24 The Phonology of Movement in Sign Language

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To watch a person communicating in a sign language is to observe a well-coordinated, multi-channel display of bodily motion. Most salient in this display is movement of the hands, which transmit lexical, morphological, and timing information. In coordination with the hands, motion of the mouth and lower face performs phonological, morphological, and gestural functions. Simultaneously, movement of the head and body provides a kind of prosodic shell to house the signing hands. Prominently embedded in this outer shell are the brows and eyes, whose movements provide intonation, the visual "tunes" of the message. The same physical articulators are all exploited by speakers as well, to augment the linguistically organized vocal–auditory signal.[1] But in sign language, it is these visually perceived actions that convey the linguistic signal itself, in a synchronized panoply of motion.

What are the primitives of movement at each level of linguistic structure? How are they organized? In what ways does the phonological organization of movement correspond to phonological properties of spoken languages? Can a comparison of the two help to separate universal linguistic properties from modality effects in language generally? How does the organization of such a system arise? These are the issues addressed in this chapter, which focuses on the phonological category of movement. The other two major phonological categories – hand configuration and location – are not the main objects of interest here.[2]

The first section describes the nature of movement in lexical signs, providing evidence for the existence and unity of movement as a phonological category. The section also provides a model for the representation of movement, briefly noting its strengths and weaknesses and those of alternative models. The goal of that section is to give the reader a feel for the nature of movement in lexical signs and for some of the issues involved in representing it phonologically.

[1] The term "speakers" as used here refers only to producers of spoken languages, while "signers" refers to producers of sign language.

[2] See Sandler and Lillo-Martin (2006) for a detailed overview of sign language phonology.

The morphology of sign languages exploits movement forms that are not found in simplex signs, a peculiarity of sign languages that is described in §2, where movement patterns in temporal aspect morphology are analyzed by means of morphological templates. The section also shows that morphological complexity is achieved not only by movement of the hands, but by movement of the mouth as well. A subsystem of the grammar in which movement appears to have certain analogic properties completes §2.

Also playing a linguistic role in sign language is movement of the upper face, head, and torso. These articulators provide prosodic and other cues, simultaneously with the lexical and timing information conveyed by the hands. The organization of movement in the service of prosody is the subject of §3, followed by §4, a brief comparison with the way speakers use visible movement.

While all established sign languages seem to exploit movement in similar ways, most likely due to the interaction of particular iconic and motoric underpinnings, evidence from a newly emerging sign language described in §5 suggests that these typological features are not "given" at the outset. Instead, lexical movement, obligatory in signs of established sign languages, takes phonological form only gradually, as the linguistic system as a whole emerges. §6 concludes the chapter by considering what the study of sign language phonology and movement might teach us about phonology in general, through a comparison of movement in sign language with phonological elements of spoken languages.

1 Movement in lexical signs

Examples of basic types of manual movement and their combinations that occur in lexical signs are illustrated in Figure 24.1. The examples are from Israeli Sign Language (ISL), except for Figure 24.1g, which is from American Sign Language (ASL), but the same types are found in other sign languages as well. The two types of lexical movement are path movement and internal movement of the hand or hands. Path movement is generated at the shoulder or elbow and results in moving the hand in a path through space. Internal movement is generated either by the wrist, resulting in orientation change, or by the fingers, resulting in a change in the shape of the hand.

Path movement can have the shapes [straight] (the default, shown in Figure 24.1a), [arc], or, in ASL, "7", the latter used primarily for initialized city names, in which the handshape is taken from the fingerspelled first English letter of the name (see CHAPTER 9: HANDSHAPE IN SIGN LANGUAGE PHONOLOGY for *initialization*), and also a rare "Z" shape, e.g. in NEVER and LIGHTNING in ASL. Lexical movement is constrained in the following ways: there is typically only one movement in a sign, performed on or near a single area of the body, the head, torso, arm, or hand. Another way to create a path movement is by moving the hand/s in a circle. Some researchers consider circling movement to be an additional movement feature in addition to [straight] and [arc], while others favor an analysis of circles as consisting of a sequence of arcs with different values for concavity, a point to which we return in §3. Lexical movements can also be characterized by the features [tense] and [doubled].[3]

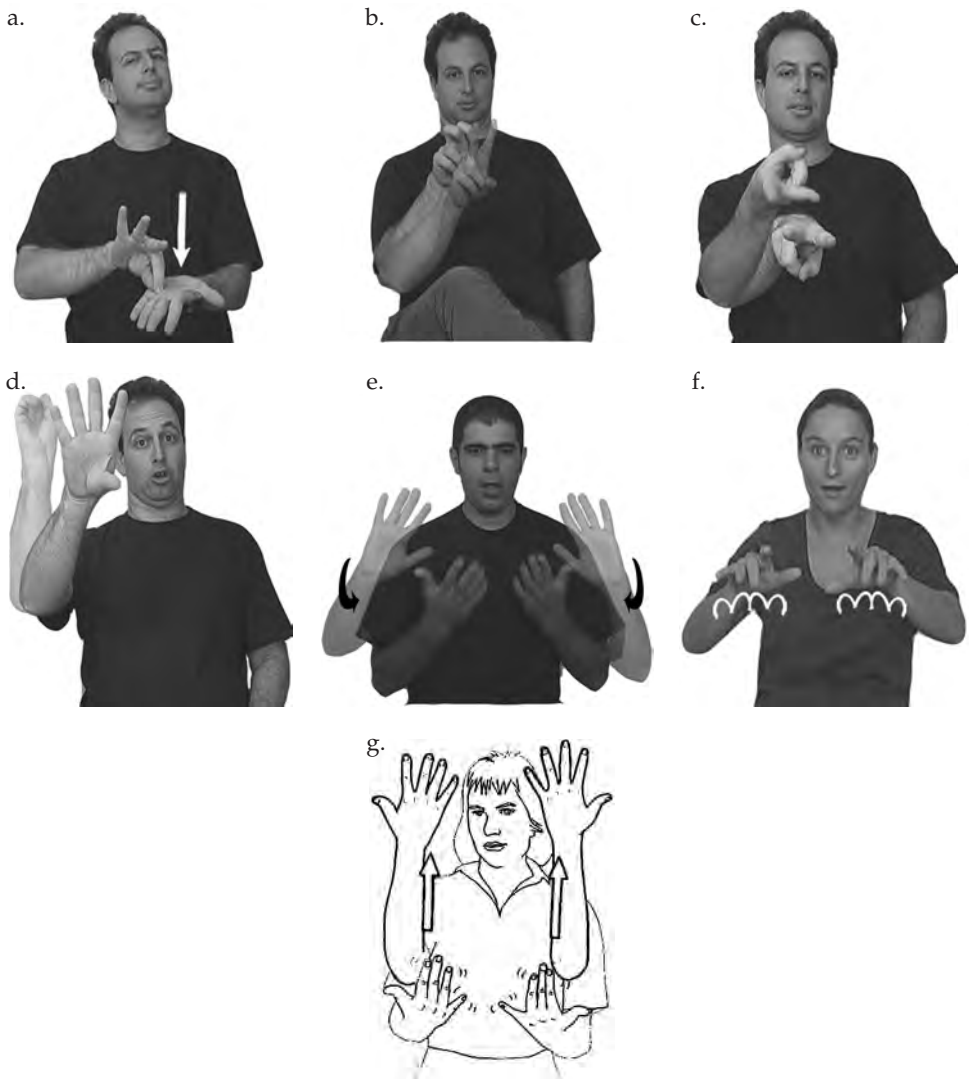


Figure 24.1 Types of movement in lexical signs. ISL: (a) path movement, (b) internal movement (handshape change), (c) internal movement (orientation change), (d) path and handshape change simultaneously, (e) path and orientation change simultaneously, (f) secondary movement (finger wiggle), and in ASL: (g) secondary and path movement together. Reprinted with permission from David Perlmutter

[3] Stokoe's (1960) original phonological description of ASL includes a much larger inventory of movement types. His view of the organization of the system is as simultaneously combined handshapes, locations, and movements. Stokoe also included features such as "contacting" and all types of interactions of the two hands as features of the movement category. This view of the sign resulted in a larger inventory than is found in the model outlined here, which assigns some of Stokoe's movement features to other categories, and adopts a linear alternation of locations with movements in signs. Examples (1) and (2) are not exhaustive, however, and there are additional types of movement, such as alternating movement of the two hands, left out for simplicity. See Brentari (1998) and Sandler and Lillo-Martin (2006) for detailed treatments.

Different types of handshape and orientation changes result in an inventory of *internal movements*, such as opening, closing, curving (shown in Figure 24.1b), bending, rotating, and nodding. These can be seen as contour movements, specified by branching features of finger position or orientation (Figure 24.1c). Internal movements can occur either by themselves in a sign or together with path movement (Figure 24.1d, e), although most signs have only one or the other. Constraints on selected fingers (see CHAPTER 9: HANDSHAPE IN SIGN LANGUAGE PHONOLOGY) prohibit the selection of more than one finger group in a morpheme, and have the effect of restricting the internal movement as well: handshape change can only involve movement from one finger position to another (e.g. from closed to open), but not from one finger group to another (such as index to all five). Orientation change is from one palm orientation to another (e.g. supine to prone). Another kind of internal movement, called secondary (or oscillating or trilled) movement, involves uncounted rapid repetition of handshape or orientation change, or else finger wiggle (Figure 24.1f). Secondary movement can occur either by itself, or, in some sign languages, together with path movement, as in Figure 24.1g, from ASL.[4]

Certain signs in many sign languages require particular shapes or movements of the mouth for their realization, together with manual movement. In these cases, the mouth movement is part of the phonological description of the sign in the lexicon. In ISL, for example, a sign meaning THE-REAL-THING requires a movement of the mouth, similar to one that would be used to pronounce the syllable *fa* (Meir and Sandler 2008). In an analysis of conventionalized mouth movements obligatorily associated with a subset of signs in British Sign Language, Woll (2001) found that the mouth movements articulatorily "echo" the manual movements. Signs of this subset that involve opening the hand, for example, also involve opening the mouth (*pa*), while closing of the hand is accompanied by a closing mouth (*ap*), in a coordinated articulation from which Woll hypothesizes that spoken syllables evolved.

