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Phonological features and feature classes: The case of movements in sign language☆

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Abstract

The signs of sign language consist phonetically of hand configurations, locations on the body or in space, and movements. Some models claim that dynamic movements and static locations are the sequential segments of sign language, and even that movements are analogous to vowels. Others claim that movements are redundant, or in any case should not be represented as fully-fledged sequential segments. The present study measures movements against stringent phonological and morphological criteria for featurehood and classhood, in light of the current controversy over their status. Data from American Sign Language and from Israeli Sign Language support the claims made here, among them, that there is a set of phonologically contrastive features of movement which is phonetically coherent, and that these features constitute a class that is referred to in a blocking constraint on Multiple inflection and other processes. It is shown that the distinction between sequences of dynamic movements and static elements in signs is exploited in templatic morphology in both sign languages. While this analysis supports the claim that movements are phonologically significant at the underlying level, it suggests that their linear position need not be lexically specified.

1. The controversy

From the earliest days of sign language linguistics, it has been accepted that there are three categories of phonological features: hand configuration, location, and

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movement.[1] The hand, in some configuration, moves in some way with respect to some location on or near the body. In Stokoe's seminal work (1960), he showed that there can be minimal pairs distinguished only by features within one of these three categories. For example, two signs can have identical hand configurations and movements, and be distinguished only by having different locations. Discovering the organization and structure of these categories and their relation to each other has kept us sign language phonologists busy ever since (for overviews, see Klima and Bellugi, 1979; Wilbur, 1987; Corina and Sandler, 1993; Brentari, 1995; Sandler, 1995a; Sandler and Lillo-Martin, in preparation). Recently, however, the very existence of one of these categories has been challenged: the category of movements (Stack, 1988; Hayes, 1993; Uyechi, 1994; van der Hulst, 1993).

Consider the Israeli Sign Language (ISL) sign, LEARN, shown in Fig. 1. The hand is characterized by a 'flat O shape; and the hand moves in a straight path toward the ipsilateral side of the forehead.

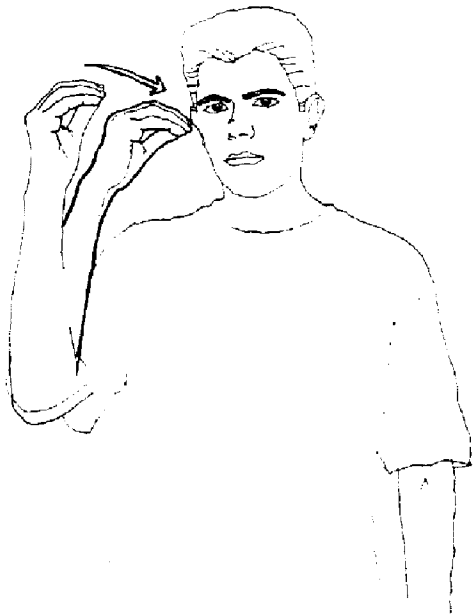


Fig. 1. LEARN.

[1] There have been some departures from this, however. Battison (1978) proposes a fourth category, palm orientation. That proposal was made because signs can be minimally distinguished by different orientations. Sandler (1987a,b, 1989, 1993a) argues that orientation is a class of features that is hierarchically dominated by the handshape category.

In Liddell's (1984a) model and its successors (e.g., Liddell and Johnson, 1985, 1989), a plethora of new categories is introduced. Discussion is beyond the scope of this paper.

Notice that the movement in this sign has no special characteristics; it is a straight path movement from a location a short distance away from the temple to a location nearer to the temple. If these two locations are specified, then the intervening movement could be seen as a mere phonetic necessity. I will not be able here to deal with each of the movemementless models mentioned above because they differ so much from each other. I think it is fair to say that each model assumes either that movement features are redundant, and may be derived from other properties of the sign, or that they are actually features of some other category. Each model diminishes the importance of movements phonologically.

Space limitations also prevent me from comparing the present model with other models that do assume underlying movements (e.g., Liddell and Johnson, 1989; Brentari, 1990; Perlmutter, 1992), though I believe that many of the arguments made here will support any model that includes a structural role for movements.

I will argue here in defense of movements, and will try to demonstrate that movements are important in the phonology and the morphology of two unrelated sign languages: American Sign Language (ASL) and Israeli Sign Language (ISL). But I will propose that the structural position of movements need not be represented underlyingly. The process of demonstrating the phonological existence of movements offers an opportunity to have a second look at the criteria for determining featurehood and classhood in phonology in general.

Section 2 gives the background necessary for understanding the discussion. It explains what movements are, and sketches the model of sign language structure in which the present discussion is couched (Sandler, 1989a). Section 3 gives evidence that there is a phonetically coherent set of phonological features belonging to the movement category and responsible for underlying contrasts. In this section, the importance of movements in morphology is also presented. Section 4 focuses on the way in which the two unrelated sign languages, ISL and ASL, manipulate the temporal relations between static locations and dynamic movements, suggesting that there are certain similarities between this system and the templatic morphology of Semitic languages, for example. The main claim of this section is that the grammars systematically distinguish between dynamic (movement) elements and static elements, and alter the duration of each discretely. The apparent importance of movements for enhancing perceptual salience is briefly discussed in section 5, which deals with the underlying representation of movements. Here I suggest that a movement slot may be absent from the underlying form. The last section concludes the discussion, summing up the main characteristics of movements that any model of sign language phonology must address.

2. What are movements?

In order to produce a sign, the hand generally follows a path from one location to another, as illustrated in Fig. 1 above. Movement along this path is the most common type of movement found in signs and is generally called 'path movement'. The hand itself is shaped and oriented in a specified configuration for any given sign, and

the fingers, their shape and the palm orientation together constitute the hand configuration category (Sandler, 1987a,b, 1989a, 1993a, 1995b, in press). Alternatively, rather than moving in a path from location to location, a different type of movement may occur in a sign: the fingers may change their position (=handshape change), or the whole hand may change its orientation (=orientation change), without moving along a path. These types of movement are referred to as hand internal movement, or local movement. Finally, local movement and path movement may co-occur in a sign, as shown in Fig. 2, for the ISL sign TAKE-ADVANTAGE-OF (path movement plus handshape change local movement).

