations that are similar to their counterparts in spoken languages. These broad-based similarities must be seen, however, in light of important differences due to modality and iconicity effects on the system. *Modality* addresses the effect of peripheral systems (i.e., visual/gestural vs. auditory/vocal) on the very nature of the phonological system that is generated (see also chapter 25). *Iconicity* refers to the non-arbitrary relationships between form and meaning, either visual/spatial iconicity in the case of sign languages (Brennan 1990, 2005), or sound symbolism in the case of spoken languages (Hinton/Nicholls/Ohala 1995; Bodomo 2006; see also chapter 18).

This chapter will be structured around the three themes of structure, modality, and iconicity because these issues have been studied in sign language phonology (indeed, in sign language linguistics) from the very beginning. Section 2 will outline the phonological structures of sign languages, focusing on important differences from and similarities to their spoken language counterparts. Section 3 will discuss modality effects by using a key example of word-level phonotactics. I will argue that modality effects allow sign languages to occupy a specific typological niche based on signal processing and experimental evidence. Section 4 will focus on iconicity. Here I will argue that this concept is not in opposition to arbitrariness; instead iconicity co-exists along with other factors – such as ease of perception and ease of production – that contribute to sign language phonological form.

2. Structure

2.1. The word and sublexical structure

The structure in Figure 3.1 shows the three basic manual parameters – Handshape (HS), Place of Articulation (POA), and Movement (MOV) – in a hierarchical structure from the Prosodic Model (Brentari 1998), which will be used throughout the chapter to make generalizations across sets of data. This structure presents a fundamental difference between sign and spoken languages. Besides the different featural content, the most striking difference between sign and spoken languages is the hierarchical structure itself – i.e., the root node at the top of the structure is an entire lexeme, a stem, not a consonant- or vowel-like unit. This is a fact that is – if not explicitly

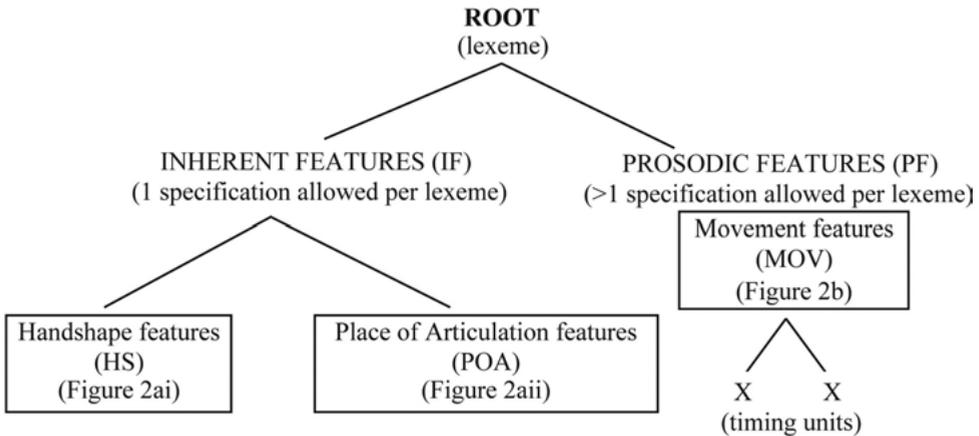


Fig. 3.1: The hierarchical organization of a sign's Handshape, Place of Articulation, and Movement in the Prosodic Model (Brentari 1998).

stated – inferred in many models of sign language phonology (Sandler 1989; Brentari 1990a, 1998; Channon 2002; van der Hulst 1993, 1995, 2000; Sandler/Lillo-Martin 2006).

Both sign and spoken languages have simultaneous structure, but the representation in Figure 3.1 encodes the fact that a high number of features are specified only once per lexeme in sign languages. This idea will be described in detail below. Since the beginning of the field there has been debate about how much to allow the simultaneous aspects of sublexical sign structure to dominate the representation: whether sign languages have the same structures and structural relationships as spoken languages, but with lots of exceptional behavior, or a different structure entirely. A proposal such as the one in Figure 3.1 is proposing a different structure, a bold move not to be taken lightly. Based on a wide range of available evidence, it appears that the simultaneous structure of words is indeed more prevalent in sign than in spoken languages. The point here is that the root node refers to a lexical unit, rather than a C- or V-unit or a syllabic unit.

The general concept of 'root-as-lexeme' in sign language phonology accurately reflects the fact that sign languages typically specify many distinctive features just once per lexeme, not once per segment or once per syllable, but once per word. Tone in tonal languages, and features that harmonize across a lexeme (e.g., vowel features and nasality) behave this way in spoken languages, but fewer features seem to have this type of domain in spoken than in sign languages. And when features do operate this way in spoken languages, it is not universal for all spoken languages. In sign languages a larger number of features operate this way and they do so universally across most known sign languages that have been well studied to date.

2.2. The Prosodic Model

In the space provided, I can provide neither a complete discussion of all of the phonological models nor of the internal debates about particular elements of structure. Please

see Brentari (1998) and Sandler and Lillo-Martin (2006) for a more comprehensive treatment of these matters. When possible, I will be as theory-neutral as possible, but given that many points made in the chapter refer to the Prosodic Model, I will provide a brief overview here of the major structures of a sign in the Prosodic Model for Handshape, Place of Articulation, Movement, and Orientation. Non-manual properties of signs will be touched on only as necessary, since their sublexical structure is not well worked out in any phonological model of sign language, and, in fact, it plays a larger role in prosodic structure above the level of the word (sign); see chapter 4. The structure follows Dependency Theory (Anderson/Ewen 1987; van der Hulst 1993) in that each node is maximally binary branching, and each branching structure has a head, which is more elaborate, and a dependent, which is less elaborate. The specific features will be introduced only as they become relevant; the discussion below will focus on the class nodes of the feature hierarchy.

The *inherent feature structure* (Figure 3.2a) includes both *Handshape* and *Place of Articulation*. The *Handshape (HS) structure* (Figure 3.2ai) specifies the active articulator. Moving down the tree in (2ai), the head and body (non-manual articulators) can be active articulators in some signs, but in most cases the arm and hands are the active articulators. The manual node branches into the dominant (*H1*) and non-dominant (*H2*) hands. If the sign is two-handed as in *SIT* and *HAPPEN* (Figures 3.3aiii and 3.3aiv) it will have both H1 and H2 features. There are a number of issues about two-handed signs that are extremely interesting, since nothing like this exists in spoken languages (i.e., two articulators potentially active at the same time). Unfortunately these issues will not be covered in this chapter in the interest of space (Battison 1978; Crasborn 1995, submitted; Brentari 1998). If the sign is one-handed, as in *WE*, *SORRY*, and *THROW* (Figures 3.3ai, 3.3aaii, and 3.3av), it will have only H1 features. The H1 features enable each contrastive handshape in a sign language to be distinguished from every other. These features indicate, for instance, which fingers are ‘active’ (*selected*), and of these selected fingers, exactly how many of them there are (*quantity*) and whether they are straight bent, flat, or curved (*joints*). The *Place of Articulation (POA) structure* (Figure 3.2aaii) specifies the passive articulator, divided into the three dimensional planes – horizontal (*y-plane*), vertical (*x-plane*), and midsagittal (*z-plane*). If the sign occurs in the vertical plane, then it might also require further specifications for the major place on the body where the sign is articulated (*head, torso, arm, H2*) and also even a particular *location* within that major body area; each major body area has eight possibilities. The POA specifications allow all of the contrastive places of articulation to be distinguished from one another in a given sign language. The inherent features have only one specification per lexeme; that is, no changes in values.

