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a. apply existing theoretical insights to sign languages to further the understanding of SL;
b. investigate, evaluate, and expand our knowledge of grammar based on the study of SL; or
c. specifically address the effect of modality (signed vs. spoken) on the structure of grammar.

Descriptive studies should offer facts embedded in, and in relation to, a theory against which they can be interpreted. Similarly, theoretical generalizations should be supported with robust evidence; the (in)adequacies of alternative analyses should be considered. The paper should reflect the author's thorough familiarity with the existing literature, its strengths and its weaknesses. To increase the accessibility of manuscripts to the larger linguistic audience, authors are encouraged to include accompanying videotaped examples. Areas of linguistics covered include: phonology, morphology, syntax, semantics, pragmatics, phonetics/kinematics, psycholinguistics, neurolinguistics, and typology.

ISSN 1387–9316

Exploitation of morphological possibilities in signed languages

Comparison of American Sign Language with English

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American Sign Language shares with spoken languages derivational and inflectional morphological processes, including compounding, reduplication, incorporation, and, arguably, templates. Like spoken languages, ASL also has an extensive non-derivational, noninflectional morphology involving phonological alternation although this is typically more limited. Additionally, ASL frequently associates meaning with individual phonological parameters. This association is atypical of spoken languages. We account for these phenomena by positing "ion-morphs," which are phonologically incomplete lexical items that bond with other compatible ion-morphs. These ion-morphs draw lexical items into "families" of related signs.

In contrast, ASL makes little, if any, use of concatenative affixation, a morphological mechanism common among spoken languages. We propose that this difference is the result of the comparative slowness of movement of the manual articulators as compared to the speech articulators, as well as the perceptual robustness of the manual articulators to the visual system. The slowness of the manual articulators disfavors concatenative affixation. The perceptual robustness of the manual articulators allows ASL to exploit morphological potential that spoken language can use only at considerable cost.

Keywords: American Sign Language, morphology, lexicon, phonology-semantics interface, word formation, signed vs. spoken language

1. Introduction

Morphology uses many mechanisms in spoken languages, with concatenative affixation among the most common. Concatenative affixation is exploited in both derivation and inflection. English makes copious use of prefixes and suffixes in derivation (e.g. 'uncommon, commonly') and suffixes in inflection (e.g. 'wash' vs. 'washes'). This

Sign Language & Linguistics 3:1 (2000), 3–58. ISSN 1387–9316

concatenative mechanism of affixation builds linearly on (or within) the root or stem (a root with or without affixes).

Another, less pervasive morphological mechanism in spoken languages is phonological feature alternation (Spencer 1991). Indo-European inflectional ablaut is a well-studied case. German, for example, has a sizable number of nouns for which vowel fronting (known as "umlauting") indicates plurality (e.g. *Vater* vs. *Väter* 'father(s)'). English offers unproductive examples of this sort for inflection e.g. 'foot' vs. 'feet', but not for derivation. Scattered examples of noninflectional morphological relatedness due to phonological feature alternation do occur, as in the noun-verb pairs 'blood' vs. 'bleed' and 'bath' vs. 'bathe'. In other pairs a voicing difference alone (without ablaut) indicates syntactic category (such as the verb-adjective pair 'lose' vs. 'loose'). However, it is not obvious in any of these pairs that one word is synchronically derived from the other. Rather, two (or more) words are related in what we call "lexical families", a term we borrow from the ASL literature (further discussion in Section 5).

Signed languages also make use of various inflectional and derivational morphological mechanisms. The most productive of those mechanisms, including compounding and reduplication, have been well studied. Like spoken languages, signed languages also relate words in lexical families (groups of words with a common correspondence between phonological form and meaning). For example, in ASL the signs MOTHER and FATHER differ only by a single phonological parameter:[1]

Figure 1. FATHER MOTHER

In this paper we look at lexical families in ASL, a phenomenon ASL uses robustly. Indeed, families characterize the lexicon. Research on other signed languages appears to support our findings (for general discussion, see Sandler 1995).[2]

We focus our attention on the mechanisms that relate the members of lexical families for three reasons. First, these mechanisms characterize a large part of ASL morphology, so much so that it cannot be fully understood without examining lexical families. For

1. Following standard conventions, we use all capitals to indicate a sign. We discuss phonological parameters of signed languages in Section 2.

2. We have looked at limited data on other signed languages in the videotapes *Signs Around the World* (Australia, France, Finland, Italy, India, Japan, Quebec, and Thailand). These tapes give data that at least at first consideration appear consistent with our findings. Work by Wendy Sandler offers compatible findings on Israeli Sign Language.

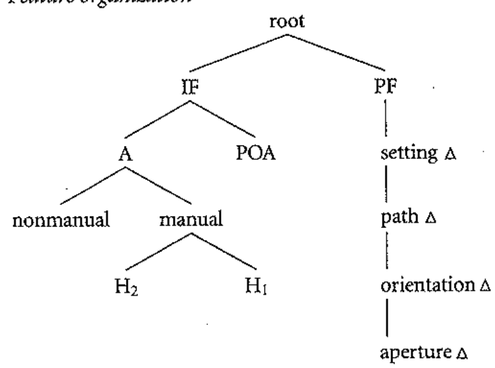
example, examination of lexical families reveals additional insight into the nature of classifiers in ASL. Second, since these mechanisms are neither derivational nor inflectional, their study provides insight into how languages relate lexical items. We present a model of these relationships. Third, these mechanisms reflect two major differences between spoken and signed languages. ASL morphology does not make significant use of concatenative affixation (an observation also made by others), but it does make rampant use of alternation of phonological parameters. That is, one mechanism (alternation of phonological features) exploited in relatively limited ways in spoken languages is embraced by signed languages, whereas another mechanism (concatenation) found frequently in spoken languages is practically eschewed by signed languages. Furthermore, phonological parameters are associated with semantic content to a greater degree in ASL than phonological features are in spoken languages.

We begin with a discussion of the analytical formalism needed for our investigation and a brief overview of literature on ASL phonology. Next we give a short overview of derivational morphological mechanisms in ASL, discussing the paucity of concatenative affixes and touching on compounding, reduplication, templates, and incorporation. We then mention inflectional mechanisms. Finally the heart of our paper is an analysis of lexical families. We close with a suggestion of why the morphological mechanisms of spoken and signed languages should differ in precisely the ways that they do.

2. Phonological parameters

There has been substantial progress over the past 40 years in the analysis of ASL phonology. The recent model of Brentari (1998:26), shown in Diagram 1, embodies that progress.

a. *Feature organization*



b. *Parameters in the model*

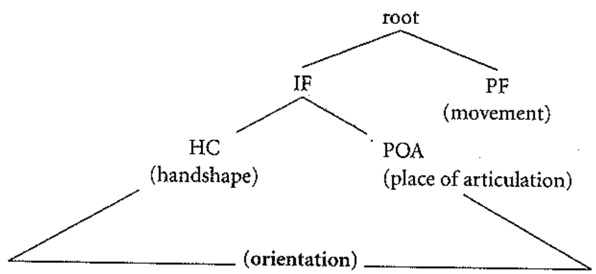


Diagram 1. Brentari's Model

"IF" stands for inherent features and "PF" indicates prosodic features. "A" indicates articulator, which involves facial expressions as well as handshape. "Δ" indicates a change in the given feature. For discussion of nonmanual features, see Baker & Padden (1978); Wilbur (2000).

The use of parameters (Diagram 1b) — Hand Configuration (HC), Movement (M), Orientation (O), and Place (POA)[3] — goes back to Stokoe's (1960) seminal work (although he had only three, and referred to them as 'aspects'). They have been built on and refined by Bellugi & Klima (1975), Battison (1978), Liddell & Johnson (1989), among others.

The parameters of HC, M, O, and POA are complex in that they are analyzable into subparts (in geometric terms, these are node labels, not terminal elements).[4] For example, HC covers the shape of fingers and palm, as well as the wrist, forearm, elbow, shoulders, for one or both hands.[5] M subsumes direction of path, contour of path (straight, arc, or indirect/angled), presence of secondary/local movement (that is, movement at the knuckles or wrist) and also manner features, such as tenseness of the muscles, speed, acceleration, and size of the movement. Multiple complexities are likewise subsumed under O and POA.

3. While many researchers claim that some signs in ASL do not have an M parameter, Sandler (1996) argues that all well-formed signs have an M in their lexical entry, where the actual movement segment (a positional and timing element) might be filled in during the derivation. (See also Brentari 1990a, b; Perlmutter 1992; Stack 1988; Wilbur 1987, 1990).

4. Furthermore, each parameter involves multiple options. Liddell and Johnson (1989) list 126 HCs and 148 POAs (51 on the body, 27 in space, 70 on the nondominant hand), for example. Certainly, these are not all necessarily contrastive. Sandler (1989) argues that there are 16 features for HC, four for O, sixteen for POA, and only one for M. On HC, see also Johnson (1990). The work in contrastive feature analysis is ongoing (Brentari 1998; Corina 1990; Mandel 1981).

5. The HCs in two-handed signs are not independent of one another. See Battison (1978), Sandler (1989), and Brentari (1990a), among others.

These four parameters are not entirely independent of one another. Sandler (1989:93) demonstrates dependencies of O on HC. We find similar dependencies in spoken language features, such as advanced tongue root — [ATR] — with respect to dorsal features in Kimatuumbi (Odden 1991). For other examples see Archangeli & Pulleyblank (1994).

The theoretical status of these parameters has been debated. Traditionally, these parameters were treated as occurring simultaneously in a bundle (Stokoe 1960). In that view, each sign is analogous to a spoken language phoneme, and the various parameters are analogous to features. Liddell (1984a), however, offered a model of signs as a sequence of movements (M) and holds (H), where each M and H constitutes a phonological segment, whereas hand configuration remains analogous to a feature. In her model, Sandler (1986) replaced H with location (L), proposing both as separate phonological segments while placing the feature of hand configuration on a separate tier, so that it could spread across the two segments. In contrast, Wilbur (1990) points out that some signs (such as STONE-DEAF) have simultaneous M and L, indicating that M and L are not sequential segments, but are located on separate tiers, just like hand configuration. This proposal brings us back closer to Stokoe's original proposal.

Indeed, there is considerable evidence that these four phonological parameters are on separate tiers as in Brentari's model (Diagram 1 above). Some arguments for the model include the following facts: (1) HC, M, and POA can all be used as rhyming elements in ASL poetry (Valli 1995); (2) HC, M, and POA can all be used as manipulable units in language games (Bienvenu & Colonomos 1987); and (3) all four parameters appear as manipulated units in sign errors (Klima & Bellugi 1979a). Brentari (1998) concludes that these parameters are class nodes in the sense of feature geometry. We follow Brentari in this position.

We have seen no evidence that features subsumed under the four complex ASL parameters of HC, M, O, and POA have any one-to-one correspondence to phonological features or nodes in spoken languages. Indeed, it is questionable whether it is valid to seek such a correspondence.[6] Nonetheless, they are certainly analogous in the general sense of being the foundation for phonological distinctions within a language. Thus lexical family membership involving variation in one of these four parameters is analogous to lexical family membership in a spoken language involving variation in features such as voicing, coronality, anteriority or height.

For our exposition we rely on Brentari's parameters (Diagram 1b). We argue in Section 4 that lexical families are determined by sets of phonological parameters, or

6. Some researchers propose sign models altogether devoid of constructs from spoken language structure. For such an approach to visual phonology, see Uyechi (1995). For discussion of the substantial and substantive similarities and differences between signed and spoken languages with regard to phonology, see Coulter (1993a) and Brentari (1998).

subparts thereof, that are associated with meanings within a limited partition of the lexicon. Morphology brings together lexical items that link phonology to semantics. The way they are brought together is a kind of syntax in the strictest sense. Our claims concern how words are put together. Because the components of words are pairings of phonology and semantics, our paper is relevant to those fields as well, but, importantly, what we say here is consistent with all current theories of phonology and semantics that we know of.

Of course, a richer feature model, like Brentari's shown in Diagram (1a), is required for a full analysis of ASL phonology, but we will not be involved with detailed phonological analyses. We look at how words are assembled and assume that the phonology is dealt with independently. We also assume that semantics is handled independently, thus we do not discuss these issues in detail either. We outline our model of lexical families with respect to the four parameters and add complexities only when they affect our argument.

3. Morphological processes in ASL

In this section we give a brief but representative discussion of morphological mechanisms in ASL. In particular, we argue that ASL lacks concatenative affixation.

3.1 Derivation in ASL

Spencer (1991), among others, discusses derivational mechanisms common in the morphology of spoken languages, including concatenative affixation, compounding, and reduplication. He also looks at less commonly found derivational mechanisms, such as template matching (as in Semitic languages), incorporation (as in Chukchee), and alternations of prosodic phonological features. He gives examples of the last type from stress in English, duration of vowels in Hausa, and tone in Chichewa. In this section we touch on all of these derivational mechanisms with respect to ASL. Spencer also discusses metathesis (as in Navajo). We save discussion of metathesis in ASL morphology for Section 4.2 (see the discussion of Figure 15).

3.1.1 *Concatenative affixation and compounding*

One typical type of affix in spoken language adds phonological segment(s) to a stem, where both the segments in the stem and the segments in the affix have a full feature bundle. An example is the English concatenative affix '-ly' that derives adverbs from adjectives (e.g. 'loud'/'loudly').

The analogous unit in a signed language adds a full bundle of phonological parameters (HC, M, O, and POA) to the already specified parameters of the stem sign.