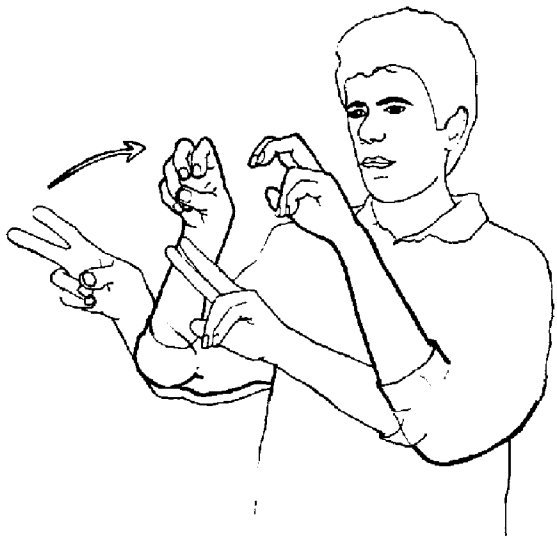
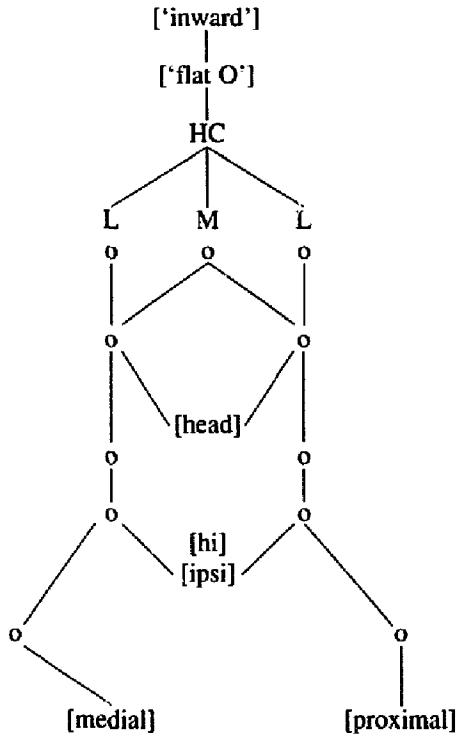


Fig. 2. TAKE-ADVANTAGE-OF.

For the most part we focus here on path movement. A partial representation of the sign LEARN is shown in (1). Terms in single quotes are informal labels, not features. Each node represents some class. Some nodes and structural relations are left out and others left unlabeled, in the interest of simplicity.

(1)



Underlyingly, the hand configuration category bears a nonlinear (autosegmental) relation to locations and movements (Sandler, 1986, 1989, 1993b); one hand configuration characterizes all locations and movements in the morpheme. The root node of the movement segment is associated to the highest category nodes of the surrounding locations, indicating that it gets its entire specification from the locations and from the hand configuration in this sign (see Liddell and Johnson, 1989, and Sandler, 1993c, for more discussion of this representation for movements).

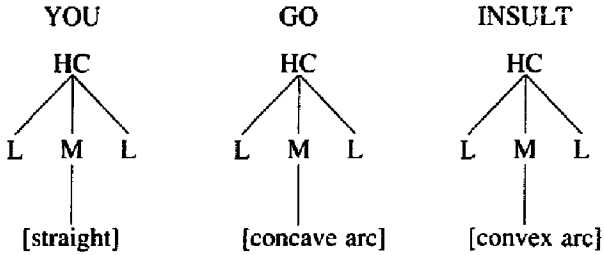
There is some phonological and much more morphological evidence that there are two linearly ordered locations in the canonical sign, that is, that the part before the movement and the part after the movement must be specified (Liddell, 1984; Liddell and Johnson, 1985, 1989; Sandler, 1989, 1990, 1993b,c). If this were the whole story, any phonological representation of the intervening movement would appear to be an embarassment: the hand has no choice but to move in order to get from one location to another. However, this is not the whole story.

3. Movement features

Monomorphemic signs may be contrasted, minimally, or nearly minimally, by features of movements. For example, movements may have an arc shape. The shape

of the arc is generally convex, but it may also be concave. The three ASL signs, YOU, GO (one-handed variant), and INSULT, for example, are primarily distinguished by movement features. YOU is signed with the hand in a pointing shape, and a straight movement away from the signer (toward the addressee). A variant of GO is signed with the same hand configuration and in the same direction, away from the signer, but with a concave arc-shaped movement path. INSULT is like GO, except that the shape of the arc is convex.

(2)



It appears that the feature [arc] is distinctive in ISL as well. A near-minimal contrast made by this feature is seen in the near minimal pair HELP and BOAT. These signs differ from each other primarily in the following way. The sign BOAT is made with a straight path movement forward, while the (citation form of the) sign HELP is made with an arc path movement forward.[2]

A contrast that supports both the existence of a movement category as well as a sequential representation of movements and locations is seen in the linear distribution of the feature [contact]. The signs PAY and WHAT are a near minimal pair, partially distinguished by which segment or segments are specified for the feature [contact]. While other features distinguish these signs as well, it is very unlikely that the temporal distribution of [contact] is influenced by any of them. That is, the linear position of [contact] is not predictable.

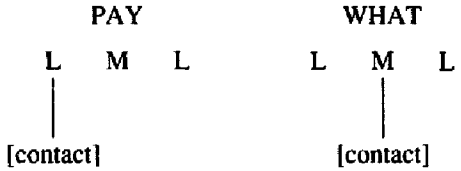
In both signs, the dominant hand moves and the nondominant hand (h2) functions as the location for the sign (Sandler, 1989a, 1993b).[3] In PAY, the contact between

[2] It is often difficult to find true minimal pairs in sign language. The reason for this, I believe, is the iconic foundation for some signs in these languages, which results in idiosyncratic details. Many of these details are phonologically irrelevant because no constraints or rules of the language require reference to them. The ISL pair HELP, BOAT is a good example. In HELP, the pinky side of the top hand rests on the inside of the top joints of the fingers of the bottom hand, giving the impression that the bottom hand is pushing up the top hand in a helping gesture. In BOAT, the two hands are aligned symmetrically along the pinky side, to create the image of a boat. While either sign would look odd if pronounced differently, it is highly unlikely that the angle of the fingers of the two hands is distinctive or otherwise phonologically significant.

