Analyzing Signs

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Sign language and speech are superficially unlike each other, since one involves a manually produced, visually received signal, while the other involves an orally produced, auditorily received signal. If we are to look for common features in the form of speech and sign behavior, then we must explore the organization of signs at a level general enough to permit some comparisons to spoken words. This necessitates a re-examination of the function of the phonological component of a grammar.

1.1 Sublexical Structure

The goals of a complete phonological description are to establish three interdependent aspects of linguistic form: (1) the sublexical analytical units which in combination with each other make up the morphemes of the language; for spoken languages these components would be segments (phonemes in the structuralist framework) described in terms of distinctive feature specifications (not to exclude tone, stress, etc.); (2) the allowable and non-allowable patterns of distribution of these units, whether stated at a deep underlying level by morpheme structure constraints, or at the surface level as the result of phonological rules and morphophonemic alternations; (3) the patterns of historical changes occurring over time; and (4) to link the above components, rules, and patterns of alternation with the physical or phonetic framework, and to seek motivation for these structures and constraints in the articulatory and perceptual processes which encode and decode the forms of the language.

What this adds up to is a set of rules and constraints that limit the possible forms which may be used in a given natural language to express meaning. For spoken languages, we may take the universe of forms to be the entire range of sounds produced by the human vocal apparatus, only a small set of which are potential human speech sounds. The phonology of a particular spoken language would further circumscribe this set, delimiting a finite set of sound elements combinable according to a set of rules and constraints to yield the allowable morphemes of the language, plus their alternative forms when used in strings (phrases or sentences).

For sign languages the task is analogous. Out of the entire range of gestures that it is possible to make with the human body (particularly torso, head and arms), the phonology of a sign language must specify the possible signs of a given sign language, and also specify their form when used in strings. In this sense a gesture is not necessarily a sign, but every sign is also a gesture.

I will continue to use the word "phonology" to refer to the analogous level of

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abstract structure in sign languages. Stokoe (1960) coined the term "cherology" to apply to much the same area. I choose to avoid this term for three reasons: (a) to avoid confusion between Stokoe's structural analysis and the present study, which is cast in a generative phonological framework; (b) to avoid using a new term where a familiar one seems both adequate and appropriate; (c) to highlight existing similarities between speech and signing.

The units of analysis posited by Stokoe still have a great deal of validity, however, and have been used by subsequent researchers in the field. He noted that signs in ASL required three different types of information about simultaneously occurring events to specify their information and to distinguish them from other signs. He refers to these as the *aspects* of a sign so as to avoid unnecessary confusion with a *sequence* of segments (Stokoe 1972):

a. The *location* of the sign in relation to the body, which Stokoe termed the *tabula* (or *tab*);
b. The *handshape(s)* or configuration(s) of the hand(s) involved in the sign, called the *designator* (or *dez*);
c. The movement executed by the hands, called the *signation* (or *sig*).

Besides the three aspects explicitly stated, Stokoe (1960) makes use of a fourth type of simultaneous formational information in his transcription system. This is the spatial *orientation* of the hands, in relation to each other and/or the rest of the body. Battison (1974), Frishberg (1974, 1975), Woodward (1973a), Woodward and Erting (1975), and others have since made orientation information more explicit in sign descriptions. Under this analysis, the lexical entry for each sign must be specified for each of these categories, and class relationships among signs can be stated in terms of shared specifications. Each of these categories of location, handshape, movement, and orientation thus may be viewed as comprising a sub-set of elements which make the equivalent of a phonological inventory. These units were termed *cheremes* by Stokoe (1960) and *primes* by Bellugi (1972). Naturally the interaction and interdependence of these hypothetical units are as important as the units themselves.

Stokoe (1960) and Stokoe et al. (1965) posited 19 distinct hand configurations, 12 distinct locations, and 24 distinct movements as the basic manual components of signs. In addition, Stokoe's (1960) analysis coded the passive hand of a two-handed sign as a location. In his structuralist analysis, independence of these units was based on their contrasting role in minimal pairs. All other variants of location, handshape, etc., were treated as "allochers" of these cheremes. At the more "phonetic" surface level there are many more possible distinctions, of course.

My own observations suggest that there are approximately 45 different handshapes and 25 different locations on the body or in space where signs are made. There are fewer different types of movements and orientations (perhaps on the order of one dozen each). Klima (1975) suggests that there are close to 40 significant handshapes, 12 locations, 16–18 orientations, and 12 simple movements. Newkirk (1975), in developing a transcription and orthography for ASL, noted more than 54 distinct handshapes, the remainder of his analysis not being comparable for enumeration.

The exact number of different primes depends upon more complete phonological and "phonetic" analyses than are now available, and depends upon the resolution of a number of descriptive problems. For one thing, there are many alternatives for coding the same type of information about the

physical nature of signs: Direct linear movement between two locations could be coded entirely in terms of those locations; finer points about manual contact could be coded by orientation and locations, or they could be coded separately, as in Friedman and Battison (1973); fine movements of the fingers are sometimes (but not always) equivalent to recognizable changes of handshapes; orientation could be just a cross-classifier of handshapes rather than having a status equal to handshape, movement, and location aspects. For another thing, the state of the art has advanced to the point where information on the psychological reality of sign phonology is only just beginning to emerge (Bellugi et al. 1975, Lane et al. 1976, Poizner 1976).

The important point at present is not how many primes there are in each of the four categories, but that there is some justification in assuming that there are four separate categories, that each category is composed of a finite set of distinct elements, and that every simple sign comprises a prime specification for each of the four categories which are to be articulated simultaneously. These assumptions, which demand a refinement going beyond the scope of this study, are sufficient to facilitate the present descriptions and discussions.

Besides describing the physical formation of signs, these primes serve to distinguish signs from each other, often minimally. Not all of these primes contrast at an underlying level of representation, as we shall see later. Minimal pairs of signs can be found that differ in form only in one particular aspect. For the aspect of handshape, there are pairs of signs which are identical in all respects except for the particular handshape involved. An example is the pair of signs CAR[1] and WHICH (Figure 1). The only difference between them is that CAR uses the standard A or S handshape[2] (compact fist, thumb closed against side or knuckles), while WHICH uses the Å handshape (compact fist, thumb extended).

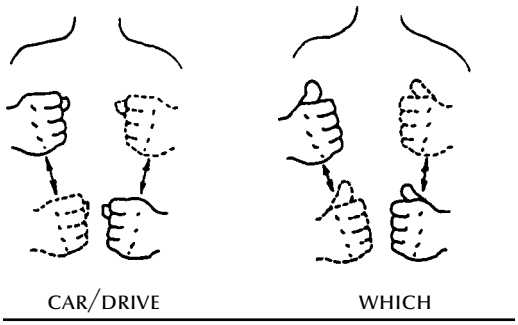

Figure 1.