Although concatenative affixation is highly favored in spoken languages, we know of only two possible candidates for concatenative affixes in ASL derivation. The first has been discussed in the literature: the highly productive agentive marker (phonologically, two hands moving downward, facing each other in a FLAT-B hand configuration, fingertips pointing away from the signer (Figure 2b). Liddell & Johnson (1989) offer the analysis of the agentive as a suffix in passing, without supporting arguments.

An alternative analysis of the agentive marker has also been proposed in which the agentive marker is analyzed as the second element of a compound (Klima, Bellugi, Newkirk, Pedersen & Fischer 1979; Napoli 1996:264). Supalla (1998), in considering data from various old ASL films, argues further that a number of ASL signs, including signs using the agentive marker, are descended from earlier compounds. In spoken languages, compounding for the agentive occurs side-by-side with affixation (compare English 'singer' and 'gasman' to German *Sänger* and *Gasmann*).

Standard compounding in ASL is concatenative, consisting of a sequence of stems, just as in English. Typically, some spreading of HC occurs, and simplification of one or both stems is common (often to assure that the resulting sign conforms to the general restriction in ASL that signs be monosyllabic or disyllabic at most; Brentari 1994; Coulter 1982; Frishberg 1975; Padden 1998; Padden & Perlmutter 1987; Perlmutter 1992; among many). The agentive marker lends itself to a compounding analysis in which it is the sign for PERSON (as Supalla 1998 argues), which, because it occurs as the second member of a compound, is phonologically simplified. The sign for PERSON (Figure 2c) occurs free (as opposed to bound to a preceding sign) and is obviously similar to the agentive marker in meaning. Its phonological form consists of the two hands at the mid-chest level in the P hand configuration, index fingers pointing away from the signer, moving straight down. Phonological change from PERSON to the agentive marker requires conversion from HC_P (HC of the alphabetic letter P) to a flat HC_B (seen in Figure 2b) and rotation from downward (inherent in HC_P) to palms facing each other.

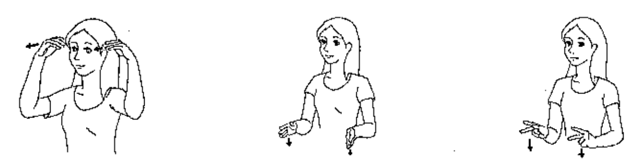


Figure 2. a. TEACH b. AGENTIVE MARKER c. PERSON

The HC changes can easily be argued to be a simplification. Only a limited number of HCs can occur as the base hand in a two-handed sign in which the hands do not echo one another (Baker-Shenk & Cokely 1980; Sandler 1993a). These HCs are HC_A, HC_S, HC_B, HC_5, HC_G, HC_C, and HC_O. HCs allowed in the base hand are considered to be unmarked (Battison 1978). Thus when HC of the second element in a compound simplifies, we expect it to change to one of the unmarked HCs. HC_P (in the sign PERSON) is marked; hence the change from HC_P to HC_B (as in the agentive) is a change from marked to unmarked HC.[7]

The argument for a compound analysis of the agentive marker is not overwhelming. But since ASL makes frequent and productive use of compounding for other purposes (Klima & Bellugi 1979b; Liddell & Johnson 1986; Sandler 1989; among others), if the behavior of the agentive marker is equally well accounted for with either an affixal or a compound analysis, we would favor the analysis which makes use of independently needed morphological mechanisms in the language and does not introduce new mechanisms; that is, we would favor the compound analysis.

However, we have found one potential diagnostic that favors the affixal analysis of the agentive marker. Sandler (1993a) claims that when the first element of a compound is a one-handed sign and the second element is a two-handed echo sign, then both hands are active throughout the compound. That is, we have coarticulation of roots that lie within word boundaries. Now the agentive marker (as well as the sign PERSON) is a two-handed echo sign. Paired with a one-handed sign, such as PREACH (Figure 3a), if the agent marker is in a compound, we would expect both hands to be active throughout. However, we find that in PREACHER (Figure 3b), the dominant hand alone is active, while the nondominant hand waits in neutral space, and then both hands become active to make the agentive marker.

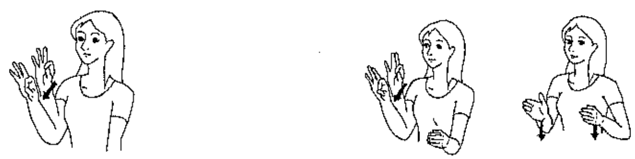


Figure 3. a. PREACH b. PREACHER

If Sandler's observation is a reliable diagnostic for compounds, the agentive marker must be an affix. However, it is not clear that the observation can be adopted as a general diagnostic for all compounds (and she did not offer it as such). Many of the compounds she considers may well be lexicalized, and it is unclear whether assimilation and reduction occur to such a great extent in productive compounds (as compared to lexicalized ones). Consider, for example, the compound CONFUSE (Costello 1994; Figure 4). The first element is the one-handed sign THINK and the second element is the two-handed alternating echo sign MIX. In this compound the nondominant hand does not become active until the beginning of the second element, just as in PREACHER.[8]

Figure 4. a. THINK b. MIX c. CONFUSE

A second potential instance of concatenative affixation in ASL derivation occurs to us, namely, the formation of the comparative and superlative. Again, what might be analyzed as an affix is transparently related to the free morpheme MOST, thus a compound analysis is also available. Because the comparative and superlative markers are both one-handed, Sandler's observation on compound co-articulation and simplification cannot help us determine which analysis is correct. Given that ASL eschews concatenative affixes elsewhere, the frequent occurrence of these markers in ASL suggests they must be the second element of compounds.

Finally, there do not seem to be any clear cases of bound concatenative morphemes in ASL — the agentive marker comes the closest. This fact alone makes suspect the notion that ASL has concatenative affixes.

We conclude that, while compounding is common in ASL, concatenative affixation does not occur with significant frequency (if at all) in derivation. This conclusion is consistent with the generalization of Klima, Bellugi, Newkirk, Pedersen & Fischer

7. With respect to O, the downward O of HC_P is inherent in that HC. Thus the question is whether with other HCs, an O of palms facing one another is less marked than a downward O. We know of no study of this question, thus we leave it open.

8. Alternatively, Sandler's observation might be a reliable phonological diagnostic for compounds, and the failure of coarticulation in CONFUSE could be due to phonetic factors, rather than phonological ones. That is, pointing both index fingers to the sides of the forehead, each to its own side, might be phonetically ill-formed. We are skeptical of this explanation, however, since many signs touch both sides of the forehead, such as COW, HORSE, RABBIT. Still, we do not know of any that use the index fingers to make this contact.

So it is not at all clear that the agentive is an affix. But even if it is, it might well be the only concatenative affix of ASL. We might expect, then, that this agentive marker, while highly productive, would be morphologically marked and thus disfavored. This is possibly the case. Susan Fischer (personal communication, 1996) has told us that in varieties of signing she has observed this particular agentive marker is used more frequently in Pidgin Signed English (PSE) and Signed Exact English (SEE) than in ASL, where a reduplicated form of TEACH can, instead, serve for TEACHER (for ways in which SEE differs from ASL and natural languages in general, see Charrow 1976; Cokely & Gawlik 1973; Supalla 1991; among others). Such an observation must not be too quickly taken as evidence for markedness. Valli & Lucas (1992) argue that the occurrence of "English" forms is both context and topic driven, with variation occurring even within a single conversation. Additionally, it is difficult to find ideologically independent criteria for distinguishing "English" from "native" forms.

(1979: 274) and others that ASL has a strong resistance to sequential morphology of the concatenative affixation type. It appears to be true of signed languages in general (Sandler 1995, but cf. Argentine Sign Language: Massone & Johnson 1991). Thus one of the most commonly found types of morphological mechanisms in spoken languages is at best rare in ASL.

3.1.2 *Alternation of prosodic features, reduplication, and templates*

Brentari (1998) argues that the root node for an ASL sign has two branches: one for 'inherent features' that do not change during the sign, and the other for prosodic features, which includes those lexical properties of signs that can change or are realized as dynamic properties of the signal (Diagram 1b). That is, prosodic features are realized sequentially.[9] Her arguments for distinguishing prosodic features from inherent ones are based on their behavior with respect to the timing of movements, the pattern of disyllabic movement sequences, the consistent many-to-one relationship between these features and their corresponding inherent counterparts, and the common phonetic reduction and enhancement that occurs among them (see Brentari & Poizner 1994 for a discussion of prosodic features in Parkinsonian signing). Some derivations in ASL involve alternation of prosodic features, and hence in the parameter M. Among these, those having to do with predicate aspect have been analyzed with templates. Other derivations involve repetition of movement and could be considered to involve reduplication.

3.1.2.1 *New word derivation and lexical category change.* A nice contrast is seen by comparing the M(s) in the signs CHURCH/PIOUS/CLOSED-MINDED (Klima, Bellugi, Newkirk, Pedersen & Fischer 1979).

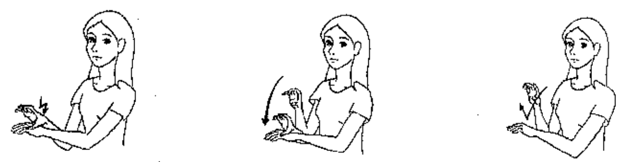


Figure 5. a. CHURCH b. PIOUS c. CLOSED-MINDED

For CHURCH the dominant hand moves to the base hand in an unmarked fashion. For PIOUS the movement is slow. And for CLOSED-MINDED the movement is quick, with a smack of the dominant hand on the base hand.[10] Some alternations in prosodic features are purely durational: STARE, for example, derives from LOOK-AT with a prolonged hold (Klima & Bellugi 1979b).[11] This alternation does not appear to be productive.

9. The idea that movement is the most perceptually sonorous part of a sign goes back to Liddell (1984a), who noted that the least restricted flow of energy is on M. For additional seminal ideas about sonority and other relevant ideas to prosody, see Blevins (1993); Brentari (1990b, 1993, 1994); Corina (1990); Perlmutter (1992); Sandler (1993b); Wilbur (1990, 1993).

Figure 6. a. LOOK-AT b. STARE

A productive prosodic alternation occurs in the derivation of certain noun and verb pairs. This alternation could be analyzed as reduplication, with the original stem mapped onto a template (see Fischer 1973 for a general discussion of types of reduplication in ASL). The noun movement is repeated, smaller, and restrained. The verb movement may or may not be repeated, is larger, and is characterized by a hold or continuous manner (Supalla & Newport 1978). An example is the pair CHAIR/SIT (Figure 7).

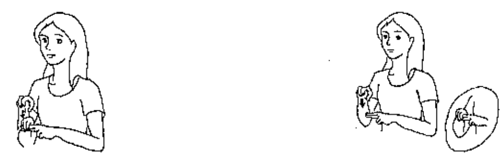


Figure 7. a. CHAIR b. SIT

3.1.2.2 *Derivation within a category: Adjectival predicates.* ASL aspectual differentiation, whether it is inflectional (operating broadly across a syntactic category or a well-defined

10. We note, however, that while this contrast is reported on in the literature, none of the signers we have consulted confirms it, using, instead, phrasal constructions or fingerspelling.

11. The reader might be tempted to consider the prosody alternation in the pair in Figure 6 iconic. However, alternation in duration and/or speed of M is often clearly not iconic and, in fact, is sometimes the opposite of expectations if duration and speed alternation in M were iconic. The sense of positive intensifier or augmentative can be conveyed by making the M of a sign short and fast and, typically, adding a hold at the beginning and end of the sign. This morpheme, imposed on the sign for SLOW, for example, is far from iconic (Klima & Bellugi 1979a).

A long tradition of studies in ASL morphology has shown that iconicity does not play a prominent role in the synchronic grammar. Because this is so widely assumed, iconicity is not a relevant issue in the alternations we analyze. For general discussion, see Goldin-Meadow & Mylander (1985), McNeill (1992), as well as the by-now-classic article, Frishberg (1975a).

subset thereof) or derivational (operating sporadically on some lexical items in a syntactic category, often with idiosyncratic meaning change), typically involves an alternation of the predicate sign's manner features (e.g. the protracted-inceptive marker described in Brentari 1996). Reduplication is often involved (Klima & Bellugi 1979a; Sandler 1990, 1993c).

This sort of prosodic alternation has been analyzed as involving affixation. However, concatenative affixation of the type described in Section 3.1.1 is clearly not at work here. Alternative types of affixes do exist in language, including segments with feature bundles that are partially or completely underspecified (spreading of features from a stem onto an affix fills in the missing values). An example in English is the negative prefix that consists of *iC-*, where the consonantal segment varies for place when followed by a nonsonorant consonant and for all values when followed by a sonorant consonant, as in 'indistinct' versus 'impatient' and also in 'immoral', 'illegal', 'irresponsible'.

Likewise, a stem can have segments that are partially or completely underspecified, with spreading from an affix filling in the missing values. Well-studied cases are those found in templatic (or infixing) languages, such as in the Semitic family. The seminal work of McCarthy (1981) analyzes Classical Arabic words as containing roots that consist of a series of two, three, or four consonants, plus vowel melodies. The roots and vowel melodies are mapped onto templates, yielding derivationally and inflectionally related words. For example, to the triliteral root *ktb*, whose sense has to do with writing, the vowel melody *uia* might be added, mapping both consonantal root and vowel melody onto the template CVCVCV, yielding *kutiba* 'it was written'. The vowel melody here could be called an affix. The templates carry meanings that are relatively consistent regardless of which root is mapped on to them. The resulting meaning is not always fully predictable, but it is at least partially compositional. In example (1), from McCarthy (1981:384), the meaning is always related to writing:

(1) a. katab 'write'
b. kattab 'cause to write'
c. kaatab 'correspond'
d. ¿aktab 'cause to write'
e. takaatab 'write to each other'
f. nkatab 'subscribe'
g. ktatab 'write, be registered'
h. staktab 'write, make write'

Various researchers (as early as Liddell 1984b) have suggested that ASL morphology is similar to that of Semitic languages in making use of templates and infixes, in both inflection (Meier 1982; Sandler 1990, 1993c, 1996) and derivation. Brentari (1996) argues that trilled movement (that is, small, rapidly repeated dynamic elements during

the production of signs — including finger wiggling and tongue wagging) can be "infixed" (in her terms) into certain polysyllabic movement verbs after the end of the first path movement to give the aspectual sense of 'gradually' or 'prolonged'. It is possible to use a templatic analysis on this sort of morphological phenomenon. The root sign can be mapped onto two templatic positions with an M parameter between them to derive signs like MISCHIEF-PRONE from MISCHIEVOUS (Sandler 1993c) and CONTINUOUSLY-DIRTY from DIRTY (Newkirk 1981). The template contributes the meaning of 'ongoing action.' Because the template imposes order and contributes meaning to the resulting sign, these cases are at least partially analogous to the templatic morphology in Semitic languages.

