American Sign Language and Phonological Universals

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Figure 0

BUG, insect
EYES
HARD
KID
MISTAKE, error
NOSE
STRANGE, odd, peculiar, weird

1All illustrations are taken from Humphries, Padden, and O'Rourke 1994, illustrated by Frank A. Paul, except where indicated otherwise.
Introduction

Only since 1960, when William Stokoe published his monograph *Sign Language Structure: an Outline of the Visual Communication Systems of the American Deaf*, have sign languages of the Deaf been the subject of serious linguistic study. Previous to that, sign languages were thought to be either crude gestural systems or spoken language “made visible on the hands” (Humphries & Padden 1994, 7). Since then, numerous works have been written that disprove these misconceptions. Sign languages are natural languages in their own right, having complex grammatical systems, strict structural constraints, and highly developed semantics that originate in the same part of the brain from which spoken language stems (see Klima & Bellugi 1979, Baker & Cokely 1980, Emmorey 1995).

Work in sign language linguistics has proven that many characteristics of language previously thought universal are in fact modality-specific. For example, Saussure’s claim that the forms of words bear no relation to their referents (Fromkin & Rodman 1993) does not hold true for many words in sign languages. For example, the structure of signs such as EYES & NOSE, while not transparent to those unfamiliar with ASL, has a definite

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2Uppercase *Deaf* is used to refer to people who have “the audiological condition of not hearing” and use a sign language (ASL, Chinese Sign Language, Auslan/Australian Sign Language, etc.) as their primary means of communication (Padden & Humphries 1988, 2). I have used the term “sign languages of the Deaf” here because the languages have primarily developed through usage by Deaf people—although some hearing people have also used these languages as a first or second language—and also to distinguish them from sign communication systems such as Plains Indian Sign and monastic signing systems that are often referred to as “sign languages” but in fact are not languages at all. (See Davis and Supalla 1995)

3By convention, ASL signs are represented by an English gloss in capital letters. A single ASL sign can be represented by a single capitalized English word or by a series of two or more capitalized English words strung together by hyphens. Two or more glosses joined together by ‘+’ indicates an ASL compound. Signs from other sign languages are represented by an English gloss in capital letters followed by the name of the language in subscript. Grammatical category, when not clear from the gloss, may also be given in brackets subscript. An illustration of each sign will be provided before the first section in which it appears. Where an illustration is unavailable, a full description will be given.
relationship to the signs' meaning. (This is certainly not true of all signed words, e.g., BUG, KID, STRANGE, MISTAKE, HARD.) His claim, once thought to be true of all languages, is not; his perspective was limited by the languages (all spoken) that he studied. The failure of spoken language word structure to bear this kind of relationship with its referent is due to modality, not a universal ban on iconicity in languages.

Similarly, the recent work in sign language phonology provides an interesting testing ground for modern phonological theory. Are concepts that have been presumed to be universal (e.g., the division of the articulatory stream into segments and prosodic units) truly universal, or are they rather the modality-specific expression of an underlying organizational mechanism?

In Section 1, I will discuss previous attempts by sign linguists to discover commonalities and differences between the phonological structures of spoken and signed languages. I will argue that some comparisons made between spoken and signed languages, though appearing to account for the sign language data while proposing universal structural principles, are in fact only specious analogies; other comparisons have enabled linguists to come to a closer understanding of the structure of signed languages and indeed of all languages.

In Section 2, I will give background on Optimality Theory, a theory of phonology that strives to demonstrate that phonological processes in all spoken languages are the result of a closed set of universal constraints.

In Section 3, I will examine phonological rules proposed by other sign linguists and reinterpret them under an Optimality framework. My goal is to examine American Sign Language (ASL), and determine which of the

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Please note that the names of phonological constraints will also be written in all capital letters by convention. The status of a capitalized word as gloss or constraint should be clear from context.
"universal" constraints are present in the ASL grammar and which, if any, are absent; and which phonological phenomena appear to be explained only by the presence of language- and/or modality-specific constraints. Clearly, such a goal is of scope that goes well beyond an undergraduate thesis. Thus, I will focus only on a few constraints affecting word formation. I hope here to show a method for beginning the task of analyzing ASL within Optimality Theory and to offer preliminary answers.
BULLSHIT: One-handed sign. B-hand contacts chin, moves toward “a location about six inches out and slightly below the chin....orientation of the hand remains constant, with the palm toward the face and the wrist toward the ground...ends as an ‘S’. “ (Liddell & Johnson 1989, 205)

GO-UP-IN-FLAMES: two-handed symmetrical sign in neutral space (in front of torso). Hands do not contact the body. 5-hands oriented toward the body begin at mid-torso level, 6-12 inches apart. Move upwards toward chest level; fingers wiggle during the upward movement, stop wiggling when upward movement ceases. (Perlmutter 1992)

KING is taken from Riekehof 1989.
Section 1: The search for universals

1.1: Early sign language phonological theory

Since 1960, two schools of thought have developed as to whether a phonemic analysis of signed languages should divide a word into several linear components (that is, segments), as is done in spoken languages, or into several simultaneous components. While both simultaneous and sequential phenomena occur in any language, the concern here is twofold: whether units that occur simultaneously with other units or units that occur in a sequenced order with respect to other units are more phonetically significant, and whether phonological phenomena occur simultaneously or sequentially.

It may come as a surprise to the linguist of spoken languages that the earlier work in sign phonetics and phonology assumed a structure of signs in which the minimal discrete components of a sign were thought to occur simultaneously rather than sequentially. For example, Friedman (1976) assumed that “there is no linear sequence” in sign language. This assumption was motivated by observations as to how minimal pairs in ASL are formed.

According to this view, signs are made up of four simultaneously occurring components, or primes (Klima and Bellugi 1979): these primes

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4 e.g., Chinese is able to form minimal pairs through tone, which occurs simultaneously with the syllable nucleus (méi ‘not, don’t’ vs. méi ‘sister’), but can also form minimal pairs through a difference in segment (du [stomach, abdomen] vs. bu [no, not]). Examples of simultaneous and sequential distinctions in ASL will be given below.

5 e.g. What is important in forming a minimal pair? A changed segment or a changed "simultaneous unit"?

6 Examples of phonemes occurring simultaneously within a sign:
A given hand configuration can be maintained over the course of a movement (as in NAME [noun] and PAY), as can a non-manual lexical or syntactic marker (for example, the lexical non-manual in NOT-YET—the tongue protrudes from between the lips—and the syntactic non-manuals, such as eyebrow raising and drawing back of the chin, that serve to indicate the grammatical function of a sign or group of signs)
include location, movement (including not only movement that involves change of location—path movement—but also secondary movements such as finger-wiggling), handshape and orientation. Minimal pairs can be formed by altering only one prime in a sign, just as minimal pairs in spoken languages can be formed by altering only one segment. Thus we get SUMMER (brow) and UGLY (mid-face) when we alter location; PAY (>) and WHAT (↑) when we alter direction of path movement; NAME[noun] (<) and CHAIR (V) when we alter palm orientation; TREE (twisting) and NOON (no secondary movement) when we change the specification for secondary movement; and LIKE (8) and WHITE (5) when we alter handshape.

But many linguists who study ASL have observed that sequential phenomena also occur within signs. These phenomena include handshape changes (e.g. UNDERSTAND, which begins with an S-hand and ends with a G-hand, and GUESS, which begins with a C-hand and ends with an S); hand relocation (e.g. KING, which begins on the contralateral shoulder and ends on the ipsilateral hip); path movements (where the hand moves through space, e.g. GO), and hand-internal movements (e.g. GO-UP-IN-FLAMES, which begins with no movement, continues with movement, and ends with no movement). (Liddell & Johnson 1989, Perlmutter 1992) Liddell and Johnson claim that minimal pairs can be formed in ASL by changing either the first or the last part of the sign. They give only one example of this type of pair: THANK-YOU vs. BULLSHIT, where both signs start with the B hand at the

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7 To anyone with even a rudimentary acquaintance with the ASL lexicon, the placement of "movement" and "location" in the category of "simultaneously occurring components" may seem peculiar; the reasoning for this placement, however, will become apparent below when I discuss Wilbur’s treatment of most movements as side-effects of location, orientation, and handshape changes; and when I discuss Brentari and Goldsmith’s claim that change in handshape is equally as important as path movement in defining the ASL syllable.

8E.g. the English minimal pairs sit and fit, hot and rot.

9Explanations of the symbols appearing in parentheses can be found in Appendices 1 & 2.
chin. The hand moves in a straight line down and forward, and the palm maintains a constant orientation toward the chin; the only difference is that THANK-YOU maintains constant handshape, while the handshape of BULLSHIT changes to S (Liddell & Johnson 1989, 205-206).