In the case of location a minimal pair is CHINESE and SOUR (Figure 2). The two signs are identical except that CHINESE is made on the temple or high on the cheek and SOUR is made near the mouth.

A minimal pair for movement is found in NAME and SHORT (BRIEF) (Figure 3). NAME is made with simple contact (sometimes repeated) while SHORT (BRIEF) is made identically except for having a side-to-side brushing motion of the upper hand.

Finally, the pair NAME and SIT (CHAIR) differ minimally only by orientation. In the sign NAME, both *volar* (palm) surfaces are oriented more-or-less toward the body, and the fingers make contact on the edges. In

Figure 2.

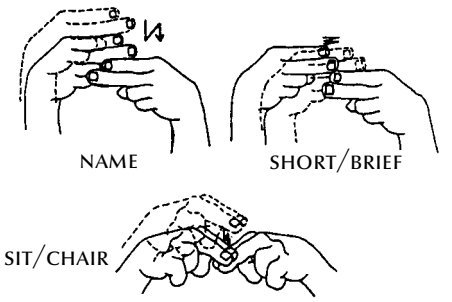

Figure 3.

SIT (CHAIR), both volar surfaces point downward.

What we have seen so far is the beginning of a sublexical or phonological analysis of signs. The four categories of location, handshape, movement, and orientation comprise classes of units which may serve to distinguish signs from each other. Before moving on to other combinatorial aspects of these units, we should consider the form of the articulator, the human body.

1.2 THE BODY AS ARTICULATOR

It may be helpful to dissociate ourselves from our bodies temporarily and to consider our bodies as machines capable of generating manual visual signs. For our purposes here, there are actually two basic ways of viewing the body as a machine—one in terms of production of signs and the other in terms of perception of signs. In terms of perception, the body is a bilaterally symmetrical object with a very complicated moving organ (hand and arm) on each side. However, in terms of production of signs and the actual usage of the body, observations indicate that signers tend to use one hand and one side of the torso much more than the other.[3] It is a major thesis of this study that this opposition between potential visual symmetry and the actual manual asymmetry of the body creates a dynamic tension of great importance for the formational organization of signs, and we shall return to it often.

In the context of this study we shall need three pairs of terms to discuss the components and activities of the left and right sides of the body. The terms *left* and *right* themselves are superfluous, since they are arbitrary labels for sides unrelated to function, and because the opposition of *left* and *right* is non-distinctive for signs—it carries no meaning. A one-handed sign means the same thing regardless of whether it is performed by the left or right hand (except for cases where the sign refers to something to the left or to the right), and a two-handed sign does not change meaning regardless of whether the left and right hands reverse their formational roles.

The term *dominant* will be used to refer to the hand preferred for most motor tasks, and *nondominant* will refer to the other hand. For descriptions of signs involving two hands, we shall use the functional terms *active* and *passive*. A two-handed sign may either have two active (moving) hands, or it may have an active and a passive hand. The active hand has a much larger role and executes a more complex motor program than its passive partner, which can be absolutely stationary. Under certain circumstances the passive hand may be in motion due to transitions from the previous sign, or due to moving up into signing space from one of the rest positions. This motion is of course quite variable and quite irrelevant for the sign itself, except when considering transitions between adjacent signs and their potential metamorphosis into compounds.

Signers can be characterized as being either left-handed with respect to signing or right-handed with respect to signing. For most signers with right (left) hand dominance, their right (left) hand will assume the active role most of the time. This is the natural, or unmarked, state of affairs. In special circumstances there is switching of the

hands (Battison 1974, Klima and Bellugi 1975, Frishberg 1976b).

A third pair of terms *ipsilateral* and *contralateral*, meaning same side and opposite side, respectively, are useful in discussing the orientation of signs with respect to where contact is made on the body. For signs which are not specified in terms of left or right, it is more germane to note which side of the body is touched in terms of *ipsilateral* (same side as that of the active hand) and *contralateral* (opposite side), rather than *right* and *left*. For example, in the American pledge of allegiance, the right hand contacts the contralateral breast; in a military salute, the right hand contacts the ipsilateral forehead or temple. Since we have already noted that left-right distinctions are superfluous to sign descriptions, the interaction between two articulators (body and hand), each having a left-right orientation, is easily described regardless of whether the left (right) hand touches the left (right) side of the body—ipsilateral contact—or whether the left (right) hand touches the right (left) side of the body—contralateral contact.

1.3 Typology of Signs

Given the preceding definitions, perspectives on the body as a sign-generating machine, and proposed elements of formation, it is now possible to return to the discussion of the formational qualities of signs in isolation. Our first task is to propose a tentative classification based on distinct types of motor acts.

For the purposes of this discussion, we shall posit six mutually exclusive, exhaustive, types of signs:

Type Ø: One-handed signs articulated in free space without contact (e.g. PREACH, Figure 4).

Type X: One-handed signs which contact the body in any place except the opposite hand (CHINESE, SOUR, Figure 2).

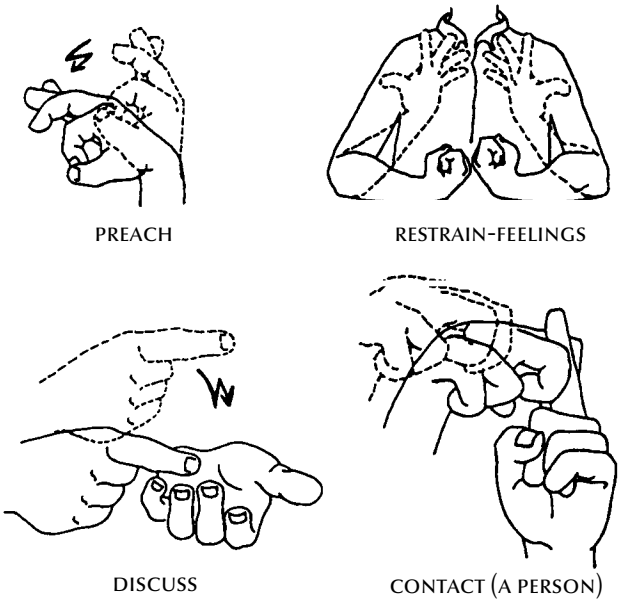

Figure 4.

Type 1: Two-handed signs in which both hands are active and perform identical motor acts; the hands may or may not contact each other, they may or may not contact the body, and they may be in either a synchronous or alternating pattern of movement (WHICH, CAR, Figure l; RESTRAIN-FEELINGS, Figure 4).

Type 2: Two-handed signs in which one hand is active and one hand is passive, but both hands are specified for the same handshape (NAME, SHORT/BRIEF, SIT/CHAIR, Figure 3).

Type 3: Two-handed signs in which one hand is active and one hand is passive, and the two hands have different handshapes. Note that signs which were excluded specifically in Type X fit in Types 2 and 3—one hand contacts the other (DISCUSS, CONTACT (A PERSON), Figure 4).

