Phonetic implementation and phonetic pre-specification in sign language phonology

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In this chapter we will propose that the set of phonological features needed for sign languages is much smaller than what is usually proposed or assumed. Even though it has been recognized (since Stokoe's seminal work) that phonological features must capture only those properties of signs that are distinctive in the language, all subsequent models for sign language phonology typically encode a lot of phonetic detail that, on closer study, isn't really distinctive (in a phonological sense). In this chapter, we argue that the non-distinctive nature of these phonetic properties is due to two sources: (a) phonetic predictability (to be accounted for in terms of phonetic implementation rules) and (b) iconicity (to be accounted for in terms of lexical pre-specification). The two routes in (a) and (b) allow us to 'clean up' the phonology which, as a result, can be shown to be quite restricted and non-random, i.e. in accordance with structural principles that appear to play a crucial role in spoken language phonology as well. A case study involving the notion place of articulation is provided. Our claims are based on a study of signs from Nederlandse Gebarentaal (NGT – Sign Language of the Netherlands), and, in particular on a database (SignPhon) that contains over 3000 signs, provided with a detailed phonetic/phonological encoding.

1. Introduction

In this article it will be argued that the set of phonological features needed for sign languages is much smaller than is usually proposed or assumed. Reduction is possible by appealing to the following principles:

a. Strict adherence to the requirement that phonological properties be distinctive.
b. Specification of *semantically driven* phonetic properties in the lexical representation.

Even though it has been recognized in the sign language phonology literature since the seminal work of Stokoe (1960) that phonological features must capture only those properties of signs that are distinctive in the language, subsequent models of sign language phonology typically encode a lot of phonetic detail that, on closer study, may not be distinctive. A first criterion for distinctiveness is that some property can be distinguished perceptually from other phonetic properties. However, not every distinction that humans can perceive is by that fact alone de facto or even potentially distinctive. It is well known that many perceptible distinctions (often called *paralinguistic* or *extralinguistic*) only play a role in the expression of pragmatic, sociolinguistic or affective values. To be called distinctive it is necessary that some property distinguishes one lexical item (i.e. one meaning bearing unit) from another in at least one language. For instance, the phonetic property of voicing distinguishes the /b/ in *bak* 'container' from the /p/ in *pak* 'package' in Dutch and is accordingly referred to as the distinctive feature [voice]. Typically, of course, distinctive features distinguish many pairs of lexical items in many languages. Distinctive features thus distinguish meanings in the lexicon, while being meaningless units themselves.[1]

In this article it will be claimed, first, that phonetic properties that are non-distinctive must be accounted for by phonetic implementation rules. This idea is neither new nor should be controversial, as it merely promotes adherence to a fundamental characteristic of phonological analysis. A second claim is that certain phonetic properties of signs, although unpredictable in terms of phonetic implementation, still should not qualify as exponents of distinctive features because they are, as we will argue, *semantically driven*. It is proposed here that these semantically driven phonetic properties can be accounted for by specifying them directly in the lexical representation of signs. The proposal will be referred to as *semantically driven phonetic pre-specification*.

With respect to phonetic predictability (cf. 1a), this approach is non-controversial and traditional. The reason that phonologists tend to grant phonological status topredictable properties is mainly due to the fact that analyses of newly studied languages (let alone languages in a new modality) naturally focus first on accurate phonetic characterizations before a rigorous phonological analysis can start. Apart from (sometimes anecdotal) remarks about the predictability of the position of the thumb or of non-selected fingers, and so on, most 'phonological' feature proposals for sign languages do not seem to be based on systematic, large-scale investi-

gations into distinctiveness. In section 3.3, we discuss several examples of phonetic properties that have been granted phonological status incorrectly, being predictably based on the presence of other formal elements.[2] Claiming that certain properties are predictable entails a commitment to spelling out the contextual factors that determine the precise phonetic exponents of the reduced set of phonological features. Therefore, the proposal for a reduced set of features comes with a proposal for a set of *phonetic implementation rules*.

The second route (specified in 1b) that allows us to reduce the set of phonological features is new and potentially controversial. It has long been recognized that many signs in sign languages have a property often referred to as 'iconic': aspects of the form of signs reflect aspects of the shape or action of referents.[3] The present study, however, will not be restricted only to the so-called iconic aspects but will include other types of semantic motivation of the phonetic shape of signs as well.[4]

If one understands language at any given point in time to result from conflicting forces, and focuses on the phonetic form of language, it seems obvious that semantic motivation is, in principle, in conflict with phonology. Whereas phonology implies a finite and minimal set of discrete meaningless building blocks[5] that are arranged in an autonomous, compositional structure, then semantic motivation (especially iconic motivation) may create an infinite array of gradual, holistic shapes that mirror the shapes of referents (object or action, directly or via metaphor). In short, phonology flourishes where meaning is absent.