1.1 Evidence for a movement category

A fundamental argument for the existence of a movement category is that signs are not well formed without it (Wilbur 1987). This is important because of the surprising fact that it is possible to pronounce many signs without movement, that is, to create strings of movementless signs with only transitional movements in between. For example, it is possible to pronounce JUST-THEN (Figure 24.1a) by simply moving the dominant hand transitionally from wherever it was before in the signing stream directly to the final position, in contact with the non-dominant hand. But this does not happen. Instead, the hand must assume the first position above the non-dominant hand and then move to contact in order to produce the sign. This point will be returned to in the context of a newly emerging sign language in §5.

Beyond obligatoriness, linguistic evidence for the movement category includes traditional arguments for the existence of phonological units, such as the

[4] [doubled] movement, named [restrained] in Sandler (1996), refers to lexical doubled movement, which differs from morphological reduplication both phonetically and phonologically.

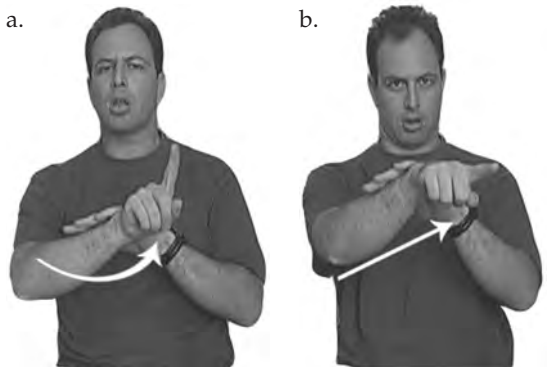


Figure 24.2 An ISL minimal pair differing only in movement shape

existence of minimal pairs distinguished by movement features and participation of movement in phonological processes. Minimal pairs that are distinguished solely by movement features like [straight] and [arc], though rare, do exist, as exemplified in the ISL signs BETRAY and ESCAPE, shown in Figure 24.2. Minimal pairs distinguished by single or doubled movement can also be found, but are also very uncommon.

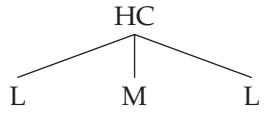
A straightforward linguistic argument for a movement category is reference to movement in phonological constraints and processes. A constraint on a rule involving movement is the blocking of a particular agreement marker in verbs that have specified movement. In ISL, verbs are blocked from undergoing inflection for multiple object agreement if they are specified for any feature belonging to the class of (non-default) lexical movement features, such as [arc] (in the vertical plane), [tense], or [doubled][4] (Sandler 1996). In such signs, the verb is not inflected for multiple object agreement; instead, an object pronoun is used, and it carries the inflection. Since the multiple agreement form consists of a horizontal arc movement which is superimposed on the sign, it appears that its blocking by a specified movement feature such as [tense] or [doubled] is a constraint on movement complexity. Verbs of the relevant type with the most common path movement, the default straight path movement, all do undergo this inflection. Apparently, a similar constraint is active in ASL (Padden 1988).

A morphological rule that refers to the movement category provides further evidence for the category in sign language phonology. This morphological rule of reduplication for Iterative and other temporal aspects reduplicates the final syllable of a sign. The rule refers to movement in the sense that a syllable is defined as consisting either of a single movement (path or internal) or of a simultaneously executed path and internal movement. Two movements in a sequence constitute two syllables. Most signs are monosyllabic, and are fully reduplicated when inflected for various temporal aspects. However, compounds may be disyllabic, and, if so, then the final syllable – with movement as its nucleus – is reduplicated (Sandler 1989). This is the case whether the movement in that syllable is path or internal, which in turn is an argument for unifying both types of movement in a single category.

1.2 Phonological representation of lexical movement

The first phonological treatment of sign language, Stokoe's (1960) monograph, characterizes the three major phonological categories – handshape, location, and movement – as co-occurring simultaneously in a sign. Later work argued explicitly for sequential structure in signs, specifically, between static and dynamic elements, though this structure is limited compared to that of most spoken languages (Liddell 1984; Liddell and Johnson 1989; Sandler 1989). The evidence for sequentiality refers mainly to locations and movements (see Sandler and Lillo-Martin 2006: ch. 9, and §2.1 below). But the hand configuration is typically constant across the sign. The Hand Tier (HT) model, inspired by autosegmental representations proposed for elements in spoken language that spread over more than one segment (Goldsmith 1979; see also CHAPTER 14: AUTOSEGMENTS), represents hand configuration on a separate tier from sequentially organized locations and movements (Sandler 1986, 1989). The model, motivated by data from ASL, is schematized in (1). Here, L and M stand for Location and Movement segments, all characterized by the same hand configuration (HC). This LML structure is argued to be the canonical form of the sign.

(1) *The basic Hand Tier model schema*

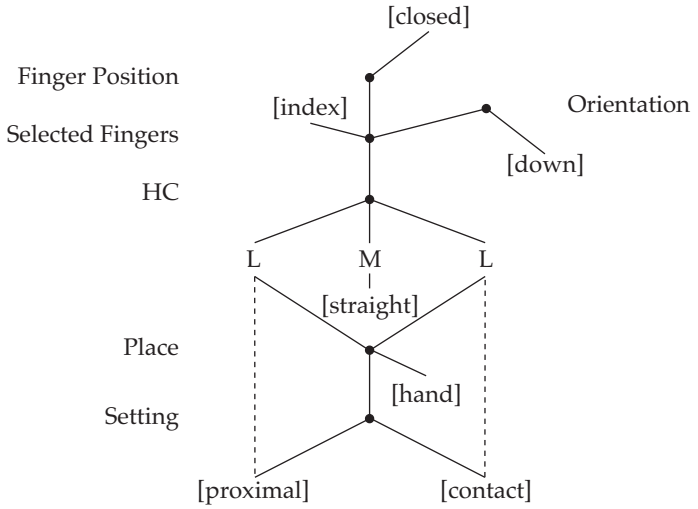


The model in (1) represents the most common type of movement, path movement by the hand or hands, as a segment between the beginning and ending location segments, following the basic conception of signs as consisting of alternations between stasis and motion that originated with Liddell (1984). While the analogy is not direct, it may be conceptually helpful to think of this canonical LML structure as comparable to CVC in spoken language (CHAPTER 33: SYLLABLE-INTERNAL STRUCTURE). And in fact, the M segment has been likened to a syllable nucleus by several investigators (Liddell and Johnson 1989; Sandler 1989, 1993; Perlmutter 1992), who argue that the surrounding static segments are visually less salient or less "sonorous."

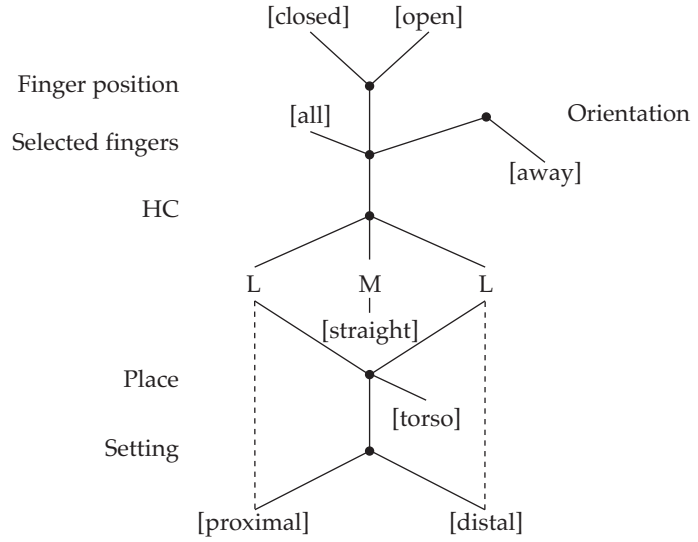
In the model schematized here, the Location category is divided into two classes: place of articulation (the major body area), and setting, i.e. the precise position with respect to that place. The sign JUST-THEN (pictured in Figure 24.1a) is partially represented in (2a). The hand moves with respect to the non-dominant hand as place of articulation, from a setting a medial distance above the hand (represented by features of the first L) to a setting in contact with the center of the hand (represented by features of the second L).

The other type of movement, internal movement, typically consists either of two positions of the fingers (as in Figure 24.1b), or two orientations of the palm (Figure 24.1c), represented in this model as contours, with branching features at the relevant node. Example (2b) is a partial representation of the citation form of SEND (pictured in Figure 24.1d), which has both path and internal movement.