[3] In the present discussion, I ignore the fact that many signs involve both hands. According to my theory, this has no bearing on the discussion of movement, since the nondominant hand either behaves the same as the dominant hand, or it functions as a location-dominated place of articulation, and requires no special structure of its own (Sandler, 1989a, 1993d, and for a comparison of two opposing views, van der Hulst and Sandler, 1994). Some of the several theories of the two hands include Liddell and Johnson, 1985; Brentari and Goldsmith, 1993; and van der Hulst, this issue.

the signing hand and h2 takes place on the initial location segment. After that, the hand moves. In WHAT, the hand begins at a location above h2; then it moves, and during the movement it makes a brushing contact with h2; finally, it ends at a location below h2.

(3)



Since [contact] is a feature that may characterize either locations or movements, it appears that there must be a linear place in the representation for both of these categories in order to express distinctions of the sort shown in (5). A similar distinction is found in ISL: the signs PAY and CASHIER-PLACE are distinguished by contact on the movement and on the final location, resp.[4]

Another movement feature is exemplified in the distinction between the ISL signs GUARD and LOOK-AT. These signs are nearly identical, except that GUARD has a restrained, doubled movement. This double movement pattern is common in ASL as well, and appears to be distinct from the true reduplications that mark such processes as temporal aspect inflections. Double movements are often underlying, may determine minimal contrasts, and generally involve muscle restraint, resulting in a small, controlled movement. Often, there is no apparent semantic motivation for this doubled movement.[5]

True reduplication, on the other hand, is not restrained, and generally involves three or more repetitions of the movement. In addition, the reduplications are semantically motivated, corresponding to temporal properties such as duration or iteration.

For simplicity, I will take the position that restrained double movement is a unified phenomenon and should be marked by some single feature, which I will call

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[4] In principle, it is possible to create different features to distinguish the signs in Fig. 3. That is, rather than propose a sequential representation in which the feature [contact] specifies segments of movement or location or both, one might sugggest features that have appeared in the literature such as [brushing], [grazing], or [continuous contact]. There are two problems with such an approach. One is that it adds to the inventory of features, complicating the model. The other is that a sequential model is still required to distinguish pairs like INTELLIGENT (middle finger variant) and SICK. These two signs are nearly identical, but INTELLIGENT has initial contact on the forehead, while SICK has final contact on the forehead. To complete the picture, the sign BLANK-MIND has the same middle finger HC, but the hand moves across the forehead from a contralateral location to an ipsilateral location, while continuously contacting the forehead across all three segments. A sequential model that includes linear positions for locations as well as movements can coherently represent the occurrence of [contact] in all of the signs discussed, as well as in signs like DEAF, in which only the first and last locations but not the movement have contact. Any segment or segments on which contact occurs is/are so marked.

[5] There is a third type of repetition that involves only two iterations but no muscle restraint: the repetition for verbs that are inherently durational (Supalla and Newport, 1978). Like reduplication in the temporal aspect system, these verbal reduplications are argued in Supalla and Newport (1978) to be derived.

[restrained].[6] I assume that [restrained] is a feature of movement which has the phonetic effect of doubling the pronunciation of the sign. When restrained signs with doubled movements are reduplicated in ISL, the domain of reduplication is the doubled movement. ISL LOOK-AT and GUARD, for example, are distinguished by the feature [restrained]. The feature [restrained] is distinctive in the uninflected ASL lexicon as well, for example in the minimal pair EASY (with [restrained] movement) and ALMOST (with plain movement).

Thus, not all repetitions are here analyzed as linear reduplication: lexical doubled movement is claimed to be represented by a single feature [restrained] on the movement segment of a sign whose linear representation is LML; its phonetic reflex is doubled movement. Contrarily, morphological reduplication, as in the temporal aspect system (Sandler, 1990, and section 3.3 of this paper), is analyzed as true linear reduplication: LML + LML. This analysis gains independent support from a psycholinguistic lexical identification experiment conducted by Emmorey and Corina (1990, also reported in Emmorey, 1995). Subjects were able to identify monomorphemic signs with doubled movement (e.g., ASL SOMETIMES) before the repeated portion occurred, while formationally similar signs with inflectional reduplication (e.g., PAY, Continual) could only be correctly identified after the repetition began. It is not surprising that the continual aspect could only be identified when it actually occurred (in the form of linear reduplication). What is of interest is that the lexical repetition for SOMETIMES was not needed for correct identification. This lends credence to the view that the two types of repetition are phonologically distinct, the view I take here. Apparently, then, we must add the feature [restrained] to the pool of movement features available to sign languages.

Another movement feature that appears to play a phonological role in ISL at least is the feature [tense],[7] characterized by muscle tension and a sharp movement. For example, the signs PUSH and HATE are distinguished by the feature [tense], which characterizes HATE but not PUSH.[8]

Given this inventory of movement features, I propose that the plain, straight movement that characterizes many uninflected signs is a default movement, and is not represented lexically. This and other redundancies are discussed in section 5.

2.1. A homogeneous set

In spoken languages, classes of features usually share articulatory properties, whether we think in terms of the natural classes designated by distinctive features (e.g., the natural class of voiced or of back sounds), or in terms of the articulator-based feature classes of feature geometry (e.g., the laryngeal class or the dorsal class). Similarly, the features that characterize movements appear to be homoge-

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[6] The feature [restrained] as used here differs somewhat in form from *restrained* as first used in Supalla and Newport (1978) to describe derived nouns in particular, and as used in Sandler (1989a).

[7] Some ASL signs are characterized by this tense type of movement, e.g., BITCH and BECKON (or CALL).