We shall also need to posit a sixth type, *Type C*, to account for those compounds which combine two or more of the above types.

Computing the frequency of types illustrates the opposition between the principles of symmetry and asymmetry. If one includes both one- and two-handed signs, then a majority of them are asymmetrical; if one looks only at the two-handed signs, most of them are symmetrical:

> In a study of more than 2,000 signs of American Sign Language, we found that only 35% involve the use of both hands where both hands are active [type 1]. About 40% of the signs are made with one hand only [types Ø and X], and another 25% are made with one hand acting on the other hand which remains stationary as a base [types 2 and 3]. Thus, for almost two-thirds of these signs, one hand is used as the dominant hand. (Klima and Bellugi 1975:232)

This classification is not intended to be absolute and definitive, as there are other bases for classification, e.g., type of movement (Supalla 1976, Grosjean 1977) or type of contact. But this classification allows us to relate signs directly to the relative complexity of certain motor acts. As discussion warrants, this general schema will be amended and refined.

Types 1, 2, and 3, the two-handed signs, are of greatest interest, since (apart from type C), they are the more complex signs and lend themselves more easily to relative measures of complexity. We can demonstrate the relative complexity of types 1, 2, and 3 by reference to Figure 5, which represents an idealized procedure for identifying the handshape specifications of a two-handed sign. Note that this is only a linguistic-analytic model and not a psycho-linguistic model. It merely reflects the amount of information coded into a two-handed sign according to the analysis of handshape specifications presented.

In terms of this model, the chain of questions which leads to the specification of the handshapes of a two-handed sign is more complex for type 3 than for type 2, and more complex for type 2 than type 1, where complexity is indicated by the number of questions. This is summarized in Table 1.

According to this model, type 1 signs can involve a greater amount of redundancy in that fewer questions are required to arrive at the specification for the two handshapes involved. Conversely, the greater number of questions required to specify both handshapes of a type 3 sign reflects a greater amount of internal structure, more complexity and less redundancy. Type 2 signs lie between these two extremes.

1.4 Morpheme Structure Constraints on Two-Handed Signs

The information presented thus far on two-handed signs can be described in terms

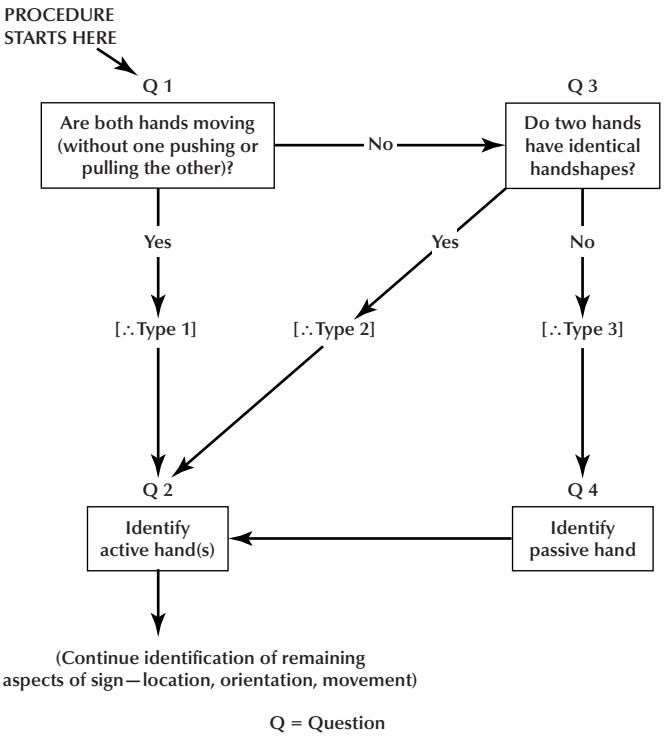

Figure 5. Idealized procedure for identifying the handshape specifications of a two-handed sign.

more compatible with linguistic descriptions, since they in fact reflect a hierarchy of constraints on the ways in which manual elements may combine to form sign morphemes. Simply by examining the descriptive definitions of types 1, 2, and 3, one can formulate two morpheme structure constraints stated over simultaneous primes which severely limit possible forms in a way which *excludes the more complex forms.* I call these two interlocking constraints the *Symmetry Condition* and the *Dominance Condition* (an earlier description can be found in Battison 1974). Both of these constraints can be stated in the familiar if-then form of morpheme structure conditions of spoken languages—*if* a certain structural configuration or element is present in the morpheme, *then* certain other things must be present (or absent) also.

The Symmetry Condition states that (a) if both hands of a sign move independently

Table 1. Questions Required to Obtain Handshape Information on a Two-Handed Sign, Following Schema in Figure 5

	Question (1)	Question (2)	Question (3)	Question (4)
Type 1	XX	XX		
Type 2	XX	XX	XX	
Type 3	XX	XX	XX	XX

Figure 6. SINCE

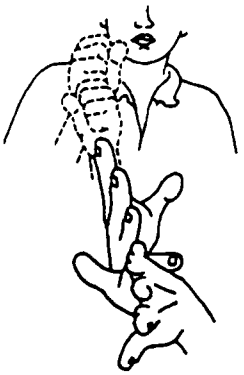

Figure 7. BE-PREPARED

during its articulation, then (b) both hands must be specified for the same location, the same handshape, the same movement (whether performed simultaneously or in alternation), and the specifications for orientation must be either symmetrical or identical.

"Same location" in this case means either (a) the physically identical location—both hands are actually in the same area; or (b) the hands are in mirror-image locations on either side of the line of bilateral symmetry. An example of physically identical locations would be the sign SINCE (also glossed UP-TILL NOW) (Figure 6), in which both hands start from the same corner of the upper chest and flip outwards. An example of (b) would be the sign WHICH (Figure 1) in which each hand is equidistant from the line of bilateral symmetry.

"Symmetrical orientation" can be defined as any orientation in which identical parts (any parts) of the two hands have mirror image orientations with respect to the plane which separates them. "Identical orientation" means that both hands have the same orientation with respect to the body (e.g., fingers pointed out from the body and palms down), but it says nothing about the orientation of the hands with respect to each other. Both SINCE and WHICH have symmetrical (and identical) orientations—identical parts of the hands "face" each other across the line which separates them. The sign BE-PREPARED (Figure 7) illustrates identical orientation without symmetricality: Both hands have volar surfaces contralateral, metacarpals outward, but identical parts of the hand do not face each other across the line which separates the hands.

Rephrased very informally, the Symmetry Condition amounts to saying: "If a two-handed sign is going to bear the added complexity of having both hands move, then both hands must perform roughly the same motor acts." A large number of logically possible gestures in which two hands perform different motor activities are thus excluded from being potential sign morphemes.

The simple Dominance Condition, inversely related to the Symmetry Condition, states that (a) If the hands of a two-handed sign do not share the same specification for handshape (i.e., they are different), then (b) One hand must be passive while the active hand articulates the movement, *and* (c) The specification of the passive handshape is restricted to be one of a small set: A, S, B, 5, G, C, and O[4] (Figure 8).