(2) a. *Representations of ISL* JUST-THEN, *a sign with plain path movement*



b. *Representations of ISL* SEND, *a sign with path and internal movement*



The aspect of internal movement captured by this representation is its intimate connection to the hand, both physically and behaviorally, in the phonology. While path movement is achieved by movement at higher joints (elbow or shoulder), internal movement is achieved by movement of the fingers (handshape change; Figure 24.1b) or wrist (orientation change; Figure 24.1c). An argument for the intimate connection between internal movement and the category of hand configuration comes from assimilation in lexical compounds, where all hand configuration features spread, including their movement. A version of a compound meaning FAINT, composed of the signs MIND and DROP, illustrates this clearly, as seen in Figure 24.3.

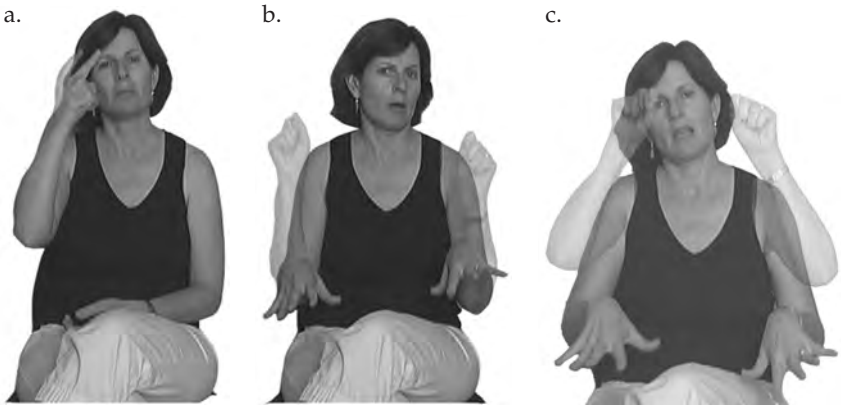
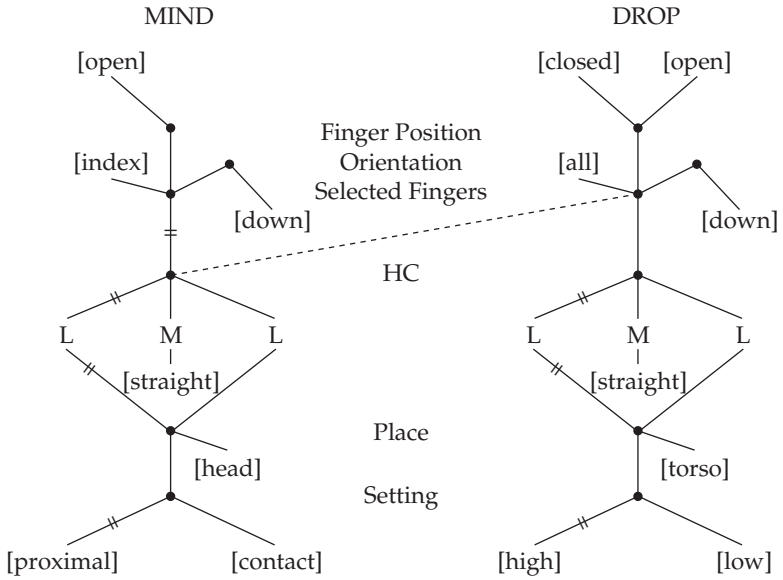


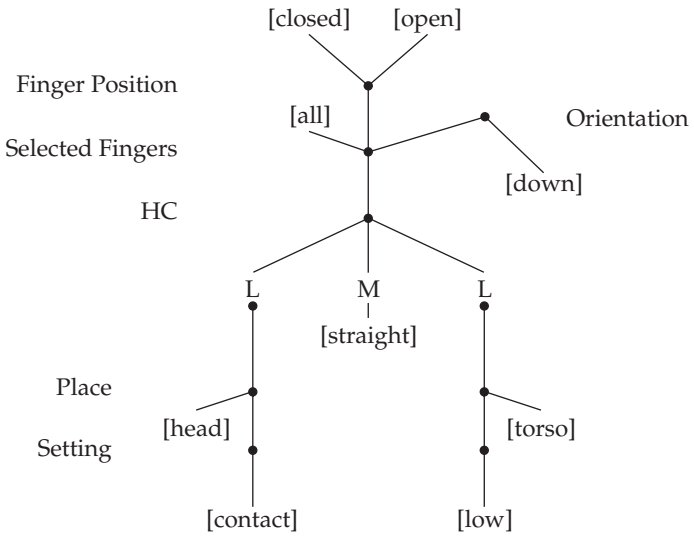
Figure 24.3 The ASL lexical compound, MIND^DROP = FAINT

Example (3a) shows that the entire hand configuration node, with its branching features for internal movement, spreads regressively (dashed line), associating to the second location of MIND. The surface form of the compound is represented in (3b).

(3) a. *Representations of compound reduction: Truncation and assimilation of* MIND^DROP



b. *The surface form of the compound* FAINT



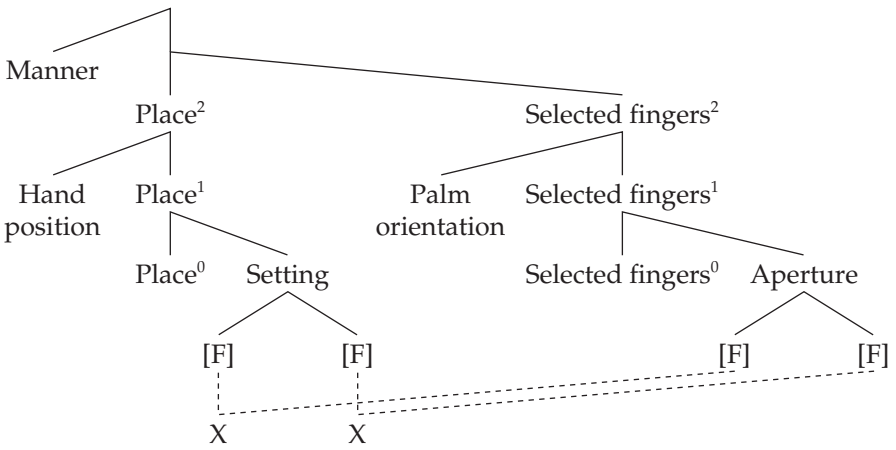
The finger positions that articulate internal movement ([closed] and [open] in DROP and FAINT) are part of the hand configuration category. Other reduced ASL compounds with internal movement in the original second member, such as RED^FLOW = BLOOD and WATER^FLOW = RIVER (both with finger wiggle), THINK^GIVE = INFORM (with orientation change) and NOSE^THROW = DISREGARD (with opening movement), all follow the same pattern. The representation follows general principles of feature geometry (Clements 1985; CHAPTER 27: THE ORGANIZATION OF FEATURES) in grouping feature classes both according to anatomical relatedness and to their behavior in spreading rules. The same features that specify internal movement belong to the inventory of finger position specifications in signs that do not have internal movement, adding an Occam's razor argument in favor of this representation.

It makes sense, then, to keep finger position features attached to the hand in the representation. However, the two finger positions or orientations inherent in internal movement temporally co-occur with the first and second location on the surface. In other words, all features at the beginning and ending of a sign, respectively, must be aligned phonetically. So in SEND (Figure 24.1d), the hand moves from a location close to the signer's upper torso outward to a location a medial distance from the signer in the citation form. The first, closed finger position is aligned with the first (proximal) location, and the second, open finger position is temporally aligned with the last (medial) location. In an early treatment posed in terms of ordered stages in phonological representation, linearization of the branching hand configuration features of internal movement was proposed to occur before the surface (Sandler 1993), indicated by dotted lines in the representation.

While particular feature classes of the HT model, as well as aspects of its hierarchical structure, have been adopted by most researchers, some propose radically different representations of movement. Van der Hulst's (1993) Dependency Model seeks to eliminate movement altogether as a primitive of phonological structure in sign language. It organizes the major feature classes differently from

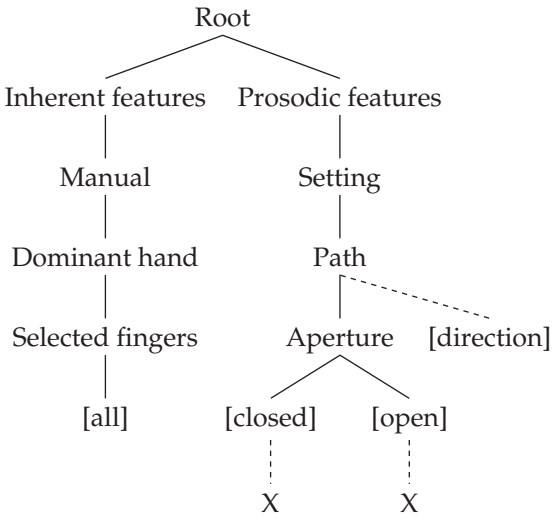
the HT model, motivated in part by characteristics of heads *vs.* dependents in language generally according to the theory of Dependency Phonology. Based partly on Sign Language of the Netherlands (SLN), the model proposes more unified representations for internal movement and for path movements: path movement by branching features at the Setting node (i.e. a sequence of location features) and internal movement as branching at the Aperture node (a sequence of finger positions) or at the Palm Orientation node (a sequence of orientations). The shape or type of the movement, e.g. arc or straight, is represented as a feature of the whole sign under a Manner node, so that the quality of movement and the feature contour that underlies it are conceived of and represented as independent of one another. The features of any branching nodes align themselves with two abstract, sequentially ordered X-slots (CHAPTER 54: THE SKELETON), roughly corresponding to the two L-slots in the HT model – but there is no slot corresponding to M, because the movement is not conceived of as part of the sequence. This model, schematized in (4), has the advantage of unifying the temporal features in a sign – be they sequential locations, handshapes, or orientations – by aligning them with two abstract X timing slots.