Linguists who argue for simultaneous structure have been able to explain the above phenomena in terms of simultaneity. For example, the difference between THANK-YOU and BULLSHIT would be a difference in handshape specification, where THANK-YOU would be underlyingly specified for only one handshape, while BULLSHIT would be underlyingly specified for one handshape to which a closing feature is attached. (See discussion of handshape change in Section 1.4.1 below.) These explanations have been found by many to be unsatisfactory: if linear phenomena occur in signed languages, shouldn't they be accounted for in the representation?
Figure 1.2

COLOR

FIND, discover

GOOD

IDEA
1.2: Overview of the segmental approach

The first major segmental theory of signed languages was developed by Liddell and Johnson (1989); Sandler and Perlmutter followed with similar theories that modified Liddell and Johnson's claims.

These three systems are similar in that they divide segments into two major classes. One of these classes is path movement, or M; the other class varies with each theory: in Liddell and Johnson, it is hold, or H; in Sandler, it is location, or L; and in Perlmutter it is place, or P. All of these theories work within the framework of autosegmental phonology, and posit that sign language movements and locations (holds, positions) exist on the same tier, just as consonants and vowels do in spoken languages.

H, L, and P are all quite similar, in that they refer to the endpoint(s) of a path movement, but they should not be confused with each other.

In Liddell and Johnson's proposal, Hs are specified for location, and Ms for the shape of path movement (arching, straight, or angled). Features like handshape can also attach to each H in a word and spread to the neighboring M. In that Ms are more sonorous than Hs (Perlmutter 1992) one can say that vowels are analogous to Ms and consonants to Hs.

Every sign can be divided into segments. For example, FIND would have an H-M-H sequence, since it begins at one location and has a movement toward another location, where it ends. COLOR would simply have one segment H, since it has no path movement (L & J 1989, 215).10

L & J propose that H is a unit which can actually be measured in time: "Holds are defined as periods of time during which all aspects of the articulation bundle are in a steady state" (1989, 210). Again, this is similar to

10Secondary movement (finger-wiggling) occurs in COLOR, but has no effect on the segmental structure of the word.
the case of spoken languages, where each segment has a temporal value (i.e.,
is produced over a measurable period of time). The weakness in this
definition is that it is relatively rare for “aspects of the articulation bundle” to be “in a steady state”; they are not held in one location for a measurable length of time.

Liddell & Johnson, as a result, often delete Hs, reassociating H features to the surrounding movements. For example, the underlying form of GOOD which they posit has the segmental sequence HMH, as does the underlying form of IDEA. When the two signs are signed in sequence, however, as in GOOD IDEA, an M is inserted between the two Hs. Thus, the segmental sequence of the two words together becomes $H_1M_1H_2(M)H_3M_2H_4$. But neither $H_2$ nor $H_3$ is held for a perceptible amount of time. Liddell and Johnson’s claim is that when an H is surrounded by two Ms, H-deletion takes place, and that the features (handshape, etc.) assigned to the Hs are reassigned to the surrounding Ms, so that the H-M sequence of GOOD IDEA would be as follows: HMMMM.

Because visible holding rarely takes place in signed discourse, and because Liddell & Johnson’s proposed cycles of epenthesis and deletion are somewhat cumbersome, Sandler argues against the idea of H and posits the segment-type Location (L) in its place (Corina & Sandler 1993). Sandler’s Location is similar to H in that the place features can associate to both. But Sandler’s L has no temporal value: “holds’ are not underlying, but are inserted, either as a result of morphological rules or phrasal prosody” (Corina and Sandler 1993, 174). Thus, Ls never need be deleted simply because they are not held in place, and their features need not be reassigned. Sandler accounts for cases in which “all aspects of the articulation bundle are in a steady state” by positing a geminate L, where the timing of the location
spreads to two positions. The weakness of this proposal is that a feature not attached to one segment cannot spread or reassociate to another segment (see Goldsmith 1990).

1.2.1: Sonority and segmentation

Perlmutter's P is not significantly different from Sandler's location (Perlmutter 1992) and so will not be discussed further here. What is different about Perlmutter's analysis is his focus on its ramifications for syllable structure. He assumes that P and M work together to form syllables in the same way that the C and V of spoken languages do. The inventory of syllables is as follows: M, PM, MP, PMP, and P (Perlmutter 1992). These combinations, translated into C and V terms, all occur in spoken languages.

Syllables such as PPMP and PMPP (with spoken language 'equivalents' CCVC and CVCC), on the other hand, can occur in no signed language because it is impossible to articulate two separate locations without also articulating a movement in between those locations. Such combinations are often undesirable in spoken languages and oftentimes forbidden; it is nonetheless physically possible to articulate several consonants successively without inserting vowels. The distaste for consonant clusters then, is caused by phonological constraints; where the ban on P-clusters in ASL is the result of physical fact. Clearly, then, caution should be taken before stating that ASL

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11 I use the word syllable here to refer to the "prosodic unit in ASL, distinct from the morpheme and the word" (Goldsmith 1990, 337). Whether or not these prosodic units should be considered syllables remains open to debate; I adopt the term "syllable" over "prosodic unit" not because it is more accurate (which it is not), but because it is less ambiguous.

12 My examples are all from English:

V: [a] of otter [a.Dr]
CV: the
VC: on, it
CVC: cut
C: an [n]
syllable structure is so transparently analogous to spoken language syllable structure, or that P and C perform similar roles in the formation of syllables.

One useful aspect of the segmental analysis is that, by the nature of its C/V analogies, it reflects assumptions by the linear and simultaneous camps alike (see e.g. Brentari 1994) about the difference in sonority between movements and locations or holds: “The way Ms and Ps are organized into syllables can be accounted for by positing a sign language analogue of the sonority hierarchy in which Ms are more sonorous than Ps. Sonority peaks are then syllable nuclei” (Perlmutter 1992).

The sonority of a given sound has to do with how salient it is; in lay terms, "the farther away a sound can be heard clearly, the more sonorous it is" (Brentari 1995). Hence, the further away a movement can be seen, the more sonorous it is. Thus, the sonority hierarchy of signed languages is as follows (Brentari 1995):

\[ \Delta \text{shoulder} > \Delta \text{elbow} > \Delta \text{wrist} > \Delta \text{base joint of finger} > \Delta \text{non-base joints} \]

That is, a movement made from the shoulder is more sonorous than the same type of movement made from the elbow or wrist.

We can further distinguish between the sonority levels of different types of movements made at different or identical locations:

\[ \text{path movement} > \text{full hs} \Delta/\text{non-manual} \Delta > \text{orientation} \Delta > \text{point of articulation} \Delta > \text{secondary movement} > \text{partial hs} \Delta [> \text{no movement}] \] (Brentari 1994, 2)

Each of these except the last may, by itself, serve as the nucleus of an ASL syllable (Brentari 1994).
STONE-DEAF: "made at the ear with a closing-hand movement" (Wilbur 1990, 89)

13HAPPEN and REBEL are taken from Sternberg 1981.
1.3: Criticisms of the segmental approach

Although the work on sonority and syllable structure done in segmental analyses is important, it does not in itself justify the segmental approach. Linguists who assume a simultaneous analysis (e.g., Brentari, Friedman, Edmondson) have also treated the question of sonority.

It is unarguable that linear phenomena occur in signed languages, and Liddell & Johnson, Sandler, and Perlmutter’s analyses are clearly motivated by that fact. But whether linearity should lead to segmentation is another issue. Wilbur argues:

There is no question that the signing stream can be broken into movements and holds, and that doing so is a relatively easy matter...movements and holds...can provide a valuable starting point for the phonetic and physical analysis of the signing stream. My argument, in agreement with Sandler’s and Edmondson’s, is that movements and holds are not significant phonological units. (Wilbur 1990, 92)

 Movements and holds, Wilbur argues, are not separate, distinct units:

One remaining problem ... is the claim that location and movement constitute two segmental categories on the same linguistic tier. Consider a sign like STONE-DEAF, which is made at the ear with a closing-hand movement. It is difficult to see how an argument could be made that this sign should be represented as LM rather than ML, since there is no temporal sequence to the location and movement. The movement and the location co-occur, suggesting that they should be represented simultaneously rather than sequentially. (Wilbur 1990, 89)

 It can be shown that even in an autosegmental framework, movement and location do not always occur on the same tier. Sometimes, as in the sign UNDERSTAND, movement seems to occur on the handshape tier or as in REBEL on the orientation tier. Movement seems to be a peculiar feature which can migrate from tier to tier; in fact, movement, as a feature, never occurs on any tier:
The problem lies with the conception of an M-tier and with the notion of movement as a natural category. The movement in STONE-DEAF is a change of handshape. The movement in a sign like GIVE is a change of location. The movement in a sign like CAN (the modal) is a change in orientation of the palm with pivot at the wrist. The movement in a sign like HAPPEN is a change in orientation of the palm with pivot at the elbow. I propose that there are three basic types of movement: change of handshape, change of location, and change of orientation. From this, I argue that there are three tiers involved here: handshape (C), Location (L), and orientation (O).
(Wilbur 1990, 90)

While Liddell and Johnson, Sandler, and Perlmutter's segmental analyses of signed languages seem similar to the segmental analyses of spoken languages in that they are both motivated by linear phenomena, they are only superficially so. M is like V in that they can both function as syllable peaks; H is like C in that it is less sonorous than M (V) and in that it can only occur on a syllable peak if nothing more sonorous is present in the syllable (Perlmutter 1992); but M and H do not form two distinct sub-classes of one class as V and C do. M, unlike V, is not a segment type; it is, as we have seen in Wilbur's arguments, the side-effect of feature changes on many different levels. Thus, the M/V H/C analogy fails.