Nevertheless, we must recognize an important distinction. Classical Arabic verb roots consist of only a series of consonants that do not constitute a well-formed word in the absence of a vowel melody. The ASL examples discussed above, on the other hand, map onto the template a root that is already a fully-formed sign; that is, they have four full parameters before they are mapped to the aspect template. We must therefore be careful not to let the application of a templatic analysis to ASL adjectival predicates obfuscate this fundamental difference between ASL and Semitic languages.

3.1.3 *Incorporation*

ASL has been argued to exhibit a number of incorporations. Numerals, for example, can be incorporated into other signs by altering the HC. Thus DAY can incorporate the handshape of the morpheme THREE (HC_3), yielding the sense THREE-DAYS (Figure 8; Chinchor 1981):

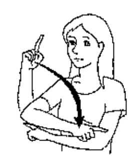


Figure 8. a. DAY b. THREE-DAYS

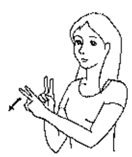
We will talk more about incorporation with respect to classifiers in Section 4.5 and Section 5.1.

3.2 Inflection in ASL

We turn briefly now to inflection. Inflection in ASL occurs primarily on predicates (including adjectival predicates, see Klima, Bellugi, & Pedersen 1979), although nominal plurals exist, often derived by reduplication (see Jones & Mohr 1975, cited in Wilbur 1987:124, and Costello 1995, among others.).

In Section 3.1.2 we discussed the application of templates to the analysis of aspectual derivation, and its possible shortcomings; those comments hold here as well. As far as we know, all aspectual inflection involves prosodic phonological alternations. The prosodic alternations include reduplication, changes in the tempo of a movement, changes in the tenseness of the muscles of the hands and arms, the presence of holds at the end of (a cycle of) movement, speed, acceleration, and elongation of movement (Bellugi & Klima 1982; Fischer 1973; Fischer & Gough 1978; Sandler 1989; Supalla 1978). These inflections often affect the duration of a sign (though they need not, see Wilbur & Nolen 1986), making it shorter or, more typically, longer. According to Klima, Bellugi, Newkirk, Pedersen, & Fischer (1979), all of these inflections follow a "principle of simultaneous organization" of the information contained in the inflection and the information contained in the stem (see also Bellugi 1980; Newport & Meier 1986; Wilbur, Klima & Bellugi 1983). We take this to mean that typically the M parameter changes, with other parameters changing only as a consequence, and that all the parameters act together to provide both the lexical sense and the inflectional sense. Indeed, Klima, Bellugi, Newkirk, Pedersen, & Fischer (1979: 274) claim that ASL inflections involve only "superimposed spatial and temporal contrasts affecting the movement of signs."

Turning now to inflection other than for aspect, we know of no arguments that inflection involves concatenative affixation, although various researchers have labeled inflectional morphemes "affixes". For example, Supalla (1982) analyzes verbs of motion as involving affixes indicating agreement with the verbs' arguments (for a different approach, see Gee & Kegl 1982). The proposition that the signer lends a book to a third party is expressed by forming the directional predicate LEND with the hands in front of the signer's chest and moving them toward the spatial locus that has been indicated as the referential anchor for the third party. The HC follows the same path as the theme argument of the movement. If the third party lends the book to the signer, the hands move from the third party to a position in front of the chest of the signer. The direction of the M for the sign LEND/BORROW is determined by the source/agent argument of the predicate and the goal/beneficiary argument, and that direction then affects the two POAs and their order in the sign (Meier 1999). The O points the fingers upward and tilted toward the first POA, then directly upward as the movement progresses, and then upward and tilted toward the second POA at the end.



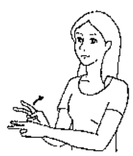
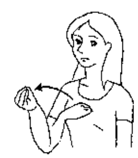


Figure 9. a. LEND b. BORROW

Shepard-Kegl (1985) analyzes the beginning and ending of the movement as "affixes". However, we claim that such "affixes" are not concatenative in that they do not add a full set of phonological parameters; for example, HC remains fixed throughout the sign. Thus we claim this inflection is one more instance of alternation of phonological features.

Significantly, the stability of HC holds generally in inflectional processes, even when those processes add considerably to the duration of the sign (see arguments to this effect in Wilbur, Klima & Bellugi 1983). For example, consider the directional predicate GIVE. If the signer wants to express giving something (unmarked for shape) to a single third person, a fixed HC follows a path from the agent argument (here, the signer) to the beneficiary argument (the third person; Figure 10a). For a plural beneficiary, the HC follows a path from the agent to one end of the points in space that are the referential anchor for the beneficiary group, then sweeps across those points in space (known as 'the plural arc') as seen in Figure 10b. To express giving to 'each member of the group' separately (the 'exhaustive'), the HC follows a path from the agent to one end of the points in space that are the referential anchor for the beneficiary group, then moves a short distance toward the agent, then back to a second point in the referential space for the beneficiary group, and so on. These movement modifications involve both prosodic phonological alternation (in the M parameter) and nonprosodic phonological alternation (in the POA parameter).



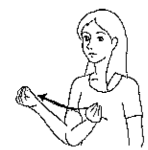


Figure 10. a. GIVE (uninf) b. GIVE (to a group)

There is debate concerning whether phenomena like those reflected in Figures 9 and 10 should be considered linguistic agreement, or whether they should be considered outside the linguistic system (Liddell 1995 versus Engberg-Pederson 1993, for example). If one accepts deictic points and lines of reference in the signing space as linguistic agreement, it is still debatable whether they are all of one type or whether there are two distinct systems, one of person agreement and one of spatial agreement (Padden 1983, 1990; Poizner et al. 1990).

The important point for our purposes here is that, should these phenomena be linguistic agreement, they cannot be analyzed as concatenative affixes. Instead of adding a full set of affix parameters (HC, M, O, and POA) to the stem's parameters, the agreement markers consist of a determination of the correct M, O, and POA parameters, a proper subset of the full set. The HC parameters are either an inalienable part of the sign (as in LEND/BORROW) or open to determination by the nature of the theme of movement (as in GIVE).

As with other derivation and inflection phenomena seen earlier, one might be drawn to a templatic analysis, but the situation here is more complex. Brentari (1998) gives overwhelming evidence that the root of the feature tree for ASL splits into inherent features and prosodic features (Figure 1a). On the inherent branch are both POA and HC. On the prosodic branch are M and changes in other features. If an affix fills the values for POA and M in the stem, the affix would have to have a root node. The problem with this is, if it has a root node, then it also must have HC and O parameters, which would have to be underspecified so that they could be filled in by the stem parameters. This would imply spreading of features in two directions: (1) from the affix onto the stem for POA and M, and (2) from the stem onto the affix for HC and O. While this sort of two-way spreading is not common in spoken languages, it can be found, as in the past tense morpheme and verb stems in Japanese (Tsujimura 1996). Again, the complexity of the required analysis makes the situation distinct from Semitic templates, in which the spreading goes in one direction only. Also, all of these directional predicates have a specified M and POA in their citation form, which can be seen in sentences that do not involve agreement. Thus, they are unlike Semitic stems.

3.3 Conclusion

ASL makes little or no use of concatenative affixation in derivation. However, it freely uses compounding, reduplication, templates (arguably, at least), various processes which involve prosodic phonological alternation, and incorporation. Certain inflectional processes are reasonably analyzed as affixation, however, unlike typical affixation in spoken languages, they are not concatenative.

4. Lexical families of signs

In this section we present representative data on lexical families in ASL, setting the stage for our analysis in Section 5. As Frishberg & Gough (1973; this volume) pointed out, ASL exhibits lexical families related by phonological alternation involving one, or sometimes multiple, parameters. These families are "groups of signs each with a formational similarity and a corresponding meaning similarity" (Frishberg & Gough 1973:1). Liddell & Johnson (1989:257) labeled the nonalternating part of signs in a family 'incomplete S(egmental)-morphs', which are matched with 'P(aradigmatic)-morphs' to give complete signs.

Quite often a particular lexical family consists of only a pair of lexical items, while other times the lexical family is relatively large and open to new members. This is not surprising because, in general, morphology, other than inflectional morphology, is often lexically idiosyncratic.

In the following subsections we exemplify lexical family membership where alternation is of HC, then M, then O, then POA. We follow with a brief discussion of alternation of more than one parameter in lexical family membership and a brief discussion of meaningful features. This discussion reveals merely the tip of the iceberg, as the subparts of these parameters also offer potential alternation for family membership.

4.1 Hand configuration alternation

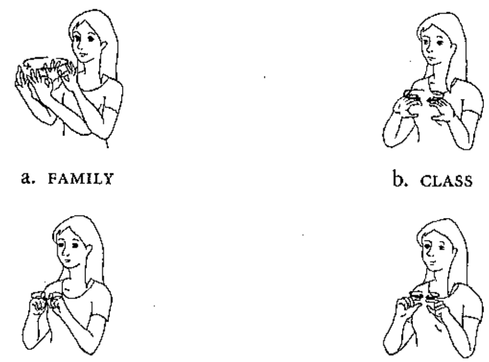
Many lexical family members differ by the parameter HC alone; an example is the pair BIRD/DUCK (Figure 11).

Figure 11. a. BIRD b. DUCK

Calling this pair members of a lexical family requires explanation. Certainly, BIRD is not derived from DUCK, nor is the reverse the case. But both share the sense of 'bird' (so the first sign in Figure 11 is the unmarked instantiation of the sense), which is conveyed in the fixed parameters of M, O, and POA, when combined with the particular HCs seen in Figure 11. We stress the point that all the parameters act together to allow the sense of 'bird' to emerge. Thus, for example, the combination of HC, O, and M seen in BIRD does not have the sense of 'bird' when the POA is neutral space (where the resulting sign is TWENTY) nor when the POA is the nondominant hand on an upward oriented flat HC_B (where the resulting sign is NEWSPAPER). Likewise the HC, O, and M seen in DUCK do not have the sense of 'bird' when the POA is in neutral space (where the resulting sign is NO).

The HCs in BIRD and DUCK are similar in that they exhibit a change in aperture: they begin with the upper finger(s) separated from the thumb (the open position) and end with the upper finger(s) touching the thumb (the closed position). The HCs differ in how many fingers protrude.

Some lexical families exhibiting HC alternation are relatively large, such as the lexical family that includes FAMILY/CLASS/TEAM/GROUP/ASSOCIATION/SOCIETY and so on (Figure 12; Earley 1996, among others).



a. FAMILY b. CLASS c. TEAM d. GROUP

Figure 12.

This particular combination of M, O, and POA, when used with a small set of HCs, seems to mean 'a whole.' In fact, one sign for COMPLETE has this same M, O, and POA with a cupped HC_B.[12] The different HCs in Figure 12 indicate the type of whole; again, they carry this information only when they are combined with this particular M, O, and POA.

The particular HC selected in each member of a family is usually due to language contact with English. The HC chosen matches the first letter of the corresponding English word; the results of this type of process are referred to as 'initialized' signs (Battison 1978; Wilbur 1987: 104; Padden 1998; among others). While initialization is a highly productive word-building process in ASL (Padden 1998), we hasten to point out that not all users of ASL are fluent in English; some of them are not familiar with English to any significant degree. The change in meaning resulting from each HC choice is arbitrary as far as these signers are concerned. Even for ASL users who do know English, there may be a problem with spontaneously predicting the correct meaning. For example, more than one English noun with an appropriate meaning may begin with the same letter (e.g., 'caste' / 'class', 'family' / 'flock', 'mob' / 'member'). We conclude that the HC in these family sets is associated with meaning by arbitrary convention.[13]

12. Once more we stress that signs can use this M, O, and P with other HCs and then the sense of 'a whole' does not emerge, as in one variation on the sign for BALLOON, in the second part of the compound sign for COCOON, in the second part of the compound sign for DAM, and so on.

13. We add the caveat that some signers use families of initialized signs in only a limited way. Thus, while initialized FAMILY and CLASS are common in ASL, initialized TEAM and GROUP are absent from some varieties of ASL (as we were informed by signers in Manhattan at a presentation at Hunter College, 1997). Instead, these ASL signers would more likely use the sign for CLASS to refer to a team or special group preceded by another sign that indicates which team or group is referred to (such as the sign FOOTBALL). Indeed, some signers very familiar with English do not consider CLASS to be an initialized sign at all (as is the case with one of our anonymous reviewers).