(4) *Dependency model schema*



Brentari's Prosodic Model (1998), schematized in (5), inherits certain feature classes and some of the hierarchy from the HT model, and adopts both the Aperture and Joints classes (the latter not shown in the schema in (4)), and the two timing slots from the Dependency Model. But the feature classes are organized quite differently. The Prosodic Model is largely motivated by the category of primitives that explicitly involve movement – a category that is entirely missing from the Dependency Model. The Prosodic Model bifurcates all features into two main groups, inherent and prosodic, the latter housing all movement features. As in the Dependency Model, path movement is represented by branching setting features or by a path direction feature, and handshape change by branching aperture features, the latter two shown in (5). The model has the advantage of unifying in the representation all features related to movement, be they path or internal, in a prosodic branch of structure, which is explored in detail in that work.

(5) *Prosodic Model schema with internal movement (handshape change)*



Each of the two models accounts for a number of different theoretical and empirical phenomena in sign language phonology, and both models alleviate certain problems inherent in the Hand Tier model, in particular, the linearization problem, in which path and internal movement are not accommodated in a unified way. But each has disadvantages as well. Omitting a movement segment from the representation, as the Dependency Model does, makes it difficult to accommodate the durational effects on movement described in §3, and the distribution of the feature [contact], which can be realized on either of the Ls, on the M, or on all segments (Sandler and Lillo-Martin 2006). A coherent account of the syllable reduplication facts described above also provides a challenge for that model.

A drawback of the Prosodic Model lies in the segregation of the internal movement features from the hand configuration features in two separate branches of structure. In this way, the model sacrifices the phonetic and phonological integrity of hand configuration (the latter supported by the compound assimilation facts, for example). Doing away with a Movement segment, a representation inherited from the Dependency Model, presents the same problems for the Prosodic Model.

No model comfortably accommodates all the facts. Unfortunately, a detailed review of existing models of movement would take us too far from the goal here of introducing movement in sign language to a general linguistic audience, and interested readers are referred to the sources cited above, and to Sandler and Lillo-Martin (2006: ch. 13), for further illustration and discussion.

1.3 Lexical movement and meaning

A central property of phonological units is that they are meaningless. This "duality of patterning" of language – the division into a meaningful level of morphemes, words, and sentences, as well as a meaningless level of auditory or visual formational elements – has been called a basic design feature of human language (Hockett 1960). This property is what gives human language its ability to create vast vocabularies from a small number of primitive elements. Yet sign

languages differ from spoken languages in that many of their words or signs have their roots in holistic iconic gestures whose form bears a resemblance to their meaning. The sign for WOMAN in one sign language will indicate breasts (e.g. Danish), in another an earring (ISL), in a third a headdress ornament (Al-Sayyid-Bedouin Sign Language), etc. Although the formatives of location, movement, and hand configuration behave as meaningless elements in the phonology of lexical signs, the meaning of these elements is often still transparent and can even be organized into classes according to meaning (Shepard-Kegl 1985; van der Kooij 2002). As for movement and meaning specifically, researchers have been able to make certain generalizations. Supalla and Newport (1978) propose that verbs which convey duration or reiteration, like SWEEP, are underlyingly characterized by lexical doubled movement. Wilbur (2008) takes this idea much farther, proposing that many movements in verbs, adverbs, and adjectives have been grammaticalized from a small group of meaningful event types reflecting such semantic properties as telicity and duration.

It cannot be a coincidence that there are many pairings of movement types with intuitively identifiable meanings. Methodical and exhaustive investigation of these pairings across sign language lexicons, using semantic categorization such as Wilbur's, promises to teach us much about the origins of movement types, about the way in which sign language lexicons are synchronically expanded, and about similarities across sign languages as well.[5] Nevertheless, the same features that can be shown to be semantically motivated may also perform a formal role unrelated to iconicity. For example, doubled movement arbitrarily distinguishes a large set of nouns from semantically and formationally related verbs in ASL (Supalla and Newport 1978). We turn to the role of the movement category in sign language morphology in §2.

2 Movement morphemes

Although there are not many movement features in the lexical inventory, a wider range of movement patterns serves to create morphologically complex forms. One common type of complex morphology involving movement is inflection for temporal aspect, for which a morphological template analysis is presented in §2.1. Movement of the mouth and tongue can also take part in morphological inflection. Finally, a particularly expressive subsystem in sign language grammar in which movement is salient is that of predicates of motion and location. All are described in the following subsections.

2.1 Templates for movement in temporal aspects

In their book *The signs of language*, Edward Klima and Ursula Bellugi describe a large number of temporal aspects occurring on verbs and predicate adjectives that the researchers in their lab at the Salk Institute documented in American Sign Language (Klima and Bellugi 1979). In all of these aspectual forms, handshapes

[5] Van der Kooij (2002) shows that certain formational elements in SLN signs are semantically motivated, and argues that these should not be part of the phonological representation, but rather introduced with semantic implementation rules.

and locations remain unchanged, while the movement pattern alone is affected – by changes in shape, duration, rhythm, and number of iterations. Klima and Bellugi describe 11 aspects for ASL, which they distinguish from one another by means of the following binary features: reduplicated, even, tense, end-marked, fast, and elongated.

The system has certain key elements in common with the root and pattern morphology of Semitic languages, in which the consonants of the root remain constant, while the vowel pattern and the rhythm (expressed through gemination of different consonant or vowel positions in the morphological template) are altered to create different verb forms (see CHAPTER 105: TIER SEGREGATION; CHAPTER 108: SEMITIC TEMPLATES). The abstract vocalic and timing patterns constitute morphemes of voice or aspect and of verb form, such as (roughly) reflexive, causative, etc. Influenced by McCarthy's model for Standard Arabic (McCarthy 1981), a templatic treatment of ASL aspect proposes similar timing templates and movement features for the aspectual system of that language. Associating morphological features to the movement segment and geminating either locations or movements produce aspectual patterns (Sandler 1990). For example, the citation forms of the verbs GIVE and LOOK-AT are shown in Figure 24.4. Each has a plain straight movement with no special shape or timing qualities. If these verbs are inflected for temporal aspect, then the form gets its shape from the path movement feature and its timing from the aspectual template. For example, inflection for Durational adds a reduplicated circular movement to the base forms, illustrated in Figure 24.5. For any verb so inflected, the movement pattern for any given aspect is the same.

Both GIVE and LOOK-AT belong to the class of verbs which in many sign languages agree for subject and object or, more precisely, for source and goal (Padden 1988; Meir 2002). Agreement is realized by moving the hand(s), configured according to the feature specifications of the base verb, from a spatial locus associated with the source to a locus associated with the goal. The citation forms shown in Figure 24.4 are very similar to the inflected forms for I-GIVE-YOU and I-LOOK-AT-YOU. That is, the initial locus (1st person) is typically near the torso of the signer, the final locus (2nd person) is at a distal location in front of the signer and movement is from the signer toward the addressee. The spatial loci for 3rd person referents are typically established during the discourse, and consist of points in space which defy precise phonological representation.

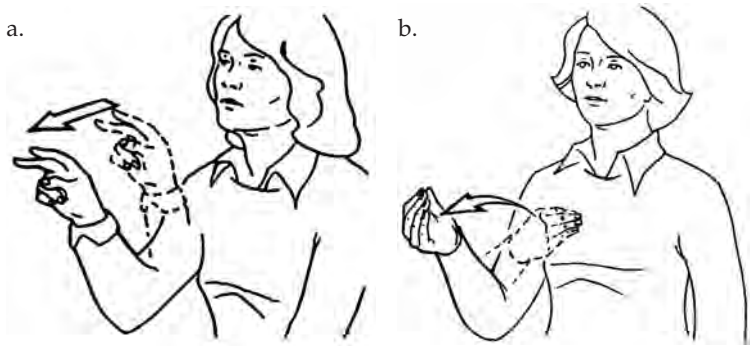


Figure 24.4 Citation forms of ASL (a) LOOK-AT and (b) GIVE. Reprinted with permission from Ursula Bellugi

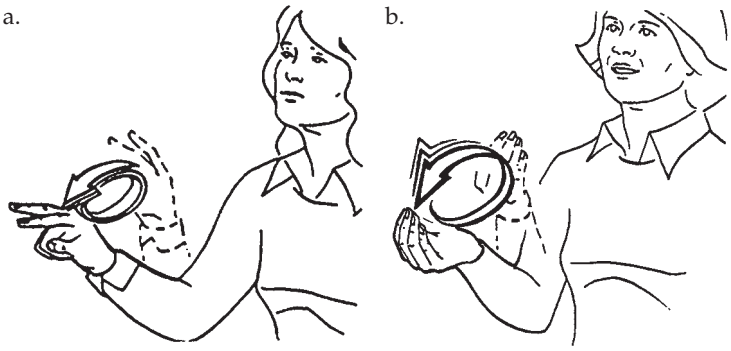


Figure 24.5 Durational forms of ASL (a) LOOK-AT and (b) GIVE. Reprinted with permission from Ursula Bellugi

Nevertheless, once established, they determine the locations for verb agreement. This copying of agreement markers from referential loci has been compared in Aronoff *et al.* (2005) to a rare type of agreement in spoken language: literal alliterative agreement. This type of agreement depends on the phonological form of individual nouns instead of on morphosyntactic categories (see Dobrin 1998). An example of 3rd subject to 3rd object agreement in ASL is shown in Figure 24.6. The locations of the L segments are determined by loci set up in space to refer to the two 3rd person referents in the discourse. In the example, the verb ASK is inflected for 3rd person subject to 3rd person object in Figure 24.6a, and Figure 24.6b shows inflection from 3rd subject to 1st person object. If the referential loci represent Charles and Alex, then 'he asked him' in Figure 24.6a references Charles as subject and Alex as object: 'he (Charles) asked him (Alex)'. Figure 24.6b means, right to left, 'he (Charles) asked me'.