Both phonology (through phonetic implementation) and semantic motivation determine the overall phonetic event of a sign. In addition, many aspects of the phonetic event are determined by factors such as the emotional state of the signer, the size of his or her articulators and all the situational factors that are part of the communicative setting (formality, distance to signee and so on). Crasborn (2001) offers an extensive discussion of the effects of these para- or extralinguistic factors on the phonetic shape of signs, and the variability that results. In doing a phonological analysis, researchers routinely abstract away from all extralinguistic factors, which are assumed to fall within the realm of 'sociolinguistics' (broadly defined). This chapter argues that it is important to also separate out the impact of the phonology and semantic motivation in a principled way.

The interplay between phonetic shape and semantic motivation could, in principle, be twofold: mediated via phonological structure or direct. In Figure 1, the circle in the center represents a phonetic form.

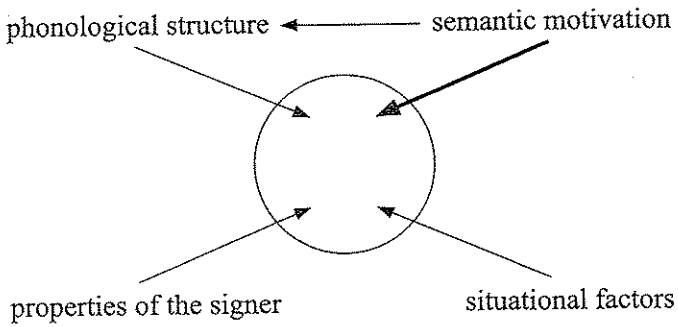

Figure 1. Diagram of the interplay between phonetic shape, phonological structure and semantic motivation in sign languages.

The view that semantic motivation of phonetic shape operates via the phonological structure is essentially that of Boyes Braem (1981). That is, the phonetic exponents of certain phonological features can be meaningful, leaving open the crucial possibility that these features also occur in signs where they do not carry meaning. For example, a feature [round] (indicating curved fingers: Boyes Braem 1981) may be semantically driven in, for instance, the ASL sign CUP, while it occurs in an arbitrary way in the ASL sign TO DECIDE. However, in NGT (*Nederlandse Gebarentaal*, Sign Language of the Netherlands) at least one can find several examples of semantically driven phonetic properties of signs that *never* occur as (arbitrary) distinctive properties. It is the latter kind of property (represented by the bold arrow in Figure 1) that one must be reluctant to give the status of phonological feature.

In early work on sign language phonology, it seemed crucial to discount the importance of iconicity in order to validate the claim that sign languages have dual patterning (independence of form and meaning) and thus a phonology. This was important because, prior to Stokoe's work, the prevailing idea was that the form of signs was determined by, and therefore not independent of, meaning. Hence, sign languages were believed to lack 'dual patterning', which had often been claimed to be a defining property of human language. Spoken languages, on the other hand, were said have dual patterning, emphasizing the Saussurian dictum that form and meaning are arbitrarily related. Thus, while on the whole spoken language phonology was taken to be arbitrary, sign language forms were taken to be iconic, or more generally meaning-driven.[6] Then, when Stokoe revealed arbitrary phonological composition in signs, it seemed best to sign researchers to deny the relevance of iconicity,

which, as we have seen is fundamentally incompatible with the notion of phonological compositional structure.

The position advanced here is that due recognition of semantic forces which determine the phonetic shape of signs is not incompatible with an account of their phonological structure. The proper question is: how can *both* semantic motivation and phonological compositionality be accounted for in a harmonious, consistent and cognitively plausible way? The answer, we suggest, lies in the hypothesis that the lexical structure of signs contains a specification of semantically-driven phonetic properties *alongside* a phonological structure. The phonetically pre-specified properties can be unique for a sign or have a certain degree of productivity, as evidenced in the formation of new signs. Pre-specified phonetic properties logically take precedence over the phonetic implementation rules that spell out the phonetic properties of the phonological structure where a conflict arises. An example of such a conflict is provided in section 3.3.