Also problematic in Liddell & Johnson's analysis is their redefinition of sign language minimal pairs. L & J argue that the classical definition of sign language minimal pairs, discussed in Section 1.1, is flawed. They claim that palm orientation, handshape, and local movement, because they occur simultaneously with location and/or movement, are features analogous to the voicing and aspiration of a spoken segment; they are not analogous to segments themselves. Thus, the difference between SUMMER and UGLY (see Figure) is not like the difference between pat and bat; it's like the difference between [p] and [b]:

It has become traditional in treatments of ASL structure to illustrate 'minimal pairs' of signs as a demonstration of phonological contrast. However, because the simultaneous model of sign structure dictates that signs are composed of a single, simultaneous bundle
of gesture features, such pairs of signs are able to demonstrate only simultaneous contrast of the sort found within segments in spoken languages. Thus, staying for the moment with the notion that signs are simultaneous, most 'minimal pairs' of signs identified in the literature on ASL exhibit contrasts analogous to the differences between [p], [t], and [b]. They are distinctions of one feature within a single, co-occurrent bundle of features.

By contrast, in spoken language analysis, the notion of 'minimal pair' is usually considered to be two words, contrastive in meaning, which are identical in all segments except one, in which they differ by only one feature. The kinds of ASL sequential details we have identified ... provide this kind of evidence for sequential contrast (204-205).

But Liddell & Johnson's comparison of the distinction between words like SUMMER and UGLY to that between the segments [b] and [p] is wrong-headed. SUMMER and UGLY have different specifications for the feature [location] in the way that [p] and [b] have different specifications for the feature [voice]; but the feature difference in SUMMER and UGLY causes a change in meaning, whereas it causes no change in meaning in the case of the segments since no meaning is associated with either of them in the first place.

Furthermore, they base their definition of minimal pair on data that excludes much of what is known about spoken languages. They assume that, because "the notion of 'minimal pair' has typically been used to demonstrate sequential contrast" [emphasis added], it cannot be used to demonstrate simultaneous contrast. But a spoken-language minimal set, as defined by Ladefoged, one of the most respected phoneticians of our time, is not defined in terms of sequentiality or simultaneity:

A set of words, each of which differs from all the others by only one sound, is called a minimal set. (1993, 26)

When we examine further Liddell & Johnson's "notion of 'minimal pair,'" we find that it has serious ramifications for spoken languages as well as sign languages. For example, because tone occurs simultaneously with
spoken-language segments, difference in tone would not be enough to form minimal pairs. Hence, Mandarin *méi* (“not, don’t”) and *mèi* (“sister”), having identical segments, would not form a minimal pair. Liddell & Johnson’s “notion of ‘minimal pair’” clearly contradicts the data and therefore should not be used as a motivating factor in any theory of phonology.

A linear analysis imposes superficial aspects of spoken language structure on sign languages, rather than looking for the deeper similarities between the two modalities:

The extensive analogizing that goes on when linguists focus their intellects on signed languages relates primarily to conclusions. Instead of independently establishing the validity of a theoretical argument, and its conclusion, in the new domain the conclusion is simply adopted ... Thus we find CV phonology is ‘borrowed’ without much sensitivity to the theoretical background and the continuing debate. CV phonology is not ‘finished’ or ‘complete’ so thoughtless borrowing is unwise.

[Also,] insufficient attention is paid to the ever-present possibility that a phenomenon in one modality may reflect an underlying process which produces a superficially different phenomenon in the other modality...Segmentation is a speech-based, theory-dependent abstraction away from the data. Consequently, analogies should not be drawn in terms of segments but in terms of underlying behavior. (Edmondson 1990)

One issue related to segmentation that has not been satisfactorily addressed by the segmental camp is that of syllable-internal organization (e.g., what part of the syllable can contain what kind of information and why?). For example, the most complex spoken language syllable is made of segments that can be divided up into three groups: those that comprise the onset, those that comprise the nucleus, and those that comprise the coda of the syllable. Onsets, which occur at the beginning of the syllable, and codas, which occur at the end, may both contain consonant(s). However, the type and even number of consonants which may occur in the coda is usually more limited than the type and number of consonants that may occur in the onset. In such
languages, the onset would be considered a primary licenser; the coda, a secondary licenser, where a "licenser is endowed by the grammar of the language with the ability to license a set of phonological features" (Goldsmith 1990).

For example, the language Lardil has an inventory of seventeen consonants, but only nine of these—the coronals—may occur in coda position (Prince & Smolensky, ms. from Kenneth Hale's "Deep-surface canonical disparities in relation to analysis and change: an Australian example"). In many other languages, the coda can contain only a sonorant or [s], with the consonants being licensed in the case of gemination.

Not all languages specify a smaller inventory of possibilities for the coda than for the onset (e.g. English), but most specify a different inventory. For example, English allows [h] in the onset but not in the coda; it allows [ts], [ks], and [N] in the coda, but not in the onset.

This kind of difference between the Pl and P2 of P1MP2 is not known to occur in ASL; there have been no studies indicating that the inventory of locations found at the ends of syllables is different from the inventory of locations found at the beginnings of syllables. Any comparison of P1 to onset and P2 to coda makes claims beyond what is empirically known about ASL and other sign languages.

Goldsmith (1990) agrees that the segmental definition of syllable is problematic and argues that "prosodic units" in ASL should not be viewed as units that can be divided into segments, but rather into primes ("co-occurrence statements"): The issue has been raised in recent work on American Sign Language (ASL) ... as to what the syllable is in ASL.... That there is something that should be called a syllable in ASL is far from clear to me, for the reason alluded to in the text: one crucial fact about spoken language, without which the notion of syllable makes no sense, is the pattern of
alternation at the lowest physical level. (In the case of spoken languages, it is essentially alternation of consonant and vowel.) The only nominees for this possibility are Movement and Hold (cf., e.g., Liddell and Johnson 1985), but there is far less prima facie evidence of such alternation at the surface in ASL than is found in spoken language when considering the C/V patterns. It may be, however, that there is a prosodic unit in ASL, distinct from the morpheme and the word, which serves as the formal domain of a single set of co-occurrence statements ... this may be the syllable in ASL. (Goldsmith 1990, 337)

In searching for linguistic universals, it is of crucial importance that we not assume that generalizations about spoken language can simply be imposed onto sign languages. Rather, we must look at sign languages on their own terms as much as possible; only when we do that will we be able to make well-founded conclusions about linguistic universality.
ABORTION: repeated movement toward a point (Brentari and Goldsmith 1993)

CURRICULUM

'blind prime'

ESTABLISH, set up, found

FINALLY, succeed

AD

HEAVY

LEAD, guide

LIBRARY

OW, demonstrate,strate

SOCIAL WORK

(Gallaudet University Press)

THROW

14THROW is taken from Sternberg 1981; CURRICULUM from Riekehof 1987. I should note that Riekehof 1987 is not looked well upon by the ASL community; it presents itself as a language textbook although it includes virtually no grammar and includes many Sign English words (words that are not native to ASL but rather invented by educators so that signing can be made more English-like) in addition to ASL signs. I have used Riekehof 1987 as a source for illustrations only when I could not find illustrations elsewhere; all signs I have used from this source are ASL, except for the two which appear in Section 3.2.2.
1.4: Non-segmental approaches to sign language syllable structure

1.4.1: Syllable size

Early definitions of the signed syllable assume location as the nucleus of the syllable. Friedman proposes that a sign with two places of articulation is disyllabic: "Some monomorphemic signs have two places of articulation; these signs might be thought of as bisyllabic. These signs always maintain the same hand configuration in both places of articulation. Examples include HEAD...and KING" (1976). Such definitions still hold water for many sign language phonologists, such as Edmondson, who has proposed "an analogy between activity restraint and sonority" (1990, 73).