Suspicion of initialized signs is widespread among Deaf people. Padden (1998) attributes this in part to sign language reformers in the 1970s (Gustason et al. 1975) who proposed substituting a large portion of the native lexicon with initialized signs (see discussion in Wilbur 1987). In spite of this suspicion, the use of initialized signs is widespread in the Deaf community. Padden (1998: 46) writes "with the movement of deaf people away from traditional and low-paying solitary trades into technical and scientific fields of work, they needed new vocabulary for their new work lives. In these new contexts, initialized signs are productive means of forming semantic and lexical oppositions between known, intimate, in-group vocabulary and scientific vocabulary (Ramsey & Padden 1998)." Padden (1998: 46) points out that initialized and abbreviation signs "occupy semantic fields linking clusters of initialized signs." In our terms, lexical families can be exploited when initialized and abbreviated signs are coined.

4.2 Movement alternation

Some derivations involve alternation in the M parameter alone. Typically these alternations are of the path and secondary features of M, that is, of the non-manner features. It may well be that ASL reserves the manner features of M for derivational and inflectional processes. To begin, compare SCHOOL to COLLEGE (Figure 13).

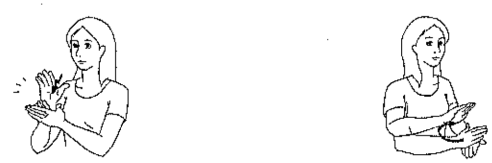


Figure 13. a. SCHOOL b. COLLEGE

The particular HC, POA, and O would be associated with a sense like 'educational institution' when combined with certain Ms, and, as in BIRD/DUCK (Figure 11 above), the first of these signs seems to be the unmarked instantiation of the sense common to both.[14] Stokoe et al. (1965) analyze the M of SCHOOL as being repeated contact. With this analysis, the upward movement between the two downward movements is only transitional, so the sign SCHOOL would have two repeated straight downward movements. Therefore the signs SCHOOL and COLLEGE would both have two Ms, but they would differ on contour and direction of the second M.

Some alternations in M have been analyzed as morphological metathesis. Wilbur,

14. Of course, they would not have this sense when combined with other Ms. Thus if the M of the dominant hand is circular in the horizontal plane, we get the sign WIPE; if both hands rotate in opposite directions, we get the sign CHEESE; if the dominant hand sweeps across the base hand from palm out past the fingertips, we get the sign CLEAN.

Klima & Bellugi (1983), for example, claim a relationship of derivation via metathesis in a few paired opposites, where a particular direction of M in one member of the pair is reversed in the other: IN/OUT, UP/DOWN, JOIN/QUIT, APPEAR/DISAPPEAR, IMPROVE/DETERIORATE (e.g. Figure 14).

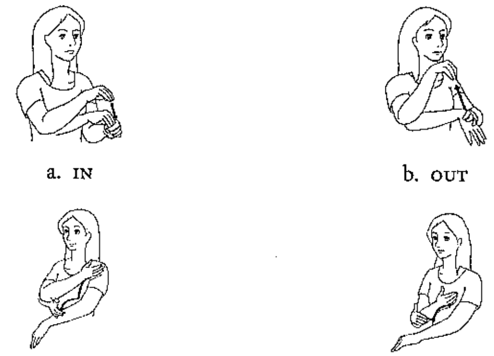


Figure 14. a. IN b. OUT c. DETERIORATE d. IMPROVE

In our terms, these are simply lexical families with alternations of M. In particular, we do not claim that one sign of the pair is derived from the other. We say that lexical families can vary by alternations in path features of M.

Likewise, lexical families can exploit secondary movement alternations (see discussion in Wilbur, Klima & Bellugi 1983). Compare the secondary movement in DIRTY (with wiggling fingers) to that in FILTHY (with a ballistic hand opening; what the ASL literature calls "spritz"; Figure 15; Bellugi & Newkirk 1981).

Figure 15. a. DIRTY b. FILTHY

These HC, O, POA, and path features of M carry the sense of 'unclean' when combined with certain secondary features of M. Given that all four parameters are involved here, we might expect that a sense at least somewhat like 'unclean' will emerge even in the absence of a secondary movement. In fact, without a secondary movement and, typically, with the nonmanual parameter of puffed cheeks, the resulting sign is PIG, which could very well be metaphorically related to the signs in Figure 15.

Sometimes two members of a lexical family can differ by path features versus secondary movement features. Thus we find a contrast in certain varieties of ASL

regarding COW and BULL (Costello 1994). These signs have the same HC, O, and POA but COW has a secondary movement of twisting the wrists so that the hands com forward while BULL has a path movement in a short arc away from the head and upwar

Figure 16. a. COW b. BULL

4.3 Orientation alternation

In some lexical families the members differ by alternation only in the parameter C The first five cardinal numbers, for example, in many varieties of ASL have the back c the hand facing the viewer for certain situations, but not others.[15]

Figure 17. a. FIVE b. FIVE

However, in these same situations, to indicate 5 in the ten's position of a number (e.g 51, 52…), for example, the palm of the hand faces the viewer. There are other sign with this combination of HC and POA but with different O that do not have the sens of 'five'. BOUNCE, for example, is such a sign, having an up and down movemer and, importantly, a downward O.

Sometimes the difference in O seems to reflect a psychological perspective on th action. Thus SEE and LOOK-AT both move the hand of (HC_V, Figure 18). With SEE th palm faces the signer and with LOOK-AT the back of the hand faces the signer.

15. The data on uses of numerals is complex, and we present only a small part here. The semanti associated with the difference in O is unclear to us. We became aware of it when we presented a pap at Hunter College in February, 1997. Deaf members of the audience engaged in a lively debate ov the semantics associated with the O in numerals. No consensus was reached, although the signe generally agreed that the situation was somehow relevant to the choice of O.

Whatever factors influenced the choice of O, these factors are not in any obvious way based c iconicity or contact with another language such as English (in contrast to initialized signs, f example). See also discussion on numerals in Stokoe et al. (1965) and on Italian Sign Langua numbers in Wilbur (1985).

Figure 18. a. SEE b. LOOK-AT

Once more, the totality of the parameters taken together yields the sense of visual perception in Figure 18, not just the particular combination of HC, M, and POA.

Other derivations involve a change in the parameter O, which can take place during path M or hold H. Again, we find examples in the number system for some varieties of ASL (Humphries, Padden & O'Rourke 1994). One way of forming the numerals between 16 and 19 is to use an initial O opposite to the O used for the corresponding numerals between 6 and 9; during the sign, the O reverses (from the back of the hand facing the viewer to the palm facing the viewer; Figure 19).

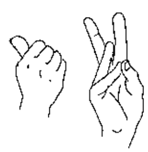


Figure 19. SIXTEEN

The semantics associated with the change of O in numbers may seem arbitrary, but is transparent when we consider the historical fact that these signs for 16–19 are derived from compounds of the sign for 10 (a fist with the thumb extended upward and the palm in a vertical plane facing the speaker) plus the signs for 6–9. The first element of the compound is phonologically simplified (that is, rather than the thumb extending upward, it rests against the side of the fist). The change in O occurs between the two elements of the compound. From a synchronic perspective, however, the change in O is associated with the sense of 'teen'.

In some sign pairs a change in O signals negation, as with WANT/NOT-WANT, LIKE/NOT-LIKE (Figure 20):

Figure 20. a. WANT b. NOT-WANT

c. LIKE d. NOT-LIKE

We see this same change in pairs like KNOW/NOT-KNOW, as well as GOOD/BAD. Historically the negated member of the pairs may come from an old compound of the affirmative sign plus the sign DON'T (Susan Fischer, personal communication; Woodward 1974).

4.4 Place alternation

Some lexical family members differ by POA alone. We use alternations of this sort in describing our model of lexical families in Section 5.1 below. Here we present a single example. Consider the pair WEAK/WEAK-MINDED (Figure 21).

Figure 21. a. WEAK b. WEAK-MINDED

Here, a BENT-5 is oriented toward the POA and the M involves contact with the POA with subsequent bending of the fingers. The common sense of this combination of HC, M, and O when coupled with these POAs is 'weak'.

4.5 Complications: Alternation of multiple parameters

Lexical family relationships can be more complex than variation in only one parameter. Many families have members that exhibit variation on more than one parameter. We illustrate this with the family containing MOTHER and FATHER (Figure 1 above). Here the HC, M, and O are fixed, and the POA varies (making this lexical family fall into the type discussed in Section 4.4). We can take either sign and hold the HC, O, and POA fixed, allowing the contour and/or direction of M to vary. If we do that for FATHER, we find the pair FATHER/GRANDFATHER (Figure 22).

Figure 22. a. FATHER b. GRANDFATHER

In FATHER the movement is straight toward the forehead. In GRANDFATHER the movement is away from the forehead in two arcs. An entirely analogous pair of signs is MOTHER/GRANDMOTHER (made at the chin). We can then say that the particular HC and O combination has the sense of 'parent' (a sense without gender specified), but only in combination with a certain set of Ms and a certain set of POAs.

The situation is even more complicated than that, however. The variation in POA seen in MOTHER/GRANDMOTHER versus FATHER/GRANDFATHER carries with it a variation in gender. This gender variation is not linked exclusively to these particular combinations of HC, O, and M. Instead, we find several pairs of signs where the POA for the female is the chin or lower cheek and the POA for the male is the forehead. In some of these pairs the other parameters are identical while in others there is also a HC and/or O difference. Examples include WOMAN/MAN, GIRL/BOY, AUNT/UNCLE, NIECE/NEPHEW and compounds using these, such as SISTER/BROTHER, DAUGHTER/SON. Another example is CHICKEN/ROOSTER, where the former is made on the chin and has the sense of 'hen' or a second sense (dissociated from gender) of 'chicken meat', and the latter is made on the forehead.

We cannot simply say, however, that the POA of the chin carries the sense of 'female' independently of other parameters and the POA of forehead carries the sense of 'male' independently of other parameters. Many signs on the chin relate to meals (e.g. BREAKFAST, RESTAURANT) and many others have nothing to do with female gender (e.g. WRONG, SWEET, JEW, LUCKY). Likewise, many signs on the forehead relate to cognitive activities or properties (e.g. THINK, KNOW, IMAGINE, WONDER, DREAM, SMART, STUPID) while other signs share unrelated meanings (e.g. BLACK, SUMMER, CATHOLIC).

Additionally, the variation in M in the signs MOTHER/FATHER versus GRANDMOTHER/GRANDFATHER carries variation in the sense of 'length', here of 'time' in the sense we call 'on and on'. This repeated M occurs with the same sense in the sign FUTURE (Figure 23). However, the same M is also found in other signs without the sense of 'on and on' (e.g. CONCEPT, MAKE UP/FABRICATE).

The above discussion shows that signs enter into multiple intersecting lexical families. MOTHER is part of a lexical family with FATHER, sharing every parameter but POA. MOTHER is part of a lexical family with GRANDMOTHER, sharing every parameter but M. MOTHER is part of a lexical family with GIRL, sharing every parameter but HC.

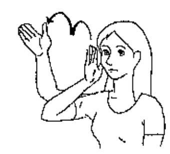


Figure 23. FUTURE

All these lexical families are tight, in that only one parameter varies. We call them ***nuclear families.*** Three nuclear families are schematized in (2):

(2) Nuclear Families

	HC	M	O	POA
MOTHER/FATHER	✓	✓	✓	✗
MOTHER/GRANDMOTHER	✓	✗	✓	✓
MOTHER/GIRL	✗	✓	✓	✓

Here a ✓ indicates a common value for the given parameter and an ✗ indicates a varying value for the given parameter. What defines each of these three families as nuclear is the fact that only a single ✗ occurs in each of the rows of parameters.

But the three signs GRANDMOTHER, GRANDFATHER, and FUTURE are all members of a more loosely connected lexical family, where O and M are shared parameters while both HC and POA vary. We call lexical families in which more than one parameter varies ***extended families.*** In example (3) the presence of more than one ✗ shows an extended family.

(3) Extended Family

	HC	M	O	POA
GRANDMOTHER/GRANDFATHER/FUTURE	✗	✓	✓	✗

The recognition of overlapping lexical families allows us to see many types of connections in the lexicon. Consider the signs EXPLAIN, with horizontal movement, and JUDGE, with vertical movement (Figure 24).

Figure 24. a. EXPLAIN b. JUDGE

These signs arguably are members of a nuclear family, where these HC, O, and POA carry the sense of 'explain' when combined with certain Ms in which the hands repeatedly move in opposite directions to one another. EXPLAIN would be the unmarked instantiation of that sense. JUDGE would include that sense plus the notion of weighing or balancing (the explanation). Hence, we can posit an extended family including EXPLAIN, JUDGE and BALANCE (the last two differing from each other by HC and O; compare Figure 24 and 25).

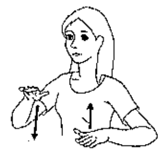


Figure 25. BALANCE

The lexical family of EXPLAIN, JUDGE and BALANCE would overlap with the nuclear family that includes BALANCE and MAYBE (example 4), which differ only by O (in MAYBE the palms face upward).

(4) Nuclear Families

	HC	M	O	POA
EXPLAIN/JUDGE	✓	✗	✓	✓
BALANCE/MAYBE	✓	✓	✗	✓

We can now see that JUDGE and MAYBE are part of an extended family, in which O and HC vary. All of these families form one big extended family in which only the POA and certain features of M (the alternating movement in a straight path) are shared by every sign (example 5):

(5) Extended Families

	HC	M	O	POA
JUDGE/BALANCE	✗	✓	✗	✓
EXPLAIN/JUDGE/BALANCE	✗	(✓)	✗	✓
EXPLAIN/JUDGE/BALANCE/MAYBE	✗	(✓)	✗	✓

In example (5), we use parentheses around a ✓ to indicate that some but not all of the features of this parameter are common to all family members. Here (✓) M appears twice in the extended families M column because all members of these two extended families have an M that consists of a straight path with alternating hands, although the direction of M varies.