Returning to our point of root-as-lexeme, we can see this concept at work in the signs illustrated in Figure 3.3a. There is just one Handshape in the first three signs: *WE* (3.3ai), *SORRY* (3.3aaii), and *SIT* (3.3aiii). The Handshape does not change at all throughout articulation of the sign. In each case, the letters ‘1’, ‘S’, and ‘V’ stand for entire feature sets that specify the given handshape. In the last sign, *THROW* (3.3av), the two fingers change from closed [–open] to open [+open], but the *selected fingers* used in the handshape do not change. The opening is itself a type of movement, which is described below in more detail. Regarding Place of Articulation, even though it looks like the hand starts and stops in a different places in each sign, the major region where the sign is articulated is the same – the *torso* in *WE* and *SORRY*, the *horizontal plane*

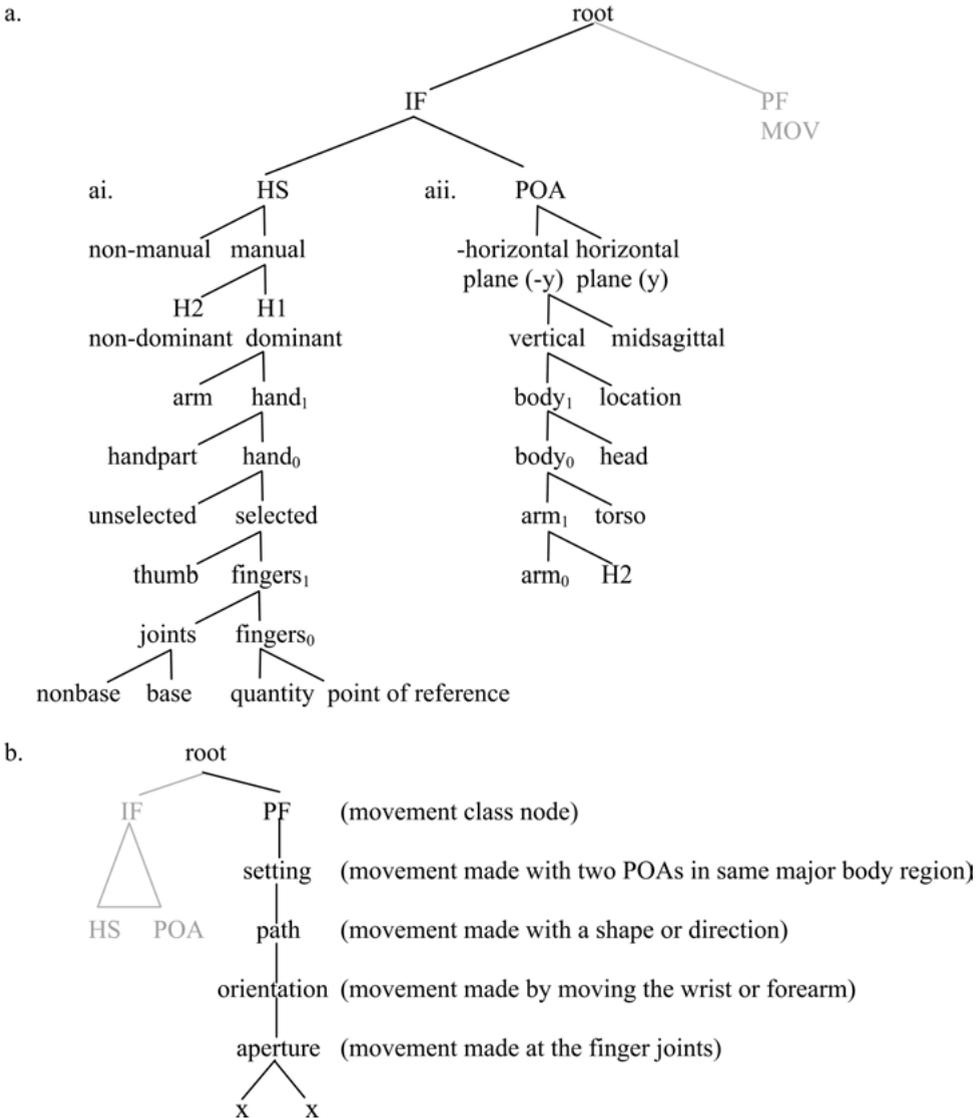


Fig. 3.2: The feature geometry for Handshape, Place of Articulation, and Movement in the Prosodic Model.

(y-plane) in front of the signer in *SIT* and *HAPPEN*, and the *vertical plane* (x-plane) in front of the signer in *THROW*. These are examples of contrastive places of articulation within the system, and the labels given in Figure 3.3b stand for the entire Place of Articulation structure.

The *prosodic feature structure* in Figure 3.1 (shown in detail in Figure 3.2b) specifies movements within the sign, such as the aperture change just mentioned for the sign *THROW* (3.3av). These features allow for changes in their values within a single root

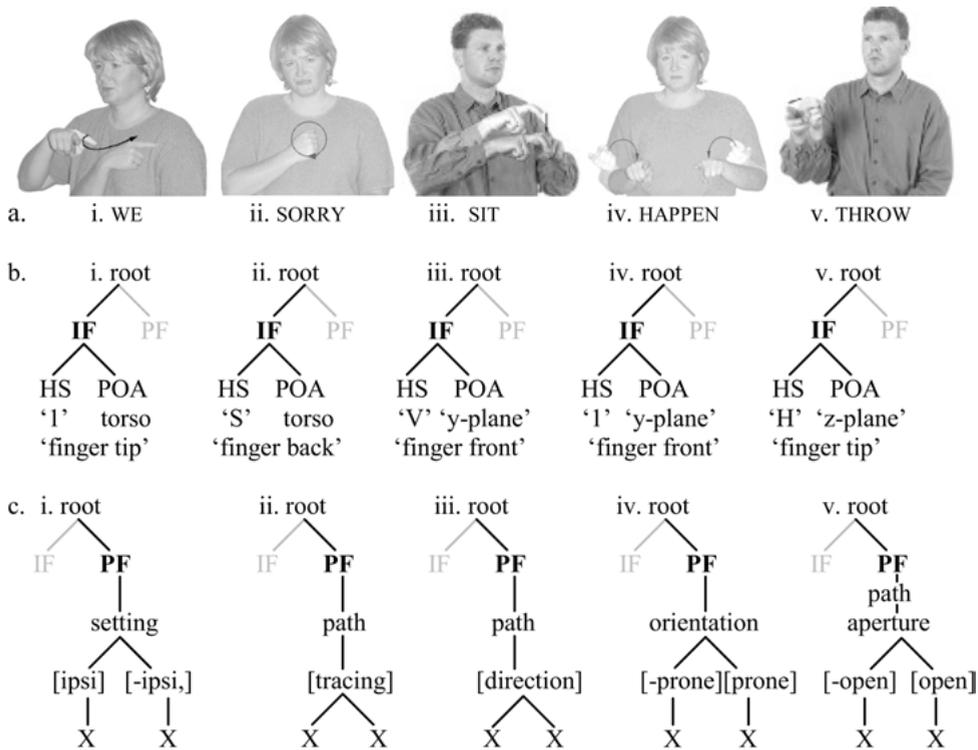


Fig. 3.3: Examples of ASL signs that demonstrate how the phonological representation organizes sublexical information in the Prosodic Model (3a). Inherent features (HS and POA) are specified once per lexeme in (3b), and prosodic features (PF) may have different values within a lexeme; PF features also generate the timing units (x-slots) (3c).

node (lexeme) while the inherent features do not, and this phonological behavior is part of the justification for isolating the movement features on a separate autosegmental tier. Note that Figures 3.3ai, 3.3iv, and 3.3av (WE, HAPPEN, and THROW) all have changes in their movement feature values; i.e., only one contrastive feature, but changes in values. Each specification indicates which anatomical structures are responsible for articulating the movement. Going from top to bottom, the more *proximal* joints of the shoulder and arm are at the top and the more *distal* joints of the wrist and hand are at the bottom. In other words, the shoulder articulating the *setting* movement in WE is located closer to the center of the body than the elbow that articulates a *path* movement in SORRY and SIT. A sign having an *orientation change* (e.g., HAPPEN) is articulated by the forearm or wrist, a joint that is even further away from the body's center, and an *aperture change* (e.g., THROW), is articulated by joints of the hand, furthest away from the center of the body. Notice that it is possible to have two simultaneous types of movement articulated together; the sign THROW has a path movement and an aperture change. Despite their blatantly articulatory labels, these may have an articulatory or a perceptual basis (see Crasborn 2001). The trees in Figure 3.3c demonstrate different types of movement features for the signs in Figure 3.3a. Note that

Figures 3.3ai, 3.3aii, and 3.3av (WE, HAPPEN, and THROW) all have changes in their movement feature values; one contrastive feature but changes in their values.

Orientation was proposed as a major manual parameter like Handshape, Place of Articulation and Movement by Battison (1978), but there are only a few minimal pairs based on Orientation alone. In the Prosodic Model, Orientation is derivable from a relation between the *handpart* specified in the Handshape structure and the Place of Articulation, following a convincing proposal by Crasborn and van der Kooij (1997). The mini-representations of the signs in Figure 3.3 show their orientation as well. The position of the fingertip of the 1-handshape towards the POA determines the hand's orientation of WE and THROW; the position of the back of the fingers towards the torso determines the hand's orientation in SORRY, and the front of the fingers towards the POA determines the hand's orientation in SIT and HAPPEN.

The timing slots (segments) are projected from the prosodic structure, shown as x-slots in Figure 3.2b. Path features generate two timing slots; all other features generate one timing slot. The inherent features do not generate timing slots at all, only movement features can do this in the Prosodic Model. When two movement components are articulated simultaneously as in THROW, they align with one another and only two timing slots are projected onto the timing tier. The movement features play an important role in the sign language syllable, discussed in the next section.