[8] The signs PUSH and HATE are further distinguished by facial expression.

neous phonetically. That is, restraint, tension, shape (arc) all naturally characterize movements and not locations for example. This fact supports the claim that these features belong to a natural class, argued here to be the movement class. The feature [contact] is less clearly one of movement only, and may characterize the static part of signs as well. It is too early in the development of feature theory for signs to say more about the classification of this feature here.

In addition to articulatory factors, another important criterion for classhood is that constraints and rules of languages refer to the whole class, regardless of the particular features in it. We turn to that issue in the next section.

3. Morphological rules and phonological constraints that involve movements

3.1. Verb agreement, and a constraint on complexity of movement in ISL

Both ASL and ISL have verb agreement systems, in which the spatial location of the subject and/or object is marked on the verb. Generally, this means that the hand, in the configuration specified for a given verb, moves from a location denoting the subject to a location denoting the object.[9] If the referents are not present, then a point in space is established as the agreement locus for each referent, and the hand moves in a path relative to those reference points. So, to sign I-GIVE-YOU in ASL, the hand, shaped in a 'flat O' shape, moves from a location near the signer's chest toward the addressee. For YOU-GIVE-ME, the locations occur in the reverse order, so that the hand moves from a location opposite the addressee toward the signer's chest. Neutral third person locations are generally to the right and left of the signer, so that to sign SHE-GIVES-HIM, the hand moves from one side to the other. These singular agreement forms, then, involve marking locations.

One agreement morpheme involves features of *movement*, rather than features of location, and it is this marker that is of special interest to the present discussion. The multiple object agreement morpheme is formed by moving the hand, characterized by the hand configuration specified for the given verb, in a horizontal arc. For second person multiple object ('all of you'), the arc is articulated opposite the addressee(s), generally in front of the signer; for third person multiple object ('all of them'), the arc is articulated to the right or left of the signer.[10] Fig. (3a) illustrates the ISL sign LOOK-AT 1st sg. subj., 2nd sg. obj.; (3b) is LOOK-AT 2nd sg. subj., 1st sg. obj.; and (3c) is LOOK-AT 1st sg. subj., 2nd multpl. obj.

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[9] Some verbs move from object to subject. See Padden (1988), Brentari (1988), and Meir (1994) for discussion of these 'backwards verbs'. For a completely different view of agreement phenomena in general see Liddell (this issue).

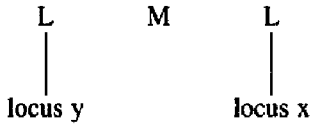
[10] In both languages, the multiple agreement morpheme consists of a horizontal arc. However, there is a grammatical difference between the two systems: ASL has a multiple agreement marker for second and third person objects only ('all of you', 'all of them'), while ISL has a multiple agreement marker for first person ('all of us') as well as second and third person multiple objects.

Fig. 3. (a) 'I look at you'; (b) 'You look at me'; (c) 'I look at you' (multiple).

The first relevant observation is that the multiple agreement morpheme itself is a type of movement. While the arcs that characterize uninflected signs, as well as those found in other types of inflections (such as the temporal aspect inflections discussed below) are generally vertical arcs, the multiple agreement morpheme in both sign languages consists of a horizontal arc. Clearly, then, the languages must distinguish the two movement planes. Given two locations, one to the signer's left and one to the signer's right, for example, and given an arc movement to connect them, the plane of the arc is not predictable. An arc could connect the two either on the vertical plane or on the horizontal plane. In addition, the arc could move outward from the signer, as in the second and third person multiple object markers in both languages, or it could move inward toward the signer, as in the first person multiple marker in ISL (see note 10). While there are other conceivable ways to account for arcs on two planes (see, for example, Nagahara, 1988; Uyechi, 1994; Hayes, 1993), the model sketched in (1) offers a coherent framework for representing the arc types: simply as features of the movement segment. The arc that marks multiple agreement is distinguished in the lexicon from the arc that marks temporal aspects by the feature [horizontal].

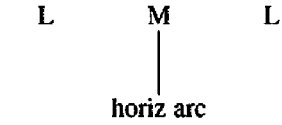
While no adequate system has been developed for representing the agreement loci, it has been proposed that they constitute features of the location segments.

(4)



The multiple number agreement morpheme requires a movement specification.

(5)



As we saw in the preceding section, uninflected verb signs in Israeli Sign Language may have underlying movement specifications, such as [tense], [arc] (on the vertical plane), and [restrained]. These specified movements interact in an instructive way with the horizontal arc of the multiple object inflection. It appears that verbs that have feature specifications on the movements of the verb base *block* multiple agreement.[11] This blocking demonstrates that features of movement are visible to the morphology. In the following subsections, this blocking phenomenon and its implications for a movement category are discussed in detail.

[11] To express multiplicity where the multiple arc verb inflection is blocked, the verb is followed by a pronominal form consisting of a pointing hand moving along a horizontal arc.

3.2. Movement specification as a phonological constraint

We now return to the interaction of underlying movement specification of the verbal base, and the multiple object horizontal arc in ISL. Of the near minimal pair, GUARD and LOOK-AT, the latter takes the multiple inflection (illustrated in Fig. 3c), while the former, lexically marked for the feature [restrained], does not. Similarly, INFORM, with plain straight movement, takes the multiple inflection, while the formationally similar TEACH, marked for [restrained], does not. All four signs inflect for singular person agreement, marked by different first or second locations, or both. That is, they are all in the category of agreement verbs. But the only agreement morpheme that involves a *movement feature*, the multiple, distinguishes among the signs, attaching selectively to signs with no underlying movement specification. There does not appear to be any plausible semantic or pragmatic reason for this; any of these blocking verbs can take a multiple theme semantically. Rather, the characteristic common to the blocking verbs, TEACH and GUARD, is that each has some movement specification, while INFORM and LOOK-AT do not.