We can now take a second look at some of our earlier nuclear families and see that they are also part of extended families. For example, the nuclear family of BIRD/DUCK is part of an extended family including PARROT (Figure 26). In PARROT the POA is beside the mouth rather than in front of it, and the gesturing fingers do not close (the HC is an X). Likewise, EAGLE is in this extended family (Figure 26), with the same HC as PARROT but with the POA being the nose. (Thus EAGLE and PARROT are members of a nuclear family.)

Figure 26. a. PARROT b. EAGLE

Most probably the HC in this extended family was historically related iconically to the size and shape of the beak of the fowl; a duck has a wider beak than the generic fowl, and both a parrot and an eagle have a hooked beak. The very fact that PARROT is made off to the side of the mouth, however, shows that the HC has become arbitrary, allowing the sign to be made in POAs other than the nose/mouth.

Given the existence of extended families in which only two parameters are shared, we might ask whether extended families exist in which only one parameter is shared, and in fact they do. Consider the signs with the sense of female gender made at the chin. We have already noted that MOTHER and GIRL are members of a nuclear family. AUNT and NIECE are also members of a nuclear family in which only HC varies. But MOTHER, GIRL, AUNT, and NIECE are all members of an extended family in which only POA is constant across the family, as seen in example (6).

(6) Extended Family

	HC	M	O	POA
MOTHER/GIRL/AUNT/NIECE	✗	✗	✗	✓

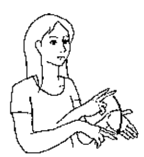
The recognition of extended families reveals a startling fact about ASL: any of the four complex parameters can itself carry semantic content when it is combined with fixed sets of the other three parameters. We have already discussed the fact that the POA of forehead or chin carries the sense of gender (male or female, respectively) when combined with certain combinations of HC, M, and O, and we mentioned that the POA of forehead can also carry the sense of cognitive activity or property when combined with other combinations of HC, M, and O, whereas the POA of chin is where many signs (but, importantly, not all) having to do with meals and food are made. Numerous other instances pervade the ASL lexicon. Thus many signs having to do with feelings use the OPEN8 HC, and many signs about allegedly unpleasant things have the parameter POA at or just under the nose (Frishberg & Gough 1973;

this volume). Some signs that are names of cities use an initialized HC with a movement that follows a '7' contour.

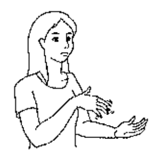
In fact, even subsets of the features that make up parameters can have a sense. Thus bending the fingers of a given HC can indicate 'problem', as in the pair SEE, where the HC is a straight V, and BLIND, where the HC is a BENT-V. We now look closely again at the pair DIRTY and FILTHY, which differs only by secondary movement. Frishberg & Gough (1973) argue that such secondary movement can contribute relatively sturdy and reliable information. For example, wiggling fingers (as in DIRTY) versus spritz (as in FILTHY) is the distinguishing featural difference between other pairs, such as AFRAID/TERRIFIED, TIPSY/DRUNK, BURN/BURST-INTO-FLAME (although there is much dialectal variation).

Frishberg & Gough suggest that a) the wiggling fingers, which are continuous and indefinitely continuable, are temporally analogous to a state (such as being on fire) or a continuing activity (such as studying) whereas b) the spritz, which takes the staggered, cyclical finger movements of the wiggle and synchronizes them into one non-repeated, high-energy opening event, is temporally analogous to a sudden, eruptive change of state (such as bursting into flame) or a high-energy activity. In other words, they suggest temporal iconicity. We wonder, though, how signs like FILTHY and DRUNK fit in here. They denote neither a sudden change of state nor a high-energy activity (quite the contrary, sometimes). Thus we do not adopt the suggestion of Frishberg & Gough, which we raise only because it may well have spontaneously occurred to the reader. The sense of continuity and the sense of intensity associated with fingerwiggling and the spritz, respectively, in these signs are arbitrary.

Still, the sense contributed by these secondary movements is so strong that one can sometimes fairly accurately guess at the meaning of an unfamiliar sign. For example, when we have presented students of ASL who already have some sense of the richness of phonological alternation in ASL morphology with the signs for READ (with the HC_V and no secondary movement), STUDY (with the HC_5 and wiggling fingers), and CRAM (with a spritz, as in Bellugi & Newkirk 1981), and we have told them the meaning of the first two signs, they have easily guessed the meaning of the third (Figure 27).



a. READ



b. STUDY

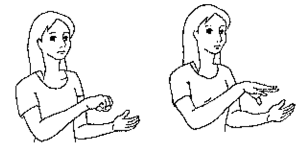


Figure 27. c. CRAM

It is important to emphasize that wiggling fingers can occur without the sense of 'continuity' and spritz can occur without the sense of 'intensity', as in the signs COLOR (Figure 28) and NOTHING (Figure 29), respectively. Thus, once more, the sense of a given parameter (here of movement features) emerges only in association with certain clusters of other parameters (that is, particular combinations of HC, POA, and O).

Figure 28. COLOR

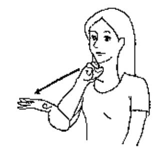


Figure 29. NOTHING

The possibility of a single parameter being meaning-bearing when associated with certain clusters of other parameters is foundational to the notion of classifiers in ASL. Indeed, ASL has been argued to make frequent and productive use of incorporation via classifiers in verbs (Fischer & Gough 1978; although they did not use the term in the current technical sense, we believe the groundwork is there. See also Mandel 1981; Kegl 1985; Kegl & Schley 1986, inter alia). For example, predicates of motion may consist of an M only, with the appropriate classifier for the particular referent of the thing that moves (theme argument) filling in the HC, and argument agreement filling in the POA(s). If the thing that moves is a vehicle, the 3 is used; if the thing that moves is a (certain kind of) animal (such as a cat or dog), the BENT-V is used; and so forth. Thus if we express the proposition that a car moved from location 1 to location 2, the HC 3 moves from a location in space that had previously been identified as location 1 to a second location in space that had previously been identified as location 2. The orientation of the hand(s) follows naturally from the spatial relationship of location 1 to location 2. The O often follows from the M and POA, of course, but the O could also be meaningful in this context, e.g. to show that the car is pointing in a certain direction, perhaps backing up rather than moving forward.

4.6 Conclusion

While nonprosodic phonological alternation as a morphological mechanism in ASL is neither reliable in terms of the output sense of a lexical family member nor predictable in terms of whether or not a given sign will be part of a lexical family or how large that lexical family will be, it is persistent: we find many such lexical families of signs (Frishberg & Gough 1973; Sandler 1989, among others). Indeed, when a new signer does not know a given sign, a guess that assumes the existence of a lexical family can often be understood, even when such a lexical family does not exist. When new signs are coined, they often add to existing lexical families (see Padden 1998). Thus the mechanism of phonological parameter alternation characterizes a good part of the morphology of ASL (just as ablaut characterized a good part of Indo-European morphology; see also Brentari 1995): lexical families permeate the ASL lexicon.

With respect to lexical families, Liddell & Johnson (1989) claimed that the basic morpheme (the one associated with the sense common to all members) has an incomplete feature bundle (that is, part of the bundle is underspecified). We have argued in this section that in order to associate a sense with an incomplete feature bundle, we must consider the alternating parameter(s). Thus we depart from Liddell & Johnson here; in particular, we assign no meaning to their incomplete S-morphs independent from the alternating parameter. Nevertheless, our analysis owes much to them.

The members of a lexical family are not in any obvious way derived from one another. How, for example, could one determine whether MOTHER is derived from FATHER or vice-versa, when they differ only by the parameter POA? Furthermore, the rules for deriving one from another would be phonologically anomalous. Converting the value of POA from chin into forehead, for instance, would be as phonologically arbitrary (with respect to feature change) as a synchronic rule changing [ij] into [ʌ] to derive 'blood' from 'bleed' in English. Derivation, then, is not involved. Rather, lexical family members share some parameters which, when found with certain other parameters, are associated with relatively robust senses. The next section presents a model of the ASL lexicon that captures these observations.

5. A model of lexical families

We begin this section laying out a model of the ASL lexicon that allows us to represent lexical family relationships. In 5.2 we consider various consequences of this proposal.

5.1 The model

We have seen that ASL shows form/meaning combinations that hold within a lexical family, but not outside it. Meanings are associated with individual phonological parameters, combinations of parameters, and even subparameters, but that association rarely, if ever, holds across the entire lexicon. Thus, we need to be able to model lexical units that have three components, one representing phonological form, another indicating the meaning associated with the form, and a third stating the restriction on the form/meaning association. We call these lexical units "ion-morphs" because they are rigged to compose with appropriate other elements in the lexicon. To represent the phonological form for one-handed signs, we give a single set of parameters between square brackets (example 7).

(7) $[HC_i, M_i, O_i, POA_i]$

For two-handed echo signs, we likewise give a single set of parameters with a note indicating whether the echo is simultaneous (like TEAM in Figure 12) or alternating (like JUDGE in Figure 24). We do not intend this representation as a phonological analysis, because of the ensuing problems of overspecification and lack of descriptive power (for discussion of more adequate phonological representation, see Brentari 1998; Brentari & Goldsmith 1993; Perlmutter 1991; Sandler 1993a). Instead, we adopt this representation as an expository convenience since our argument and our analysis are independent of choices among phonological analyses.

For two-handed signs in which one hand serves as a base to the dominant hand (like READ in Figure 27), we give two sets of parameters, using the convention of putting the dominant hand's parameters above the base hand's parameters and calling the dominant hand **h1** and the nondominant hand **h2** (example 8).

(8) h1: $[HC_i, M_i, O_i, POA_i]$
h2: $[HC_j, M_j, O_j, POA_j]$

In some signs a parameter will change during the sign, even when the sign is not a compound. We represent parameter change within a morpheme by giving two parameter values, one on top of the other, using the convention that the one on top happens first (example 9).[16]

16. Here again we gloss over issues important to the phonological representation of signs in ASL, referring the reader to Brentari (1998, particularly Chapter Seven) for a thorough survey of the relevant literature. Issues such as whether what we represent as two parameter matrices should involve a single or multiple phonological root nodes are independent of our analysis, which is compatible with either sort of model. Thus we assume a representation that is perspicuous for our purposes, if not sophisticated.

(9) $\begin{bmatrix} HC_i, M_i, O_i, POA_i \\ HC_j \end{bmatrix} \begin{bmatrix} HC_i, M_j, O_i, POA_i \\ M_j \end{bmatrix} \begin{bmatrix} HC_i, M_i, O_j, POA_i \\ O_j \end{bmatrix} \begin{bmatrix} HC_i, M_i, O_i, POA_j \\ POA_j \end{bmatrix}$

An example of a monomorphemic sign in which HC changes is HIGH-SCHOOL; one in which M changes is GRADUATE; one in which O changes is COOK; one in which POA changes is MAN (Figure 30).

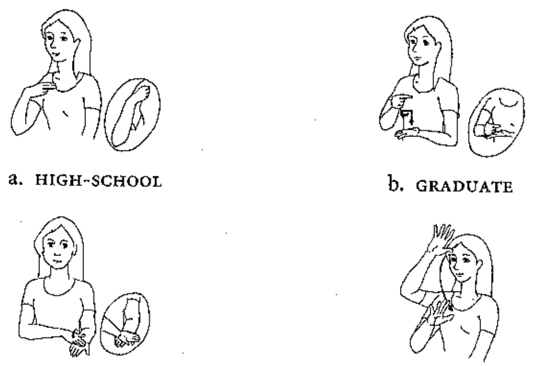


Figure 30. a. HIGH-SCHOOL b. GRADUATE c. COOK d. MAN

We can now start with the analysis of the least complex case: a nuclear family in which the alternating parameter contributes a sense that does not appear to be shared by other lexical families. We saw such a case in the lexical family in Figure 12: FAMILY/TEAM/CLASS/ASSOCIATION and so on. Let us call the M of curved path with the direction outward from the signer M_a, the POA in the center of neutral space POA_a, and the O of hands facing one another with wrists downward O_a. Then the combination of $[M_a, POA_a, O_a]$ has the sense of 'whole' when matched with a HC that varies over a given set.[17]

We will indicate the variable HC by x, where $x \in \{HC_F, HC_T, HC_C, HC_A, etc.\}$. The HC determines the particular type of whole, but none of these HCs determines the same information for any sign outside this nuclear family. Thus this nuclear family is not part of an extended family. Our ion-morph is shown in example (10).

(10) $[x, M_a, O_a, POA_a]$ = 'whole' when $x \in \{HC_F, HC_T, HC_C, HC_A, etc.\}$
Note: two-handed simultaneous echo

17. We use arbitrary small letters of the alphabet as indices here rather than specifying the exact values for these particular parameters simply because the specific values of the parameters is not of interest to us — rather, the model is.

The rule that maps specific HCs from the permissible set (the domain of x) onto this ion-morph (that is, the rule that assigns values to x) yields the phonological representations in example (11).

(11) a. FAMILY: $[HC_F, M_a, O_a, POA_a]$
Note: two-handed simultaneous echo
b. TEAM: $[HC_T, M_a, O_a, POA_a]$
Note: two-handed simultaneous echo
c. CLASS: $[HC_C, M_a, O_a, POA_a]$
Note: two-handed simultaneous echo

Now consider a nuclear family in which the alternating parameter contributes a sense that is shared by other lexical families. We start with Figure 1: MOTHER/FATHER. We have HC_5; index the M (repeated contact with the POA) as M_b and the O (palm facing leftward, fingertips upward) as O_b. In this family there are only two possible values for POA, the forehead, which we will index as POA_b, and the chin, which we will index as POA_c. Our ion-morph is shown in example (12).