2.3. The syllable

The syllable is as fundamental a unit in sign as it is in spoken languages. One point of nearly complete consensus across models of sign language phonology is that the movements are the nuclei of the syllable. This idea has its origin in the correlation between the function of movements and the function of vowels in spoken languages (Liddell 1984; Brentari 2002), which is that both vowels and movements are the 'medium' by which signs are visible from considerable distance, just as vowels are the 'medium' in spoken languages making words audible from considerable distance. This physical fact was determined to have theoretical consequences and was developed into a theory of syllable structure by Brentari (1990a) and Perlmutter (1992). The arguments for the syllable are based on its importance to the system (see also Jantunen/Takkinen 2010). They are as follows:

2.3.1. The babbling argument

Petitto and Marentette (1991) have observed that a sequential dynamic unit formed around a phonological movement appears in young Deaf children at the same time as hearing children start to produce syllabic babbling. Because the distributional and phonological properties of such units are analogous to the properties usually associated with syllabic babbling, this activity has been referred to as manual babbling. Like syllabic babbling, manual babbling includes a lot of repetition of the same movement, and also like syllabic babbling, manual babbling makes use of only a part of the phonemic units available in a given sign language. The period of manual babbling develops without interruption into the first signs (just as syllabic babbling continues without

interruption into the first words in spoken languages). Moreover, manual babbling can be distinguished from excitatory motor hand activity and other communicative gestures by its rhythmic timing, velocity, and spectral frequencies (Petitto 2000).

2.3.2. The minimal word argument

This argument is based on the generalization that all well-formed (prosodic) words must contain at least one syllable. In spoken languages, a vowel is inserted to insure well-formedness, and in the case of sign languages a movement is inserted for the same reason. Brentari (1990b) observed that American Sign Language (ASL) signs without a movement in their input, such as the numeral signs ‘one’ to ‘nine’ add a small, epenthetic path movement when used as independent words, signed one at a time. Jantunen (2007) observed that the same is true in Finnish Sign Language (FinSL), and Geraci (2009) has observed a similar phenomenon in Italian Sign Language (LIS).

2.3.3. Evidence of a sonority hierarchy

Many researchers have proposed sonority hierarchies based ‘movement visibility’ (Corina 1990; Perlmutter 1992; Sandler 1993; Brentari 1993). Such a sonority hierarchy is built into the prosodic features’ structure in Figure 3.2b since movements represented by the more proximal joints higher in the structure are more visible than are those articulated by the distal joints represented lower in the structure. For example, movements executed by the elbow are typically more easily seen from further away than those articulated by opening and closing of the hand. See Crasborn (2001) for experimental evidence demonstrating this point. Because of this finding some researchers have observed that movements articulated by more proximal joints are a manifestation of visual ‘loudness’ (Crasborn 2001; Sander/Lillo-Martin 2006). In both spoken and sign languages more sonorous elements of the phonology are louder than less sonorous ones (/a/ is louder than /i/; /l/ is louder than /b/, etc.). The evidence from the nativization of fingerspelled words, below, demonstrates that sonority has also infiltrated the word-level phonotactics of sign languages.

In a study of fingerspelled words used in a series of published ASL lectures on linguistics (Valli/Lucas 1992), Brentari (1994) found that fingerspelled forms containing

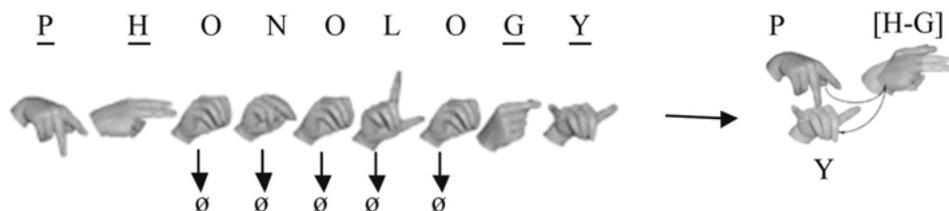


Fig. 3.4: An example of nativization of the fingerspelled word P-H-O-N-O-L-O-G-Y, demonstrating evidence of the sonority hierarchy by organizing the reduced form around the two more sonorous wrist movements.

strings of eight or more handshapes representing the English letters were reduced in a systematic way to forms that contain fewer handshapes. The remaining handshapes are organized around just two movements. This is a type of nativization process; native signs conform to a word-level phonotactic of having no more than two syllables. By native signs I am referring to those that appear in the core vocabulary, including monomorphemic forms and lexicalized compounds (Brentari/Padden 2001). Crucially, the movements retained were the most visible ones, argued to be most sonorous ones, e.g., movements made by the wrist were retained while aperture changes produced by the hand were deleted. Figure 3.4 contains an example of this process: the carefully finger-spelled form P-H-O-N-O-L-O-G-Y is reduced to the letters underlined, which are the letters responsible for the two wrist movements.

2.3.4. Evidence for light vs. heavy syllables

Further evidence for the syllable comes from a division between those movements that contain just one movement element (features on only one tier of Figure 3.2b are specified), which behave as *light* syllables (e.g., WE, SORRY, and SIT in Figure 3.3 are light), vs. those that contain more than one simultaneous movement element, which behave as heavy syllables (e.g., THROW in Figure 3.3). It has been observed in ASL that a process of nominalization by movement reduplication can occur only to forms that consist of a light syllable (Brentari 1998). In other words, holding other semantic factors constant, there are signs, such as SIT, that have two possible forms: a verbal form with the whole sequential movement articulated once and a nominal form with the whole movement articulated twice in a restrained manner (Supalla/Newport 1978). The curious fact is that the verb SIT has such a corresponding reduplicated nominal form (CHAIR), while THROW does not. Reduplication is not the only type of nominalization process in sign languages, so when reduplication is not possible, other possible forms of nominalization are possible (see Shay 2002). These facts can be explained by the following generalization: *ceteris paribus*, the set of forms that allow reduplication have just one simultaneous movement component, and are *light* syllables, while those that disallow reduplication, such as THROW, have two or more simultaneous movement elements and are therefore *heavy*. A process in FinSL requiring the distinction between heavy and light syllables has also been observed by Jantunen (2007) and Jantunen and Takkinen (2010). Both analyses call syllables with one movement component light, and those with more than one heavy.

2.4. The segment and feature organization

This is an area of sign language phonology where there is still lively debate. Abstracting away from the lowest level of representation, the features themselves (e.g., [one], [all], [flexed], etc.), I will try to summarize one trend – namely, features and their relation to segmental (timing) structure. Figure 3.5 shows schematic structures capturing the changes in perspective on how timing units, or segments, are organized with respect to the feature material throughout the 50 years of work in this area. All models in Figure 3.5 are compatible with the idea of ‘root-as-lexeme’ described in section 2.1; the

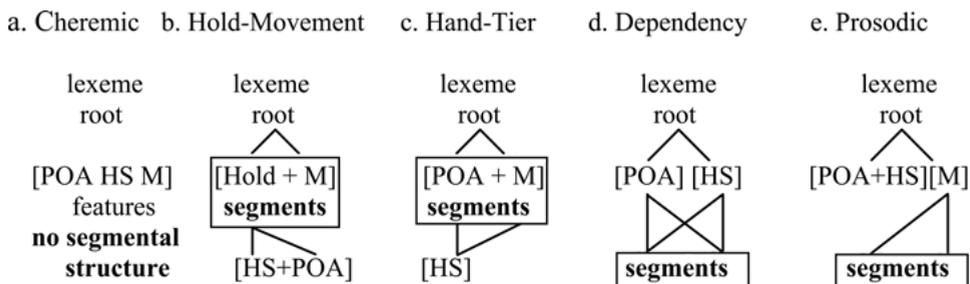


Fig. 3.5: Schematic structures showing the relationship of segments to features in different models of sign language phonology (left to right): the Cheremic Model (Stokoe 1960; Stokoe et al. 1965), the Hold-Movement Model (Liddell/Johnson 1989), the Hand-Tier Model (Sandler 1989), the Dependency Model (van der Hulst 1995), and the Prosodic Model (Brentari 1998).

root node at the top of the structure represents the lexeme. Figure 3.5a represents Stokoe's *Cheremic Model* described in *Sign Language Structures* (1960). The sub-lexical parameters of Handshape, Place of Articulation, and Movement had no hierarchical organization, and like the spoken models of the 1950s (e.g., Bloomfield 1933), were based entirely on phonemic structure (i.e., minimal pairs). It was the first linguistic work on sign language linguistics of any type, and the debt owed to Stokoe is enormous for bringing the sub-lexical parameters of signs to light.