It must be stressed that allowing pre-specification of phonetic properties conflicts with the traditional idea that all non-predictable properties are phonological (i.e. distinctive). After all, a semantically driven property may very well be the only difference between two signs that are otherwise identical. Hence, the danger should be recognized of using phonetic pre-specification as a wild card to be used to 'protect' the phonology from an excess of phonological features. The semantic motivation at the basis of pre-specification needs careful argumentation in the context of a theory about the interface between phonetic properties and semantics. One way to investigate the cognitive reality of recurrent form-meaning associations experimentally is to set up a sign recognition test in which signers would have to provide a meaning for signs consisting of recombinations of form elements from meaningful signs (i.e., pseudo-signs). Alternatively, signers could be asked to make up new signs given a certain description of an (imaginary) object or action. It could then be determined whether the form elements of the resulting new signs match the extra-phonological form-meaning pairings normally found in the lexicon.

In this section, the two strategies for reducing the number of elements in sign language phonology have been outlined, i.e. strict adherence to the idea that phonological features are distinctive and not predictable, and the proposal to specify semantically motivated phonetic properties in the lexical representation.

In the next section the phonological model and feature set that emerged from this reductionist approach is briefly sketched mainly to provide the

background for the case study involving a proposal for the representation of Place of Articulation or Location properties that will be provided in section 3.

The claims made in this article are based on a study of signs from NGT and, in particular on a database (*SignPhon*; Crasborn et al. 1998. Crasborn 1998) that contains over 3000 NGT signs in isolation or citation forms, provided with a detailed phonetic/phonological encoding. An extensive report of this study can be found in Van der Kooij (2002). An accessible description of the Signphon database can be found in Crasborn, van der Hulst, van der Kooij (2001) and on http://www.let.kun.nl/sign-lang/signphon2.html.

2. Model

The reductionist model that is laid out in this section, the Dependency Model, is restricted by various structural principles, specifically binary branching and head-dependency relations. Heads express relative salient and/or stable information, whereas dependent nodes contain more moveable (e.g. in terms of spreading behavior) or dynamic information. The features that are used in this model are unary and are hierarchically organized into class nodes (such as *Selected Fingers* or *Orientation*). In the representation of signs in Figure 2, phonological under-specification is used, i.e. phonological features that are predictable from other, more basic features are left unspecified. These theoretical aspects, which cannot be motivated in the context of this brief article, were first introduced and examined in van der Hulst (1993) and have been further supported and developed in the form of several variants of the basic model in subsequent work. For a full recent version of the model (and relevant references), we refer to van der Kooij (2002:280).[7]

As for the manual node, the major cut is that between the *(active) articulator* and *location* (or *passive articulator*). The former then splits into *orientation* and *handshape*, a grouping that was adopted from Sandler (1989). Handshape proves to be the most detailed class node, as shown by the fact that it divides into *Finger Selection* and *Finger Configuration*, both with their own detailed internal structure (not shown here). The articulator node is taken to be the head of the whole sign segment because, intuitively, the articulator is the most central and obligatory unit, and because it is the most highly structured node. Location, as we will see in a moment, is not an obligatory aspect of signs.

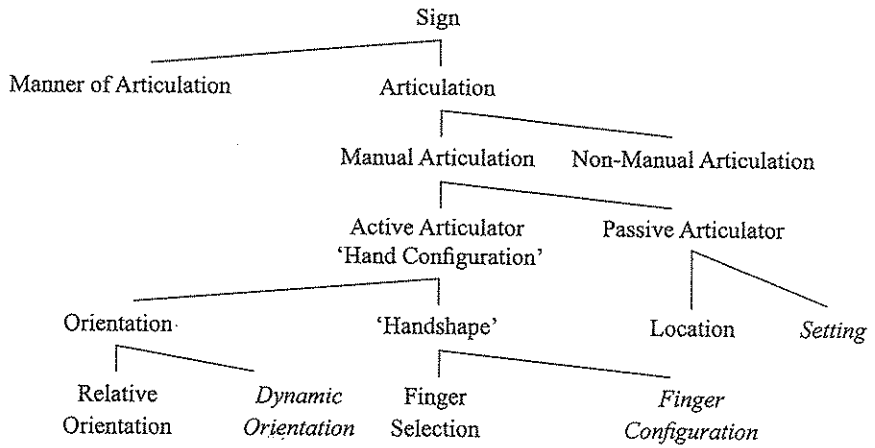

Figure 2. A partial version of the Dependency Model of signs.