We now return to Durational aspect, which has a circular path movement in ASL. In §1, it was posited that what looks like circular movement is actually a sequence of arcs. It is the combination of verb agreement with aspect that best supports this analysis. The direction of movement is determined by the agreement

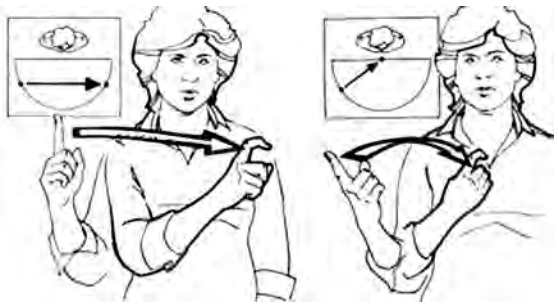
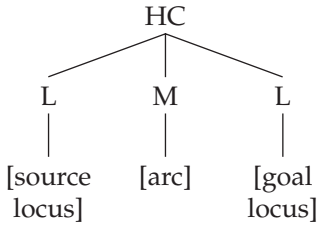


Figure 24.6 ASL verb ASK with agreement: (a) 3rd person to 3rd person; (b) 3rd person to 1st person. Reprinted with permission from Carol Padden

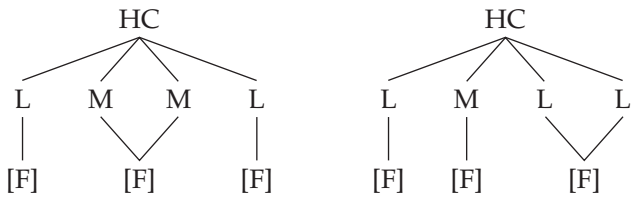
loci attached to the locations that determine the path movement between the two locations. So, the movement pattern seen in Figure 24.5 consists of an arc whose first location is the source and whose second location is the goal. The [arc] feature of Durational is added, and the form is reduplicated for this aspect. The connecting arcs between the iterations are assigned the opposite value for concavity, to create a circle. If the movement pattern of such verbs were specified as circles rather than as arcs, then there would be no coherent way to specify the source-to-goal direction of the movement. Furthermore, the last reduplication of all circular aspects ends with the second location of the form, that is, at the end of the arc, not of the full circle. Since uninflected signs that have circular movement (like SORRY in ASL) typically also have repeated movement that ceases at the end of the base arc, the simplest representation for circles generally is as repeated arcs joined by connecting arcs of inverse shape (Sandler 1989, 1990; Corina 1990). The sign GIVE inflected for both agreement and for Durational aspect is represented schematically in (6), where the agreement markers are [source locus] and [goal locus]. This representation illustrates the monosyllabic nature of signs: even this inflected verb with four morphemes has a single movement (in this case, fully reduplicated).

(6) *Schematic representation of agreement and Durational aspect form*



Different aspectual patterns are found in different sign languages. For example, the template for Intensive in ISL geminates the movement, while the template for Continuative in that language geminates the final L. Representations of these templates are shown in (7).

(7) a. *ISL intensive template* b. *ISL continuative template*



The movement possibilities in the aspectual system of American Sign Language, and other sign languages as well, can be quite complex – involving gemination of one location or the other or of the movement segment, and shapes ranging from straight to arc, from circular to elliptical. The templatic account sketched here is meant to capture the generalization that the hand configuration and locations are specified by the base verb (the locations may be specified by agreement inflection

in the class of agreement verbs), while there is a conventionalized set of movement shapes and timing templates which determine aspect.

2.2 *Mouth movement in sign language morphology*

In addition to the infrequent lexical specification of mouth and movements, noted in §1 above, repeated tongue flap ("lalalala") plays a grammatical role in many sign languages, often marking predicates for iterative or exhaustive inflection, sometimes with additional manually produced inflection such as reduplication or horizontal arc. For example, in ISL, the horizontal arc of the exhaustive verb inflection can be accompanied by a rapid tongue movement of this kind (Meir and Sandler 2008).

A different tongue movement – side-to-side tongue wag – has been closely investigated in the Delayed Completive aspect in ASL (Brentari 1998). In this language, tongue wag is an allomorph of finger wiggle, marking the Delayed Completive aspect. This operation productively applies to telic verbs, with some phonological restrictions, and adds the meaning "delay the completion of x," where x is the base verb.

In addition to morphological functions, mouth shapes and movements perform prosodic and gestural functions (Sandler 1999, 2009; Boyes Braem and Sutton-Spence 2001). In fact, in these "manual" languages, the mouth is often in constant motion – not in the service of speech, but in the service of language.

2.3 *Predicates of motion and location: A partly linguistic subsystem*

Established sign languages typically have a subsystem within their grammars for designating location and motion of classes of referents. This system, called verbs of motion and location, classifier predicates, or classifier constructions, combines classifier handshapes with motions and locations in space. Identified and analyzed in the early years of sign language research (by Supalla 1982, 1986, and others), the system has subsequently been tackled by a number of other researchers of ASL and several other sign languages (see Emmorey 2003). The organization of these constructions clearly has conventionalized properties, and the system is apparently difficult to acquire by both first and second language learners.

In classifier predicates, there is a conventional set of handshapes corresponding to classes of referents (hence the term "classifiers"). Unlike the handshape category in lexical signs, which is a meaningless phonological unit, the classifier handshapes are meaningful morphemes, which fall into three categories. Size and shape classifiers class objects according to physical properties, like small and round, flat, or cylindrical. Handling classifiers mimic the shape of the hand or object (like a hook or tongs) handling another object, be it flat and thin, like paper, or thick, like a book, for example. Entity classifiers refer to semantic classes such as humans, small animals, legs, eyes, or vehicles. The handshapes in classifier systems are conventionalized, and vary from sign language to sign language; they are part of the grammatical system.

These classifier handshapes can combine with other classifier shapes on the non-dominant hand, an impossibility in lexical signs, in which the non-dominant hand too has meaningless phonological status and is strictly constrained in shape

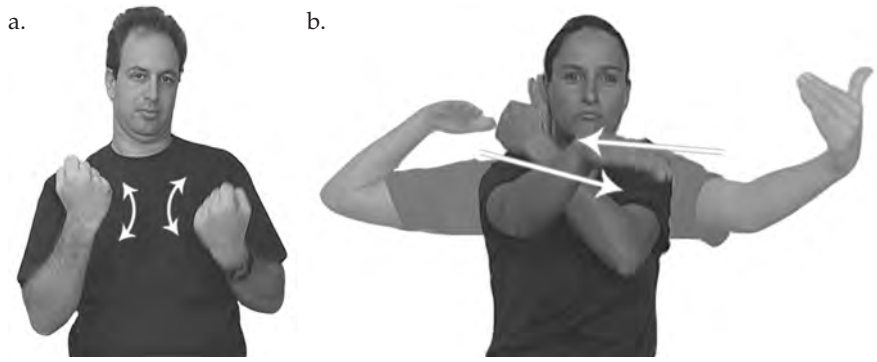


Figure 24.7 (a) The lexical sign CAR; (b) classifier predicate, 'two cars (VEHICLES) passed each other'

and motion. The classifiers are articulated with locations and movements that express spatial relations among objects, their locations in a scene, and the shape, direction, and manner of movement of the objects. While the referents encoded in these predicates typically correspond to independent lexical signs, such as CAR, PAPER, or SUITCASE, the classifiers are used instead when the signer wishes to convey spatial relations or manners of movement more vividly. For example, the Israeli Sign Language sign for CAR is shown in Figure 24.7a, and the classifier predicate with an entity classifier for vehicle, denoting 'two cars passed each other', in Figure 24.7b. The handshapes in Figure 24.7a are meaningless phonological elements; while the two handshapes in Figure 24.7b are morphemes denoting the entity classifier, 'vehicle', combining with movement manner and direction to convey motion and spatial relations in a more analogical fashion.

Particular combinations of classifiers with movements and locations may become lexicalized, so that the system provides a rich source for broadening the vocabulary of sign languages. But non-lexicalized predicates of motion and location can be formationally anomalous compared to signs; they are not signs in the sense of lexical items or words. Rather, the classifier handshapes exist in the lexicon as bound morphemes, and they are combined post-lexically with locations and movements to form these constructions, in which one nominal classifier, combined with a sequence of movements and locations, can span constituents as large as several intonational phrases (Zwitserlood 2003; Sandler and Lillo-Martin 2006: chs. 5, 20).