Thirty years later, Liddell and Johnson (1989) looked primarily to sequential structure (timing units) to organize phonological material (see Figure 3.5b). Their Hold-Movement Model was also a product of spoken language models of the period, which were largely segmental (Chomsky/Halle 1968), but were moving in the direction of non-linear phonology, starting with autosegmental phonology (Goldsmith 1976). Segmental models depended heavily on slicing up the signal into units of *time* as a way of organizing the phonological material. In such a model, consonant and vowel units take center stage in spoken language, which can be identified sequentially. Liddell and Johnson called the static Holds 'consonants', and Movements the 'vowels' of sign languages. While this type of division is certainly possible phonetically, several problems related to phonological distribution of Holds make this model implausible. First of all, the presence and duration of most instances of holds are predictable (Perlmutter 1992; Brentari 1998). Secondly, length is not contrastive in movements or holds; a few morphologically related forms are realized by lengthening – e.g., [intensive] forms have a geminated first segment, such as GOOD vs. GOOD [intensive] 'very good', LATE vs. LATE [intensive] 'very late', etc. – but no lexical contrast is achieved by segment length. Thirdly, the feature matrix of all of the holds in a given lexeme contains a great deal of redundant material (Sandler 1989; Brentari 1990a, 1998).

As spoken language theories became increasingly non-linear (Clements 1985; Sagey 1986) sign language phonology re-discovered and re-acknowledged the non-linear simultaneous structure of these languages. The Hand-Tier Model (Sandler 1989 and Figure 3.5c) and all future models use feature geometry to organize the properties of the sign language parameters according to phonological behavior and articulatory properties. The Hand-Tier Model might be considered balanced in terms of sequential

and simultaneous structure. Linear segmental timing units still hold a prominent place in the representation, but Handshape was identified as having non-linear (autosegmental) properties. The Moraic Model (Perlmutter 1992) is similar to the Hand-Tier Model in hierarchical organization, but this approach uses morae, a different type of timing unit (Hyman 1985; Hayes 1989).

Two more recent models have placed the simultaneous structure back in central position, and they have made further use of feature geometry. In these models, timing units play a role, but this role is not as important as that which they play in spoken languages. The Dependency Model (van der Hulst 1993, 1995, see Figure 3.5d) derives timing slots from the dependent features of Handshape and Place of Articulation. In fact, this model calls the root node a segment/lexeme and refers to the timing units as timing (X)-slots, shown at the bottom of this representation. The Movement parameter is demoted in this model, and van der Hulst argues that most of movement can be derived from Handshape and Place of Articulation features, despite its role in the syllable (discussed in section 2.3) and in morphology (see sections 4.3 and 4.4). The proposals by Uyechi (1995) and Channon (2002) are similar in this regard. This differs from the Hand-Tier and Prosodic Models, which award movement a much more central role in the structure.

Like the Dependency Model, the Prosodic Model (already discussed in section 2.2, Brentari 1990a, 1998) derives segmental structure. It recognizes that Handshape, Place of Articulation, and Movement all have autosegmental properties. The role of the sign language syllable is acknowledged by incorporating it into the representation (see Figure 3.5e). Because of their role in the syllable and in generating segments prosodic (Movement) features are set apart from Handshape and Place of Articulation on their own autosegmental tier, and the skeletal structure is derived from them, as in the Dependency Model described above. In Figure 3.5e timing slots are at the bottom of the representation.

To summarize these sections on sign language structure, it is clear that sign languages have all of the elements one might expect to see in a spoken language phonological system, yet their organization and content is somewhat different: features are organized around the lexeme and segmental structure assumes a more minor role. What motivates this difference? One might hypothesize that this is in part due to the visual/gestural nature of sign languages, and this topic of modality effects will be taken up in section 3.

3. Modality effects

The modality effects described here refer to the influence that the phonetics (or communication mode) used in a signed or spoken medium have on the very nature of the phonological system that is generated. How is communication modality expressed in the phonological representation? Brentari (2002) describes several ways in which signal processing differs in sign and spoken languages (see also chapters 2 and 25). ‘Simultaneous processing’ is a cover term for our ability to process various input types presented roughly at the same time (e.g., pattern recognition, paradigmatic processing in phonological terms) for which the visual system is better equipped relative to audition.

‘Sequential processing’ is our ability to process temporally discrete inputs into temporally discrete events (e.g., ordering and sequencing of objects in time, syntagmatic processing in phonological terms), for which the auditory system is better equipped relative to vision. I am claiming that these differences have consequences for the organization of units in the phonology at the most fundamental level. Word shape will be used as an example of how modality effects ultimately become reflected in phonological and morphological representations.

3.1. Word shape

In this section, first outlined in Brentari (1995), the differences in the shape of the canonical word in sign and spoken languages will be described, first in terms of typological characteristics alone, and then in terms of factors due to communication modality. Canonical word shape refers to the preferred phonological shape of words in a given language. For an example of such canonical word properties, many languages, including the Bantu language Shona (Myers 1987) and the Austronesian language Yidin (Dixon 1977), require that all words be composed of binary branching feet. With regard to statistical tendencies at the word level, there is also a preferred canonical word shape exhibited by the relationship between the number of syllables and morphemes in a word, and it is here that sign languages differ from spoken languages. Signed words tend to be monosyllabic (Coulter 1982) and, unlike spoken languages, sign languages have an abundance of monosyllabic, polymorphemic words because most affixes in sign languages are feature-sized and are layered simultaneously onto the stem rather than concatenated (see also Aronoff/Meir/Sandler (2005) for a discussion of this point).

This relationship between syllables and morphemes is a hybrid measurement, which is both phonological and morphological in nature, due in part to the shape of stems and in part to the type of affixal morphology in a given language. A spoken language such as Hmong contains words that tend to be monosyllabic and monomorphemic with just two syllable positions (CV), but a rather large segmental inventory of 39 consonants and 13 vowels. The distinctive inventory of consonants includes voiced and voiceless nasals, as well as several types of secondary articulations (e.g., pre- and post-nasalized obstruents, lateralized obstruents). The inventory of vowels includes monophthongs, diphthongs, and seven contrastive tones, both simple and contour tones (Golston/Yang 2001; Andruski/Ratliff 2000). Affixal morphology is linear, but there isn’t a great deal of it. In contrast, a language such as West Greenlandic contains stems of a variety of shapes and a rich system of affixal morphology that lengthens words considerably (Fortescue 1984). In English, stems tend to be polysyllabic, and there is relatively little affixal morphology. In sign languages, words tend to be monosyllabic, even when they are polymorphemic. An example of such a form – re-presented from Brentari (1995, 633) – is given in Figure 3.6; this form means ‘two bent-over upright-beings advance-forward carefully side-by-side’ and contains at least six morphemes in a single syllable. All of the classifier constructions in Figure 3.10 (discussed later in section 4) are monosyllabic, as are the agreement forms in Figure 3.11. There is also a large amount of affixal morphology, but most of these affixes are smaller than a segment in size; hence, both polymorphemic and monomorphemic words are typically just



Fig. 3.6: An example of a monosyllabic, polymorphemic form in ASL: ‘two bent-over upright-beings advance-forward carefully side-by-side’.

one syllable in length. In Table 3.1, a chart schematizes the canonical word shape in terms of the number of morphemes and syllables per word.

- (1) Canonical word shape according to the number of syllables and morphemes per word

Tab. 3.1: Canonical word shape according to the number of syllable and morphemes per word

	monosyllabic	polysyllabic
monomorphemic	Hmong	English, German, Hawaiian
polymorphemic	sign languages	West Greenlandic, Turkish, Navajo

This typological fact about sign languages has been attributed to communication modality, as a consequence of their visual/gestural nature. Without a doubt, spoken languages have simultaneous phenomena in phonology and morphophonology such tone, vowel harmony, nasal harmony, and ablaut marking (e.g., the past preterite in English (‘sing’ [pres.]/‘sang’ [preterit]; ‘ring’ [pres.]/‘rang’ [preterit]), and even person marking in Hua indicated by the [\pm back] feature on the vowel (Haiman 1979)). There is also nonconcatenative morphology found in Semitic languages, which is another type of simultaneous phenomenon, where lexical roots and grammatical vocalisms alternate with one another in time. Even collectively, however, this doesn’t approach the degree of simultaneity in sign languages, because many features are specified once per stem to begin with: one Handshape, one Place of Articulation, one Movement. In addition, the morphology is feature-sized and layered onto the same monosyllabic stem, adding additional features but no more linear complexity, and the result is that sign languages have two sources of simultaneity – one phonological and another morphological. I would argue that it is this combination of these two types of simultaneity that causes sign languages to occupy this typological niche (see also Aronoff et al. (2004) for a similar argument). Many researchers since the 1960s have observed a preference for simultaneity of structure in sign languages, but for this particular typological comparison it was important to have understood the nature of the syllable in sign languages and its relationship to the Movement component (Brentari 1998).

Consider this typological fact about canonical word shape just described from the perspective of the peripheral systems involved and their particular strengths in signal processing, described in detail in chapters 2 and 25. What I have argued here is that signal processing differences in the visual and auditory system have typological consequences for the shape of words, which is a notion that goes to the heart of what a language looks like. In the next section we explore this claim experimentally using word segmentation task.