Movement, in this model, is represented in terms of branching nodes that are dependent on the head nodes that determine the scope of the movement, as shown in Table 1.

Table 1. Specification of different types of movement in the Dependency Model

Head node:	*Dependent node branches:*	*Resulting movement:*
Location	Setting	Path Movement
Relative Orientation	Dynamic Orientation	Orientation change
Finger Selection	Finger Configuration	Hand-internal change

In this respect, the present model deviates from models that represent movement in terms of a 'skeletal position' M(ovement) that is sandwiched between two static skeletal positions (cf. Liddell & Johnson 1989, Sandler 1989, Perlmutter 1992).

In the Dependency Model, *path movement*, a movement of the whole articulator, is represented as a transition between two settings. For example a downward movement on the chest as in the NGT sign TIRED is represented as in Figure 3.

The settings [high] and [low] are interpreted with reference to the feature [trunk] specified in the head node. The same setting specification combined with the Location feature [cheek] would result in a much smaller path movement.

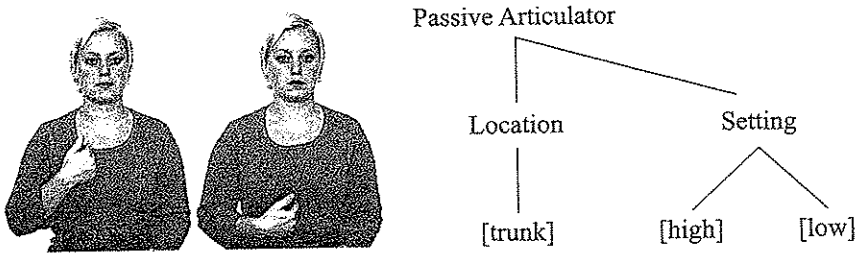

Figure 3. Downward path movement in NGT sign TIRED.

Sandler (1989) was the first to separate *Major Location* and *Setting*. In her model Setting is used to represent finer distinctions within one major area. Setting features include three pairs of features concerning the distance to the location (peripheral-distal), the height within the location (high-low), and the lateral side of the major location (ipsi-contra). Moreover, the feature [contact] is subsumed under the setting node. In Sandler's model, a combination of Major Location features and setting features establishes the set of *distinctive* locations. A distinctive location can thus consist of a Major location and one setting value, i.e., in the absence of movement. In addition, Setting in Sandler's model is used as a means to describe path movement. In that case, the setting specifications occur pairwise. A downward path movement consists of a specification of the settings 'high' and 'low'. Table 2 presents the setting specifications distinguished by Sandler.

Table 2. Setting specifications (Sandler 1989)

Setting:	
ipsilateral	setting on the same side of the body as the articulating hand
contralateral	setting on the opposite side of the body as the articulating hand
high	above the middle of the specified place (near the fingertip edge in case the place is 'hand')
low	below the middle of the specified place (near the heel edge or base in case the place is 'hand')
proximal	within a few inches of the place
distal	a comfortable arm's length from the place
contact	touching specified location by articulating hand(s)

In the current Dependency Model, the division in Location and Setting is adopted, but a clear division of labor between them is postulated. Location features are used to make underlying contrasts of distinctive areas on the

head, body and arm and hand. Contrary to what is found in Sandler's model, therefore, setting is not used to make finer location distinctions. Setting features are *only* used to represent path movement within those distinctive areas. Consequently, Setting features only come in pairs, parallel to the features of other dependent nodes (*Aperture* and *Dynamic Orientation*). Path movements are thus regarded as the dynamic part of the location component. As in Sandler's model, the interpretation of the setting pairs representing the path movements is contingent on the distinctive location they depend on. In Figure 4, the passive Articulator node and the features that are subsumed under it are illustrated.

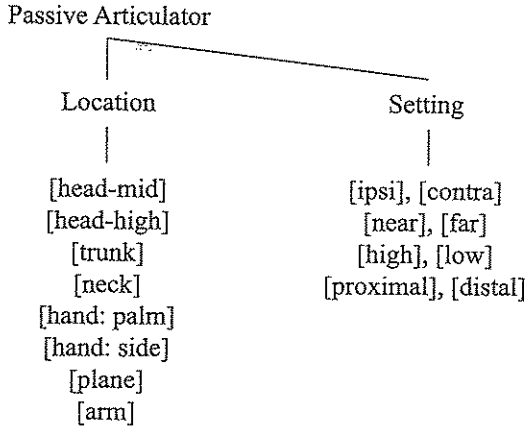

Figure 4. The Passive Articulator in the Dependency Model.