Type 3 signs obey this constraint with very few exceptions. In effect, the Dominance Condition rules that if a two-handed sign is so complex as to involve two different

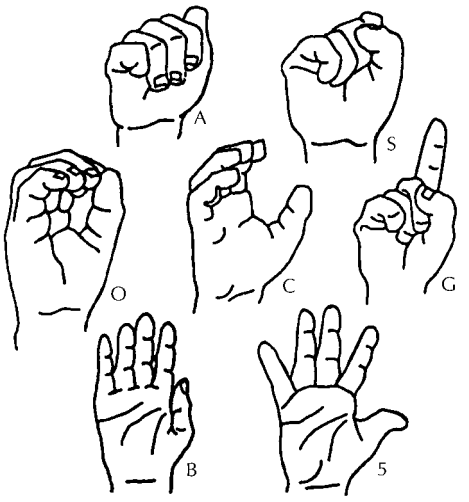

Figure 8.

handshapes, then the overall complexity of the sign must be reduced by (a) prohibiting movement of one hand (usually the nondominant) and (b) severely restricting the possible handshapes which may appear on this passive hand. The reduction from approximately 45 handshapes to a mere 7 greatly reduces the complexity of the sign and increases the redundancy, since a specification of one hand from among seven possibilities requires less information than a specification of one handshape among 45 possibilities. This constraint on complexity should tend to facilitate both the production and perception of such a complex sign. Looked at another way, the answer to question 4 of Table 1 does not carry as much information as the answer to question 2, since it chooses from among fewer possibilities.

Finally, it should be noted that the two-handed signs not delimited by either the Symmetry or the Dominance Condition constitute the in-between group, type 2, in which the handshapes are identical, but only one hand is active.

1.5 Marked and Unmarked Handshapes

The seven handshapes mentioned in reference to the Dominance Condition form an interesting group of critical importance. The first thing of note bears repeating: These particular seven handshapes may take the role of the passive hand in type 3 asymmetrical signs when dozens of others are proscribed. Secondly, a glance at Figure 8 suggests that these seven handshapes are maximally distinct, basic geometrical shapes. A and S are closed and maximally compact solids; B is a simple planar surface; 5 is the maximal extension and spreading of all projections; G is a single projection from a solid, the most linear; C is an arc; O is a full circle. They are thus the most basic possible handshapes, given these geometrical criteria, suggesting that they are maximally distinct in both articulatory and perceptual terms (with the exception of A and S, which are very distinct from the others, but very similar to each other).

There is also reason to believe that these seven are the most natural basic handshapes in a phonological sense also—i.e., that they are the unmarked elements in their set: (1) They have a high frequency of occurrence in a wide array of contexts (some of them exclusive contexts, as we have seen); (2) They are found in all other sign languages for which information is presently available to us; (3) They are among the first handshapes mastered by deaf children acquiring ASL from their parents (Boyes 1973, McIntire 1977); (4) In a visual perception experiment designed to test hypothetical feature analyses for 20 handshapes, Lane et al. (1976) found that the four hands least confused (i.e., most resistant to distortion by noise) were, in order, 5, B, C, and O, with A ranking 7th; (5) Children make production errors of handshape substitution which tend

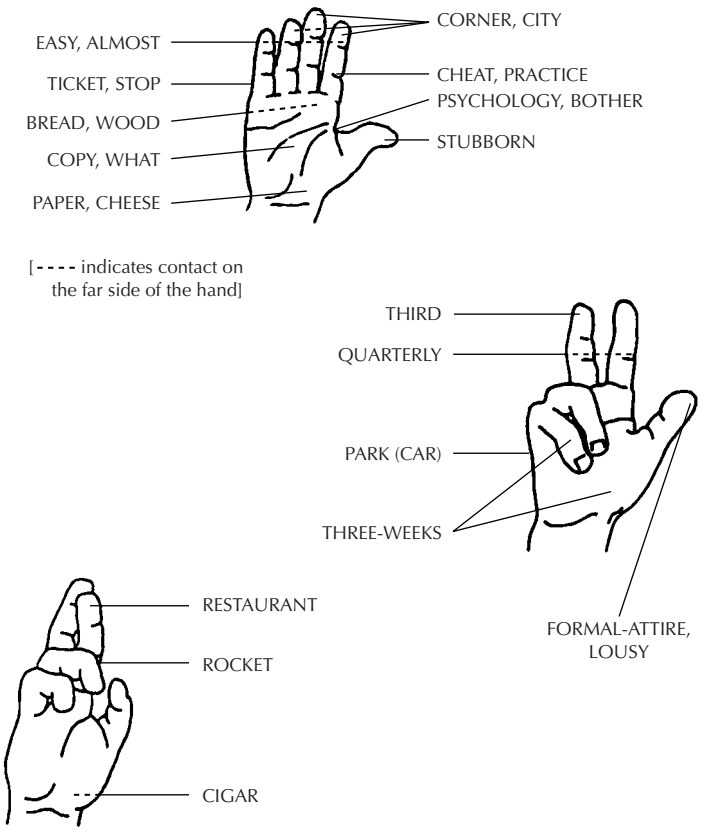

Figure 9. Comparison of potential points of contact of unmarked (B), intermediate (3), and marked (R) handshapes. (Glosses are examples of signs made by contacting these points.)

toward elements of this set (Boyes 1973); (6) This small set of unmarked handshapes functions less restrictively than other more marked handshapes—not only in terms of frequency as in (1) above, but in interaction with other elements of the sign: These seven handshapes have greater variety in how they may contact the body or the other hand in order to form signs; the more marked handshapes have greatly restricted points of contact (pointed out to me by Richard Lacy). Figure 9 compares the points of contact possible with an unmarked handshape (B), a handshape of intermediate status (3), and a highly marked handshape (R), which nearly always occurs in initialized[5] signs. These seven handshapes predominate in signs which require the active hand to change handshapes during the articulation of the sign. Of these 155 "dez-changing" or "double-handshape" signs, 136 (87.7%) have at least one unmarked handshape, and 98 (63.2%) change from one unmarked handshape to another (double-handshape signs are discussed in greater detail later in this chapter).

From the discussion thus far, it is evident that the complexity of handshapes individually and in simultaneous combinations are offset by quite stringent restrictions of distribution and co-occurrence. Unmarked handshapes have wider distribution and more freedom of co-occurrence than the more marked, more complex handshapes. The increased complexity of certain handshape combinations

in two-handed signs also prompts certain restrictions to balance out the complexity: Where both hands are required to move in a sign, they must perform identical or nearly identical motor acts—they cannot move independently within a given sign (Symmetry Condition). For those signs which require two dissimilar handshapes, one of the hands must be passive, and must be one of the seven most basic, unmarked handshapes (Dominance Condition).