3.2. Word segmentation is grounded in communication modality

If this typological difference between words in sign and spoken language is deeply grounded in communication modality it should be evident in populations with different types of language experience. From a psycholinguistic perspective, this phenomenon of word shape can be fruitfully explored using word segmentation tasks, because it can address how language users with different experience handle the same types of items. We discuss such studies in this section. In other words, if the typological niche in (1) is due to the visual nature of sign languages, rather than historical similarity or language-particular constraints, then signers of different sign languages and non-signers should segment nonsense strings of signed material into word-sized units in the same way.

The cues that people use to make word segmentation decisions are typically put into conflict with each other in experiments to determine their relative salience to perceivers. Word segmentation judgments in spoken languages are based on (i) the rhythmic properties of metrical feet (syllabic or moraic in nature), (ii) segmental cues, such as the distribution of allophones, and (iii) domain cues, such as the spreading of tone or nasality. Within the word, the first two of these are ‘linear’ or ‘sequential’ in nature, while domain cues are simultaneous in nature – they are co-extensive with the whole word. These cues have been put into conflict in word segmentation experiments in a number of spoken languages, and it has been determined crosslinguistically that rhythmic cues are more salient when put into conflict with domain cues or segmental cues (Vroomen/Tuomainen/Gelder 1998; Jusczyk/Cutler/Redanz 1993; Jusczyk/Hohne/Bauman 1999; Houston et al. 2000). By way of background, while both segmental and rhythmic cues in spoken languages are realized sequentially, segmental alternations, such as knowing the allophonic form that appears in coda vs. onset position, requires language-particular knowledge at a rather sophisticated level. Several potential allophonic variants can be associated with different positions in the syllable or word, though infants master it sometime between 9 and 12 months of age (Jusczyk/Hohne/Bauman 1999). Rhythm cues unfold more slowly than segmental alternations and require less specialized knowledge about the grammar. For instance, there are fewer degrees of freedom (e.g., strong vs. weak syllables in ‘**chil**.dren’, ‘**break**.fast’) and there are only a few logically possible alternatives in a given word. If we assume that there is at least one prominent syllable in every word (two-syllable words have three possibilities; three-syllable words have seven possibilities). Incorporating modality into the phonological architecture of spoken languages would help explain why certain structures, such as the trochaic foot, may be so powerful a cue to word learning in infants (Jusczyk/Hohne/Bauman 1999).

Word-level phonotactic cues are available for sign languages as well, and these have also been used in word segmentation experiments. Rhythmic cues are not used at the word level in ASL, they begin to be in evidence at the phrasal level (see Miller 1996; see also chapter 4, Visual Prosody). The word-level phonotactics described in (1) hold above all for lexical stems; they are violated in ASL compounds to different degrees.

- (1) Word-level phonotactics
- a. Handshape: within a word selected finger features do not change in their value; aperture features may change. (Mandel 1981)
 - b. Place of Articulation: within a word major Place of Articulation features may not change in their value; setting features (minor place features) within the same major body region may change. (Brentari 1998)
 - c. Movement: within a word repetition of movement is possible, or 'circle + straight' sequences (*'straight + circle' sequences). (Uyechi 1996)

Within a word, which properties play more of a role in sign language word segmentation: those that span the whole word (the domain cues) or those that change within



ai. One sign, based on ASL



aii. Two signs, based on ASL



bi. One sign, based on ASL



bii. Two signs, based on ASL

Fig. 3.7: Examples of one- and two-movement nonsense forms in the word segmentation experiments. The forms in (a) with one movement were judged to be one sign by our participants; the forms in (b) with two movements were judged to be two signs by our participants. Based on ASL phonotactics, however, the forms (ai) and (bi) should have been judged to be one sign and those of (aii) and (bii) should have been judged to be two signs.

the word (i.e. the linear ones)? These cues were put into conflict with one another in a set of balanced nonsense stimuli that were presented to signers and non-signers. The use of a linear cue might be, for example, noticing that the open and closed aperture variants of handshapes are related, and thereby judging a form containing such a change to be one sign. The use of a domain strategy might be, for example, to ignore sequential alternations entirely, and to judge every handshape or movement as a new word. The nonsense forms in Figure 3.7 demonstrate this. If an ASL participant relied on a linear strategy, Figure 3.7ai would be judged as one sign because it has an open and closed variant of the same handshape, and Figure 3.7aaii would be judged as two signs because it contains two distinctively contrastive handshapes (two different selected finger groups). Figure 3.7bi should be judged as one sign because it has a repetition of the movement and only one handshape and 3.7bii as two signs because it has two contrastive handshapes and two contrastive movements.

In these studies there were six groups of subjects included in two experiments. In one study groups of native users of ASL and English participated (Brentari 2006), and in a second study four more groups were added, totaling six: native users of ASL, Croatian Sign Language (HZJ), and Austrian Sign Language (ÖGS), spoken English, spoken Austrian German and spoken Croatian (Brentari et al. 2011). The method was the same in both studies. All were administered the same word segmentation task using signed stimuli only. Participants were asked to judge whether controlled strings of nonsense stimuli based on ASL words were one sign or two signs. It was hypothesized that (1) signers and non-signers would differ in their strategies for segmentation, and (2) signers would use their language-particular knowledge to segment sign strings. Overall, the results were mixed. A “1 value = 1 word” strategy was employed overall, primarily based on how many *movements* were in the string, despite language-particular grammatical knowledge. As stated earlier, for ASL participants Figures 3.7ai and 3.7bi should be judged one sign, because in 3.7ai the two handshapes are allowable in one sign, as are the two movements in 3.7bi. Those in Figures 3.7aaii and 3.7bii should be judged as two signs. This did not happen in general; however, if each *parameter* is analyzed separately, the way that the Handshape parameter was employed was significantly different both between signing and non-signing groups, and among sign language groups.

The conclusion drawn from the word segmentation experiments is that modality (the visual nature of the signal) plays a powerful role in word segmentation; this drives the strong similarity in performance between groups using the Movement parameter. It suggests that, when faced with a new type of linguistic string, the modality will play a role in segmenting it. Incorporating this factor into the logic of phonological architecture might help to explain why certain structures, such as the trochaic foot, may be so powerful a cue to word learning in infants (Juszyk/Cutler/Redanz 1993) and why prosodic cues are so resilient crosslinguistically in spoken languages.

3.3. The reversal of segment to melody

A final modality effect is the organization of melody features to skeletal segments in the hierarchical structure in Figure 3.1, and this will be described here in detail. The reason that timing units are located at the top of the hierarchical structure of spoken

languages is because they can be contrastive. In spoken languages, affricates, geminates, long vowels, and diphthongs demonstrate that the number of timing slots must be represented independently from the melody, even if the default case is one timing slot per root node. Examples of affricate and geminates in Italian are given in (2).

- (2) Spoken language phonology – root:segment ratios [Italian]
- a. 1:1 [n] in *pena* ('bother') b. 2:1 [n:] in *penna* ('pen') c. 1:2 [tʃ] in *ci* ('us')
- | | | |
|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| $\begin{array}{c} x & x & x & x \\ & & & \\ \text{root} & \text{root} & \text{root} & \text{root} \\ p & e & n & a \end{array}$ | $\begin{array}{c} x & x & x & x & x \\ & & & & \\ \text{root} & \text{root} & \text{root} & \text{root} & \text{root} \\ p & \varepsilon & n: & & a \end{array}$ | $\begin{array}{c} x & x \\ & \\ \text{root} & \text{root} \\ t & \int \\ & \\ & i \end{array}$ |
|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|

The Dependency and Prosodic Models of sign language phonology build into them the fact that length is not contrastive in any known sign language, and the number of timing slots is predictable from the content of the features. As a consequence, the melody (i.e., the feature material) has a higher position in the structure and timing slots a lower position; in other words, the reverse of what occurs in spoken languages where timing units are the highest node in the structure (see also van der Hulst (2000) for this same point). As shown in Figure 3.2b and 3.3c, the composition of the prosodic features can generate the number of timing slots. In the Prosodic Model path features generate two timing slots, all other features generate one timing slot.

What would motivate this structural difference between the two types of languages? One reason has already been mentioned: audition has the advantage over vision in making temporal judgments, so it makes sense that the temporal elements of speech have a powerful and independent role in phonological structure with respect to the melody. One logical consequence of this is that the timing tier, containing either segments or moras, is more heavily exploited to produce contrast within the system and must assume a more prominent role in spoken than in sign languages. A schema for the relationship between timing slots, root node, and melody in sign and spoken languages is given in (3).