This explanation is lent support by the behavior of verbs with specified movements other than [restrained]: other movement features also block the multiple horizontal arc. Examples discovered so far are the feature [tense], as in the sign HATE, and a circling movement on a point of contact, as in the sign CONVINCE. CONVINCE is distinguished from the sign INFLUENCE by its movement pattern; CONVINCE involves small circles on the nondominant hand, while INFLUENCE involves only a straight movement to contact with the nondominant hand.

As expected, INFLUENCE may take the horizontal multiple arc, while CONVINCE may not. Clearly, the semantic argument structure of these two verbs is identical, or at the very least, too similar to account for the difference in inflection pattern.[12]

The fact that the horizontal arc of the multiple inflection may not combine with signs that have movement specifications strongly suggests that the ISL verb agreement system is manifesting a constraint on movement complexity. This analysis appears to be supported by data from American Sign Language. In her treatment of the syntax of verb agreement in ASL, Padden (1988) notes that signs with lexical double movement do not take the multiple agreement marker. As in ISL, the multiple form consists of a horizontal arc. Thus, the constraint is active in ASL as it is in ISL, at least in the case of the double movement feature (here called [restrained]).

The blocking phenomenon is stated as a constraint in (6).

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[12] Elsewhere, I have argued that circles are generally best understood as a sequence of arcs with complementary values for concavity (Sandler, 1989, 1990). For consistency, I represent the small, repeated circling on a point of contact seen in CONVINCE with the features [arc] and [restrained]. Since [restrained] has the phonetic effect of doubling the movement, the correct surface form results. There may be a small set of signs that resist phonological breakdown into arcs: signs in which circling is created by rotation of the finger or wrist joint, rather than at the elbow.

(6) Constraint on multiple inflection

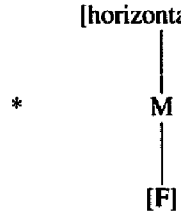


Table 1 shows that verbs with underlying movement specifications do not inflect for multiple, while those with no underlying movement specifications do take the multiple inflection. It is assumed, following time-honored practice in spoken language phonology, that a criterion for classhood is that the grammar must make reference to the purported class, regardless of its featural content. (6) is a constraint that adheres to this criterion. It does not matter which of the phonetically coherent set of movement features characterizes the sign; if any of these features does so, then the morphological process is blocked. In this way, this discussion has provided two separate pieces of evidence for movement as a category. First, the horizontal arc that marks the multiple inflection is an underspecified movement morpheme. Second, it is blocked from attaching to a verb stem that has any specification for movement. In addition to this constraint, I have discovered a process that refers to movements regardless of features, to be described in section 4.

Table 1
ISL agreement verbs with movement specifications block affixation of the horizontal arc of the multiple agreement marker.

(i) Default movement	± multiple	(ii) Specified movement	± multiple
GIVE	+	HATE [tense]	–
INFLUENCE	+	CONVINCE [arc, restrained]	–
INFORM	+	TEACH [restrained]	–
LOOK-AT	+	GUARD [restrained]	–
ACCUSE	+	TAKE-REVENGE [arc]	–
DISTRIBUTE	+	TELL-STORY[arc,restrained]	–

3.3. Verbs of motion and location: Movement roots

In his dissertation (1982), Ted Supalla describes the system of verbs of motion and location in ASL. In this system, roots that consist solely of movement features are combined with classifiers that are represented solely by hand configuration features. For example, if the classifier signifying VEHICLE is combined with an ARC movement, the resulting verb would mean VEHICLE-TRAVEL-IN-AN-ARC-PATH. Supalla argues convincingly that this system is not analogic to real world action, but rather is a finite and componentially constructed system. The lists of pos-

sible classifiers and possible movement roots are quite restricted, and the classifiers and movement roots freely cross-select.

A phonological treatment of this system has yet to be undertaken, and representations of the roots proposed by Supalla have not been worked out. However, certain purported movement roots, such as arc and zig-zag, do not seem to lend themselves to any interpretation other than that they do indeed belong to a movement category.

3.4. Temporal aspects

Another area of the grammar of ASL which refers to movement features is in the temporal aspect system (Klima and Bellugi, 1979; Sandler, 1989a, 1990). Several temporal aspects are created by changing the relative timing of the sign elements of the base verb, by changing the feature specification of the elements, or both. Liddell (1984b) and Sandler (1989a, 1993b) propose that such changes involve associating the base form to a template which is sometimes partially specified.

Some of the aspects, such as the resultative, are marked by geminating locations, resulting in a form in which the hand is held static at some location. These will be returned to in section 4. Other aspects, such as durational, habitual, and continuative, involve reduplicated circular movement patterns. Fig. 4 shows the form LEARN Continuative (illustrated in citation form in Fig. 1).

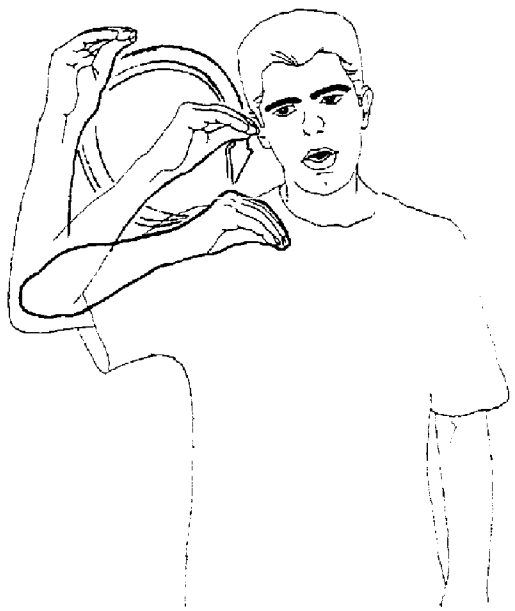
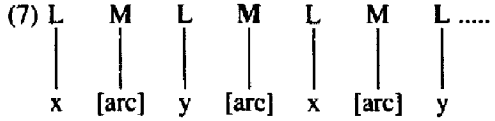


Fig. 4. LEARN (continuative).