This dynamic tension between increased complexity of some aspects of a sign and decreased complexity in other areas is a theme which will recur frequently in this study. It suggests that there are some relative, and perhaps absolute, restrictions on the allowable complexity of ASL signs. This is well illustrated by the preceding data on handshapes. In the following sections we shall consider additional evidence from locations, and from the number of beats in the articulation of individual signs.

1.6 Morpheme Structure Constraints on Location

The location aspect of signs is quite different from the handshape aspect, both in articulatory and perceptual terms. Handshapes are differentiated by the spatial configurations of the hand, involving the extension, contraction, contact, and divergence of the fingers. These relatively fine movements and configurations are acted out and displayed in an area of less than 50 square inches (the fully extended and open "5" hand of an average adult would not quite fill an area of 50 square inches). Fingerspelling, which relies almost totally on differentiation of handshapes, normally takes place in the region of the small circle in Figure 10 (shown for a right-handed person).

The manifestation and differentiation of the locational aspect of signs are necessarily

Figure 10. Fingerspelling (shaded) and signing areas.

grosser in many ways, since the extent of the space used is larger. Signs may be articulated freely in space, or they may involve contacting parts of the body. The general area in which signs are made is indicated by the large circle in Figure 10. Exaggerated signs, certain gestures, and pantomime may exceed these limits, but most signs would be made in this restricted area, which has been termed "signing space" by Bellugi (1972) and Frishberg and Gough (1973a).

The differentiations in location, whether on or off the body, are made within a much larger area than the differentiations for static handshapes. Obviously, there must be some compensation for this disparity in physical range. Three contributing factors act to balance out the motor-perceptual tasks on the relatively finely differentiated hand versus those on (or in front of) the more grossly differentiated body. The first of these is that the movements performed in this large signing space are performed by the brachial system, the movements of which probably cannot be as finely controlled or differentiated as

those of the digital system. Thus locational targets within this large space should be further apart. The second factor involves the visual backdrop of the body itself. Locations in signing space are not differentiable by relative distance alone, but by their proximity or relations to the gross landmarks of the body—the head, chin, shoulders, waist, etc.

Third, the entire signing space is not used uniformly. Certain areas allow greater complexity of motor acts. This can be shown in two ways:

(1) Measuring vertically we could compare the discrete levels on the body where signs are made. For this purpose we need only consider signs made by contacting the head, neck, or trunk (the "height" of signs made by contacting the arm itself is difficult to establish, since the arm is a mobile organ). Figure 11 shows the different heights at which various signs may contact the body. Not all of these height differences are phonologically distinctive, and for many of them minimal pairs cannot be found—but this is not crucial to the argument. It is apparent that greater vertical location differentiation is possible as one moves from the waist to the head.

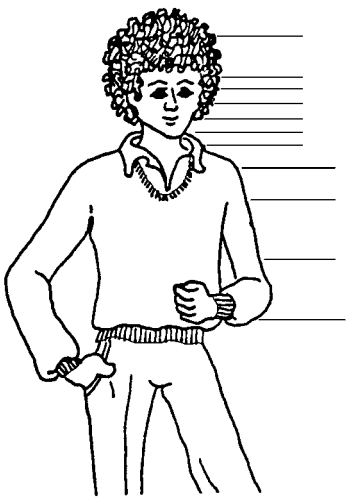

Figure 11. Vertical location distinctions.

(2) We could gauge the relative complexity of handshapes occurring in signs made at these various levels. One approach to this problem would be to trace the relationship between the unmarked handshapes (A, S, B, 5, G, C, and O) and the height of the location of the signs in which they occur.

Table 2 shows the number of unmarked and marked handshapes occurring in signs in either of two major areas: The head (including 15 signs made on the neck) and the trunk (from shoulders to waist). The signs were taken from DASL (Stokoe et al. 1965), and included signs which are normally made in close proximity without contact.

The percentage of marked handshapes in the head area is certainly higher than the percentage of marked handshapes occurring in the trunk area—33.1% as opposed to 24.1% ($\chi^2 = 4.10$; d.f. = 1; $p < .05$). While this is a significant difference, but not an overwhelming one, we should note additionally that 33 of the 34 signs made on the trunk with marked handshapes either involved contact on the upper or central trunk alone (e.g., RELIGION, EGOTISTIC, VOLUNTEER) or involve both upper and lower trunk contact (e.g., KING, LORD). Thus Table 2 does not reflect the fact that the lower portion of the trunk is almost "off limits" to marked handshapes. [We should note that, although DASL was compiled with the aid of many data corpora, it makes no claims to be complete. As more signs come to the attention of linguists and lexicographers, the counts in Table 2 will surely change, although the proportional results are assumed to be correct.]

Thus it does appear that the vertical location component of signs is systematically restricted in a manner consistent with the need to keep visual elements perceptually

Table 2. Number of Signs with Marked and Unmarked Handshapes Located in Two Major Areas

	Unmarked Handshapes	Marked Handshapes	Totals
Head and Neck Locations	311 (66.9%)	154 (33.1%)	465
Trunk Locations	107 (75.9%)	34 (24.1%)	141
Totals	418	188	606

Source: Enumeration of signs from Stokoe et al. (1965), *Dictionary of ASL*.
$\chi^2 = 4.10$, d.f. = 1, $p < .05$

distinct. Areas higher in the signing space permit more complex combinations of manual visual elements, both in terms of fineness of location distinctions and the complexity of individual handshapes.

An explanation for both these restrictions based on visual perception was proposed by Siple (1973), who suggested that in areas of high visual acuity, finer differentiation of handshapes and locations was to be expected. Signers in a conversation do not look at each other's hands, since the hands move radically and rapidly; instead we observe that they seem to fix their gaze on the lower part of the signer's face (regardless of whether the signer is accompanying the signs by mouthed or spoken words).

Thus Siple hypothesized that visual acuity should be highest in this area (the small circle in Figure 12), and should fall off rapidly as the distance from this central area increases. Siple also proposed that in the areas in the outer reaches of sign space, in areas of low visual acuity, not only should there be signs with simpler handshapes (i.e., more unmarked handshapes), but also more two-handed signs. Every two-handed sign that contacts the body is highly symmetrical (according to the criteria already discussed under the Symmetry Condition), and thus a greater proportion of two-handed signs insures a greater amount of articulatory and perceptual redundancy for the signs made in this area. Note also the finer differentiation of vertical locations in the combined head and neck area is also consistent with her explanation.

An alternative explanation to these findings is one based on visual "landmarks" rather than visual acuity. Coincidentally, the area delimited by Siple as corresponding to the highest visual acuity is also the area which has the greatest number of visually distinguishable (and readily nameable) body parts. On the visual backdrop of the facial surface we can readily distinguish the lips, chin, teeth, mouth, nose, nostril, cheek, jaw, dimple, moustache, temple,

Figure 12. Central area of signing space.

eye, eyebrow, etc., while the lower part of the signing space offers relatively fewer visible landmarks—shoulder, chest, side, waist. These distinguishable backdrop cues may facilitate the perception of the location of the sign.