(12) $[HC_5, M_b, O_b, x]$ = 'parent' when $x \in \{POA_b, POA_c\}$

The rule that assigns values to x yields the phonological representations in example (13).

(13) a. FATHER: $[HC_5, M_b, O_b, POA_b]$
b. MOTHER: $[HC_5, M_b, O_b, POA_c]$

Another nuclear family that makes use of these same POA values contributing the same sense (i.e., gender) is HEN/CHICKEN (for those varieties of ASL that have the relevant variation on the sign) and ROOSTER, with HC_3. The ion-morph is shown in example (14).

(14) $[HC_3, M_b, O_b, x]$ = 'chicken' when $x \in \{POA_b, POA_c\}$

The rule that assigns values to x yields the phonetic representations in example (15).

(15) a. ROOSTER: $[HC_3, M_b, O_b, POA_b]$
b. HEN/CHICKEN: $[HC_3, M_b, O_b, POA_c]$

Another nuclear family that makes use of the same POA values contributing the same sense is NIECE/NEPHEW. All the fixed parameters for this lexical family are different from those of the other two related lexical families: the HC is N (labeled HC_N), the O faces the viewer (labeled O_c), and the M is a small circle (labeled M_c). The ion-morph is given in example (16).

(16) $[HC_N, M_c, O_c, x]$ = 'child of sibling' when $x \in \{POA_b, POA_c\}$

And the mapping rule yields example (17).

(17) a. NEPHEW:[HC_N, M_c, O_c, POA_b]
b. NIECE:[HC_N, M_c, O_c, POA_c]

We could go on, but these three examples are enough to demonstrate that a shared domain of x with the associated senses for each value of x defines an extended family revolving around a sense assigned to the parameter POA. Note that we could also represent the ion-morphs of 'parent', 'chicken', and 'child of sibling' as in example (18).

(18) a. [HC_5, x] = 'parent' when x ∈ {[M_b, O_b, POA_b], [M_b, O_b, POA_c]}
b. [HC_3, x] = 'chicken' when x ∈ {[M_b, O_b, POA_b], [M_b, O_b, POA_c]}
c. [HC_N, x] = 'child of sibling' when x ∈ {[M_c, O_c, POA_b], [M_c, O_c, POA_c]}

We see that the ion-morphs 'parent' and 'chicken' form a nuclear family since they differ with respect to only one parameter, HC. That is, the domains for x are identical. Likewise, the ion-morphs 'parent', 'chicken', and 'child of sibling' together form an extended family since 'child of sibling' differs from the other two with respect to two parameters, HC and M. It should be clear that our terms 'nuclear family' and 'extended family' are purely descriptive and are in no way crucial to our analysis. The representation is what is crucial.

We can now give the lexical representations for POAs that have fixed senses in combination with sets of fixed values for HC, M, and O. For the two values of POA in the extended family immediately above, we have the two ion-morphs in example (19).

(19) a. [x, POA_b] = 'male'
b. [x, POA_c] = 'female'
where x ∈ {[HC_5, M_b, O_b], [HC_3, M_b, O_b], [HC_N, M_c, O_c]}

The mapping rule yields the phonological representations for the signs FATHER, ROOSTER, NEPHEW, and MOTHER, HEN, NIECE. That is, the rule can map one ion-morph onto another to yield the phonological representation of a sign. The more lexical items there are in an extended family, the greater the domain of x. This model serves for all the example types discussed in this paper, and, so far as we know, for all lexical families in ASL.

We have seen that, in many cases, ion-morphs unify with other ion-morphs to form a complete sign. For example, the ion-morphs 'female' and 'parent' combine to produce MOTHER. It is very clear that 'female' is an ion-morph because it can unify with the other ion-morphs 'chicken', and 'child of sibling'. If 'female' were not an ion-morph, we would have no way to capture the generalization that the signs MOTHER, NIECE, and HEN have the place parameter and its associated meaning in common. Similarly, 'parent' can unify with the ion-morph 'male' to produce FATHER, so we must treat 'parent' as an ion-morph.

We have argued that 'whole' is an ion-morph because it represents the form and meaning held in common among FAMILY, TEAM, CLASS, etc. The ion-morph we posited is given in example (20).

(20) [x, M_a, O_a, POA_a] = 'whole' when x ∈ {HC_F, HC_T, HC_C, HC_A, etc.}
Note: two-handed simultaneous echo

What 'whole' combines with appears to be a single parameter that does not combine with any other ion-morphs. That is, the HC_F combines with 'whole' to yield FAMILY, but we are not aware of any other sign that associates HC_F with the meaning 'family'. It is important for us to consider this case carefully, because we would like to know whether it is ever possible for an ion-morph to unify with a parameter that itself is not an ion-morph.

We could also posit ion-morphs for each of the HC/meaning pairs allowed in the restriction of the ion-morph for 'whole'. For example, we could maintain that the combinations shown in example (21) are ion-morphs.

(21) a. [HC_F, x] = 'family' when x ∈ { [M_a, O_a, POA_a] }
b. [HC_T, x] = 'team' when x ∈ { [M_a, O_a, POA_a] }
c. [HC_C, x] = 'class' when x ∈ { [M_a, O_a, POA_a] }
d. [HC_A, x] = 'association' when x ∈ { [M_a, O_a, POA_a] }

If we do not admit such objects into our lexicon, we lose the explicitness of saying where the meaning of the sign FAMILY comes from. If we do admit such ion-morphs into the lexicon, we allow ion-morphs that have restrictions with only a single member. We see no reason why this should not be possible. If we were approaching this issue in a different way, we might have first asked whether there could be any ion-morphs that have singleton restrictions. The lexical family above would lead us to an affirmative answer.

Admitting the ion-morphs in (21) into our lexicon also makes it possible to consider the meanings associated with them. We might like to state the meaning of [HC_F, x], for example, as whatever meaning results from removing the meaning 'whole with subparts' from the meaning 'family'. Doing this is probably the correct approach because it makes the meaning of FAMILY completely compositional based on the meanings of its subparts. But it is indeed difficult to see what that meaning should be. This does not, however, indicate that the meaning is incoherent.

We will opt for explicitness in our theory, and we will take the representations in (21) to be ion-morphs. This has the consequence of predicting that any of the ion-morphs in (21) could be employed in composing a new sign, although they certainly would not have to be, and we are not at present aware of other signs that use them.

We conclude that ion-morphs combine only with other ion-morphs. The morphological process that accomplishes this is unification. It is the only morphological rule required by our analysis, and we state it as example (22).

(22) UNIFICATION RULE: an ion-morph *x* can merge with any other ion-morph *y* that is compatible with it; *x* is compatible with *y* just in case *x* is in the restriction of *y* and *y* is in the restriction of *x*.

An important result emerges from our analysis. Consider the phenomenon of classifiers in ASL. For example, HC_3 is the vehicle classifier, which can be used with many predicates of motion. At the end of Section 4.5, we described how a predicate of motion can vary its parameters of M, O, and POA. Some of the factors affecting the choice of these parameters include the endpoints of the motion, whether or not the signer wants to convey additional information about the shape of the path of the M, the timing of the motion along that path, the orientation of the thing that moves with respect to the beginning and end points of movement, and so on. We can now give a definition of classifiers using our formalism for lexical families. The vehicle classifier, for example, is the ion-morph shown in example (23).

(23) $[HC_3, M_x, O_y, POA_z]$ = 'vehicle'
where
x is determined by properties of the referent of movement,
y is determined by properties of the referent of the thing that moves with respect to the endpoints of movement,
and z encodes arbitrary referential points in the signing space.

Classifiers in ASL are, with this analysis, the same type of morphological form as any other single parameter that is uniquely shared by all the members of an extended lexical family. A classifier is theoretically no different from the POA of forehead that carries the sense of 'male' in combination with a range of other phonological parameters. Both are ion-morphs. The only empirical difference is that the combination of other phonological parameters is not arbitrarily determined with classifiers, in contrast to the situation with the POA of forehead that carries the sense of 'male'. Instead, the other phonological parameters with the classifier are determined by other aspects of the event described.

Interestingly, classifiers can occur with a range of types of predicates of motion, for example, predicates like GO, in which the referent of the subject is the thing that moves, and predicates like CARRY-BY-HAND, in which the referent of the object is the thing that moves. In the latter instance, the classifier can be based not just on properties of the referent of the thing that moves, but also on properties of the referent of the agent of the motion (in this example, of giving) in performing the motion. So if the agent argument of a predicate (located at point 1) gives the beneficiary argument of that predicate (located at point 2) a sheaf of papers, a flat HC_C will travel from point 1 to point 2, with the tips of the fingers pointing toward point 2 and the palm facing upward. But if the sheaf of papers is very thick and heavy, a bent HC_L will be used probably with both hands (to show the object was heavy enough to merit two hands moving it). If the agent gives the beneficiary a bucket and holds it around the sides while giving it, both hands will have a wide HC_C. But if the agent passes the bucket while holding it by the handle, only the dominant hand will move and it will probably have HC_S with a downward O (as though holding onto a handle).

Classifiers of motion verbs of the first type (where the agent of the action is moving), then, are determined differently from classifiers of motion predicates of the second type (where the theme or patient is moving); these latter have been called 'predicates of carrying'. We can use this fact to distinguish motion from carrying predicates in the lexicon. A motion predicate would be one with the classifiers HC_3 (for vehicle), HC_1 or inverted HC_V (for persons), bent HC_V (for animals), and so on. The lexical entry for a motion predicate ion-morph would be as shown in example (24).

(24) $[HC_w, M_x, O_y, POA_z]$ = 'move'
x is determined by properties of the referent of movement,
y is determined by properties of the referent of the thing that moves with respect to the endpoints of movement,
z is arbitrary referential points in the signing space,
and $w \in$ {3, 1 or inverted-V, BENT-V, ...}

That is, the representation of a motion predicate would be the set of classifiers for motion predicates. Carrying predicates have analogous lexical entries.

Again, an important result of this analysis emerges. Consider, for example, the sign RUN. If a signer were to ask the addressee how he came to school today, the addressee might respond by pointing to himself, then making the sign RUN. Alternatively, the viewer might point to himself, then use HC_V moving rapidly from one point to another in the signing space. The citation form of RUN will never appear in this second sentence, yet a sign has been used. And, significantly, the signer and viewer understand it, even though this might be the first (and last) time they encounter it. In our analysis that sign is not some anomaly, but merely the ion-morph 'move'. Only an analysis involving ion-morphs accounts for the association of the same sense of 'move' with varying phonological forms.

In sum, the representations in our model are ion-morphs consisting of three parts: a description of phonological form (a parameter group or groups along with any notes, such as whether the sign is a two-handed echo sign), the meaning associated with the form, and a restriction on what other parameters the form-meaning pair can combine with. Ion-morphs combine with other ion-morphs by unification to produce signs.

5.2 Questions and consequences

We are now in a position to ask certain questions about the model and the phenomena it represents. First, we need to consider what sorts of lexical units our ion-morphs actually are. As we consider this, we will examine phenomena in spoken languages that are similar to the lexical families in ASL. We will also discuss the value of adding ion-morphs, which turn out to be a new grammatical entity, to morphological theory. Second, we can ask what the limits are on family relationships. Finally, we would like to be certain that our lexical families are not related by commonly observed morphological mechanisms; here we will show that lexical family morphology is clearly distinct from templatic morphology.

5.2.1 *The nature of ion-morphs and an analysis of phonaesthemes*

In our model, we have posited representations for fully formed signs and also for items that are not full signs but that consist of a form, a meaning, and a restriction on when the form can have the stated meaning. These ion-morphs combine with other parameters listed in the restriction (that is, in the domain of x) to form full signs. It is time to ask what status ion-morphs have in our theory of lexical grammar.

Of course it would be possible to deny ion-morphs any theoretical status. We could try to maintain that the ASL lexicon consists only of fully formed signs and then claim that ion-morphs simply are descriptive devices. We will not do this for two reasons. First, doing this would be less interesting theoretically than taking ion-morphs seriously as actual items in the lexicon. Second, it is clearly false that the ASL lexicon consists only of fully formed signs. Classifiers might well not have all their parameters specified in the lexicon (although, depending upon one's analysis of inflection, they might). Similarly, motion predicates of the type discussed at the end of Section 5.1 could not possibly have all their parameters specified in the lexicon. We clearly want ion-morphs to be listed in the lexicon.

So now we find ourselves claiming that ion-morphs are morphological entries in the lexicon. But what sort of entries are they? They are certainly not signs. Are they morphemes? Can they be analyzed as roots and affixes? Or must we admit a new entity into morphological theory? While the model we have proposed is meant to handle signed language data — in particular, ASL data — there is nothing to prevent it from being applied to data in spoken languages. Furthermore, doing so can help both in understanding what ion-morphs are and in evaluating their efficacy for morphological analysis.

We already noted in the introduction to this paper that lexical families exist in spoken languages as well as in signed languages, but typically to a lesser degree.[18] In

18. Navajo and other Apachean verbs offer partially analogous phenomena. Young (2000: 1) writes that Navajo has only about 550 verbal roots and that these have fairly abstract meanings. Meanings are made more specific by substantial prefixation processes yielding a nearly limitless verb lexicon. Most Navajo roots are monosyllabic and the minimal verb has two syllables (e.g. Speas 1987). Thus, they are phonologically incomplete. However, the incompleteness of Navajo roots is a matter of prosody: at the nonprosodic level, Navajo roots are complete.

The meanings of Navajo roots are semantically identifiable (at least in a general way) independently of the prefixes that appear with them, making them different from ASL ion-morphs but similar to Semitic roots. The Navajo situation differs from both templatic morphology in Semitic languages and lexical families in ASL with respect to phonology.