In Sandler (1989a, 1990), I argue that most circles in ASL consist of a sequence of two arcs (see note 12), and that the circular temporal aspects are formed by associating an underspecified morpheme consisting of an [arc] to the movement segment of the base verb, and then reduplicating. An arc with the opposite specification for concavity (shown in bold print in (7)) is epenthesized between the reduplicated forms.[13]

(7)



Both the verbs of motion and location, and the temporal aspect systems, then, involve changing movement patterns, here argued to involve underspecified movement morphemes. Since these are morphological processes, the movement morphemes must be listed in the lexicon; therefore, they exist.

3.5. Features and morphemes of movement: A summary

The following features have been argued to characterize movements: [contact], (vertical) [arc], [horizontal arc], [tense], [restrained]. Three kinds of evidence for the existence of these features have been presented. First, the features [arc], [tense], and [restrained] have been shown to distinguish minimal or near minimal pairs in ASL and ISL. Second, it was argued that the feature [contact] must be associated to particular segments in order to partially distinguish certain signs.[14] This is an argument for both sequentially represented positions and for movement as constituting one of those positions. Finally, the feature [arc] is argued to constitute the phonological content of underspecified morphemes in the ASL verbs of motion and location system, as well as in the temporal aspect system.

Clearly, any suggestion that movements are merely phonetic transitions is severely undermined by these facts. Since these features all characterize movements, the facts indicate that sign language phonologies care about movements.

Let us take a step back and ask whether the phenomena examined so far must be attributed to a movement category, or whether it is possible to divide up the phonology according to some other type of categorization. This is an attempt to avoid circularity of a claim such as, "These are movement features; therefore, elements characterized by these features are movements".

At the phonetic level, these features all specify either the shape or quality of the transition between two static elements. Shape features such as [arc] define the move-

[13] Whether an arc is concave or convex is apparently predictable on the basis of the relative height of the two locations with respect to each other, and the epenthetic movement between reduplications gets the inverse specification (Sandler, 1989a, 1990).

[14] The feature [contact] on any segment blocks deletion when signs are reduced under compounding (Liddell and Johnson, 1986; Brentari, 1990; Sandler, 1989a, 1993c), providing another argument for the existence of this feature.

ment portion of the sign, and do not affect other components such as hand configuration or location.

That [arc] explicitly specifies movements and not locations can be seen clearly where the morphology manipulates locations and movements independently in the same sign. For example, the sign LOOK-AT in ASL is an agreement verb, and can therefore be inflected for different subjects and objects by changing the first or second locations (or both). So, to sign 'you look at me', the hand moves from the addressee toward the signer. In addition, this sign may inflect for a temporal aspect that imposes a circular movement pattern on the base. This circular pattern, represented schematically in (7), is achieved by associating the underspecified [arc] morpheme to the movement segment and reduplicating. The direction of the resulting circles is determined independently by the location specifications. Thus, the direction of the circles will be away from the signer in the form meaning 'I look at you' durational, and toward the signer in the form meaning 'you look at me' durational (Sandler, 1989a, 1990). This shows that the feature [arc] distinctly specifies the movement segment.

Similarly, the quality features [restrained] and [tense] seem phonetically to belong to movement. Phonetic impressions are not enough, however. It is conceivable that one might consider these features to be manner features characterizing the whole sign, in the spirit of van der Hulst (1992, 1993). Here we appeal to the tendency of features to announce their class membership by their behavior in processes. The fact that [restrained] and [tense] pattern with more prototypical movement features such as [arc] in the ISL verb agreement system, blocking attachment of the multiple agreement marker, indicates that they belong to the same category as [arc]. Features that are specific to locations (such as [contralateral]) or to hand configurations (such as [open]) play no role in blocking the multiple form. Location features phonetically specify static targets.

Most importantly: given that the horizontal arc multiple morpheme itself consists of a movement (shape) feature, by making the phonetically natural assumption that [arc], [tense], and [restrained] are also movement features, we are able to *explain* this blocking in terms of a constraint on the complexity of movement. If this analysis is correct, then it indicates that the criterion for feature classhood is met: the class of movements is referred to regardless of the features that characterize it.

The feature [contact], on the other hand, has been shown to characterize either the movement portion of signs, or a location segment, or both. We have so far discovered no agreement verbs whose movement is specified for contact, so we have not been able to test whether such a specification would block horizontal arc attachment. We therefore cannot use this as a test of whether [contact] belongs to the movement class, or whether it has some status that simply enables it to specify either location or movement segments in the way that [nasal] may specify either a consonant or a vowel.[15] In any case, the temporal privileges of occurrence of [contact] serve to provide evidence that locations and movements are distinct and sequenced.

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[15] See van der Hulst (1994) and Clements (1989) for investigation and discussion of interactions of consonant and vowel features.

The features attributed to movements in this theory, then, apparently form a phonetic as well as a phonological class.

4. The movement/non-movement sequence

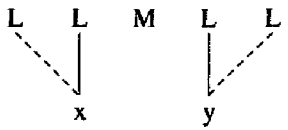
The model adopted here posits a sequence of locations and movements such that the canonical sign is seen as an LML sequence. The comparison with a spoken CVC syllable is inescapable, and several researchers have discussed such a comparison (Liddell, 1984a; Sandler, 1989; Perlmutter, 1992; Sandler, 1993c). It has also been suggested that movements are perceptually more salient than other elements in the sign (Brentari, 1990 (a nonsequential model); Perlmutter, 1992; Sandler, 1993c).

Space limitations do not permit examination of those suggestions and analyses (but see section 5 for a discussion of salience). However, to make the point that the distinction between static and dynamic elements is important in sign languages, I will briefly describe the way in which sign languages manipulate the relative duration of static (L) and dynamic (M) elements for grammatical purposes. Since sign languages apparently distinguish movements from the static parts systematically, then this bifurcation must be real. That is, regardless of whether or not the analogy with consonants and vowels turns out to be valid, the reference to dynamic elements as distinct from static elements supports the claim that movements are a significant part of the sign linguistic system.