More common today is the notion that movement is the optimal candidate for serving as the nucleus of a syllable. According to Brentari and Goldsmith (1994), we can tell a syllable by two characteristics: one set of selected fingers maintained throughout, and one distinct path movement. Brentari and Goldsmith do not make clear exactly what they mean by "one distinct path movement," though one assumes that they mean "a movement along one plane in one direction." However, they claim that the sign ABORTION, consists of at least three movements total, is disyllabic. They are only counting the two movements toward the point of articulation and not the movement in the middle of the word that connects them (26). But why does that middle movement not form its own syllable? Brentari and

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15Brentari and Goldsmith do not discuss what is meant by "select," but after considering their data and the work of other sign language phonologists (particularly Battison 1978), it is possible to infer what they mean. "Select" denotes the number of fingers that are not folded into [or toward, if into is not physically possible] the palm of the hand. So, for example, W would have three active fingers; V, two; and B, four. Handshapes in which all fingers are folded into the palm—A and S—are treated as if all fingers are select.

16They describe the sign as having two movements toward the point of articulation, so there must be a movement away from the point of articulation after the first movement, as in NAME[noun].
Goldsmith do not explain, though the issue of prominence may come into
play here. (I will return to the discussion of prominence below).

What is clear is that words such as THROW, which has one set of
selected fingers (thumb and four fingers) and one path movement, would be
monosyllabic; CURRICULUM, with one movement and two sets of selected
fingers (thumb and four fingers; followed by index, middle, and ring fingers),
would be disyllabic; and ESTABLISH, with one set of select fingers and two
path movements (circular and straight) would be disyllabic (26). Brentari and
Goldsmith's analysis of THROW and ESTABLISH results in the same
judgment on number of syllables that Perlmutter's analysis would give. But
the analysis of CURRICULUM differs from Perlmutter; following
Perlmutter's logic, CURRICULUM should be monosyllabic, since it contains a
PMP sequence. Brentari and Goldsmith conclude that CURRICULUM is
disyllabic because they are taking into account not only the linear sequence of
locations and movements, but also what primes (in this case, handshape) co­
occur with that sequence.

Their analysis seems influenced by previous work that looked at the
number and types of handshapes that can occur within a native,
monomorphemic sign. Battison (1978) claims: "Some signs may require that
one or both hands change handshape while making a sign; these signs are
limited to no more than two such different handshapes" (49). In addition,
each of these two handshapes must share the set of select fingers with the
other handshape. According to Friedman, "the sign must either begin or end
in a neutral shape ... I would prefer to analyze signs of this type as having a
single handshape and an opening or closing action" (Friedman 1976, 25). In
signs involving one (the index), four (all fingers but thumb) or five fingers,
this opening/closing action entails the folding or straightening out of the
joints; in signs involving two fingers (the index and middle), the opening and closing action can either be of the type already mentioned or between the two fingers. So, for example, the sequence V->U is possible, but not the sequence I->G. The handshape changes that involve contrasts between closed and open handshapes follow: B"->B17; B->B"; V->V"; 5, C->S; V"->V; X->G; O, S, A->5; H->Ö18 (Battison 1978, 52).

While I am tempted by Brentari and Goldsmith’s claim that a change in the number of select fingers constitutes a new syllable even when direction of path movement has not been changed, I am not convinced that such a change does constitute a new syllable.

It seems that the motivating factor for this claim is that handshape changes in most monomorphemic, native ASL signs involve a single set of select fingers (see above); it would be nice if we could explain this fact by saying that there is indeed a select finger constraint at work in the language, one that forbids the set of select fingers from changing within the syllable or perhaps the word.

But is there such a constraint? Brentari & Goldsmith claim that there is, but even some monomorphemic native ASL signs involve changes of the select set of fingers, e.g., WHY (5->Y). WHY should then be considered disyllabic under Brentari & Goldsmith’s definition. Is it? They do not say.

The methodology for determining what a spoken language syllable is has been quite different from that used by Brentari & Goldsmith. According to Ladefoged, “there is no agreed phonetic definition of the syllable“:

If I ask you how many syllables there are in ‘minimization’ or ‘suprasegmental,’ you can easily count them and tell me. Nevertheless, it is curiously difficult to state an

17 " indicates folding or bending of fingers
18 Ö indicates O articulated with thumb, index and middle fingers. See Appendix 2 for illustrations.
objective phonetic procedure for locating the number of syllables in a word or a phrase in any language. (1993, 243)

How, then, do we know what a syllable is? Phoneticians rely on native speaker judgments, sonority and prominence levels, and articulatory phenomena:

We can say that there are two types of theories attempting to define syllables. First, there are those in which the definitions are in terms of properties of sounds, such as sonority (acoustic energy) or prominence (some combination of sonority, length, stress, and pitch). Second, there are theories based on definitions that are in terms of activities of the speaker, principally the notion that a syllable is a unit in the organization of the sounds of an utterance. (Ladefoged 1993, 248)

Brentari & Goldsmith, on the other hand, do not seem to be looking at phonetic criteria. They make assumptions about the amount of information that can be packaged into a syllable and use those assumptions to determine what a syllable is, rather than determining what a syllable is first and then figuring out the amount of information that can fit into one. How, then, can they be sure they are not defining another kind of organizational unit, such as the word or morpheme, the onset or nucleus?

While I object to the wholesale imposition of spoken language linguistics onto signed languages, I do believe that sign linguists should not completely abandon the methodologies used by spoken language linguists. I think the best way to determine what the syllable in sign languages is (or if there is, indeed, any such correlate) would be to ask native speakers themselves. I have found no studies that do this. The closest I have come are papers written by Deaf linguists that discuss issues of prominence (Supalla & Newport 1978, Padden & Perlmutter 1987), where prominence is the interaction of sonority, stress, and length (Ladefoged 1993). In these papers, movement in and of itself does not have prosodic importance as it does in
Perlmutter's model (1992); rather, what is valued is the relative prominence of the movement. For example, NAME[noun] would have three syllables under the Perlmutter analysis even though it has only two prominence peaks according to Supalla & Newport.

Note that a prominence peak is not analogous to stress; a prominence peak may be stressed or it may not (Coulter 1990). I propose that there are two types of movements: [+prominent] and [-prominent]. The [-prominent] movements are often epenthetic and cannot receive stress; the [+prominent] are in the input and can, but do not have to, receive stress.

Short of more conclusive studies of native speaker intuitions, we must also rely on the sonority hierarchy. If we accept Brentari's sonority hierarchy (1994, see Section 1.2), it would appear that the partial handshape change in CURRICULUM does not in itself constitute disyllabicity. It is a smaller\(^{19}\) change than C->S and 5->S, which are considered monosyllabic under Brentari & Goldsmith's analysis. CURRICULUM should therefore be monosyllabic.\(^{20}\)

It is important to note that Brentari & Goldsmith's illustration of SOCIAL-WORK—another sign considered disyllabic by them because its set of selected fingers changes—shows a small, repeated up and down movement in addition to handshape change. The h1 (dominant hand), in the S configuration, moves downward to contact the h2 (non-dominant hand);\(^{20}\) it moves upward again, changing to a W configuration, and moves downward again to contact the h2 a second time. It may be that the downward

\(^{19}\) It is smaller because it involves the closing in of only two fingers—the pinky and thumb—and the partial lowering of the three middle fingers; while C->S requires all fingers to close in toward the palm.

\(^{20}\) The dominant hand, for right-handed signers, is the right hand; the non-dominant hand, the left. One-handed signs are made with the dominant hand. In discourse, an individual may switch hand-dominance; for example, a right-handed person may sign with the left hand acting as the dominant one. This will not concern us here.
movements are what determine SOCIAL-WORK's disyllabic nature—not the change in the set of select fingers.

Wilbur's definition of the ASL syllable (1990, 1994) is based more directly on ideas of sonority than is Brentari & Goldsmith's. Significantly, it allows for more than one path movement within a syllable.

Under Wilbur's analysis, each syllable has a nucleus. This nucleus can be a single unidirectional straight or arched movement (HEAVY) or a circular movement (LIBRARY). The movements in these words are called peaks, and they are the most sonorous part of there respective syllables.

In some cases, there may be a second, smaller movement as well, as in the sign ESTABLISH: a small circular movement above the base hand (the peak) followed by a short straight movement to contact with the base hand. This smaller, less sonorous movement is called the postpeak.

The postpeak is analogous to off-glides in spoken languages not only in that it is less sonorous than the peak, but also in that it often assimilates to the surrounding environment. The straight movement in ESTABLISH assimilates to the location of the non-dominant hand just as the off-glide in the English word "fire" assimilates to the roundness features of the nucleus.21

An elliptical movement (cf. DIRT-PRONE) is treated as two separate arched movements of equal size and sonority, hence two syllables.

In the rest of this paper, I will assume Wilbur's definition of the syllable, taking into account issues of prominence discussed in Supalla & Newport (1978) and Padden & Perlmutter (1988).