The question of the relative merits of these two alternative explanations is best left to experimental determination; it is possible that the two systems interact and support one another. The issue of one- vs. two-handed signs in relation to sign locations will come up again in Chapter 2 [see original text].

If we take a slightly different view of the body and consider the lateral, not the vertical, placement of signs, we find restrictions also. We can distinguish three types of contact laterally: *Ipsilateral*, in which the hand (whether left or right) touches the corresponding side of the body; *Contralateral*, in which the hand crosses the line of symmetry and contacts the opposite side of the body; *Central*, in which the hand contacts the midline of the body.

In general, we observe that no ipsilateral or central contact is restricted—most ipsilateral and midline areas (on the different levels specified previously in Figure 11) are utilized by some signs. Contralateral contact is somewhat more restricted. Compare the shaded areas on the bodies in Figures 13a and 13b.

The shaded areas indicate where a right hand is attested in making a bodily contact during the articulation of a sign (the corresponding areas for the left hand of a left-dominant signer would be depicted by holding the page to a mirror). If we consider *all* types of body-contact signs, then Figure 13a represents where these contacts may take place.

Figure 13b shows a reduced contact area where signs specified for only a single contact may be made. Note that the areas which are shaded in Figure 13a but unshaded in

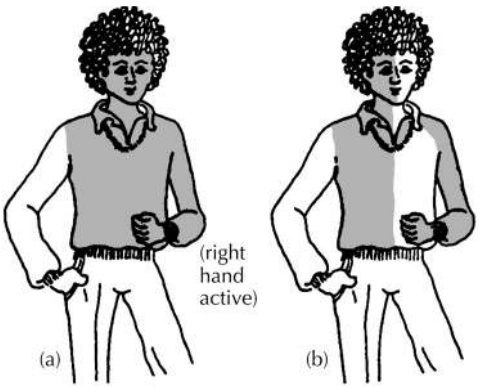

Figure 13. (a) Body locations for all signs. (b) Body locations for single-contact signs.

Figure 13b are just those where a specific type of sign is made—signs which require two contacts, one on each side of the body's midline.

In the forehead area, there are signs such as SUMMER and BLACK, both of which brush a forefinger from contralateral to ipsilateral. At midface there is FLOWER, which contacts first the ipsilateral, and then the contralateral side of the nose. At the chin are the examples FARM, BACHELOR, RESTAURANT, SLOPPY, DRY and BORING, which contact the contralateral side and then move to contact the ipsilateral side of the chin. At the marginal area of the waist we have the sign SAILOR, in which both hands (in the O configuration) contact first the side contralateral to the dominant hand, then the ipsilateral side.

Regarding the shaded areas which are not common to both bodies in Figure 13, a morpheme structure condition is suggested: If a sign is specified for contralateral contact for a place other than the opposite breast or arm, then it is also specified for ipsilateral contact; *contralateral contact does not occur on its own.* But this constraint actually has very few signs in its domain; most of them are listed above. This fact, coupled with the

very restrictive nature of the constraint, suggests that ipsilateral locations are the more natural or unmarked, while contralateral locations are marked.

This seems in accordance with the intuitive notion that extra effort is required to move the manual articulator to a location on the opposite side of the body's midline. The exceptional nature of the opposite hand and arm as locations is likely due to the fact that they themselves are mobile and do assume a more central position when used as locations (e.g., as the passive hand in a type 2 or type 3 sign). The opposing hand, when used as a location where the moving hand articulates, is generally held in front of the central meridian of the body; it does not remain at the extreme edge of the body.

For locations of signs, we thus find that there are systematic restrictions on the use of certain locational elements, and some restrictions on combinations of these elements. This is true of both the vertical and lateral dimensions of location. We find some basis for these systematic restrictions in considering the dynamics of the moving articulator and principles of visual perception.

1.7 Metric Restrictions

The last set of constraints to be proposed, before moving on to phonological processes in Chapter 2, involves specifying the temporal complexity of a sign by counting the number of manual articulations involved. Not surprisingly, there appears to be an upper limit, which shall be one of the principal concerns when we discuss the lexical restructuring of borrowed forms (loan signs) in Chapters 4 and 5 [see original text].

In fact, *two* is the upper limit of complexity for the formation of signs. A simple sign can be specified for no more than two different locations (a sign may require moving from one location to another), and no more than two different handshapes (a sign may require that the handshape changes during the sign). It is not clear whether such an absolute metric restriction applies to either orientations or movements. Note that these restrictions are claimed for simple signs only, not compound signs. However, it is interesting to note that many, if not most, compounds are themselves composed of no more than two simple signs.

1.7.1 Locations

We have already discussed some restrictions on signs with double locations; now we can look at the range and variety of the occurrence of these signs. No sign is specified for more than two locations, which themselves must be located in the same major area. Figure 14 demarcates four major areas on the body where signs make contact. Any sign which makes two separate contacts with the body confines those contacts to the same major area. The only exceptions to this are

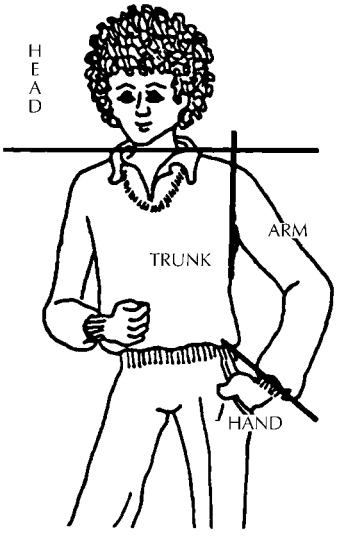

Figure 14. Four major areas.

compound signs or signs derived from compound signs.

Examples of signs made in two separate locations are (a) *Head area*—FLOWER (both sides of the nose), INDIAN (nose to crown or temple), BACHELOR (chin, contralateral to ipsilateral); (b) *Trunk area*—KING (contralateral breast to ipsilateral waist), SAILOR (both hips), OUR (breast, ipsilateral to contralateral); (c) *Arm area*—BRIDGE (wrist to elbow), IMPROVE (wrist to forearm), POWER (shoulder to forearm); (d) *Hand area*—TOAST (i.e., toasted bread; volar and dorsal surface), FLATTER (volar and dorsal surface of extended index finger), THEN (thumb tip to index tip).

In contrast to this restriction on simple signs, compound signs (or signs derived from compounds) may move from a location in one major area to a location in another major area: SISTER, derived from GIRL + SAME, contacts the cheek and then the opposite hand; REMEMBER, derived from THINK + SEAL, may contact the forehead before contacting the opposite hand; DAUGHTER, derived from GIRL + BABY, contacts the cheek and then the forearm. An examination of phonological processes in the following chapter will show that these complex compounds crossing major area boundaries are unstable, and tend to delete one of their locations.