There are clearly linguistic elements here, in particular the classifier handshapes, which belong to a conventionalized set, listed in the lexicon, and differing from sign language to sign language, and there certainly are limits and constraints within the system. But the movement aspect of this system is sometimes more analogical and gradient, suggesting that gestural properties are integrated with linguistic ones in sign languages (Liddell 2003; Schembri 2003; Duncan 2005). This freedom of expression is exploited in sign language poetry, where creative extension of the possibilities already inherent in the system takes artistic form (Sandler and Lillo-Martin 2006). To understand the sign language system, a distinction must be drawn between movement as used in the classifier predicate system and the movement category in the lexemes of sign languages. Once movement

assumes the role of a meaningless formational unit in words of sign language, phonology whips it into shape, and, as shown in §1, its inventory and behavior are drastically reduced and constrained.

3 Linguistic movement of body and face: Prosody

While the hands move to convey the text, the rest of the upper body is active too, and together the different articulators provide the temporal envelope and intonational coloring of the prosodic system of sign language.

Taking the intonational phrase in Israeli Sign Language as an example, the prosodic components are realized in the following way. A change in the timing (pause, hold, or reiteration, slow tempo) and often an increase in size of the last sign of the phrase provide the boundary of the unit. Change in the head and/or torso position and frequently eyeblink align with the manual cues. Superimposed on the whole prosodic constituent and aligned with its boundaries is linguistic facial expression. Both the scope and the pragmatic content of facial expression support the claim that facial expression is the intonation of sign language (Reilly *et al.* 1990; Nespor and Sandler 1999; Dachkovsky and Sandler 2009; Sandler, forthcoming a, forthcoming b), containing a repertoire of raised brows, furrowed brows, squint (the last found at least in ISL), and other facial articulations.

Figure 24.8 shows the two signs on either side of an intonational phrase boundary in the ISL conditional sentence *If he invites me to his party, I will go*. At the end of the first constituent, the brows are raised, eyes are widened, and the head and upper body are tilted forward. As noted, the face and body movements that achieve this configuration typically accompany timing changes in the motion of the hands: hold, pause, or reiteration, as well as enlarged movement and slowed duration of the last sign in the constituent. At the beginning of the next intonational phrase, the brows and upper body move to a neutral position. Figure 24.9 shows the way in which these movements are distributed over the text.

The prosodic component is important to the interpretation of utterances in signed as in spoken language (recent overviews are Wilbur 1999, Sandler and Lillo-Martin 2006 and Sandler, forthcoming b). While some treatments of certain non-manual cues consign them to the syntactic component, others argue that they are better understood as intonational and part of the prosodic component, which is related to but not isomorphic with syntax (see Sandler, forthcoming a).

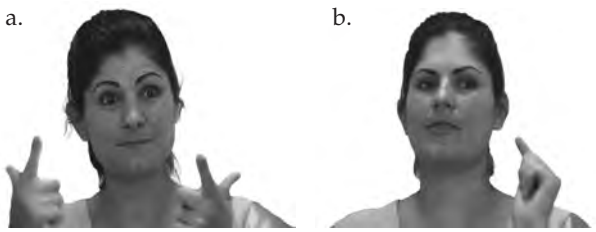


Figure 24.8 Movement of facial articulators and head at intonational phrase boundary. The sentence is, IF HE INVITE-ME PARTY HIS, I GO-TO PARTY HIS ("If he invites me to his party, I will go"), and the pictures are from the underlined words on either side of the boundary

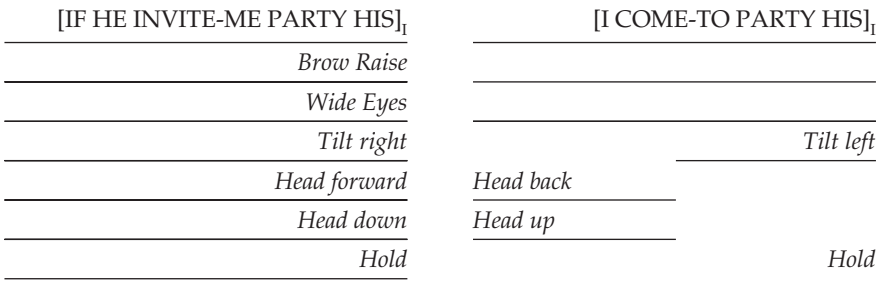


Figure 24.9 Alignment of facial and head positions with the timing cues of the hands at the end of each intonational phrase produces salient and synchronized movement at the boundary. The timing cue in the text is cessation of movement (holding the signing hands still)

4 Movement of hands, face, and body in spoken language: A comparison

Unlike sign language, spoken language is usually not described in terms of movement of the face, hands, and body. Instead we think of language in the auditory modality as produced by the largely hidden vocal tract, suggesting that hearing people are not conduits of the variegated motion ensembles described above – and speakers may indeed look rather strange to deaf people. But that is not because speakers are static. They, too, make use of the head, body, face, and hands when they communicate, as the burgeoning fields of co-speech gesture and "visual prosody" reflect. Speakers of all languages and cultures use their hands rhythmically and imagistically to augment the linguistically organized signal in ways that have motivated a theory of co-speech gesture as integral to language (see e.g. McNeill 1992; Goldin-Meadow 2003; Kendon 2004). Speakers use the face and body as well to "punctuate" and augment their speech (see Swerts and Krahmer 2009 for a recent collection of articles on visual prosody). But the motions of the face and body that accompany speech, though rich, are not as finely tuned, conventionalized, or systematically coordinated as are the motions of prosody accompanying signed utterances. In sign language, these signals are organized into a linguistic system.[6] Current work on a new sign language gives clues to how such a linguistic system emerges.

5 Emergence of the movement category

The foregoing exposition leapt back and forth in rather cavalier fashion from ASL to ISL, with forays to SLN, as if the system being described were common to all sign languages. And indeed, while there certainly are language-specific differences, most of the characteristics of movement described in the broad description

[6] While sign languages organize motion of the hands, face, and body into a linguistic system, this does not mean that they do not also avail themselves of paralinguistic gestural elements corresponding to co-speech gesture. In fact, they do. A particular kind of iconic co-sign gesture in sign languages is commonly made with the mouth (Sandler 2009).

presented here are found in sign language after sign language: the requirement that a sign have movement to be well formed; the tendency toward monosyllabicity; the relatively small inventory of movement features in lexical signs; the tendency for only one movement type (i.e. path or internal) to characterize a sign, with both together being less favored; the existence of a number of movement patterns for different temporal aspects; and the coordinated movement of different parts of the upper face, hands, and body for intonation and constituent marking in the prosodic system. Why is this so? Are these sign language universals, and, if so, are they part of our innate language endowment?

One way to begin to address this question is by taking advantage of a situation that occurs with sign languages but not with spoken languages: the emergence of a language *de novo*. In such a language, we can ask whether the movement properties described above arise wholesale at the moment that a sign language is born. It is impossible to ask this question in the case of spoken languages, because we can no longer observe the inception of a new spoken language without a model. All traces of the origins of spoken languages vanished long before language was recorded and linguists appeared on the scene, and all hearing children in modern times acquire language from a model. But since sign languages arise whenever a group of deaf people have opportunity to gather regularly and interact, we sometimes have the privilege of catching such a language in the act of being born. And when we do, we can consider the question of the origin of phonological form on the basis of empirical evidence, by observing whether an apparently universal pattern inevitably explodes at the outset, or whether it develops gradually, in the course of language use and interaction.

My colleagues Mark Aronoff, Irit Meir, Carol Padden, and I have been studying a new sign language for the past several years. The language – Al-Sayyid Bedouin Sign Language (ABSL) – is found in a Bedouin village in the south of Israel, where the presence of a gene for deafness and marriage patterns within the community have resulted in the birth of a proportionately large population of deaf people over the past 75 years – around 150 out of about 4000, or roughly 50 times the proportion in the United States.

The sign language arose in relative isolation in this village, used today by all deaf people and a large number of hearing people as well. Signers converse on topics as diverse as hospitality, national insurance, marriage, childbirth, and jobs, and as remote as the clan structure of the village, descended from the five sons of the patriarch, who migrated from Egypt and set up his tent 200 years ago. The language of the second generation of deaf people (now from early 30s to over 50 in age) has robust word order patterns: SOV and noun–modifier (Sandler *et al.* 2005). There is a productive type of compounding or affixation in ABSL which sequentially adds a size and shape specifier to a nominal sign to describe objects (Meir *et al.*, forthcoming; Sandler *et al.*, forthcoming).[7] Surprisingly (to us at least), other kinds of morphology common to sign languages, such as verb agreement, rich aspectual morphology, and classifier predicates, have not been found in the language (Padden *et al.* 2010).

What about phonology? There is good evidence that established sign languages that have been studied have phonological systems, as the articles on sign

[7] The size and shape specifiers of ABSL are not like size and shape classifiers described in §2, as they do not combine simultaneously with movements and locations to form predicates. Instead, they are adjoined sequentially to nominal signs to form complex nouns.

language in this *Companion* show (CHAPTER 9: HANDSHAPE IN SIGN LANGUAGE PHONOLOGY; CHAPTER 10: THE OTHER HAND IN SIGN LANGUAGE PHONOLOGY; CHAPTER 56: SIGN SYLLABLES), and as the references cited in this chapter elaborate and substantiate. Indeed, Stokoe's discovery that ASL has duality of patterning was what prompted the linguistics community to accept sign languages as bona fide languages half a century ago. However, this new language, ABSL, does not have a crystallized phonological system (Sandler *et al.*, forthcoming). There is a dearth of minimal pairs in our data, and we find a good deal of apparently random variation in production of the same lexical item compared to ASL and ISL (Israel 2009; Israel and Sandler 2009). These productions vary across ABSL signers in ways that potentially produce contrasts in other sign languages, and the overall impression is that signers are often aiming for a holistic iconic prototype rather than manipulating meaningless formational primitives to produce meaningful signs. The latter, if present, would be characteristic of a phonological level. Alternations of meaningless formational elements, such as assimilations, are all but absent. The movement parameter is instructive in demonstrating the lack of formational regularity in the language, and in addressing the question of how movement as a phonological category comes to be.