- (3) Organization of phonological material in sign vs. spoken languages
- | | |
|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| <p>a. Spoken languages</p> $\begin{array}{c} x \text{ (timing slot)} \\ \\ \text{root} \\ \\ \text{melody} \end{array}$ | <p>b. Sign languages</p> $\begin{array}{c} \text{root} \\ \\ \text{melody} \\ \\ x \text{ (timing slot)} \end{array}$ |
|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|

To conclude this section on modality, we see that it affects other levels of representation. An effect of modality on the phonetic representation can be seen in the similar use of movement in signers and non-signers in making word segmentation judgments. An effect on the phonological representation can be seen when the single movement (now assuming the role of syllable in a sign language phonological system) is used to express a particular phonological rule or constraint, such as the phonotactic constraint on handshape change: that is, one handshape change per syllable. An effect of modality

on the morphophonological representation can be seen in the typological niche that sign languages occupy, whereby words are monosyllabic and polymorphemic.

Modality effects are readily observable when considering sign languages because of their contrast with structures in spoken languages, and they also encourage an additional look at spoken language systems for similar effects of modality on speech that might be typically taken for granted.

4. Iconicity effects

The topic of iconicity in sign languages is vast, covering all linguistic areas – e.g., pragmatics, lexical organization, phonetics, morphology, the evolution of language – but in this chapter only aspects of iconicity that are specifically relevant for the phonological and morphophonemic representation will be discussed in depth (see also chapter 18 on iconicity and metaphor). The idea of analyzing iconicity and phonology together is fascinating and relatively recent. See, for instance, van der Kooij (2002), who examined the phonology-iconicity connection in native signs and has proposed a level of phonetic implementation rules where iconicity exerts a role. Even more recently, Eccarius (2008) provides a way to rank the effects of iconicity throughout the whole lexicon of a sign language. Until recently research on phonology and research concerning iconicity have been taken up by sub-fields completely independent from one other, one side sometimes even going so far as to deny the importance of the other side. Iconicity has been a serious topic of study in cognitive, semiotic, and functionalist linguistic perspectives, most particularly dealing with productive, metaphoric, and metonymic phenomena (Brennan 1990; Cuxac 2000; Taub 2001; Brennan 2005, Wilcox 2001; Russo 2005; Cuxac/Sallandre 2007). In contrast, with the notable exceptions just mentioned, phonology has been studied within a generative approach, using tools that make as little reference to meaning or iconicity as possible. For example, the five models in Figure 3.5 (the Chericmic, Hold-Movement, Hand-Tier, Dependency, and Prosodic Models) make reference to iconicity in neither the inventory nor the system of rules.

‘Iconicity’ refers to mapping of a source domain and the linguistic form (Taub 2001); it is one of three Peircean notions of iconicity, indexicality, and symbolcity (Peirce, 1932 [1902]); see chapter 18 for a general introduction to iconicity in sign languages. From the very beginning, iconicity has been a major topic of study in sign language research. It is always the ‘800-lb. gorilla in the room’, despite the fact that the phonology can be constructed without it. Stokoe (1960), Battison (1978), Friedman (1976), Klima and Bellugi (1979), Boyes Braem (1981), Sandler (1989), Brentari (1998), and hosts of references cited therein have all established that ASL has a phonological level of representation using exclusively linguistic evidence based on the distribution of forms – examples come from slips of the hand, minimal pairs, phonological operations, and processes of word-formation (see Hohenberger/Happ/Leuninger 2002 and chapter 30). In native signers, iconicity has been shown experimentally to play little role in first-language acquisition (Bonvillian/Orlansky/Folven 1990; Conlin et al. 2000 and also chapter 28) or in language processing; Poizner, Bellugi, and Tweney (1981) demonstrated that iconicity has no reliable effect on short-term recall of signs; Emmorey et al. (2004) showed specifically that motor-iconicity of sign languages (involving movement) does not alter the neural systems

underlying tool and action naming. Thompson, Emmorey, and Gollan (2005) have used ‘tip of the finger’ phenomena (i.e., almost – but not quite – being able to recall a sign) to show that the meaning and form of signs are accessed independently, just as they are in spoken languages (see also chapter 29 for further discussion). Yet iconicity is present throughout the lexicon, and every one of these authors mentioned above also acknowledges that iconicity is pervasive.

There is, however, no means to quantitatively and absolutely measure just how much iconicity there is in a sign language lexicon. The question, ‘Iconic to whom, and under what conditions?’ is always relevant, so we need to acknowledge that iconicity is age-specific (signs for TELEPHONE have changed over time, yet both are iconic, cf. Supalla 1982, 2004) and language-specific (signs for TREE are different in Danish, Hong Kong, and American Sign Languages, yet all are iconic). Except for a restricted set of cases where entire gestures from the surrounding (hearing) community are incorporated in their entirety into a specific sign language, the iconicity resides in the sub-lexical units, either in classes of features that reside at a class node or in individual features themselves. Iconicity is thought to be one of the factors that makes sign languages look so similar (Guerra 1999; Guerra/Meier/Walters 2002; Wilcox/Rossini/Pizzuto 2010; Wilbur 2010), and sensitivity to and productive use of iconicity may be one of the reasons why signers from different language families can communicate with each other so readily after such little time, despite crosslinguistic differences in lexicon, and, in many instances, also in the grammar (Russo 2005). Learning how to use iconicity productively within the grammar is undoubtedly a part of acquiring a sign language.

I will argue that iconicity and phonology are not incompatible, and this view is gaining more support within the field (van der Kooij 2002; Meir 2002; Brentari 2007; Eccarius 2008; Brentari/Eccarius 2010; Wilbur 2010). Now, after all of the work over recent decades showing indisputably that sign languages have phonology and duality of patterning, one can only conclude it is the *distribution* that must be arbitrary and systematic in order for phonology to exist. In other words, even if a property is iconic, it can also be phonological because of its distribution. Iconicity should not be thought of as either a hindrance or opposition to a phonological grammar, but rather another mechanism, on a par with ease of production or ease of perception, that contributes to inventories. Saussure wasn’t wrong, but since he based his generalizations on spoken languages, his conclusions are based on tendencies in a communication modality that can only use iconicity on a more limited basis than sign languages can. Iconicity does exist in spoken languages in reduplication (e.g., Haiman 1980) as well as expressives/ideophones. See, for example, Bodomo (2006) for a discussion of these in Dagaare, a Gur language of West Africa. See also Okrent (2002), Shintel, Nussbaum, and Okrent (2006), and Shintel and Nussbaum (2007) for the use of vocal quality, such as length and pitch, in an iconic manner.

Iconicity contributes to the phonological shape of forms more in sign than in spoken languages, so much so that we cannot afford to ignore it. I will show that iconicity is a strong factor in building signed words, but it is also restricted and can ultimately give rise to arbitrary distribution in the morphology and phonology. What problems can be confronted or insights gained from considering iconicity? In the next sections we will see some examples of iconicity and arbitrariness working in parallel to build words and expressions in sign languages, using the feature classes of handshape and orientation and movement. See also chapter 20 for a discussion of the Event Visibility Hypothesis (Wilbur 2008, 2010), which also pertains to iconicity and movement. The mor-

phophonology of word formation exploits and restricts iconicity at the same time; it is used to build signed words, yet outputs are still very much restricted by the phonological grammar. Section 4.1 can be seen as contributing to the historical development of a particular aspect of sign language phonology; the other sections concern synchronic phenomena.

4.1. The historical emergence of phonology

Historically speaking, Frishberg (1975) and Klima and Bellugi (1979) have established that sign languages become ‘less iconic’ over time, but iconicity never reduces to zero and continues to be productive in contemporary sign languages. Let us consider the two contexts in which sign languages arise. In most Deaf communities, sign languages are passed down from generation to generation not through families, but through communities – i.e., schools, athletic associations, social clubs, etc. But initially, before there is a community per se, signs begin to be used through interactions among individuals – either among deaf and hearing individuals (‘homesign systems’), or in stable communities in which there is a high incidence of deafness. In inventing a homesign system, isolated individuals live within a hearing family or community and devise a method for communicating through gestures that become systematic (Goldin-Meadow 2001). Something similar happens on a larger scale in systems that develop in communities with a high incidence of deafness due to genetic factors, such as the island of Martha’s Vineyard in the seventeenth century (Groce 1985) and Al-Sayyid Bedouin Sign Language (ABSL; Sandler et al. 2005; Meir et al. 2007; Padden et al. 2010). In both cases, these systems develop at first within a context where being transparent through the use of iconicity is important in making oneself understood.

Mapping this path from homesign to sign language has become an important research topic since it allows linguists the opportunity to follow the diachronic path of a sign language *al vivo* in a way that is no longer possible for spoken languages. In the case of a pidgin, a group of isolated deaf individuals are brought together to a school for the deaf. Each individual brings to the school a homesign system that, along with other homesign systems, undergoes pidginization and ultimately creolization. This has happened in the development of Nicaraguan Sign Language (NSL; Kegl/Senghas/Coppola 1999; Senghas/Coppola 2001). This work to date has largely focused on morphology and syntax, but *when and how does phonology arise in these systems?* Aronoff et al. (2008) and Sandler et al. (2011) have claimed that ABSL, while highly iconic, still has no duality of patterning even though it is ~75 years old. It is well known, however, that in first-language acquisition of spoken languages, infants are statistical learners and phonology is one of the first components to appear (Locke 1995; Aslin/Saffran/Newport 1998; Creel/Newport/Aslin 2004; Jusczyk et al. 1993, 1999).