4.1. Prosodic templates

It has been shown elsewhere (Klima and Bellugi, 1979; Sandler, 1989a,b, 1990, 1993b,c) that there is a rich system of temporal aspect morphology that alters the relative timing of static and dynamic parts of signs. For example, one way of marking the intensive in ASL is by lengthening the static beginning and ending of a sign. This is represented in the model assumed here in the following way:

(8)



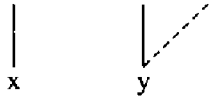
Under this inflection, neither path nor internal movements are lengthened. But if there is an internal movement, such as a handshape change, then the beginning and ending handshapes are geminated together with the beginning and ending location features. Sandler (1989b, 1993b) proposes that this is achieved by linearizing the handshape features (which are underlyingly associated to hand configuration) and alligning them with the Ls, allowing them to geminate with the other L features. The important point for our purposes here is that the movement that intervenes between the lengthened static parts is not affected by this process.

In ISL, there is an intensive form that lengthens the movements rather than the locations (lengthens them durationally, not spatially):

(9) L M M L

In this form as well, hand internal movements are affected the same way as path movements: like the path movement, the movement of the fingers from one position to another is lengthened. The precise temporal dynamics are more complex and are currently under study, but it is clear that this process affects movement duration and not the duration of the static parts of the sign. In the *same* language, there is another process that lengthens only the final static L and not the M, one that gives verbs the meaning 'for a long time'. This form is reduplicated:

(10) L M L L] redup



It is not yet clear what the restrictions are on these processes, and whether they can each apply to the same bases. However, it is striking that the same language distinguishes static from dynamic elements in this way. Both sign languages discretely and systematically select either the movements or the static units to lengthen, depending on the meaning to be conveyed.[16] The fact that sign languages must refer independently to locations or movements (regardless of their feature content) in order to state grammatical processes indicates that each must represent a linguistically significant class.

4.1.1. Slots are prosodic

I have shown in earlier work (Sandler, 1989a, 1990, 1993a,b) that this system bears similarities to templatic morphology in Semitic languages that manipulates the length of vowels or of consonants (McCarthy, 1979, 1981). It was pointed out by a reviewer that the analogy may not hold, since spoken language templates are now generally reanalyzed as consisting of 'real' prosodic categories such as the mora or the syllable (McCarthy and Prince, 1986, 1993).

Apparently, sign languages do not have moraic or other subsyllabic prosodic structure independent of skeletal structure (contra Perlmutter, 1992). There are no known onset/rhyme asymmetries. Rather, what's good for the onset appears to be just fine for the rhyme. For example, either the beginning or the ending of a sign or

[16] It is noteworthy that the distinction between sequential movement and nonmovement portions of signs (Supalla and Newport, 1978; Newkirk, 1981) led to the development of the first sequential models of sign language (Liddell, 1984; Sandler, 1986).

both may be geminated. No processes have been shown to single out heavy rhymes, and no formational constraints hold for onsets or rhymes indpendently. This suggests that morae are a notational variant of skeletal slots in sign languages. So, the most economical approach is to assume that the skeletal slots borrowed from the earlier CV theory and required for other reasons in sign language do have prosodic status in sign language. That is, they serve the dual purpose of providing positions for aligning features (Sandler, 1993a,b), and of constituting the units of prosody below the level of the syllable.

4.1.2. No underlying length distinctions

Furthermore (and a point also questioned by the same reviewer), there are no convincing examples of *underlying* length distinctions. That is, while these length alternations are apparently part of the grammar of sign languages, there is as yet no convincing evidence that they play a role in underlying contrasts. To propose the strongest testable hypothesis, I make the following generalization from what has been uncovered so far in these two unrelated sign languages: Sign languages have no underlying length distinctions, but do have derived contrastive length distinctions at the level of systematic morphological and intonational patterns.[17,18] Here we may have a genuine difference between signed and spoken languages. That is, if the verb form templates of classical Arabic, for example, never exceed maximal syllable structure for underived forms, then this would differ from the situation described here for sign languages. This issue clearly requires more attention in future research.

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[17] The model of Liddell (1984) and Liddell and Johnson (1989) proposes that there is a sequence of movement and hold segments (Ms and Hs). Holds are seen as lengthened static portions. The theory proposes that the holds exist underlyingly because they are there in citation form, but that they are deleted in most cases in spontaneous signing. Sandler (1986, 1989a) and Perlmutter (1992) argue against a global rule of hold deletion, claiming instead that holds (lengthened static portions) are derived, and their occurrence in citation forms is the result of the signs being produced in isolation, like phrases.

[18] Hayes (1993) presents a purported minimal pair with an underlying final length distinction, taken from Supalla and Newport (1978). The signs THAT'S-THE-ONE and STAY are said to contrast, in that STAY has a final hold and THAT'S-THE-ONE does not, having instead a slight retraction of the hand at the end. While these signs support the original Supalla and Newport claim that signs must be linearly segmented in order to account for the contrast, they do not necessarily support Hayes' claim that the distinction is underlying. The form of STAY under consideration is most likely a one word phrase and a command, better glossed STAY-THERE!. It differs formationally from the usual sign glossed STAY. If the one with final length is indeed a full phrase and command, then the length is expected to be the result of phrase final lengthening (Perlmutter, 1992) and/or intensification (Klima and Bellugi, 1979; Sandler, 1989, 1993b,c), which also results in final length. Similarly, THAT'S-THE-ONE is also likely to be derived. In this case, it is very similar to the sign THAT; THAT involves contact with the nondominant hand, while THAT'S-THE-ONE is produced in space and involves a slight retraction characteristic of tense movement. The production in space rather than on the nondominant hand is likely to be the result of spatial agreement, and the retraction may well be a prosodic effect, distinguishing THAT'S-THE-ONE from THAT-ONE. I am suggesting that the signs with final length are derived, and therefore do not provide evidence for an underlying length distinction. This is at the moment an unanswered empirical question, but the existence of a likely alternative explanation seriously undermines Hayes' claim.

Returning to the matter at hand, the mere fact that these processes must refer discretely to movements as a class is yet more evidence for their existence formally, and their importance in the sign language system.