1.72 Handshapes

Some signs may require that one or both hands change handshapes while making a sign; these signs are limited to no more than two such different handshapes. These signs which change handshapes during the articulation of a sign will be referred to as *double-handshape* signs, and are of great importance to understanding the restructurings of Chapter 4. Double-handshape signs fall into two broad types—those which also involve moving from one location to another, and those which remain in one relatively confined area. Both of these types include signs made in space and signs made on the body. Examples of each of these follow.

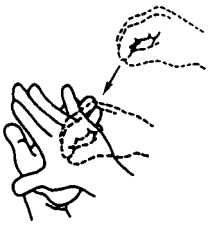

Figure 15. NOTE-DOWN

NOTE-DOWN (Figure 15) is made on the opposite palm, and involves changing the active hand from an O to a 5, without any additional movement. (This sign means "to make a note of something important," not "taking notes in a class.") Other double-handshape signs made in one location on the body include ACCEPT (5 becomes O, contacting the trunk), ORANGE (C closes to S, in front of the mouth or chin), CHEWING-GUM (V becomes V̈ [Bent V], fingertips contacting cheek).

Double-handshape signs which move on the body include RESTRAIN-FEELINGS (Figure 16) (5 becomes S, moving down the trunk), SPLIT/DISAPPEAR (L becomes bO [baby O], moving along the extended index of the opposite hand), FAR-OUT (5 becomes S, with the same location and movement as SPLIT).

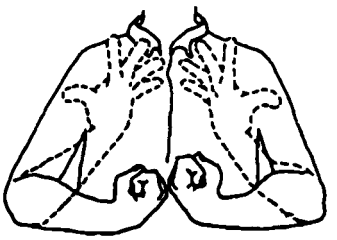

Figure 16. RESTRAIN-FEELINGS

Double-handshape signs made in space, off the body, may also be either static or moving, although locational points are not as easy to supply, since there are no convenient reference points in space without reference to the body. Static double-handshape signs made in space include MILK (hand held about shoulder height, C becomes S, repeatedly), and one of the signs for BEAT/OVERCOME (S becomes H). Other signs which might fit this class include 81 of the signs for the numbers between ELEVEN and NINETY-EIGHT. However, these are all transparently analyzable as compounds.

Finally, signs which move in space and also change handshapes: SIGN-ASL (verb; Figure 17) (each hand alternatively moves forward, changing from S to 5, repeatedly); WELFARE/SUBSCRIBE (hand moves from head height to shoulder height, changing from L to bO (baby O)); BE-PREPARED (Figure 18) (ulnar surface of one S-hand contacts thumb surface of the other S-hand, hands thrust forward and change to 5-hands, once); BAWL-OUT (same as BE-PREPARED, but rapidly reduplicated).

Double-handshape signs, in spite of their apparent complexity, appear to be a stable part of the language if we judge on the basis of their prominence—there are 155 double-handshape signs listed in *DASL*. They exhibit a number of interesting characteristics which bear on the present discussion and

Figure 17. SIGN-ASL (repeated)

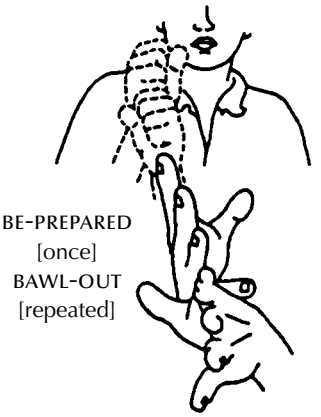

Figure 18.

on the later discussion of loan signs. There are four major points to be made about the *type* of handshapes which occur in double-handshape signs:

(1) As already pointed out, the handshapes which predominate in these signs are the unmarked seven—A, S, 5, B, G, C, and O. Of the 155 signs which change handshapes, 136, or 87.7%, involve at least one member of this select set; in 98 of the signs, or 63.2%, both handshapes are unmarked.

(2) The dimension of change which is most often involved in these handshape changes is that of relative *openness* and *closedness* of the handshapes. Thus straight, extended fingers may bend or fully contract into the palm (B→B̈, V→V̈, 5→S); extended fingers which are bent or curved may straighten out (B̈→B, V̈→V, O→5, X→G) or they may close (C→S); fingers which are contracted into a compact fist may extend fully (A→5, S→5). 153 signs, or 98.7%, vary in this way along the closed/open dimension. (The two exceptions are HAIRCUT and BOTH, in which V→U; the fingers converge but do not close or bend.)

(3) It follows from the above that most of these handshapes involve *maximal* changes

along the closed/open dimension. If we consider the two handshapes A and S to be the maximally compact, closed handshapes, and B and 5 as the maximally open handshapes, then these two end-points enjoy a prominent role in double-handshape signs. 125 signs, or 80.6%, involve at least one element from the set A, S, B, and 5 (83 as the initial handshape, 73 as the final handshape, and 31 signs which involve a maximal change from A/S to B/5, or vice-versa).

(4) The handshape changes on the dimension of open/closed are generally relevant to all involved fingers. Thus, if two fingers are extended, both will be bent; if five fingers are extended, all of them will be bent over or closed completely, etc. In measuring this tendency, we find that 136 signs, or 87.7% of the double-handshape signs, change the closed/open dimension of all involved fingers, instead of merely some of them. So while there are signs where C → S (closing all fingers), we do not find C → V̈ (leaving two bent extended fingers); we find O opening all its fingers to 5 and closing all its fingers to S, but we do not find signs where an O opens two of its fingers to an L, nor do we find signs where O closes three of its fingers to bO (baby O).

Double-handshape signs exhibit restricting tendencies on handshapes which exclude many logically possible, but overly complex gestures. Complexity of these signs is held to a minimum by favoring the involvement of unmarked handshapes which make simple transitions to other unmarked handshapes along a single dimension of *open* vs. *closed* hand.

1.73 Iterations

Besides measuring the number of locations and number of handshapes included in a sign, we can also measure the number of unit *executions* or beats that are required to articulate a sign. Execution here means the production of the basic specified units of the sign—its location, handshapes, orientation, and movements all in one bundle (some of these locations or handshapes may be doubled or complex, as we have just seen). Thus a single execution or beat is one complete cycle of a sign, with no part of it being repeated.

Some signs require internal repetition; the individual lexical item may consist of a reduplicated gesture. Sometimes this serves to mark an inflection on a sign which commonly consists of one execution. Some noun plurals are formed this way, for example, and some verb inflections are marked by special types of repetition (Fischer 1973). But what concerns us here are the parameters of monomorphemic lexical description and differentiation. In this regard, it turns out that some signs simply require two beats, some for seemingly arbitrary reasons, and some because they are derived from signs which once had two different locations, but currently have a reiterated gesture made in one location (Frishberg 1975, 1976).