Phonological locations in the Dependency Model, then, refer to distinctive *areas* within which a setting change can take place rather than to specific *points* on the head, hand or body. This representation accounts for the observation in Battison (1978) that the movement of mono-morphemic signs stays within one major location. This observation was based on the behavior of so-called double contact signs that have contact at the beginning and at the end of the movement. For NGT it is found that not only double contact signs, but basically all signs with a simple path movement stay within their location, provided that we interpret distinctive location as an area rather than a point. In NGT there appear to be no mono-morphemic signs that, for instance, start out with contact on the chin and then touch the nose, or signs that start out near the left eye and then go to the right ear. For NGT, the generalization thus holds that *all simple path movements* take place within one location.

Further evidence for the head-dependent relation between location and setting comes from the observation about the size of path movements already made with reference to (3). The *size* of the movement seems to correlate with the major location where movement is made (Battison 1978). For instance, a linear horizontal movement on the trunk is larger than a linear horizontal movement on the chin, and a circular movement on the weak hand has similar size as a circular movement on the cheek. In the representation proposed here, this correlation is formally accounted for by a head-dependent structure (cf. van der Hulst 1993, 2000).[8] Setting is dependent on Location, thus expressing the observation that the size of path movements correlates with their location. If there were no formal account of (the size of) path movement in relation to location, one would need specifications for all sizes of movement. In the representation proposed here, the same setting pair representing a horizontal movement ([contra] to [ipsi]) will result in a larger path movement on the trunk (LATE in Figure 5b.) than for instance on the chin (MOTHER in Figure 5a.).

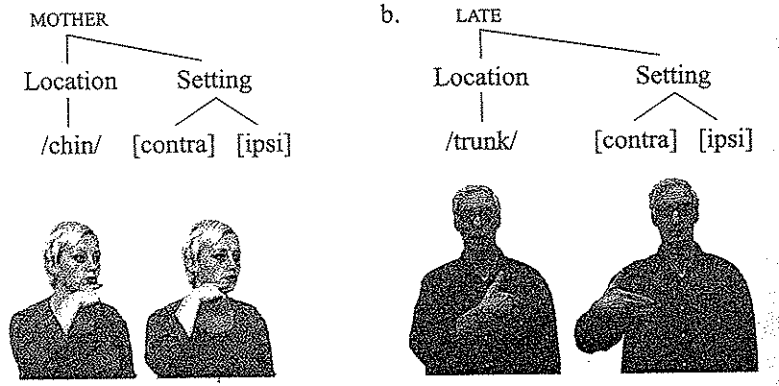

Figure 5. Partial representation of the NGT signs MOTHER and LATE

By formally linking location and movement it is implied that a distinctive location is not necessarily a specific point in space or on the body but rather an area, i.e. a set of phonetic points. This view of location as an area does more justice to the range of phonetic variation we find for certain signs. For example, the NGT sign NORMAL is made on the trunk and consists of a repeated downward brushing movement. The realization of the phonetic location of this sign ranges horizontally from the contralateral side (near the arm pit) to the center of the chest (the chest bone) and vertically from shoulder height to diaphragm-height. One even finds variants that are made in the space right in front of the diaphragm, without actually contacting the chest. In the Dependency Model all variants would be adequately described with the location feature [trunk] and the setting features [high], [low].

With this brief sketch of the Dependency Model in place, the next section focuses on one distinctive location, the trunk. The aim of this section is to illustrate the reduction strategies that were discussed in section 1. It will be shown how a small set of distinctive location features can be postulated when a proper role is given to phonetic implementation rules (to account for non-distinctive phonetic properties) and to the mechanism of semantic pre-specification (to account for meaning-driven phonetic properties).

3. A case study: the feature [trunk]

3.1. Location features

Traditionally, location (or place) is recognized as one of the major components of signs. In the different models that describe ASL phonology, we find an abundance of features for this dimension of signs. This is due, in part, to the fact that often every phonetic location that is touched by the articulator is adopted as a phonological specification in these models. In table 3 (page 277), adapted from van der Kooij (2002a), a comparison of the location features for ASL in various sign models is provided. The rightmost column lists the features resulting from an analysis of NGT that incorporates phonetic implementation rules and semantic pre-specification. Although these features are based on the description of NGT signs, the resulting proposal is put forward as a general hypothesis for sign language phonology in general.