Phonology emerges in a sign language when properties – even those with iconic origins – take on conventionalized distributions, which are not predictable from their iconic forms. Over the last several years, a project has been studying how these subtypes of features adhere to similar patterns of distribution in sign languages, gesture, and homesign (Brentari et al. 2012). It is an example of the intertwined nature of iconicity and phonology that addresses *how* a phonological distribution might emerge in sign languages over time.

Productive handshapes were studied in adult native signers, hearing gesturers (without using their voices), and homesigners in handshapes – particularly the selected finger features of handshape. The results show that the distribution of selected finger properties is re-organized over time. Handshapes were divided into three levels of selected finger complexity. *Low complexity* handshapes have the simplest phonological representation (Brentari 1998), are the most frequent handshapes crosslinguistically (Hara 2003; Eccarius/Brentari 2007), and are the earliest handshapes acquired by native signers (Boyes Braem 1981). *Medium complexity* and *High complexity* handshapes are defined in structural terms – i.e., the simpler the structure the less complexity it contains. *Medium complexity* handshapes have one additional elaboration of the representation of a [one]-finger handshape, either by adding a branching structure or an extra association line. *High complexity* handshapes are all other handshapes. Examples of low and medium complexity handshapes are shown in Figure 3.8.

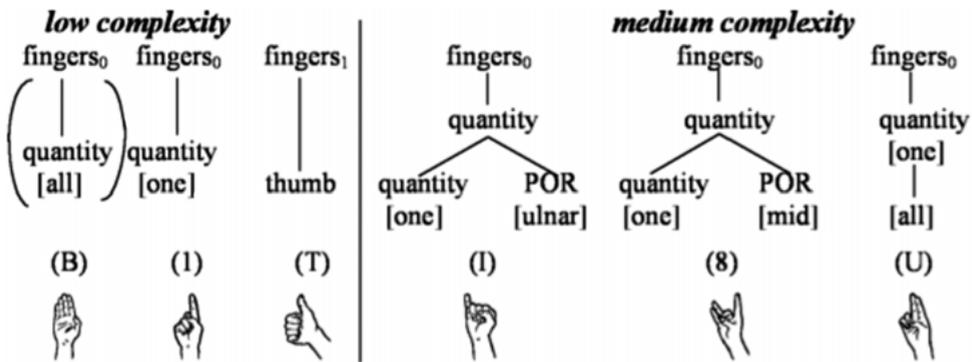


Fig. 3.8: The three handshapes with low finger complexity and examples of handshapes with medium finger complexity. The parentheses around the B-handshape indicate that it is the default handshape in the system.

The selected finger complexity of two types of productive handshapes was analyzed: those representing *objects* and those representing the *handling* of objects (corresponding to whole entity and handling classifier handshapes in a sign language, respectively see section 4.2 and chapter 8). The pattern that appeared in signers and homesigners showed no significant differences along the dimension analyzed: relatively higher finger complexity in object handshapes and lower for handling handshapes (Figure 3.9). The opposite pattern appeared in gesturers, which differed significantly from the other two groups: higher finger complexity in handling handshapes and lower in object handshapes. These results indicate that as handshape moves from gesture to homesign and ultimately to a sign language, object handshapes *gain* finger complexity and handling handshapes *lose* it relative to their distribution in gesture. In other words, even though all of these handshapes are iconic in all three groups, the features involved in selected fingers are heavily re-organized in sign languages, and the homesigners already display signs of this re-organization.

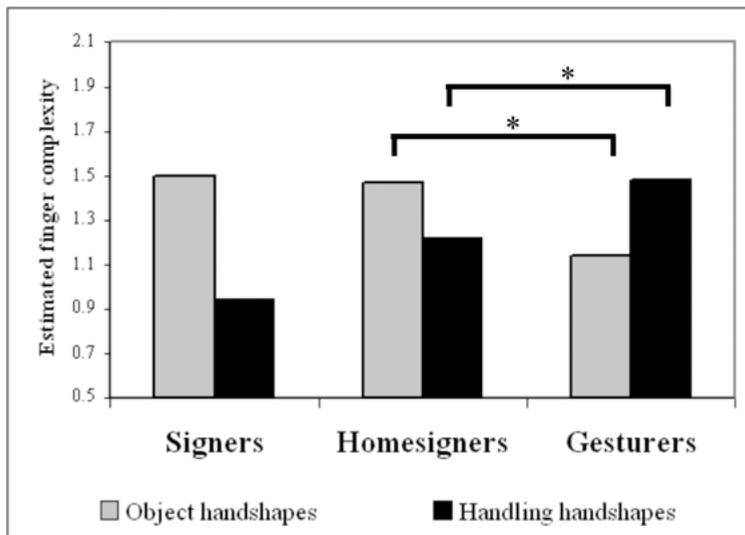


Fig. 3.9: Mean finger complexity, using a Mixed Linear statistical model for *Object* handshapes and *Handling* handshapes in signers, homesigners, and gesturers (Brentari et al. submitted).

4.2. Orientation in classifier constructions is arbitrarily distributed

Another phonological structure that has iconic roots but is ultimately distributed arbitrarily in ASL is the orientation of the handshape of classifier constructions (see chapter 8 for further discussion). For our purposes here, classifier constructions can be defined as complex predicates in which movement, handshape, and location are meaningful elements; we focus here on handshape, which includes the orientation relation discussion in section 2. We will use Engberg-Pedersen's (1993) system, given in (4), which divides the classifier handshapes into four groups. Examples of each are given in Figure 3.10.

- (4) Categories of handshape in classifier constructions (Engberg-Pedersen 1993)
- Whole Entity:** These handshapes refer to whole objects (e.g., 1-handshape: 'person' (Figure 3.10a)).
 - Surface:** These handshapes refer to the physical properties of an object (e.g., B-B-handshape: 'flat_surface' (Figure 3.10b)).
 - Limb/Body Part:** These handshapes refer to the limbs/body parts of an agent (e.g., V-handshape: 'by_legs' (Figure 3.10c)). In ASL we have found that the V-handshape 'by-legs' can function as either a body or whole entity classifier.
 - Handling:** These handshapes refer to how an object is handled or manipulated (e.g., S-handshape: 'grasp_gear_shift' (Figure 3.10d)).

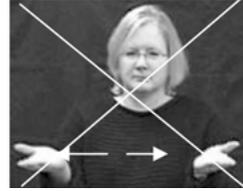
Benedicto and Brentari (2004) and Brentari (2005) argued that, while all types of classifier constructions use handshape morphologically because at least part of the handshape is used in this way, only classifier handshapes of the handling and limb/

Phonological use of orientation:ai. upright
whole entity (1-HS 'person')

aai. upside down



bi. surface of table

bii. surface upside down
surface/extension (B-HS 'flat surface')*Morphological use of orientation:*ci. upright
body part (V-HS 'person')

cii. upside down



di. grasp from above

dii. grasp from below
handling (S-HS 'grasp-gear shift')

Fig. 3.10: Examples of the distribution of phonological (top) and morphological (bottom) use of orientation in classifier predicates (ASL). Whole Entity and Surface/Extension classifier handshapes (10a) and (10b) allow only phonological use of orientation (so a change in orientation is not permissible), while Body Part and Handling classifier handshapes (10c) and (10d) do allow both phonological and morphological use of orientation so a change in orientation is possible.

body part type can use *orientation* in a morphological way. Whole entity and surface classifier handshapes cannot. This is shown in Figure 3.10, which illustrates the variation of the forms using orientation phonologically and morphologically. The forms using the whole entity classifier in Figure 3.10ai 'person' and the surface classifier in Figure 3.10bi 'flat surface' are not grammatical if the orientation is changed to the hypothetical forms as in 3.10aai ('person upside down') and 3.10bii ('flat surface upside down'), indicated by an 'x' through the ungrammatical forms. Orientation differences in whole entity classifiers are shown by signing the basic form, and then sequentially adding a movement to that form to indicate a change in orientation. In contrast forms using the body part classifier and the handling classifier in Figure 3.10ci ('by-legs') and 3.10di ('grasp gear shift') are grammatical when articulated with different orientations as shown in 3.10cii ('by-legs be located upside down') and 3.10dii ('grasp gear shift from below').

This analysis requires phonology because the representation of handshape must allow for subclasses of features to function differently, according to the type of classifier handshape being used. In all four types of classifiers, part of the phonological orientation specification expresses a relevant *handpart's* orientation (palm, fingertips, back of hand, etc.) toward a place of articulation, but only in body part and handling classifiers is it allowed to function morphologically as well. It has been shown that these four

types of classifiers have different syntactic properties as well (Benedicto/Brentari 2004; Grose et al. 2007).