5.1 Amorphous movement

In a comparative study of 15 lexical items each signed by 10 signers in ABSL, ISL, and ASL, Israel (2009) found first of all that 62 percent of the signs in ABSL had only one type of movement (path or internal) together in a sign. By contrast, in ASL, the oldest and most established of the three languages, 81 percent of the tokens in the sample had only one movement type, representative of the proportion of such signs in the language as a whole (Stokoe *et al.* 1965; Brentari 1998). That is, in American Sign Language, signs of the JUST-THEN type (Figure 24.1a), with path movement only; the TAKE-ADVANTAGE-OF type (Figure 24.1b), with handshape internal movement only; or the DEAD type (Figure 24.1c), with orientation internal movement only; are preferred over signs like SEND (Figure 24.1d) or FAST (Figure 24.1e), with both path and internal movement.

This distribution is compatible with the following interpretation. In a sign language like ASL, with phonological categories, movement classes and features belong to a formal movement category, so that specification of the meaningless phonological features of only one formal class is sufficient to make distinctions among signs. As these are formally simpler than signs with both path and internal movement, they are preferred.

Israel's preliminary study, though limited in scope, suggests that signs in ABSL are more likely to incorporate more than one movement type in a sign than is the case in ASL or ISL. Apparently, the features of movement have not yet been isolated and fully organized into a formal system. Instead, signers produce simultaneous movement at different joints (e.g. elbow and finger or elbow and wrist) in an effort to create a holistic iconic image. For example, the sign for CAMEL simultaneously involves down-up-down undulation at the wrist (indicating the head of the camel) together with forward path movement from the elbow joint (the forward motion of the camel walking). The same concept in Israeli Sign Language is produced with a doubled forward path movement only.

Second, of the three languages in the study, ABSL was the only language in which some signs were produced with no movement at all. That is, the hand(s) arrived

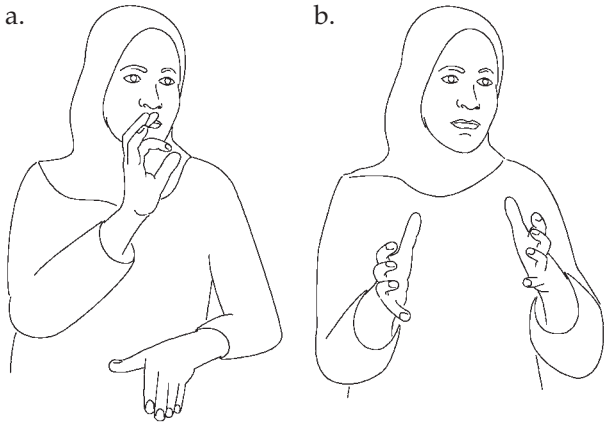


Figure 24.10 Al-Sayyid Bedouin Sign Language (ABSL) KETTLE, comprised of CUP and ROUND-OBJECT, as signed in an extended family with many deaf members

at some location with a transitional movement only – a phonetic possibility that established sign languages do not exploit. A system like that of ABSL does not need to count syllables, unlike ASL, for example (see §1), and has not arrived at LML signs as a (possibly perceptually advantageous) alternation between static and dynamic elements. In such a system, movements are not mandatory. Interestingly, in the third generation, among children who dwell in households with a deaf parent and deaf siblings, we begin to see mandatory movement emerging. Movement segments are introduced into everyday signs such as GOAT and KETTLE in these children, performed without movement by others in the village (Sandler *et al.*, forthcoming). KETTLE as signed in one household, a compound made up of the signs CUP and ROUND-OBJECT, is shown in Figure 24.10.

The second part of the sign KETTLE is typically signed by placing the hands in front of the torso in the configuration shown in Figure 24.10b. But a young girl in this household signed it differently, introducing a salient movement of the two hands toward each other, as shown in Figure 24.11. This movement is counter-iconic, as the kettle does not become any smaller. An epenthetic movement is introduced in the sign GOAT by two children in different deaf households that include a deaf parent (an unusual situation, as the gene is recessive). That sign is typically made with an "L" hand, by placing the thumb in contact with the temple – an iconic representation of a goat's horn. But the two children from deaf households whom we recorded introduced a repeated tapping movement at the temple. Again, the movement is not iconic. A goat's horn does not tap its head, and this movement can be seen as introducing a formal element that will ultimately be exploited in a phonological system.

6 Summary and conclusion

Perhaps a key to understanding sign language phonology, and movement as part of it, is to recognize the fact that no potential visual signal goes unexploited. But these signals, available to all humans, are molded in sign languages into a

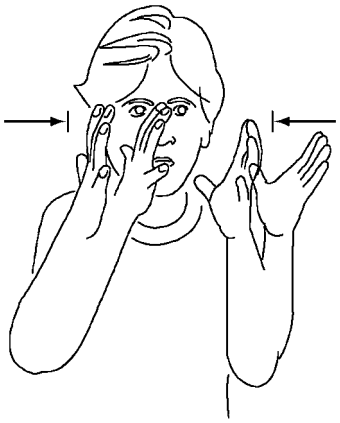


Figure 24.11 Movement epenthesis in ROUND-OBJECT by a small child in the family

well-disciplined vehicle for conveying particular kinds of linguistic information at different levels of structure.

Lexical signs must have some movement, even if it is only a default straight path, a requirement that implies an organizational advantage for the category – perceptual, articulatory, contrastive, or all three. Within signs, the primary movement is manual – either path, hand internal, or the two simultaneously – characterized by a small set of movement features.

More evidence for the existence of a movement category comes from morphological constraints and rules that refer to it. Aspectual morphology makes systematic use of movement patterns – templates of movement shape and timing that are comparable in some respects to the templatic morphology of Semitic languages. More freedom of movement appears to be available to the classifier predicate subsystem, which is exploited for types of discourse in which spatial relations and manners of movement are prominent, and which provides a vehicle for stylistic creativity, as in poetry.

As the hands move in space, assuming various configurations, they are sometimes accompanied by coordinated movement of the mouth, which can serve lexical, morphological, prosodic, or gestural functions. Above the lexical level, prosodic constituents such as the intonational phrase are marked by movement of the head and torso, and meaningful intonational arrays are overlaid on these displays by actions of the upper face.

Non-trivial similarities to spoken language phonological categories can be identified here: (i) signs must have an alternation between static and dynamic components, as spoken words must have consonants and vowels;[8] (ii) there is a limited inventory and combination of features in a given phonological category (here the movement category) within lexemes (CHAPTER 17: DISTINCTIVE FEATURES); (iii) constraints and rules may be appealed to in order to provide linguistic

[8] This comparison between Ls and Ms and Cs and Vs is not meant to imply that these categories have similar properties or distribution in the two modalities, because they do not. Rather, the comparison is much broader, reflecting the fact that these phonological categories manifest different rhythmic properties.

evidence for the existence of the phonological category of movement (CHAPTER 63: MARKEDNESS AND FAITHFULNESS CONSTRAINTS).

At a more general level, similarities between the linguistic systems of spoken and signed languages as a whole were revealed by the discussion above: (i) there is a meaningless phonological level of structure containing major categories, subclasses, and features; (ii) sub-lexical elements that are meaningful or grammatical also exist, and combine systematically to form complex words; (iii) above the word, phonological material with particular phonetic characteristics is organized into a hierarchy of prosodic constituents, typically but not exclusively coinciding with syntactic constituents such as clauses.

It is striking that the articulators of sign language, so very different from those of spoken language, can combine to create a system with important similarities. However, there are instructive differences as well.

One difference in organization between the two modalities is revealed by the movement in the classifier predicate system, which has some analogical combinatorial characteristics that are more gradient than discrete. While post-lexical structure in spoken languages can also be gradient, the gradience is presumably the result of performance factors such as co-articulation, rather than the result of analogy with real-world motion or change of shape, as in the sign language case. To be sure, there are conventions in the classifier system, such as a lexical list of language-specific classifier handshapes, size and shape specifiers that are comparable to verbal classifiers found in some spoken languages (Aronoff *et al.* 2003), and constraints on the combinations of movement patterns (in ASL; Supalla 1986; see also CHAPTER 89: GRADIENCE AND CATEGORICALITY IN PHONOLOGICAL THEORY). But taking all of its characteristics together, the subsystem may be best understood as one which combines the grammatical and the gestural, the lexical and the post-lexical (CHAPTER 94: LEXICAL PHONOLOGY AND THE LEXICAL SYNDROME), into a single system that is quite central in many sign languages, yet in certain ways quite unlike anything we see in spoken language.

Another difference is seen in the prosodic system. The possibilities for simultaneous layering of phonological and morphological elements create formal differences in the system. For example, units of facial intonation as well as some head and body postures typically characterize entire prosodic constituents simultaneously, rather than lining up at their boundaries, as do spoken language prosodic features such as the high and low tones of intonational tunes. It is the physical modality that accounts for the nature of the formal features and constrains their distribution in each modality.