Contrary to the models in the middle columns, there are only a few distinctive locations in the new proposal, which is actually quite close to that of Stokoe (1960). In Figure 6, a schematic summary of the needed place specification is offered.

The locations printed in italics are considered to be *marked* vis-à-vis their complementary choices. In NGT, [head] is the most frequent body-related location (61%). This makes [head] the least marked body-related location. The recurrent observation that lesser marked locations allow the greatest array of subdivisions (cf. van der Hulst 1993) is born out by the fact that both [head]

and [hand] have further subdivisions. In the case of [head], it is assumed that the location features [mid] and [high] can enter into a combination. Either feature can be in syntactic head or dependent position, resulting in a four-way distinction on the head. In the case of [hand], the palmside of the hand is most frequent and is represented by the feature [broad]. The thumb side of the hand, which is represented by the feature [narrow], is much less frequent. The backside of the hand is highly marked and is represented by a further specification of the feature [broad].

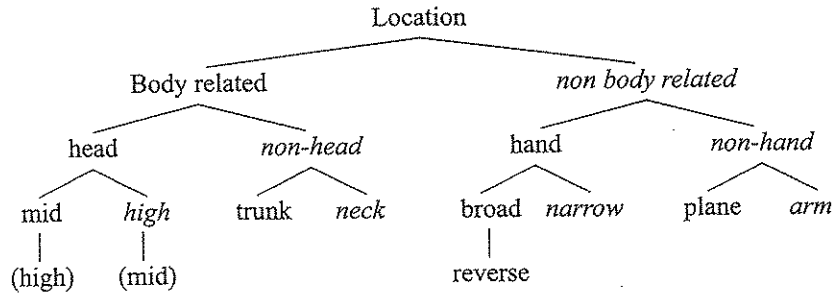

Figure 6. Schematic summary of place specifications for the Dependency Model.

The major distinction is between body-related and non-body related locations. This distinction correlates to a certain extent with linguistic function: the former are primarily relevant in the lexical domain, whereas the latter serve a more morpho-syntactic role.

In the typology of location, no feature is proposed to cover the phonetic property of 'neutral space', i.e. the space in front of the signer. Neutral space is the most frequent location in NGT lexical sings (71%). Given that, in this study, lexical frequency is considered to be an important indicator of markedness, neutral space is taken to be the *literally* unmarked location (i.e *no* location). This representation of neutral space signs does not preclude that the articulator *can* move with respect to specific locations in neutral space. These locations can be provided by other components of the grammar. The morphosyntax of agreement may provide the locations in neutral space that are associated with the arguments of a verb. Also the spatial expression of time ('time lines', see Schermer & Koolhof 1990) may demand the use of specific locations in neutral space. However, the present model recognizes *one* distinctive non-body related location in neutral space on phonological/phonetic grounds. Based on a survey of movement types, a virtual horizontal plane in space is assumed. End-hold movements in space can be analyzed

in the same way as movements ending in contact with some body location, if one assumes that the end hold is caused by a (virtual) end contact with a (virtual) horizontal plane.

Table 3. Overview of location specifications of various ASL models

Stokoe (1960)	*Sandler (1989)*	*Brentari (1998)*	*Liddell&Johnson (1989)*	*Van der Kooij (2002)*
neutral space	neutral space	3 planes		plane
Head	Head	head	top of head back of head	head:high
Forehead		forehead	forehead forehead-side	
Midface		Eye		head:mid=>high
side of face		Cheek/nose	cheek ear jaw	head:high=>mid
lower face		Upper lip	Nose	head;mid
		mouth	Lip	
		Chin	Chin	
Neck	neck	under chin neck	Neck	Neck
Trunk	shoulder	Shoulder	Shoulder	Trunk
	trunk	Clavicle torso-top torso-mid	sternum chest trunk	
		torso-bottom waist hip	abdomen	
			Leg	
Upperarm	arm	upper arm elbow front elbow back	upper arm	Arm
Forearm wrist back wrist front		forearm front forearm back forearm ulnar wrist back wrist front	Forearm	
weak hand (several shapes)	weak hand	weak hand (8 locations)	weak hand (38 locations)	weak hand (palm, back, side)
13+	78[9]	32+	82[10]	11

3.2. The trunk

Stokoe (1960) proposed that no phonological distinctions are made on the trunk. The ASL signs that use the extreme upper (ANGEL, RESPONSIBILITY) and

lower (RUSSIA) limits of the trunk are claimed to carry their contrast in hand configuration and movement only. However, unless all redundancies concerning the combination of handshape and location are investigated, this seems a rather *ad hoc* and unsatisfying solution.