English noun (N)-verb (V) pairs like 'blood' / 'bleed', which differ by vowel quality, and V-Adjective (A) pairs like 'lose' / 'loose', which differ by the feature of voicing on the last segment, are scattered and small. Still, sensitivity to their existence can lead one to identify additional potential lexical family members. For example, 'prove' and 'proof' quite obviously seem to be the V and N counterparts of one another (without making any claim about one being derived from the other), but does the V 'probe' perhaps enter into the same lexical family? We postpone a discussion of the issue of limiting membership of lexical families to Section 5.2.2.

Additionally, our model sheds light on the classical phenomenon of phonaesthemes in spoken languages, a phenomenon discussed in almost any introductory work on morphology (see Jespersen 1949). Phonaesthemes are sounds associated with certain meanings only in a list of given roots. Phonaesthemes can carry a connotation or an underdetermined denotation. For example, English has the phonaestheme [gl] for 'light-emitting', as in 'glow/glimmer/glisten', and so on (but contrast: 'glue'). If we were to meet a new verb, 'gless', we might expect it to have something to do either with 'light' or with feelings we associate with light (maybe 'happiness' or 'energy'). Other examples are [fl] for 'easy or quick movement', as in 'fly/flow/flutter/fluid' (but contrast to 'floor'). In some instances phonaesthemes (or items like them) carry information that is relevant to the grammatical behavior of certain words, as in the minimal pairs 'then/when' and 'there/where' (see Pope 1976). Here the voiced interdental fricative itself seems to arbitrarily carry the meaning of 'definiteness' (also in 'the/that/those'), while the labial glide arbitrarily carries the meaning of 'interrogative' (also in 'why/what/which'). The following syllable rhyme ties that definiteness or interrogativeness to the word's full meaning, adding the sense of time or place or proximity (as in 'this' versus 'that'). As with lexical families, this sense is attached to this rhyme only in association with the particular onset. So the sense of the word 'pen' (rhyming with 'then') is not related to time, the sense of the word 'bear' (rhyming with 'there') is not related to place, the sense of the word 'bliss' (rhyming with 'this') is not related to proximity. We can analyze such phenomena in terms of ion-morphs as follows shown in example (25).

(25)	a. /wh + x/	= 'question'	where x ∈ {en, ere, o, at, y, ether,…}
	b. /th + x/	= 'definite'	where x ∈ {e, en, ere, is, at, ose, ese,…}
	c. /x + en/	= 'time'	where x ∈ {th, wh}
	d. /x + ere/	= 'location'	where x ∈ {h, th, wh}

These examples seem perfectly analogous to our ASL ion-morphs and we can easily apply such an analysis to other lexical items, such as terms for relatives as seen in example (26).

(26) /x + ther/ = 'close relative' where x ∈ {mo, fa, bro, (sis), (daugh)}

Linguists long have noted the existence of phonaesthemes, but morphologists have done little more than mention them in passing. That is not surprising. Any attempt to call such a unit 'morpheme' leads to problems with the basic principles of morphology that words should be exhaustively analyzable into morphemes and that morphemes should not overlap. Thus the specified strings (i.e. the nonvariable portion) in (25) and (26) are not the sort of material that are considered to be morphemes in any standard theories of morphology. We would be reluctant to call them 'roots' or 'affixes' because the items they combine with (the possible values for x) are not morphemes themselves. Likewise, if we say the 'gl' of 'glisten' is a morpheme, how do we analyze the 'isten'? Taking the analysis of such phenomena seriously, then, is grammatically expensive: it costs the introduction of the new notion of ion-morph. Nevertheless, if we are to capture the information that native speakers share, (25) and (26) must be listed in the English lexicon. While linguists looking at spoken language have, almost to a one, chosen not to formalize information like that captured in (25) and (26), there are several reasons why the grammatical expense is worth it to the linguist looking at ASL. Those reasons concern the particular language situations in which signers find themselves.

A first point concerns a person's signing/speech vocabulary versus reading vocabulary. A typical hearing person's reading vocabulary in their native language is thousands of words larger than their speaking vocabulary. We simply do not use as many words in speech as we know from reading. However, if we need to, we can pull out our reading vocabulary and use it in ordinary conversation. The ASL signer's situation is different. The signer's signing vocabulary is not augmented by reading. Instead, the signer has two vocabularies — one in ASL for conversation, and one in English words for reading. When the signer wants to use an item from reading vocabulary in ordinary conversation, the signer might well hit a snag because of not knowing the sign for the reading vocabulary item.

A second point concerns the employment patterns of signers in America. Historically, employment opportunities for deaf people have been limited — some professions have been virtually inaccessible to deaf people. The rise of the computer industry, however, and the use of the Web have expanded the employment options for deaf people. With signers going into new professions, signers again might not know relevant signs for new job situations.

A third point concerns the fact that many signers are not native signers. Less than ten percent of deaf individuals have deaf parents. If they do, they typically learn sign from birth with the same linguistic development that characterizes hearing children learning speech. Of the other ninety percent, some get little linguistic input for a while after birth or after the onset of deafness, sometimes for years. When the linguistic input finally comes, it might be in the form of teaching speech production and lipreading. Thus a significant number of deaf people do not learn a natural sign language until later in childhood or even past adolescence. These signers may also find themselves in situations lacking the signs they need to express themselves.

Given the three points above, it seems likely that signers will more often both be creative with their lexicon and be in situations in which they have to guess at what signs mean. Our contention is that the existence of lexical families and the unconscious linguistic exploitation of those families can aid in these two processes.

That lexical families do play a role in creative play in the ASL lexicon is apparent from name signs. As Supalla (1992) points out, many name signs fall into two basic types. One type is arbitrary, and sometimes (though not necessarily) involves simple initialization, e.g. shaking the relevant letter HC in neutral space or in some other arbitrarily chosen place. For example, a person named Maria might have a name sign of a HC_M shaking in neutral space. The second type of name sign is descriptive. It is based on some personal characteristic, and involves classifier HCs. Thus a person with buck teeth might have a hooked HC_4 repeated at the mouth.

However, Supalla notes that some descriptive name signs, which he does not find well-formed, do not use classifiers, but instead involve initialization. He attributes the increasing frequency of such signs to the influence of hearing people learning ASL as a second/foreign language (1992: 10). We note that these name signs, by incorporating parameters common to other signs which refer to characteristics of the person, are part of a family of signs. We have found in the various Deaf communities in the Philadelphia and Washington, D.C. areas that this use of lexical families in coining name signs is typical when a Deaf person enters a new Deaf community, and sometimes is found even when a person has been in a community for a long while. We give just three examples in (27), all of which involve Deaf people who have long been Deaf (in contrast to the situations described by Supalla).

(27) a. A woman named Rachael has curly hair and is known for acting silly. When she became a student at Gallaudet, she was given the name sign of HC_R rotating around the ear, like the movement in SILLY.

b. A man named Ron is of Polish ancestry. The old sign for POLAND is HC_A with the thumb brushing up the underside of the nose. When Ron moved to Philadelphia, his sign name became HC_R, with the thumb out and brushing up the underside of the nose.

c. A woman named Donna has a big and frequent smile, and from her elementary days, she has gone by a HC_D made at each corner of her mouth (like the signs for RESTAURANT or CAFETERIA, which are made in the same way but with HC_R and HC_C, respectively). The sign SMILE is two-handed, with a hand starting at each corner of the mouth.

Furthermore, name signs can enter into families with other name signs. Donna of example (c) has a husband named Bob, who is also Deaf. When he married her, he moved and joined her Deaf community, and his name sign became HC_B made at both sides of the mouth, simply because he is her husband. We also know a man named Dennis, whose name sign is a HC_D that starts at the chin and moves down to the top of the chest. He considers his name sign arbitrary. However, his significant other has the initials SC, and when they became a couple, that person's name sign became HC_S starting at the chin and moving down to become HC_C at the top of the chest, simply because of the relationship between the two. The creative potential of lexical families is clearly being exploited here.

Another common situation in which name signs are coined is the introduction of a new television program or a very popular movie. In a Philadelphia area Deaf community near us, the name sign for the old primetime soap opera 'Dynasty' offers a funny and salient example. It begins as a D on the center of the forehead (with the palm oriented toward the forehead), moves straight down to N on the nose, and finally moves straight down to Y on the chin. As Dennis Dillahunt (personal communication, 2000) explained it to us, this name sign is made up of DUMB (at the forehead), NOSY (at the nose), and WRONG (at the chin), which he feels is a good description of the show. The joke works via knowledge of lexical families.

In addition, as Padden (1998: 46) notes, initialized and abbreviated signs often are related in what she calls "semantic fields." Our proposal allows an account of these relationships. Finally, we consider a point about cross-cultural communication raised by Battison & Jordan (1976). This article scrutinizes and debunks glib claims about signers of different signed languages being able to understand one another perfectly. However, they do note that signers of different signed languages are able to communicate with greater ease than speakers of different spoken languages. "The fact that deaf signers can and do communicate despite not sharing the same signed language is interesting, and it bears more investigation" (1976: 64). We tentatively offer the conjecture that the rampant use of lexical families in signed languages plays a role here. Lexical families make it easier for the novice of a signed language to guess accurately at (a portion of) the meaning of an unfamiliar sign provided that the person knows a different sign in the family of which the new sign is a member.

We conclude that the value of ion-morphs in accounting for data in signed languages merits the expense of adding this notion to morphological theory. Once the notion is admitted to the theory, it is then available for the analysis of lexical families in spoken languages.

5.2.2 *The limits on family membership*

In our presentation of data in Section 4, the reader might have wondered what limits the grammar imposes on family membership. For example, should we analyze WEAK (in Figure 21) and GELATIN as part of a nuclear family having a fixed HC, O, and POA, but in which M varies? (The M of GELATIN is one of shaking rather than bending the fingers.) Certainly it is possible to argue that GELATIN shares the sense of 'weak' via metaphor. So then WEAK, WEAK-MINDED, and GELATIN would all be members of an extended family, with only HC and O (toward the POA) fixed. Likewise, is the M in GRANDFATHER and FUTURE (in Figures 22 and 23) to be identified in its sense with the M in ABSURD (Figure 31), where the 'on and on' sense would relate to 'continued nonsense'? Would we be going too far to relate MEAN to MISUNDERSTAND (Figure 32)?

Figure 31. ABSURD

Figure 32. a. MEAN b. MISUNDERSTAND

We could claim that the combination of HC, M, and O means something like 'sense' when combined with these POAs. (But note that this HC, M, and O in neutral space forms the sign SECOND).[19] It is probably going too far to claim that MISUNDERSTAND enters into a family with MEAN and that CARE and CAREFUL are part of it as well (but see Costello 1994). Still, such proposals beg to be considered as we explore principles to identify the bounds on family membership.

19. We note that there are additional slight phonological differences between the two signs in Figure 32. First, the fingertips of both the index and middle finger touch the POA simultaneously before and after wrist rotation in MEAN, but the index fingertip alone touches before rotation and the middle fingertip alone touches after rotation in MISUNDERSTAND. This difference, however, is not distinctive. Rather, the difference in POA (nondominant hand in MEAN vs. forehead in MISUNDERSTAND) leads to the dominant hand comfortably being orthogonal to the POA in MEAN (so both fingertips can touch simultaneously), but being angled upward toward the POA in MISUNDERSTAND (so that only the lower finger — before and after rotation — can comfortably touch the POA). Second, the O in MEAN changes from slightly outward to almost fully inward, but the O in MISUNDERSTAND changes from mostly leftward to mostly rightward. Again, this difference is not distinctive: and, again, it follows from the difference in POA. So the phonology and sense work together to make this look like a potential nuclear family.

Figure 33. a. CARE b. CAREFUL

The same questions arise in discussing lexical families in English. Above, we wondered whether 'probe' might be related to 'proof' and 'prove'. Could 'pinch' perhaps be related to 'punch', where size of the action varies with the vowel quality? Is it possible that the vowel quality (maybe because of its pitch) is iconic to the smallness, harshness, or loudness of a noise in a set like 'bing/bang/bong' (see Sapir 1921)? What about sets of verbs like 'drip, drop, droop, drape'?

Our answer to these questions is forced by our analysis: a family relationship is expressed by the existence of an ion-morph in the lexicon. Clearly, it is difficult to give standards for delimiting a lexical family, just as it is difficult to give standards for delimiting derivational connections, as any introductory text in morphology explains. When we discussed the GRANDFATHER/GRANDMOTHER family, we wondered whether FUTURE might belong to this lexical family. There is a common phonological form among these words, but is there a common meaning? We suggested that this meaning might be glossed as 'on and on', but we are not entirely confident that this is correct. The problem we face here is typical of morphological analysis in general. We cannot open up language users' heads and see whether two lexical items are related in this way or not. Nevertheless, this is not a problem for the theory itself because either the words are related or they are not. If they are related, then they are members of a family.

5.2.3 *Affixation and templatic morphology versus lexical family morphology*

In this section we compare our analysis of lexical families in ASL with affixation and templatic morphology. Classical Arabic verbs are derived by the use of several templates as shown in example (28); from McCarthy's 1981 ex. 13).

(28) a. CVCVC e. CVCVVCVC
b. CVCCVC f. CCVCVC
c. CVVCVC g. CCVCCVC
d. CVCVCCVC

Verbal roots contribute the consonants that are mapped onto these templates. The aspect and grammatical voice (active vs. passive) of the verb determine the vowels. The roots and the vowels do not combine randomly, and that is why templates are needed. The templates stipulate exactly how the consonants and vowels are ordered, and this ordering, together with the meanings of the consonantal root and the vowels, is significant for the meaning of the resulting word. Each consonantal root can be mapped onto a variety of different templates, and each template can have a large class of roots and a smaller class of vowel melodies mapped onto them.