---

21My choice of the word "fire" is deliberate. Native speakers of English who pronounce the word identically disagree as to whether it contains one or two syllables (Ladefoged 1993). This same kind of disagreement occurs among sign linguists over words like ESTABLISH; Brentari & Goldsmith (1993) argue it has two syllables, Wilbur claims one.
1.4.2: The coda question: secondary licensing and syllable internal structure

In section 1.3 I discussed the absence of a linearly defined coda in signed languages. One might then assume that, because there are no linearly defined secondary licensers in ASL, ASL has a syllable structure that does not allow for different types of licensers. ASL syllable structure would then be fundamentally different from that of spoken language.

There is, however, evidence of secondary licensers in sign languages. Battison (1978) notes that, in a two-handed sign, the non-dominant hand must either have one of seven basic handshapes (A, S, B, 5, G, C, O) or copy the handshape of the dominant hand:

I. The Symmetry Condition: If both hands of a sign move independently [i.e. not in continuous contact with one another] during its articulation, then ... both hands must be specified for the same location, the same handshape, the same movement (whether performed simultaneously or in alteration), and the specifications for orientation must be either symmetrical or identical ... “Same location” ... means either (a) the physically identical location ... ; or (b) the hands are in mirror-image locations on either side of the line of bilateral symmetry. (33)

II. The Dominance Condition: (a) If the hands of a two-handed sign do not share the same specification for handshape (i.e., they are different), then (b) One hand must be passive while the active hand articulates the movement, and (c) The specification of the passive handshape is restricted to be one of a small set: A, S, B, 5, G, C, O. (35)

II.b. is vaguely-worded; one is not sure whether “passive” indicates lack of movement, or whether it simply means “unable to move unless in continuous contact with the other hand.” I will assume the second interpretation; otherwise, the Conditions would not account for a small group of signs in which both hands move but have different shapes (SHOW [verb], LEAD). It should also be noted that the h2 of ASL signs that fall into

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2Battison calls these “unmarked handshapes” (36). They are “maximally distinct, basic geometrical shapes” (36) and occur more frequently than the other ASL handshapes. See Appendix 3 for illustrations of the unmarked handshapes.
category II.a. cannot have secondary movement and must be located in neutral space.

In short, the type of material that h2 may license is strongly limited: "[Battison's] conditions are part of a single generalization, a limitation on the amount of information that can be specifically borne by h2" (Brentari and Goldsmith 1993, 28). Hence, the h2 functions as a secondary licenser as the coda does in spoken languages. Brentari and Goldsmith suggest that the h2 behaves like a coda also in that it may contain non-basic material (a segment/prime that does not belong to this subset) if that material is copied from an adjacent primary licenser. However, h2 seems to work at the word level, not at the syllable level as the coda does.

A spoken-language coda may contain non-basic material if that material is copied from the adjacent onset (this is the phenomenon known as gemination). In signed languages, an h2 may contain non-basic material if that material is copied from the adjacent (simultaneously occurring) h1 (Brentari and Goldsmith 1993). This parallel, unlike the imposed analogy of segmentation, hints at the possibility that prosodic units universally have hierarchical structure. Whether this structure is sequentially or simultaneously organized is relatively unimportant; what is important that such it appears in both signed and spoken languages, belying universal organizing principles.

Brentari & Goldsmith's proposal is not uncontroversial. Sandler (1993) argues that it collapses two distinct roles of the h2: that of copying the dominant hand (as in FINALLY) and that of acting as a place of articulation (as in CURRICULUM). The weakness of Sandler's argument is that the two roles are not as distinct as she makes them out to be; signs such as SHOW act as a place of articulation for the h1 while also copying its movement.
The proposal that the h2 acts like a secondary licenser is a good example of an instance when sign linguists forego attempts at making superficial analogies to spoken language in favor of examining the data for less obvious, but more important similarities. It shows that we need not reject what we have learned about language through the study of spoken languages; but we must ensure that when we use that knowledge as a base, we do not allow it to mislead us into asking the wrong questions.

23 By "more important," I mean that they reveal the way in which the brain organizes structural information.
Section 2: Optimality Theory

Optimality Theory, a theory of phonology as put forth in Prince and Smolensky (1993, henceforth P & S), is a theory designed to reflect the existence of a Universal Grammar. P & S claim that “Universal Grammar consists largely of a set of constraints on representational well-formedness, out of which individual grammars are constructed”; that in any language, these constraints are ranked with respect to one another (“the satisfaction of one constraint can be designated to take absolute priority over the satisfaction of another”); and that languages “differ primarily ... in the way they rank these universal constraints in strict dominance hierarchies that determine the circumstances under which constraints are violated.” (2-3) Thus, “Universal Grammar provides not only the formal mechanisms for constructing particular grammars, it also provides the very substance that grammars are built from”; i.e. universal constraints are the stuff that create language grammars.

Optimality Theory, unlike other theories of morphology or phonology, has no rules and no underlying representations. Rather than an underlying form to which rules apply, a word has an input form to which a function called Gen applies. Gen generates a set of possible output\textsuperscript{24} forms according to the following principles: “any amount of structure may be posited;...no element may be literally removed from the input form;...[and] no changes in the exponence of a phonologically-specified morpheme are permitted.” (McCarthy and Prince 1993, henceforth M & P). The resulting set is called a candidate set.

\textsuperscript{24}A winning output form is superficially similar to the surface form of generative phonology; but while the term “surface form” assumes one or more underlying form, Optimality theory assumes no underlying representation.
Rather than having rules, each language has a set of ranked constraints that determine which candidate is the most well-formed. All constraints are violable; however, the "winning" candidate (i.e., the most well-formed) violates lower constraints than do the losing candidates.

This last point should be made clearer. Say, for example, that a given language has two constraints (though according to the theory, every human language has the same number of constraints, since they are all universal). Constraint 1 is ranked higher than Constraint 2. Gen generated two candidates: Candidate A and Candidate B. Candidate A violates Constraint 1, and Candidate B violates Constraint 2. The surviving candidate will be B, because A violates the higher-ranking constraint, while B does not. Although B violates a constraint, it still survives, because that constraint is not ranked as high as the other violated constraint.

<table>
<thead>
<tr>
<th>/candidate/</th>
<th>Constraint 1</th>
<th>Constraint 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>candidate A</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>--&gt;candidate B</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

A solid line between two columns indicates that the constraint to the left is the higher-ranked; a dotted line indicates that the constraints to either side are of equal ranking with respect to one another or that their ranking has yet to be determined. An asterisk indicates that the candidate has violated a constraint; an exclamation mark indicates that the violation is fatal (rules a candidate out). Shading indicates that the given constraint is irrelevant; the winning output form has already been determined by higher-ranked constraints.
A violation of a constraint is not fatal for a given candidate if (1) a fatal violation has already been incurred on a higher-ranked constraint or (2) all surviving candidates have the same amount of violations of the constraint in question. In the following table, both candidates violate Constraint 1; but these violations are not fatal since both candidates incur the same amount. We must therefore look at lower-ranked constraints to determine which of the candidates is optimal:

<table>
<thead>
<tr>
<th>/candidate/</th>
<th>Constraint 1</th>
<th>Constraint 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>→→candidate A</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>candidate B</td>
<td>*</td>
<td>*!</td>
</tr>
</tbody>
</table>

No mechanism analogous to the cycle exists in Optimality Theory. A word cannot go through one round of constraints on one level and then through another round on a higher level. All constraints apply simultaneously. The output is not dependent on some chronological ordering of constraints, but rather on which constraint is most important and which is least so.

The constraints in Optimality Theory are all universal constraints, but some, because they are ranked highly in only one or two languages, affect only those languages and thus behave as if they were language-specific (M & P).

What are the universal constraints? They include the Faithfulness Constraints PARSE (segmental material is parsed; any "deletion" would be a violation of parse) and FILL ("syllable positions are filled with segmental material" [25]; hence, any syllable position containing epenthetic material
would be a violation of FILL). These deal with the faithfulness of the output
form to the input form. They also include Alignment Constraints which
align different aspects of the word to each other (for example, stress may be
aligned to the left of a foot, or an affix edge may be aligned to a word edge),
and constraints that are related to syllable and prosodic well-formedness, like
ONSET (a syllable needs an onset), EDGEMOST R ("the most prominent foot
in the word is at the right edge" [M & P 29]).

Constraints like ALIGN and EDGEMOST R have the appearance of
being language-specific, but they are not. Even if the most prominent foot in
a word never occurs at the right edge in a given language, EDGEMOST R is
nonetheless a constraint—albeit a low-ranking one—in that language. If the
most prominent foot occurs at the right edge of the word and the second most
prominent occurs at the left edge, this is a result of the interaction of two
constraints: EDGEMOST R and EDGEMOST L ("the most prominent foot in
the word is at the left edge").