Other researchers assume many distinctions on the trunk, mainly based on the observation that the articulator contacts the trunk in various locations. As an example of this 'phonetic' approach, Brentari (1998) assumes 28 potentially distinctive locations on the trunk, resulting from seven vertical level distinctions (shoulder, clavicle, top of the torso, torso-mid and torso-bottom, waist, hip) combined with two horizontal levels and two distinctions parallel to the body surface.

Following Stokoe, it is proposed here that there are no phonological contrasts among locations on the trunk. There is only one phonological specification: [trunk]. The actual realization of a location on the trunk can be predicted in terms of the phonetic implementation rules or semantic pre-specification. The phonetic implementation rules that account for the allophonic locations on the trunk need reference to the number of hands and to the relative orientation of the dominant hand. For some trunk locations, there is ample evidence for the role of semantic motivation. The use of extreme limits of the trunk, shoulders and waist, especially, will be shown to be controlled by semantics.

3.3. Predictability in terms of phonetic implementation rules

Based on a review of the signs in the SignPhon database, some tendencies were found in frequencies of occurrence of various phonetic distinctions. As can be seen in Table 4, most signs on the body are made in the center of the chest. For one-handed signs, this rate is even higher. The center of the chest is thus considered to be the *default* implementation, at least for one-handed signs. An articulatory reason may be that the center of the chest is the easiest position for the articulator to touch if it is lifted up while keeping the elbow in neutral (low, non-raised) position.

Two-handed signs can be divided into *balanced* and *unbalanced* signs (van der Hulst 1996). In unbalanced signs, there is one active hand; the passive hand serves as the location for the active hand. Balanced signs involve two identical articulators moving in tandem or in an alternating manner. In balanced signs, both on the body and in space, the default location of the strong hand is on the ipsilateral side of the midsagittal plane. In general, the

non-dominant hand is placed in the exact mirror location, the mirror being placed at the midsagittal plane. As the location for the weak hand can be predicted in balanced signs, location in these signs is represented by specifying only the location for the strong hand.[11] However, this observation needs some refinement. If the two hands make contact with the chest at the end of the movement, the hands tend to be located in the center of the chest, one hand above the other. An example of such a sign is LONELY.

Table 4. Distribution of phonetic locations of NGT signs made on the trunk

Trunk	389	8% of all signs in SignPhon
upper chest, center	182	47%
upper chest, ipsi	77	20%
upper chest, contra	61	15%
lower chest, center	28	7%
lower chest, ipsi	16	4%
waist	14	5%
top of shoulder, ipsi/contra	7	2%
lower chest, contra	4	1%

We can summarize as follows:

a. In balanced signs, the articulators tend to stay on their own side of the midsagittal plane.
b. In balanced signs *with end contact*, the articulators tend to touch the chest in the center, one hand above the other.

The type of contact thus influences the exact location on the trunk. Another generalization concerning contact is made by Battison (1978) for ASL. He noted that contact with the contralateral side of the body is more marked than contact with the ipsilateral side of the head or body. In general, this also holds for NGT. Although one finds signs involving both contralateral and ipsilateral contact, single-setting contralateral contact on the head indeed never occurs. On the trunk, contralateral contact is marked for both one-handed and two-handed balanced signs. However, there is a group of signs that refute this tendency. These signs can be accounted for if one notes which part of the hand has contact with the location. The contacting part of the hand is subsumed under what is called the *relative orientation* of the hand. (Crasborn & van der Kooij 1997, Van der Kooij 2002) In signs that have the radial (or thumb-) side of the hand contacting the body, the *contralateral* side of the

trunk appears to be unmarked location. Examples are: ALSO, BROTHER, NORMAL, TO BORROW, PRIZE. This tendency seems to be phonetically grounded. Contacting the ipsilateral side of the trunk, or even the center of the chest, with the radial side of the hand would require more articulatory effort, since it is hard to accomplish without lifting the elbow and/or bending the wrist to an extreme position. While all other points of contact in one-handed signs seem to favor the center of the trunk, thumb-side contact thus favors the contralateral side of the trunk. To re-state:

> If the relative orientation is [radial] in one-handed signs, the articulator touches the contralateral side of the trunk.