It might be possible to represent the formation of lexical items in ASL, and even in many spoken languages, such as Italian, as involving templates. That is, the procedural device is available. The issue is whether such an analysis would be perspicuous. In Italian, we could use templates to form nouns. For example, a root like amic [amik] 'friend' could be mapped onto a template and a gender/number affix could be mapped onto the same template as shown in example (29).

(29) Root Gender/Number/affix
amic- o(MS)/i(MP)/a(FS)/e(FP)

```
amic-
 | \ \
V C V C V  →  amica
         /
a
```

Templates could likewise be posited for ASL lexical families. In representing the form component of an ASL ion-morph, after all, we have listed the parameters in a consistent order, which looks at least somewhat similar to a template as shown in example (30).

(30) HC M O POA

There are two important reasons not to propose a templatic analysis for Italian nouns and ASL lexical families in contrast to Classical Arabic verbal items, however. First, the template is required for Classical Arabic and not for Italian or ASL, which lend themselves to alternative analyses. Italian looks like a simple case of affixation, although we note that the template in example (29) at least serves the purpose of ordering the affix after the root. If a template is not used, the affix must somehow be marked in the lexicon as a suffix. The ASL representation in (30) does not even fill this function. While (30) looks like a template, appearances are deceptive; formally there is no need to linearly order the parameters since it would not be possible to mistake a HC, for example, with a M. We could as easily have used any of the other twenty-three possible permutations on the order of these four parameters, or simply jumbled them in a pile. In contrast, Classical Arabic templates, which are written in terms of a sequence of n number of Cs and m number of Vs interspersed, impose organization in terms of the temporal (reflected as linear) ordering of consonants and vowels. That is, we cannot map consonantal roots and vowel melodies onto just any linear arrangement of n Cs and m Vs. Instead, the particular arrangement of the Cs and Vs is crucial.

Another difference between the Classical Arabic and the Italian and ASL situations involves productivity across a category. In general, Classical Arabic verb roots combine with any semantically appropriate verbal template. Similarly, verb roots in ASL can be mapped onto a template for continuous aspect (a template that, significantly, does impose order on the elements mapped onto it), so long as the verb root is semantically appropriate (Sandler 1993c). But no similar productivity across a category characterizes the analysis of ASL lexical families. That is, we cannot say, for example, that all noun ion-morphs will designate the same parameter as the variable (the *x*). Quite to the contrary, any of the four parameters can be variable. Furthermore, ion-morphs are highly selective about the domain of the variable parameter. Thus no explanatory value would be gained by imposing a templatic analysis on lexical families. Similarly, nothing is gained by such an analysis for Italian nouns. Indeed, we would have to posit an enormous number of noun templates, since the exact number of Cs and Vs in the template and their order follows from the given root. *Amic-* 'friend' would be mapped onto one template; *considerazion-* 'consideration' would have to be mapped onto another, *can-* 'dog' would have to be mapped onto another, and so forth. Clearly, affixation is a better way of analyzing these cases.

We conclude that a templatic analysis would be inferior to our ion-morph analysis. However, we'd like to point out that ASL is like Classical Arabic in that ion-morphs, like Arabic verb roots, are not well-formed signs/words. In fact, roots in Romance languages also have this characteristic. However, the three languages differ with respect to how minimally formed their lexical items can be. Italian allows a gap only at the right most edge of the root, and the root itself is phonologically complete. Thus, *amic-* is a nominal root meaning 'friend'. But *amic-* is not a well-formed word without the addition of a suffix indicating gender and number (*amico, amica, amici, amiche* are full-fledged words). The incompleteness, then, is at the morphological level. Classical Arabic consonantal verb roots are prosodically incomplete in that they do not include vowels. However, verb roots consist of consonantal segments that are themselves phonologically complete. ASL ion-morphs are phonologically incomplete at the segmental level. That is, ion-morphs cannot be articulated without a value assigned to the variable parameter. In this respect, ASL ion-morphs also differ from the analysis of English phonaesthemes we suggested in Section 5.2.1.

6. Implications

ASL makes use of associations in the lexicon that gather signs together into nuclear and extended families. The members of these families are related neither by derivational nor inflectional processes, but the associations account for the semantic and phonological relatedness of lexical items whose similarities would otherwise have to be treated as accidents. The analysis here offers a model of morphological mechanisms that have not previously been considered formally by linguists so far as we know.[20] Thus this study adds to our knowledge of morphological possibilities in human language.

The next question is why ASL makes such frequent use of lexical families in contrast to their infrequent use by spoken languages. In Fernald & Napoli (1996) we offer an answer that bears in mind the fundamental similarities of all languages, tying together three facts. First, ASL makes frequent use of lexical families, a mechanism that is underexploited by comparison in spoken languages. Second, ASL does not make use of concatenative affixation, whereas many spoken languages do. And, third, ASL attributes semantic content to individual phonological parameters or subparts of parameters in a robust way, whereas spoken languages do not.

In that work we point out research on differences in grammar which may follow from differences in the modality of language (for general discussion see Siple 1978; Bellugi & Studdert-Kennedy 1980; Studdert-Kennedy & Lane 1980; Supalla 1986; Emmorey & Lane 2000).[21] Some of this research has shown that phonological changes of a single parameter or subpart of a parameter in a sign are perceptually quite salient (visually), while phonological changes of a single feature in a word, particularly nonprosodic phonological changes, are perceptually less salient (aurally). The human auditory system has significantly sharper acuity for relative duration and the perception of temporal rate than the visual system (Welch & Warren 1986). Thus the auditory system is perfectly adapted to process morphological distinctions that affect duration and/or temporal rate, which concatenative affixation and prosodic alternations typically do.

In ASL, on the other hand, differences in nonprosodic phonological features can be more easily noticed because of the comparative slowness of the movement of the manual articulators and the robustness and transparency of the manual articulators in three-dimensional space. Furthermore, as Mark Mandel (personal communication, 1999) points out, visual perception and processing have a distinct advantage over aural perception and processing: many of the features of signs are spatially distributed, and

20. Faltz (1999) sketches a model for Navajo morphology that is similar to ours in that it involves the kind of ion-morph (that is, a form, a meaning, and a restriction on when the form can have the stated meaning) that we are employing. The Navajo lexicon differs from ASL, however, in that the relevant lexical entity in Navajo is clearly affixal: the phonological content of a Navajo ion-morph is more fully specified than the phonological content of an ASL ion-morph, and Navajo ion-morphs unify with morphemes that clearly contain roots.

21. Evidence that signed languages are produced by linguistic mechanisms rather than gestures comes from studies on language pathologies (Bellugi, Poizner, & Klima 1989; Damasio et al. 1986; Poizner & Kegl 1992; Poizner, Klima, & Bellugi 1987), from studies on language acquisition (Masataka 1996 and references cited there), and from studies of language errors (Fischer 1979). See also Bellugi & Fischer (1972) for general remarks.

our visual perceptors are spatially distributed to take advantage of this fact (see discussion in Siple 1978). Indeed, the human visual system has sharper spatial acuity than the auditory system (Welch & Warren 1986). We can see, for example, the HC of the dominant hand and its spatial relationship to the nondominant hand, generally with no interference between them, because the relevant data impinge on different parts of our retinas and can be processed separately into the visual cortex. In contrast, all the data in a speech signal come through a single channel (or two, to the extent that binaural hearing can help), and must be decoded through much potential mutual interference (Anderson 1993). Thus, the visual channel of human sensory ability has a larger bandwidth than the auditory channel (Meier 1993 for discussion). Given these differences, it is feasible for signed languages to exploit such alternations, whereas it is much less feasible for spoken languages.

Signed languages are prone to exploit these alternations, however, for reasons that go beyond feasibility. One of them is efficiency. The manual apparatus moves slowly (in comparison to the articulatory apparatus of spoken languages; see Mandel 1979; Wilbur 1999a). Spoken words in English can be produced at about twice the rate of signs in ASL (Bellugi & Fischer 1972; Grosjean 1977). Yet propositions in both languages are produced at the same rate (Bellugi & Fischer 1972) and ASL manages to use fewer signs than English uses words to express a given proposition without sacrificing information. In fact, when Bellugi & Fischer (1972) compared propositions expressed in Pidgin Signed English (PSE) to the same ones expressed in ASL, they found that PSE takes on the average 2.8 seconds to express a proposition, while ASL takes on average 1.5 seconds (see similar comparisons in Wilbur & Petersen 1998). Supalla (1991) also found that deaf children exposed to Signed Exact English (SEE) modify it in a variety of ways which appear consistent with the proposal of a somewhat steady ratio of duration-of-expression to information-conveyed-by-expression (Bellugi 1980; Klima, Bellugi, Fischer & Newkirk 1979). Certainly a way to pack information into a single sign without increasing its duration is by exploiting alternations of phonological features. Thus if an alternation in a single parameter can do whatever morphological job needs to be done, such a mechanism should be favored over concatenative affixation, which calls for an entire set of parameters (HC, M, O, POA) to be added to a sign.

The issue is not just one of avoiding extra duration. In fact, signed languages make use of various morphological mechanisms that can increase the duration of a sign, such as reduplication and alternation of prosodic phonological parameters (Wilbur & Nolen 1986). Furthermore, in conversation signers often increase the duration of a sign in a number of ways. For one, ASL employs phrase-final lengthening, similarly to the phenomenon in spoken languages (Coulter 1993b; Wilbur 1999a, b). Additionally, signers can use multiple reduplication for emphasis and they can draw out the movement of a sign to give the information that the action denoted by the sign was slow.

Furthermore, the duration of individual signs — both of different signs and of different tokens of the same sign — varies significantly (Wilbur & Nolen 1986). Yet this variation creates no problem in communication. In particular, there is no evidence that ASL signers try to avoid using durationally longer signs.

The above phenomena, however, differ from concatenative affixation crucially, in that they do not call for a whole new set of parameters. Instead, reduplication repeats an already given set of parameters. The alternation of prosodic phonological parameters (which we saw in predicate aspect, for example, and which one might see when a signer wants to indicate that an action happened slowly) alters the M parameter only. In sum, ASL favors mechanisms of morphology that introduce few new phonological parameters over mechanisms that introduce whole sets of new parameters.

Now why should ASL so frequently allow individual phonological parameters and sometimes even subparts of parameters to bear meaning? The answer is that ASL can do it feasibly (as we argued above) and gets great rewards for doing so. With respect to first language learning, simple phonological variations on already existing signs facilitate both acquisition and usage (Bellugi 1980). Second, as communicators, we make connections between the various meaning-bearing units in our language. In ASL, the cognitive connections between signs like BIRD and DUCK, for example, are made via both the phonology and the semantics. So lexical families enhance our access to the richness of the lexicon. Third, given the fact that ASL is pressed for time (in light of the slowness of the manual articulators), ASL favors making full use of the available resources of morphology.

The next question that should be asked is why spoken languages do not exploit lexical families to a greater degree. The question itself may well be based on a misperception about spoken language, and this is an area we plan to study. At this point we suspect that spoken languages do, in fact, make extensive use of lexical families, but typically only at points in their history when they need to coin a large number of lexical items.

Consider the hypothetical situation of a new language starting from scratch. Exploitation of lexical families allows rapid expansion of the lexicon. As time passes, the various members of a lexical family change their meanings in ways unrelated to one another, just as over time iconicity in language gives way to arbitrariness (Frishberg 1975; Hock 1991:287–301). Over time, many phonological changes take place. After enough time, lexical families become harder to recognize. Given that ASL is a relatively young language (Sacks 1989), the great number of lexical families in ASL is not surprising.

We are not predicting, however, that lexical families will become unrecognizable in ASL. They may very well become less pervasive in the lexicon. But it is quite possible that ASL could maintain recognizable families for a long time. Productivity of lexical families should naturally decrease in spoken languages because of grammatical expense (as we have discussed). In contrast, productivity of lexical families in signed languages could well persist as a result of feasibility. If this suggestion is on the right track, we could expect that made-up languages (such as the languages used by twins studied in Keenan 1974, 1975a, 1975b, 1976; Keenan & Klein 1975) would be riddled with lexical families.

Acknowledgments

We are deeply indebted to Mark Mandel and Tom Purnell, whose comments on an earlier version of this paper led to extensive revision. For comments on an even earlier version of this paper, we thank Diane Brentari, Susan Fischer, and Stephanie Strassel. We also thank Stephanie Strassel for help preparing the figures on an earlier draft, and we thank Eva Furrow and Jane Ng for helping prepare the final figures. We thank Bruce Hayes for discussing the distinction between prosodic and nonprosodic features with us. We thank Nancy Frishberg and Carol Padden for talking with us about many different issues. We thank Mark Steedman for discussing possible models for lexical families. We thank Lynn Messing for acting as both language expert and linguistic theory critic. We thank Dennis Dillahunt for extensive and enlightening discussions about name signs. For help in preparation of the final draft, we thank Eric Raimy. We thank the people who attended the TriCollege Cognitive Science Colloquium at Swarthmore College in November, 1996, for suggestions and criticisms. We thank the people who attended the International Linguistic Association meeting in New York on February 8, 1997, especially the participants from the Lexington School for the Deaf, who offered data and relevant discussion, particularly on initialized signs, and those who attended the Delaware Linguistics Colloquium on November 21, 1997, especially Bill Idsardi and Irene Vogel. And, finally, we thank our anonymous reviewers, who pointed the way with comments on every aspect of this work, and Ronnie Wilbur, for her clear, concise, and kind editorial guidance.

Often our readers/audience gave us similar criticisms and suggestions, in which case we did not attribute the change or argument in the text to any particular person. We are, however, grateful to all our readers/audience.

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