Examples of signs that require two metrical beats include MANY (which itself is a double-handshape sign in which S→5, so the sign consists of a chain of handshapes; S→5→S→5), SCHOOL, KNOCK (on a door), GO-BACK-AND-FORTH (or COMMUTE), BAWL-OUT (Figure 18), DISCUSS (Figure 4), PAIN, PREACH (Figure 4), and NAME (Figure 3).

There are also some signs which always have only a single beat, the movements of these often being sharp. Reduplication in these forms is either not attested, or only found when the sign is inflected in some other manner. These include the signs: BE-PREPARED (Figure 18), TRICK ("to trick someone;" volar side of active A hand hits dorsal side of upright passive G, once); ILLEGAL (volar knuckles of active L strikes

and rebounds from volar surface of passive B, once); LOSE ("to lose a game;" volar folded knuckles of active V contacts volar surface of passive B, once); CONVINCE (ulnar edge of B strikes edge of upright G, once); KNACK/CAN-DO (tips of thumb and index of F contact chin, once; see DASL pp. 155–156).

Further, we should note two things. First, while there are signs which are limited to one beat in unmarked contexts, the signs which require at least two beats have no absolute limit on the actual number of iterations. The number two is a required minimum; such a sign may be produced with three iterations, or four iterations, etc. There are no lexical distinctions based on the difference between two and four iterations, or two and five iterations, etc.; the difference is between signs with one beat and those with iterations.

1.8 Summary

We have seen that for the submorphemic level of American Sign Language, the formational level, one can establish goals of description and explanation which are consonant with those of generative phonology. In particular, the phonological component of a language must determine the permissible and inadmissible forms of a language. Starting with a brief description of the manual visual elements of ASL, the primes which fall into the four aspects of location (tab), handshape (dez), movement (sig), and orientation, we have seen that ASL restricts the formation of admissible signs:

(1) The units themselves have a hierarchy of complexity which is measurable. Certain handshapes (A, S, B, 5, C, G, and O) are unmarked handshapes. Certain locations of the body are favored over others for the complexity of signs they enter into: Ipsilateral and central locations are unmarked in this regard, and contralateral locations are marked; locations in proximity to the head area allow finer differentiation of handshapes and locations than in the trunk area, and this is in accordance with strategies for visual perception available to the sign perceiver.

(2) Other constraints regulate the combinational properties of these elements as they form morphemes. The Symmetry Condition requires symmetry if both hands of a sign are moving, in order to limit the complexity of the sign; likewise, the Dominance Condition restricts the movements and possible handshapes of the passive hand in signs which have two different handshapes, one on either hand. Bilateral symmetry is thus unmarked, and asymmetry is marked.

(3) For double-handshape signs (signs which change handshapes during the sign), signs which have two locations, and signs which have a double execution (or reduplication), we also find restrictions. We have posited an upper limit on the underlying form of a sign, which states that it may not require more than two handshapes, two locations, or two separate executions of the basic gestural motor act. Double-handshape signs themselves are restricted in the types of handshapes which they may involve.

There remains another very important question: Do these proposed constraints systematically disallow certain manual formations in ASL, or do they merely represent accidental gaps in the lexicon which could be filled but are not? A tentative answer will be proposed after more evidence is presented in Chapter 2.

In conclusion, these are the basic points:

a. It is possible to describe and measure formational complexity of signs.
b. There are severe restrictions on the

formation of signs which exclude the more complex combinations of manual-visual components.

c. Therefore not all possible manual-visual gestures are permissible signs in ASL.

d. The restrictions on possible occurring signs of ASL are motivated by the dynamics inherent in manual articulation and visual perception: The restrictions are linguistic limitations on information coding, partly brought about by a need for systematic redundancy in the signals.

In informal terms, Chapter 1 has pointed out "what signs look like, and why." In Chapter 2 we shall see how these principles and structures take a more active role in determining the shape and substance of American Sign Language—in other words, how signs behave, both in terms of passage of time, and in terms of juxtaposition to other signs.

NOTES

1. Sign glosses are given in small capital letters. The gloss is simply a common translation of the sign into an English word, and the semantic, syntactic, and morphological properties of the word and the corresponding sign do not necessarily coincide. For example, the English word "attend" has two different ASL translations, one sign meaning "pay attention," and the other meaning "to go to an event." Conversely, the single ASL sign SINCE can also be translated into English as "lately," "up till now," "has been," etc. As such, *the capitalized gloss is merely a convenient label or name of a sign.* As much as possible, the same capitalized gloss (name) will always be applied to the same sign. Additional notes on other transcription conventions will be found in Chapter 4.
2. The capital letters and numerals used in descriptions of signs are names (or symbols) of handshapes, and should not be confused with letters of any alphabet (although in some cases that is the motivation for the symbol). The symbols in this study are based on Stokoe's (1960) transcriptional system. The reader who is unfamiliar with the handshapes involved in fingerspelling and in American Sign Language should consult Appendix A; Stokoe's symbols for handshapes appear in Appendix B [see original text].
3. This concurs with Kimura's findings (1973a, b) that the dominant hand makes more free movements while accompanying speaking activity. From these studies and many more, including cases of aphasia in deaf signers, she makes a strong case for left hemispheric control (in right handers) of the motor activities underlying verbal and gestural activity, including sign language (Kimura 1974, Kimura, Battison, and Lubert 1976).
4. For the purpose of simplifying the discussion here, this "select set of seven handshapes" includes phonetically distinct variants which do not always contrast at any underlying level of representation. A permissible variant of A on the passive hand (and certain other contexts) is S, which differs only in that the thumb is more compact—placed over the knuckles rather than at the side of the index finger—the A is generally found in signs requiring volar contact and the S hand with ulnar contact. B (with thumb held at side of index finger—not folded into palm as with fingerspelled B) and 5 also co-vary or freely vary in many contexts. See Friedman (1976) for a more detailed description of the distributional patterns of handshapes.
5. "Initialized" signs (or "initial dez" signs, or "initial handshape" signs) are those whose handshapes correspond (via fingerspelling) to the first letter of the English word which commonly translates the sign. Thus the sign WAY may use a W handshape, although it is standardly made with a B handshape. More commonly, many signs use one of the handshapes that do not correspond to a letter of the fingerspelled alphabet (e.g. AIRPLANE, HATE, and THIRD); recall that there are more than 26 different handshapes. Other signs coincidentally use handshapes which correspond to fingerspelled letters, but they may have no connection to an English gloss (e. g. SCHOOL with B handshapes, TELEPHONE with a Y handshape, SIGN(ATURE) with a B and an H hand). For some handshapes (e.g. D, E, R, T, and W), nearly all the signs which employ them are initialized signs. In this sense they can be said to occur in a restricted context, since they are not freely productive handshapes. For example, signs commonly made with an R handshape include RESTAURANT, ROCKET, ROOM, RAT, RATHSKELLAR, RED, REGISTER, RESEARCH, RULE, REASON, RESPOND, and REHEARSE.