It would certainly be more iconic to have the orientation expressed uniformly across the different classifier types, but the grammar does not allow this. We therefore have evidence that iconicity is present but constrained in the use of orientation in classifier predicates in ASL.

4.3. Directional path movement and verb agreement

Another area in sign language grammars where iconicity plays an important role is verb agreement (see also chapters 7 and 10). Agreement verbs manifest the transfer of entities, either abstract or concrete. Saliency and stability among arguments may be encoded not only in syntactic terms, but also by visual-spatial means. Moreover, path movements, which are an integral part of these expressions, are phonological properties in the feature tree, as are the spatial loci of sign language verb agreement. There is some debate about whether the locational loci are, in fact, part of the phonological representation because they have an infinite number of phonetic realizations. See Brentari (1998) and Mathur (2000) for two possible solutions to this problem.

There are three types of verbs attested in sign languages (Padden 1983): those that do not manifest agreement ('plain' verbs), and those that do, which divide further into those known as 'spatial' verbs, which take only take source-goal agreement, and 'agreement' verbs, which take source-goal agreement, as well as object and potentially subject agreement (Brentari 1988; Meir 1998, 2002; Meir et al. 2007). While Padden's 1983 analysis was based on syntactic criteria alone, these more recent studies include both semantics (including iconicity) and syntax in their analysis. The combination of syntactic and semantic motivations for agreement in sign languages was formalized as the 'direction of transfer principle' (Brentari 1988), but the analysis of verb agreement as having an iconic source was first proposed in Meir (2002). Meir (2002) argues that the main difference between verb agreement in spoken languages and sign languages is that verb agreement in sign languages seems to be thematically (semantically), rather than syntactically, determined (Kegl (1985) was the first to note this). Agreement typically involves the representation of phi features of the NP arguments, and functionally it is a part of the referential system of a language. Meir observes that typically in spoken languages there is a closer relationship between agreement markers and structural positions in the syntax than between agreement markers and semantic roles, but sign language verbs can agree not only with themes and agents, they can also agree with their source and goal arguments.

Crucially, Meir argues that 'DIR', which is an abstract construct used in a transfer (or directional) verb, is the iconic representation of the semantic notion 'path' used in theoretical frameworks, such as Jackendoff (1996, 320); DIR denotes spatial relations. It can appear as an independent verb or as an affix to other verbs. This type of iconicity is rooted in the fact that referents in a signed discourse are tracked both syntactically and visuo-spatially; however, this iconicity is constrained by the phonology. Independently a [direction] feature has been argued for in the phonology, indicating a path moving to or from a particular plane of articulation, as described in section 2 (Brentari 1998).

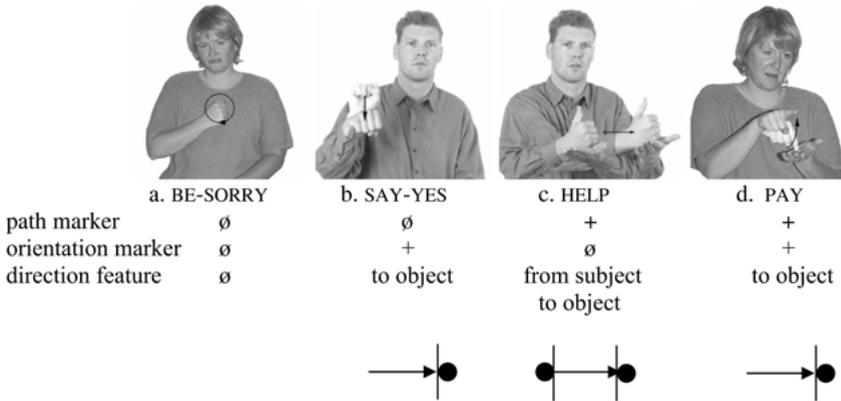


Fig. 3.11: Examples of verb agreement in ASL and how it is expressed in the phonology: *BE-SORRY* expresses no manual agreement; *SAY-YES* expresses the direction feature of agreement in orientation; *HELP* in path; and *PAY* in both orientation and path.

The abstract morpheme *DIR* and the phonological feature [direction] are distributed in a non-predictable (arbitrary) fashion both across sign languages (Mathur/Rathmann 2006, 2010) and language internally. In ASL it can surface in the path of the verb or in the orientation; that is, on one or both of these parameters. It is the phonology of the stem that accounts for the distribution of orientation and path as agreement markers, predicting if it will surface, and if so, where it will surface. Figure 3.11 provides ASL examples of how this works. In Figure 3.11a we see an example of the agreement verb, *BE-SORRY*, that takes neither orientation nor source-goal properties. Signs in this set have been argued to have eye gaze substituted for the manual agreement marker (Bahan 1996; Neidle et al. 2000), but there is debate about exactly what role eye gaze plays in the agreement system (Thompson et al. 2006). The phonological factor relevant here is that many signs in this set have a distinct place of articulation that is on or near the body. In Figure 3.11b we see an example of an agreement verb that takes only the orientation marker of agreement, *SAY-YES*; this verb has no path movement in the stem that can be modified in its beginning and ending points (Askins/Perlmutter 1995), but the affixal *DIR* morpheme is realized on the orientation, with the palm of the hand facing the vertical plane of articulation associated with the indirect object. In Figure 3.11c there is an example of an agreement verb that has a path movement in the stem – *HELP* – whose beginning and endpoints can be modified according to the subject and object locus. Because of the angle of wrist and forearm, it would be very difficult (if not impossible) to modify the orientation of this sign (Mathur/Rathmann 2006). In Figure 3.11d we see an example of the agreement verb *PAY* that expresses the *DIR* verb agreement on both path movement and orientation; the path moves from the payer to the payee, and the orientation of the fingertip is towards the payee at the end of the sign. The analysis of this variation depends in part on the lexical specification of the stem – whether orientation or path is specified in the stem of the verb or supplied by the verb-agreement morphology (Askins/Perlmutter 1995) – and in part on the phonetic-motoric constraints on the articulators involved in articulating the stem – i.e., the joints of the arms and hands (Mathur/Rathmann 2006).

In summary, iconicity is a factor that contributes to the phonological inventories of sign languages. Based on the work presented in this section, I would maintain that the distribution of the material is more important for establishing the phonology of sign languages than the material used – iconic or otherwise. One can generalize across sections 4.1–4.3 and say that, taken alone, each of the elements discussed has iconic roots, yet even so, this iconicity is distributed in unpredictable ways (that is, unpredictable if iconicity were the only motivation). This is true for which features – joints or fingers – will be the first indications of an emerging phonology (section 4.1), for the orientation of the hand representing the orientation of the object in space (section 4.2), and for the realization of verb agreement (section 4.3).

5. Conclusion

As stated in the introduction to this chapter, this piece was written in part to answer the following questions: ‘Why should phonologists, who above all else are fascinated with the way things *sound*, care about systems without sound? How does it relate to their interests?’ I hope that I have shown that by using work on sign languages, phonologists can broaden the scope of the discipline from one that includes not only analyses of phonological structures, but also how modality and iconicity infiltrates and interacts with phonetic, phonological, and morph-phonological structure. This is true in both sign and spoken languages, but we see these effects more vividly in sign languages. In the case of modality this is because, chronologically speaking, analyses of sign languages set up comparisons with what has come before (e.g., analyses of spoken languages grounded in a different communication modality) and we now see that some of the differences between the two languages result from modality differences. An important point of this chapter was that general phonological theory can be better understood by considering its uses in sign language phonology. For example, non-linear phonological frameworks allowed for breakthroughs in understanding spoken and sign languages that would not have been possible otherwise, but also allowed the architectural building blocks of a phonological system to be isolated and examined in such a way as to see how *both the visual and auditory systems* (the communication modalities) affect the ultimate shape of words and organization of units, such as features, segments, and syllables.

The effects of iconicity on phonological structure are seen more strongly in sign languages because of the stronger role that visual iconicity can play in these languages compared with auditory iconicity in spoken languages. Another important point for general phonological theory that I have tried to communicate in this chapter has to do with the ways in which sign languages manage iconicity. Just because a property is iconic, doesn’t mean it can’t also be phonological. Unfortunately some phonologists studying sign languages called attention away from iconicity for a long time, but iconicity is a pervasive pressure on the output of phonological form in sign languages (on a par with ease of perception and ease of articulation), and we can certainly benefit from studying its differential effects both synchronically and diachronically.

Finally, the more phonologists focus on the physical manifestations of the system – the vocal tract, the hands, the ear, the eyes – sign and spoken language phonology

will look different but in interesting ways. The more focus there is on the mind, the more sign language and spoken language phonologies will look the same in ways that can lead to a better understanding of a general (cross-modal) phonological competence.

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