Thus, each constraint exists in the grammar of every language. Those
which never affect the shape of a word in a given language are simply ranked
so low that they never effect the output.

Each language has its own, unique constraint ranking, consisting of
universal constraints; i.e., a variety of unique grammars are born out of a
closed set of constraints.

What may be surprising to many phonologists who work exclusively
with spoken languages is that many of the constraints used in the grammars
of spoken languages may also be present in the grammars of signed
languages. How could a phonological theory developed to describe speech,
which is produced orally, also describe signing, which is produced manually?
Quite simply, Optimality Theory reflects the idea that the brain is pre-programmed with a finite number of universal language constraints. These constraints are present in the brain before language is ever acquired; the process of language acquisition involves ordering these previously unordered constraints and modifying some in such a way that they become language-specific. Because most constraints developed thus far within the theory refer to prosodic well-formedness and to units such as “feature,” “segment,” and “word,” rather than to auditory or articulatory processes themselves, it seems that the constraints should apply to any natural language, not exclusively to spoken ones.

My goal here is not to prove that Optimality constraints can be imposed on ASL data with acceptable results. Rather, it is to look at the ASL data first, and from there determine what kind of constraints are motivating its behavior. Some of these constraints will have an obvious relationship to spoken language constraints; others will not. Whether any of these constraints is motivated by the same principles that guide the structure of spoken languages is for future research to discover.

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25P & S discuss the alteration of the universal constraint FREE-V (“word-final vowels must be parsed”) in Lardil, where FREE-V becomes: “word-final vowels must be parsed (in the nominative).” Here, the morphology takes advantage of universal phonological constraints, altering them so that they apply only in certain syntactic/semantic environments. (P & S 101)
NAME[verb]: dominant H-hand begins in neutral space a few inches above non-dominant H-hand, which is oriented toward the body. Dominant hand moves downward until middle finger comes into contact with index finger of non-dominant hand. Similar to NAME[noun], but not restrained and without repeated movement.

ACT, perform

BABY

BLACK, Black-person

NAME

BLACK NAME meaning 'bad reputation'

BLUE

BLUE SPOT meaning 'a bruise'

---

24DYE taken from Riekehof 1987; BLACK+NAME, BLUE+SPOT, SPOT, SICK[frequentative aspect], from Klima & Bellugi 1979.
Section 3: Constraints effecting ASL word structure

3.1: Interaction of syllable and word

In her work on the lexicalization of fingerspelled words, Brentari proposes that phonological words are maximally disyllabic (1994). I will call this constraint 2 SYLL:

2 SYLL: phonological words are maximally disyllabic

This constraint is reminiscent of spoken language constraints that require a phonological word to be minimally a foot, where a foot is two light syllables, a light and a heavy syllable, or a heavy syllable (Hayes 1993). The difference is that ASL disfavors words that exceed two syllables, while spoken languages disfavor phonological words that are less than two syllables.

In spoken languages, we have evidence of minimal foot constraints (McCarthy & Prince 1993). Whether or not we want to discuss 2 SYLL as a maximal foot constraint is unclear as of yet. Wilbur (1994) and Coulter (1990) discuss stress assignment in disyllabic ASL words, giving evidence of trochaic feet; but I am wary of incorporating these proposals into the constraints without further research.

Wilbur (1994) points out that multimorphemic words need not obey the same constraints that act on monomorphemic words. She agrees with Brentari that monomorphemic disyllabic signs are possible, such as BABY and DYE, but specifies that the second movement must be a 180° or 90° rotation of the first syllable. She claims that "compounds, which are multimorphemic, do not obey these constraints."

Wilbur does not address the issue of unidirectional alternating signs such as ACT, which has three major movements: two by the h1 and one by the h2. Presumably, the h2 is not able to
While multisyllabic compounds may have movements that are not 90° or 180° rotations of each other, they behave like monomorphemic words in that they are maximally disyllabic (Klima & Bellugi 1979).

For example, BLUE+SPOT ("bruise"), made up of the disyllabic BLUE and monosyllabic SPOT, is reduced to only two syllables overall. Similarly, the word BLACK has one syllable and NAME[noun] has two; but when they are combined to form BLACK+NAME ("bad reputation"), a syllable is lost.

This is due to the disyllabic constraint working in conjunction with a constraint forbidding deletion. Because the language prefers deletion to maintaining more than two syllables, we know that 2 SYLL is ranked higher than this constraint, which will be called PARSE.

A PARSE violation is incurred for every prime that fails to be parsed. If an entire hand is deleted from a given sign, this is the result of none of its primes being parsed. Therefore, were the non-dominant hand to be deleted in FAST, this would be the result of five parse violations: one each for place, path movement, secondary movement, orientation, and handshape. If the non-dominant hand of GLASS were deleted, this would be the result of three parse violations: place, orientation, and handshape. The following is a formalized definition of PARSE, which is related to M & P's PARSE-segment:

PARSE: “A given element [must] be dominated by an appropriate node in the prosodic tree” (M & P 14). PARSE-p, shortened in this paper to PARSE, “demands that [primes] belong to syllabic or moraic structure” (ibid.)

license a syllable with its movement, but is rather sharing syllable structure with the h1. As for the sign JUDGE, it cannot be viewed as disyllabic under Wilbur's analysis but can be viewed as such under a prominence-based analysis.

28The absence of secondary and path movements in the h2 of GLASS is not due to PARSE violations; these movements are lacking from the input form and therefore cannot be parsed in the first place.
Other constraints come into play here. One is in response to the hypothetical proposal that the number of movements in BLUE+SPOT can be preserved if one says that the two prominent movements of BLUE form a single syllable. This proposal is problematic because we would have as the peak of our syllable a non-prominent connecting movement. This would be inconsistent with the definition of syllable provided in 1.4.1 and would violate the following constraint:

\[ *P/\text{NON-PR}: \text{non-prominent material may not associate to the peak of a syllable.} \]

This constraint excludes not only non-prominent movements from associating to the peak, but also locations, as in the sign DYE, where we get two syllables because the location at which the direction of movement changes cannot serve as the peak.

When we examine P&S, we discover a constraint not unlike \[ *P/\text{NON-PR} : \]

\[ *P/C: \text{a consonant may not associate to a syllable peak.} \]

It may be, when discussing the question of sonority and syllable structure, that non-prominent movements are as or more analogous to spoken language consonants than are holds; I hope to see this question addressed in future research.

We must consider two more constraints before presenting a candidate table. The first of these is \[ *\emptyset \text{LEX MORPH}: \]

\[ *\emptyset \text{LEX MORPH}: \text{At least some material from each lexical morpheme must be parsed.} \]
This means that entire lexical morphemes may not be deleted.

The second of these constraints is FILL. The definition of FILL in spoken language phonology is "Syllable positions are filled with segmental material" (P & S 25). This simply means that everything that surfaces in a syllable should be present in the input form. FILL is a ban on epenthetic material.

In sign languages, we have a similar (violable) ban on epenthetic primes. Handshapes, orientation changes, local and path movements, and location may not be added to the input form of a sign. Also, if a second hand is added to a sign that is one-handed in its input, we have a violation of FILL; or rather, multiple violations of FILL—one for each prime.

I do not believe it is unreasonable to argue that the ban on epenthetic material in spoken languages and the ban on such material in sign languages are rooted in the same constraint. FILL applies to both sign languages and spoken languages, though its definition certainly must be reworded so as not to preclude application to one modality or another:

FILL: Epenthetic material is forbidden.

FILL is needed here to explain why candidates that contain non-prominent movements, which are epenthetic, are disfavored.

Now we are ready to examine candidates in light of these constraints. In the following table, I will represent in the input only the aspect of the word in question: its prominent movements (represented by 'Pr'). Please note that the dotted lines between candidates indicate that their relative rankings have yet to be determined. A syllable boundary is marked by ';'; a PARSE violation
is indicated by ‘<>’, a FILL violation by ‘_’. See Section 3.2.1 for evidence of FILL’s lower ranking than PARSE.²⁹

<table>
<thead>
<tr>
<th>/BLUE+SPOT/</th>
<th>*Ø LEX MORPH</th>
<th>*P/NON-PR</th>
<th>2 SYLL</th>
<th>PARSE</th>
<th>FILL</th>
</tr>
</thead>
<tbody>
<tr>
<td>.Pr._Pr.Pr.</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.Pr._PrPr.</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.Pr.PrPr.</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.Pr&lt;Pr&gt;_Pr.</td>
<td></td>
<td></td>
<td>*</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>-&gt;.Pr&lt;Pr&gt;Pr.</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.Pr._Pr&lt;Pr&gt;</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dimorphemic words made up of one lexical and one derivational morpheme (e.g. NAME[noun], which is formed from the lexical morpheme NAME[verb] and a derivational morpheme which dictates restrained manner³⁰ and doubling of the verb’s movement [Supalla & Newport 1978]) are also disyllabic under the prominence-based analysis I discussed in 1.4.1.