We are now in a better position to address the question of why many sign languages have so much in common in their phonologies, including movement. The phonological similarities in use of movement across sign languages suggest that the human cognitive and motor systems are likely to exploit available signals in such a way as to converge on certain kinds of organization and constraints, much as syllable structure in all spoken languages obeys the same general sonority scale, for example (see Sandler, forthcoming b). More specifically, similarities may be a function of language age, as all sign languages are less than 400 years old, implying that what we see is the initial stage in organizing a system of this kind.

Yet this structure is not built in. In a new sign language within a small, relatively insular community, phonological structure including movement is still in its infancy.

Taken together, these facts prompt the prediction that new sign languages will become like the older ones, and that there will be more and more language-specific properties in movement and other phonological categories as sign languages accrue diachronic depth. The same path may well have been taken by spoken languages as they unfolded over the millennia.

ACKNOWLEDGMENTS

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REFERENCES

Aronoff, Mark, Irit Meir, Carol Padden & Wendy Sandler. 2003. Classifier complexes and morphology in two sign languages. In Emmorey (2003), 53–84.

Aronoff, Mark, Irit Meir & Wendy Sandler. 2005. The paradox of sign language morphology. *Language* 81. 301–334.

Boyes Braem, Penny & Rachel Sutton-Spence (eds.) 2001. *The hands are the head of the mouth: The mouth as articulator in sign languages*. Hamburg: Signum.

Brentari, Diane. 1998. *A prosodic model of sign language phonology*. Cambridge, MA: MIT Press.

Clements, G. N. 1985. The geometry of phonological features. *Phonology Yearbook* 2. 225–252.

Corina, David. 1990. Reassessing the role of sonority in syllable structure: Evidence from a visual-gestural language. *Papers from the Annual Regional Meeting, Chicago Linguistic Society* 26(2). 33–44.

Dachkovsky, Svetlana & Wendy Sandler. 2009. Visual intonation in the prosody of a sign language. *Language and Speech* 59. 287–314.

Dobrin, Lise. 1998. The morphosyntactic reality of phonological form. *Yearbook of Morphology* 1997. 59–81.

Duncan, Susan. 2005. Gesture in signing: A case study from Taiwan Sign Language. *Language and Linguistics* 6. 279–318.

Emmorey, Karen (ed.) 2003. *Perspectives on classifier constructions in sign languages*. Mahwah, NJ: Lawrence Erlbaum.

Goldin-Meadow, Susan. 2003. *Hearing gesture.* Cambridge & London: Belknap & Harvard University Press.

Goldsmith, John A. 1979. *Autosegmental phonology*. New York: Garland.

Hockett, Charles F. 1960. The origin of speech. *Scientific American* 203. 88–96.

Hulst, Harry van der. 1993. Units in the analysis of signs. *Phonology* 10. 209–241.

Israel, Assaf. 2009. Sublexical variation in three sign languages. M.A. thesis, University of Haifa.

Israel, Assaf & Wendy Sandler. 2009. Sublexical variation and duality of patterning in a new sign language. Paper presented at the 83rd Annual Meeting of the Linguistic Society of America, San Francisco.

Kendon, Adam. 2004. *Gesture: Visible action as utterance*. Cambridge: Cambridge University Press.

Klima, Edward S. & Ursula Bellugi. 1979. *The signs of language*. Cambridge, MA: Harvard University Press.

Kooij, Els van der. 2002. Phonological categories in Sign Language of the Netherlands: The role of phonetic implementation and iconicity. Ph.D. dissertation, University of Leiden.

Liddell, Scott K. 1984. THINK and BELIEVE: Sequentiality in American Sign Language. *Language* 60. 372–399.

Liddell, Scott K. 2003. Sources of meaning in ASL classifier predicates. In Emmorey (2003), 199–220.

Liddell, Scott K. & Robert E. Johnson. 1989. American Sign Language: The phonological base. *Sign Language Studies* 64. 197–277.

McCarthy, John J. 1981. A prosodic theory of nonconcatenative morphology. *Linguistic Inquiry* 12. 373–418.

McNeill, David. 1992. *Hand and mind.* Chicago: Chicago University Press.

Meir, Irit. 2002. A cross-modality perspective on verb agreement. *Natural Language and Linguistic Theory* 20. 413–450.

Meir, Irit & Wendy Sandler. 2008. *A language in space: The story of Israeli Sign Language.* Mahwah, NJ & New York: Lawrence Erlbaum/Taylor & Francis.

Meir, Irit, Mark Aronoff, Wendy Sandler & Carol Padden. Forthcoming. Sign languages and compounding. In Sergio Scalise & Irene Vogel (eds.) *Compounding.* Amsterdam & Philadelphia: John Benjamins.

Nespor, Marina & Wendy Sandler. 1999. Prosody in Israeli Sign Language. *Language and Speech* 42. 143–176.

Padden, Carol. 1988. *Interaction of morphology and syntax in American Sign Language.* New York: Garland. (1983 Ph.D. dissertation, University of California, San Diego.)

Padden, Carol, Irit Meir, Mark Aronoff & Wendy Sandler. 2010. The grammar of space in two new sign languages. In Diane Brentari (ed.) *Sign languages*, 570–592. Cambridge: Cambridge University Press.

Perlmutter, David. 1992. Sonority and syllable structure in American Sign Language. *Linguistic Inquiry* 23. 407–442.

Quer, Josep (ed.) 2008. *Signs of the time: Selected papers from TISLR 2004*. Hamburg: Signum.

Reilly, Judy, Marina McIntire & Ursula Bellugi. 1990. The acquisition of conditionals in American Sign Language: Grammaticized facial expressions. *Applied Psycholinguistics* 11. 369–392.

Sandler, Wendy. 1986. The spreading hand autosegment of American Sign Language. *Sign Language Studies* 50. 1–28.

Sandler, Wendy. 1989. *Phonological representation of the sign: Linearity and non-linearity in American Sign Language.* Dordrecht: Foris.

Sandler, Wendy. 1990. Temporal aspect and American Sign Language. In Susan Fischer & Patricia Siple (eds.) *Theoretical issues in sign language research*, vol. 1, 103–129. Chicago: University of Chicago Press.

Sandler, Wendy. 1993. A sonority cycle in American Sign Language. *Phonology* 10. 243–279.

Sandler, Wendy. 1996. Phonological features and feature classes: The case of movements in sign language. *Lingua* 98. 197–220.

Sandler, Wendy. 1999. Cliticization and prosodic words in a sign language. In T. A. Hall & Ursula Kleinhenz (eds.) *Studies on the phonological word*, 233–254. Amsterdam & Philadelphia: John Benjamins.

Sandler, Wendy. 2009. Symbiotic symbolization by hand and mouth in sign language. *Semiotica* 174. 241–275.

Sandler, Wendy. Forthcoming a. Prosody and syntax in sign language. *Transactions of the Philological Society.*

Sandler, Wendy. Forthcoming b. The uniformity and diversity of language: Evidence from sign language. *Lingua.*

Sandler, Wendy & Diane Lillo-Martin. 2006. *Sign language and linguistic universals.* Cambridge: Cambridge University Press.

Sandler, Wendy, Irit Meir, Carol Padden & Mark Aronoff. 2005. The emergence of grammar: Systematic structure in a new language. *Proceedings of the National Academy of Sciences* 102. 2661–2665.

Sandler, Wendy, Mark Aronoff, Irit Meir & Carol Padden. Forthcoming. The gradual emergence of phonological form in a new language. *Natural Language and Linguistic Theory.*

Schembri, Adam. 2003. Rethinking "classifiers" in signed languages. In Emmorey (2003), 3–34.

Shepard-Kegl, Judy. 1985. Locative relations in ASL word formation, syntax and discourse. Ph.D. dissertation, MIT.

Stokoe, William C. 1960. *Sign language structure: An outline of the visual communication systems of the American deaf*. Silver Spring, MD: Linstok Press.

Stokoe, William C., Dorothy Casterline & Carl Croneberg. 1965. *A dictionary of American Sign Language on linguistic principles*. Washington, DC: Gallaudet College Press. Reprinted 1976, Silver Spring, MD: Linstok Press.

Supalla, Ted. 1982. Structure and acquisition of verbs of motion and location in American Sign Language. Ph.D. dissertation, University of California, San Diego.

Supalla, Ted. 1986. The classifier system in American Sign Language. In Collette Craig (ed.) *Noun classes and categorization*, 181–214. Amsterdam: John Benjamins.

Supalla, Ted & Elissa Newport. 1978. How many seats in a chair? The derivation of nouns and verbs in American Sign Language. In Patricia Siple (ed.) *Understanding language through sign language research.* New York: Academic Press. 91–132.

Swerts, Marc & Emil Krahmer (eds.) 2009. Special issue on visual prosody. *Language and Speech* 2.

Wilbur, Ronnie. 1987. *American Sign Language: Linguistic and applied dimensions*. Boston, MA: College Hill Press.

Wilbur, Ronnie. 1999. Stress in ASL: Empirical evidence and linguistic issues. *Language and Speech* 42. 229–250.

Wilbur, Ronnie. 2008. Complex predicates involving events, time and aspect: Is this why Sign Languages look so similar? In Quer (2008), 217–250.

Woll, Bencie. 2001. The sign that dares to speak its name: Echo phonology in British Sign Language. In Boyes Braem & Sutton-Spence (2001), 87–98.

Zwitserlood, Inge. 2003. Classifying hand configurations in Nederlandse Gebarentaal (Sign Language of the Netherlands). Ph.D. dissertation, Utrecht University.