5. Representation

We have seen that movements have phonological and morphological significance, and it has been shown that their contrast with static units is exploited by the grammar of sign languages. If this is the case, then how is it possible to propose models with no representation of movement, as some investigators have done?

When these issues are thoughtfully considered, a rather startling observation arises. In order for a sign to be well-formed, hand configuration, location, and movement are each necessary. Yet phonetically speaking, movement is not necessary. That is, a hand in some configuration can be held at some single location, and this would be a pronounceable unit. For example, the sign LEARN (illustrated in Fig. 1) could be produced simply by placing the hand at the temple; the sign LOOK-AT (Fig. 3) could be produced by placing the two hands together with the appropriate orientation. The only movements left in such a hypothetical system would be transitional movements between the unitary static locations. The converse is not true: a sign cannot be pronounced without either a hand configuration or a location.

Although movementless signs are phonetically possible, such signs virtually do not occur. Rather, movement is mandatory in the vast majority of signs. In those few instances where movements are deleted under some morphological or prosodic process, informal observation reveals that some other type of movement will often take its place – either movement of the face or of the body! In addition, although we have seen that movements have a significant phonological and morphological role to play, they appear to carry far less lexically contrastive information than do either hand configurations or locations. It is conceivable that the sign language lexicon would be afforded enough possible contrasts even without movements. So it becomes all the more important to point out that movements are still necessary for well-formedness.

To recap, movements are arguably not necessary on purely phonetic grounds or on grounds of affording the lexicon sufficient contrastive possiblilities. Yet, movements are overwhelmingly pervasive within signs. The mandatoriness of movements, even in the many signs in which they carry no lexically contrastive information, lends support to the argument that movements enhance perceptual salience in this visually perceived language system.[19] Future research must deal with this explicitly prosodic role of movement. For our purposes here, we must be able to account for those areas

[19] Following this line of reasoning, Sandler (1993c) proposes a 'sonority' hierarchy, according to which segments with more movement, e.g., path and local movement together (as in the sign TAKE-ADVANTAGE-OF, Fig. 2) are more sonorous than plain path movement segments (as in LEARN, Fig. 1, and locations specified for contact are lowest on the scale (e.g., the final segment in LOOK-AT, Fig. 3).

of the phonology and morphology in which movement is indeed linguistically significant, without allowing glaring redundancies in the representation. And it is to that end that the following discussion is addressed.

The model adopted here represents the canonical sign form as the sequence LML, standing for a position and timing tier.[20] This representation is useful and perspicuous, allowing for the expression of all linear effects, such as the linear position of the feature [contact], the gemination of segments, and other linear processes described in the literature. However, the fact remains, as pointed out in movementless theories of sign language, that the linear position of the movement with respect to the locations is utterly redundant. This section very briefly sketches a solution to this problem, relying partly on studies reported in detail elsewhere (e.g., Sandler, 1993c; see note 19).

A similar situation – redundancy of linear position – holds of vowels in Mayan, a language with CVC morphemes. McCarthy (1988) suggests that the position of the vowel should not be present in underlying representation in such languages. Corina and Sandler (1993) suggest that underlyingly, signs are represented as L1, L2, M – that is, only the locations are ordered underlyingly. One might take this a step further and suggest that there is no M at all underlyingly, only floating movement features, that allign themselves with M slots late in derivations.[21] The ASL sign INSULT, with a convex arc movement, is partially represented as follows according to this proposal, where 'F' stands for all features of each category instantiation, and the linear position of hand configuration features and of the [convex arc] feature are not specified:

(11)

HC	L1	L2	[convex arc]
|	|	|	
F	F	F	

HC features later associate to all segments (for reasons spelled out in Sandler, 1986, 1989a, 1993b,c, and elsewhere), while the movement feature later associates to the movement segment (which must occur in any case, since it is impossible to pronounce two different successive locations without movement in between).

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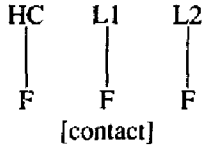
[20] The claim that the vast majority of signs, morphologically simple or complex, are of the form LML is supported in Sandler (1989a,c) and discussed in Corina and Sandler (1993). Other linear models (Liddell and Johnson, 1985, 1989; Perlmutter, 1992) assume much more variety. Such variety, which can often be verified impressionistically, has not yet been justified phonologically.

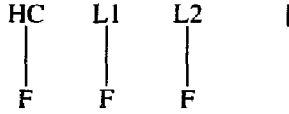
[21] This proposal bears some similarity to ideas of van der Hulst (1993, this issue), in which feature clusters associate themselves to X slots. The movement features described here are seen as manner features in van der Hulst's theory. Conceptually, manner features might be distinguished from movement features in that the former characterize the whole sign, while the latter characterize only the dynamic part of the sign. I suggest that the latter position, the one argued for in the present paper, is supported by the fact that the dynamic portion is extracted from the rest of the sign in the templatic aspectual system and in 'brushing' contact signs.

This leaves a problem only for the feature [contact], since that feature may characterize either locations or movements, as we have seen. The problem can be solved by associating the feature to locations that are [contact] (12), and leaving the feature underlyingly unassociated only for signs in which movements are [contact], as shown schematically in (13). By redundancy rule, the feature eventually associates to the M slot.

(12) PAY



(13) WHAT



Compare the underlying representations shown in (12) and (13) to the representations in (3), which are seen as surface representations according to this view.

6. Summary and conclusion

The present study delimits some of the facts that must be accounted for by any theory of sign language structure:

(1) Movement features are contrastive.
(2) Movement features form a phonetically coherent set.
(3) Movement features form a class that is referred to in a blocking constraint.
(4) There are sets of movement features that constitute underspecified morphemes.
(5) Movements are referred to in morphological processes that discretely lengthen them. Other processes discretely lengthen static elements and skip movements.
(6) Movements are required for well-formed signs.

The theory outlined here accommodates these facts by positing features belonging to a movement class, and by making a movement segment available in the representation that can assume movement features and undergo gemination. While movement features must exist in lexical entries, the movement segment – a positional and timing element – is here suggested to be derived and not underlying.

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