²⁹ .Pr._Pr.Pr. represents the candidate in which the citation form of BLUE precedes the citation form of SPOT; this candidate does not differ formationally from the two words being articulated separately as if they were not members of a compound .Pr._PrPr. would look the same as the preceding candidate when articulated, but would be treated abstractly as two syllables rather than three .Pr.Pr.Pr., when articulated, would look the same as the first candidate, but would be treated abstractly as two syllables rather than three .Pr<Pr>_Pr. is not a theoretically interesting case; it is like the illustration of BLUE+SPOT found in Figure 3.1 except that has a superfluous epenthetic movement before the SPOT part of the compound is executed. This candidate is included here simply to show why epenthetic movements cannot be inserted haphazardly .Pr<Pr>Pr.: an illustration of this sign can be found in Figure 3.1; note that it is not actually important whether the syllabic boundary occurs before or after the unparsed prominent movement .Pr<Pr>.Pr. would do equally well as a candidate .Pr._Pr<Pr>: the first two prominent movements are the same ones that occur in BLUE; the unparsed prominent movement is the movement of SPOT. Therefore, this candidate would look just like the sign BLUE.

³⁰ Note that manner features such as restraint cannot be used to form minimal pairs among lexemes (e.g., we would never find two semantically different lexemes such as “dog” and “river”
Interestingly, the derivational morpheme seems to be lost in the compound BLACK+NAME; NAME[noun] loses its reduplicated movement, but BLACK+NAME retains its status as a noun. This is always the case with compounds that end in derived nouns, e.g., SLEEP+DRESS.

Multimorphemic words made up of lexical and grammatical morphemes, however, are not all required to be mono- and disyllabic; they often contain between three and ten syllables. Grammatical morphemes like aspect specify number, shape, and manner (tenseness or laxness, restrain, etc.) of movements. Unlike the derivational morpheme discussed in the preceding paragraph, they can specify between three and six movements, rather than just two (Klima and Bellugi 1979). They also differ from the derivational morpheme in that none of these movements may be deleted.31

We cannot account for the preservation of material specified by a grammatical morpheme by saying that to delete the material would be a violation of PARSE, since 2 SYLL is ranked higher than PARSE. As shown in the following table, we would obtain the wrong output if these were the only two constraints under consideration:

<table>
<thead>
<tr>
<th>/SICK+frequentative/</th>
<th>2 SYLL</th>
<th>PARSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>/PrPrPrPr[i+tense]/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.Pr.Pr.Pr.Pr.[+tense]</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>.Pr.Pr.&lt;PrPr&gt;[+tense]</td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>

whose structures were only distinguishable from one another by the presence of restrained manner in one form), but can be used to distinguish one derived form of a lexeme from another derived form of that lexeme or from a non-derived form (e.g., SICK vs. SICK[protractive], which has "a long tense hold" (Klima & Bellugi 1979).

31SICK[frequentative aspect] may be pronounced with four, five, or six syllables. I do not believe that the frequentative aspect specifies a particular number (e.g. five) of syllables, sometimes deleting and sometimes adding a syllable; it rather specifies that the word will have between four and six syllables, where no particular number within this range is preferred.

42
Thus, we must posit a highly-ranked constraint that forbids the deletion of material specified by a grammatical morpheme. A modified version of *Ø LEX MORPH will not suffice to explain this data, since *Ø LEX MORPH tolerates some deletion, while grammatical morphemes tolerate no deletion:

PARSE GM: material specified by the grammatical morpheme must be parsed.

This constraint is ranked more highly than 2 SYLL:
We have seen that the interaction of different constraints on the syllable and word produces the optimal output in ASL. A variety of constraints are needed: the faithfulness constraints FILL and PARSE, constraints that refer to a morpheme’s lexical or grammatical status, and constraints on syllable number and structure. In the next section, 3.2, we will focus on phonological processes involving the h2, discovering constraints that effect the structures of two-handed signs.
DRESS

FAST

GLASS, CAN, cup

SLEEP

SLEEP+DRESS meaning 'pyjamas'

---

28SLEEP, DRESS, and SLEEP+DRESS from Klima & Bellugi 1979.
Section 3.2: Constraints effecting the h2

3.2.1: #HANDS

There exist certain constraints which all ASL words—regardless of the number of morphemes they contain—must obey. For example, a compound word formed from a one-handed and a two-handed sign, such as SLEEP+DRESS (where SLEEP, signed independently, is one-handed, and DRESS, signed independently, is two-handed) becomes two-handed throughout (Sandler 1993). This behavior is motivated by a constraint which requires the number of hands involved to remain consistent throughout a sign. I will call this constraint #HANDS:33

#HANDS: the number of hands used to articulate a word must remain consistent throughout that word

Why does SLEEP+DRESS become two-handed throughout rather than maintaining a structure closer to the input form or becoming one-handed throughout? #HANDS interacts with FILL and PARSE to produce the optimal output.

Since SLEEP+DRESS is two-handed throughout, we know that #HANDS and PARSE are ranked higher than FILL, as the following table demonstrates (‘+’ marks the joining of multiple morphemes. ‘;’ marks sequential ordering—it does not imply a syllable boundary):

<table>
<thead>
<tr>
<th></th>
<th>#HANDS</th>
<th>PARSE</th>
<th>FILL</th>
</tr>
</thead>
<tbody>
<tr>
<td>h1+h1h2</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h1;h1h2</td>
<td></td>
<td></td>
<td>****</td>
</tr>
<tr>
<td>h1;h1&lt;h2&gt;</td>
<td></td>
<td>****!</td>
<td></td>
</tr>
<tr>
<td>→h1_;h1h2</td>
<td></td>
<td></td>
<td>*****</td>
</tr>
</tbody>
</table>

33#HANDS may be an alignment constraint, in that it requires the number of hands on one edge of the word to align to the opposite edge, as well.

46
In fact, #HANDS constraint is never violated in ASL (Sandler 1992), so we know it is in the group of constraints that, while unranked with respect to one another, is ranked more highly than all other constraints in the language (P&S).
3.2.2: Word-level secondary licensing: ASL vs. other signed languages

In Section 1.4.2, I discussed Brentari & Goldsmith's observation that the h2 in ASL shows characteristics of a secondary licensor. It cannot carry the variety of information that the h1 can; it can have a basic handshape and no internal movement, or it must copy all of its primes from h1.

Not all sign languages place these kinds of restrictions on the h2. For example, Hong Kong Sign Language (HKSL) allows the h2 to license internal movement (ROCKET\textsubscript{HKSL}), as do Japanese Sign Language (TELEVISION\textsubscript{JSL}) and Chinese Sign Language (AND\textsubscript{CSL}). Both languages might also allow the h2 to license unmarked handshape (TELEVISION\textsubscript{JSL}, PUBLIC\textsubscript{HKSL}), but I know of no studies that have been done as to what the unmarked handshapes of those languages. It would be bad form to assume that the handshapes that occur in the non-dominant hand are non-basic in those languages just because they would be considered non-basic in ASL. These observations do not exclude the possibility that the h2 in these languages is restricted in other ways, though it also very well may not be any more restricted than the h1. This matter will hopefully be addressed in future research.

Thus, the h2 is restricted in this particular way in ASL not because to form signs otherwise would be physically awkward or impossible; rather, the conditions appear to be the result of several phonological constraints.

These constraints are different from Battison's Symmetry and Dominance Conditions, which are simply descriptions of the phenomenon that result from the constraints. I will not be able to list all of the constraints in question here, but will rather list only a few. The first of these is H2 \textsc{cond}:
H2 COND: an h2 can have only unmarked handshape and no internal movement or else no handshape specification of its own at all.

This is similar to the constraint CODA COND for spoken languages:

CODA COND: “A coda consonant can have only [unmarked] place or else no place specification of its own at all.” (P & S ms.)

H2 COND is violable in ASL when a word is borrowed from another sign language or sign system\(^\text{35}\), as in the sign TOTAL-COMMUNICATION (borrowed form an English-based signing system\(^\text{36}\)), which violates H2 COND because it has a marked handshape which is not copied from the h1. TOTAL-COMMUNICATION and the borrowed sign SIMULTANEOUS-COMMUNICATION, which does not violate H2 COND, violate other ASL morpheme structure constraints as well. In both of these signs, the h1 and h2 move without being in contact with each other, and yet they have different shapes—a phenomenon not permitted in native signs.

H2 PM COND: In a two-handed sign, the h2 may move only if it shares place specifications (e.g. is in constant contact with) or handshape specifications with the h1.

Note that MOVE H2 does not require the h2 to move under these circumstances; rather, it permits an h2 to move if it shares a place or handshape specification with the h1 and forbids an h2 from moving if it does not share one of these specifications with the h1.

\(^{35}\)The term “sign system” refers to any system that uses the hands and/or gestures to communicate. It may refer to a language or a non-language communication system. See Davis and Supalla 1995 for distinctions between the different types of systems.

\(^{36}\)See Supalla 1986 for a discussion of the status of English-based sign systems. He claims that they show traits uncharacteristic of natural languages.
Both H2 COND and H2 PM COND are unviolable in ASL words. We need not account for the failure of words borrowed from other sign systems (and which are used very rarely, in any case) to obey ASL's constraint-ranking, since borrowed words in any language do not necessarily assimilate to the constraints of that language immediately but rather integrate into the language over time (and in some cases never change enough to behave like a native word; for example, Japanese allows words borrowed from Chinese to end in nasals, although native Japanese words may never do so). One might posit a highly-ranked constraint that says "preserve foreign forms," but this constraint would not tell us much about why the structures of some foreign forms are preserved longer than the structures of others, and therefore would not be very useful.
Figure 3.2.3

PLAY
YELLOW/PLAY (weakdrop)
READ

READ (Weak Drop)

33READ(weakdrop) from Padden & Perlmutter 1987.
3.2.3: Weak drop

Padden & Perlmutter (1987) discuss a phenomena that they name *weak drop*. Weak drop is the dropping (or deletion) of the non-dominant hand in signs that are normally two-handed. Weak drop may occur in “echo articulator” signs (those in which all of the features of the h2 are copied from the h1 [Sandler 1993, 140-1]) and in “h2 place” signs (signs in which only some of the features of the h2 can be copied from the h1 [ibid., and Brentari and Goldsmith 1994]) where the hands do not come in contact with one another. Weak drop cannot occur in many alternating signs or in many base-hand signs where the h1 is specified for contact with the h2 (Stack 1995).

I will not be discussing in this paper the cases in which weak drop does not occur. That question must be left for future work. Here, I will be examining the signs in which weak drop *can* occur. I will argue that the weak drop form of a given sign is governed by the same constraints as the form in which weak drop does not occur. The difference between the two forms is not that different rules apply to them; rather, the difference is caused by a reordering of constraints.

This reordering is permitted by what Reynolds (1994, 116) calls a “floating constraint.” Floating constraints are constraints “whose hierarchical rankings may change in a principled manner in relation to a certain subset of other constraints whose rankings are fixed” (Nagy & Reynolds ms., 4).

---

38 An Optimality treatment of weak drop was first proposed in Stack 1995.

39 "Alternating signs [are] signs in which the hands alternate in movement. Signs that satisfy this definition are necessarily two-handed. The sign ACT illustrates this class: first the strong hand moves, then the weak hand follows in the same direction, then the strong hand repeats its initial movement…. There is another class of signs we classify as alternating: those in which the hands move back and forth, moving in opposite direction at the same time … signs like JUDGE” (Padden and Perlmutter 1987, 339-341). The hands in alternating signs never come in contact with one another; hence CHRIST and HANDS are not considered bidirectional (ibid. 342).
The constraints involved in two-handed signs that can undergo weak drop are:

*MOVE H2: the non-dominant hand must not move.

H2H1: h2 must share all features with h1; otherwise, it must not be present in the sign PARSE

Note that *MOVE H2 and H2 PM COND (see Section 3.2.2) are redundant in that H2 PM COND forbids movement of h2 in some cases while *MOVE H2 forbids movement of h2 in all cases. This redundancy is indeed problematic and might be avoided if I were to use different constraints altogether to explain these phenomena. Note, however, that this kind of redundancy is not unique to my analysis; P & S's CODA COND and *CODA are redundant in a similar way, in that CODA COND forbids certain kinds of material in the coda while *CODA forbids any material from being in the coda. Ito & Mester (1994) avoid this redundancy by proposing alignment constraints in their place; however, align constraints refer to syllable and word boundaries in a way that relies on linearity, so I see no way to adapt Ito & Mester's approach here. I would like to revisit this question in future work.

*MOVE H2 and H2H1 are equally ranked; that is, one is not ranked higher than the other. PARSE is a floating constraint whose domain is *MOVE H2, H2H1; it can be ranked lower or higher than *MOVE H2, H2H1.

In signing where weak drop does not occur, the ranking of the constraints is PARSE >> *MOVE H2, H2H1. In the following table, we consider three candidates. Other candidates are also possible but would not win and would not show us anything important about the ranking, so they are not being considered here. The three candidates I have chosen will enable
us to see that the constraint ranking I have given above is necessary. I have chosen to test the winning form, which violates *MOVE H2 but does not violate PARSE or H2H1; the weak drop form, which violates PARSE but does not violate H2H1 or *MOVE H2; and a weak freeze (P & P 1987) form that violates PARSE and H2H1, but not *MOVE H2. Where all the primes connected to a given hand have not been parsed, I indicate that by putting brackets around the symbol for that hand; in those cases where only a subset of the primes have failed to be parsed, I indicate this by subscripting the unparsed prime(s) to the hand in question:

<table>
<thead>
<tr>
<th>PLAY /h1h2/</th>
<th>PARSE</th>
<th>*MOVE H2</th>
<th>H2H1</th>
</tr>
</thead>
<tbody>
<tr>
<td>-&gt;h1h2</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>h1&lt;h2&gt;</td>
<td>****!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h1h2 &lt;mvmt&gt;</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This ranking accounts not only for echo signs, but also for base-hand signs:40

<table>
<thead>
<tr>
<th>READ /h1h2/</th>
<th>PARSE</th>
<th>*MOVE H2</th>
<th>H2H1</th>
</tr>
</thead>
<tbody>
<tr>
<td>-&gt;h1h2</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>h1&lt;h2&gt;</td>
<td>***!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h1h2&lt;o&gt;</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When PARSE is ranked below *MOVE H2, H2H1, the winning output form is the weak drop form:

---

40The input form of READ does not indicate movement of either type for the h2; therefore, I've deleted orientation in order to make the candidate set of READ as parallel as possible to that of PLAY.
<table>
<thead>
<tr>
<th>PLAY /h1h2/</th>
<th>*MOVE H2</th>
<th>H2H1</th>
<th>PARSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>h1h2</td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>→h1&lt;h2&gt;</td>
<td></td>
<td></td>
<td>***</td>
</tr>
<tr>
<td>h1; h2 &lt;mvmt&gt;</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>READ /h1h2/</th>
<th>*MOVE H2</th>
<th>H2H1</th>
<th>PARSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>h1h2</td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>→h1&lt;h2&gt;</td>
<td></td>
<td></td>
<td>***</td>
</tr>
<tr>
<td>h1h2 &lt;c&gt;</td>
<td>!</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>
3.3: ASL constraint ranking

The ranking for all of the constraints discussed in this section is as follows (">>" means "dominates"; ",," means "is equally ranked with or as yet of undetermined rack with respect to"; constraints within brackets are the domain of the preceding constraint):

PARSE GM, H2 PM COND, H2 COND >>
2 SYLL, *Ø LEX MORPH, *P/NON-PR >>
#HANDS, PARSE [*MOVE H2, H2H1] >>
FILL

This ranking accounts for weak drop, the reduction of compounds, the maintenance of a consistent number of hands throughout the sign, symmetry in "echo" signs, and the preservation of grammatical morphemes. I hope to account for even more ASL phonological phenomena in future work.
Conclusion

We have seen that ASL shares certain phonological traits with spoken languages. ASL makes use of prosodic units and secondary licensers. It appears to have a sonority hierarchy, though syllable structure may rely more on prominence than sonority. It differs from many spoken languages—though not all—in that it forms most minimal pairs not through contrasts between linearly-organized segments, but through contrasts between simultaneously-organized primes.

My Optimality Theory analysis of ASL has shown that sign language phonological phenomena can be explained by ranking structural constraints with respect to one another. It has shown that both signed and spoken languages are restricted by the faithfulness constraints PARSE and FILL. Both signed and spoken languages also have phonological constraints that effect only certain groups of morphemes (Section 3.1, P&S 101). They both seem to place importance on groupings of two syllables in the prosodic word, though the tendency in spoken languages is to desire a minimum of two syllables, while in ASL the preferred number is a maximum of two syllables. Both types of languages also display variations in pronunciation that can be explained by the presence of floating constraints.

Constraints that refer explicitly to modality (e.g., CODA COND, *MOVE H2, H2H1) are not, of course, universal; but they may stem from similar organizing principles (e.g., CODA COND and H2 COND). My work here will hopefully assist attempts to discover whether phonological phenomena that seem dependent on modality are in fact based upon universal linguistic principles.
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