As for two-handed signs, very few have relative orientations other than palm or fingertip. According to the general tendencies for balanced signs, the hands stay on the ipsilateral side of the body. There is one two-handed balanced sign from the *Groningen* variant[12] (KITCHEN) that has contact with the ulnar (or pinky-) side of the hand and a few signs (CHIEF, DUCK) that have contact with the radial side of the hand. These two-handed signs are made lower on the trunk. Presumably this is also due to ease of articulation. In order to contact the trunk with the lateral side of the articulator, the lower arm has to rotate, but this seems less effortful in locations relatively low on the trunk.

Table 5. Summary of predictable locations on the trunk

Relative orientation	One-handed signs		Two-handed signs	
Palm	center	FRIDAY	ipsi	GLAD
radial	contra	ALSO	center	LONELY
fingertip	center	FINALLY-UNDERSTAND	ipsi	BEHAVIOR
Ulnar (few signs)	center	GUYOT[13]	lower ipsi	KITCHEN $_{\text{Groningen}}$[14]
Back/wrist (few signs)	center	POSSESSIVE-I$_{\text{VOORBURG}}$	ipsi	ACCEPT

Summarizing the noted refinements, it appears that by default, one-handed signs are located in the center of the trunk (neither ipsi- nor contralateral) whereas two-handed signs are made on the ipsilateral sides of the body. This observation can be rephrased as follows: if the sign is one-handed, the whole trunk is used, whereas if the sign is two-handed only one half of the trunk (i.e., ipsilateral of the midsagittal plane) is available.

Other relevant factors cannot, of course, be excluded at this point. First, Table 5 is not intended to be a complete account of phonetic predictability.

Moreover, for some combinations only one or two signs exist. In general, only very few signs make contact with the back or wrist part of the hand. Only one sign was found in this category, namely the *Voorburg* variant (cf. footnote 12) of the directional first person possessive MINE.

Second, these tendencies of NGT do not preclude the possibility that in other sign languages, whether in general or in specific sub-regions of the lexicon (e.g. in name signs), the ipsi-contra distinction is not predictable and would need a phonological specification. As David Perlmutter (personal communication) has pointed out, name signs in ASL do make use of the different sides of the chest; for this stratum, a distinctive use of the setting features [ipsi] and [contra] may be used. Another way of dealing with the locations of name signs could be by phonetic pre-specification. If distinctive features are typically used recurrently in the lexicon, one could propose that distinctions must be used more than once or twice in the lexicon in order to be accepted as phonological. Since name signs are typically unique, one could deal with the unique locations in these signs in a similar manner as semantically motivated locations, i.e. by phonetic pre-specification.

The next section discusses a set of one-handed signs that make contact with the palm and radial side of the hand. It will be shown how semantically motivated locations escape the phonetically motivated tendencies illustrated in this section.

3.4. Semantic pre-specification

With just one phonological distinction on the body – [trunk] – and the set of phonetic implementation rules, finer distinctions on the trunk have been accounted for. There are signs, however, that seem to escape the general tendencies. As for the height distinctions, the locations high and low on the trunk are infrequent (21 and 5 of the SignPhon signs, respectively). Almost without exception, these relatively high and low locations are semantically motivated.

Examples from SignPhon of signs that are made at shoulder height are: (UNDER-)SHIRT, COAT, SWEATER, BEAUTY-QUEEN, and PROFESSOR. These signs all refer to the shape of a piece of clothing and the way people wear it. Other signs made at shoulder height , which were collected separately, are: GYMNASTICS, BAG, TO-CARRY, FUNERAL/BURIAL, MILITARY-RANKS, TO-CARRY-RESPONSIBILITY, BROAD-SHOULDERED, SEAT-BELT, YOKE. Except for GYMNASTICS, all these signs relate to the shoulders or to carrying things (on the shoulders).

Signs from SignPhon that are made on the lower part of the body are: TROUSERS, UNDERPANTS/PANTIES, SKIRT, LIVER, ORGANS. Signs made on the lower body that were collected separately are: BELLY, FAT-ROLLS (ON THE BELLY), KIDNEYS, INTESTINES, APPENDIX/APPENDICITIS, SEX-ORGAN (M/F), ERECTION, SEXUAL-INTERCOURSE, PREGNANT, SICK, ABORTION, MISCARRIAGE, STERILIZATION (M/F), DELIVERY, CAESARIAN-SECTION, UMBILICAL-CORD, UMBILICAL-BANDAGE, CORSET, WRAP-UP-SKIRT. It is clear from the meaning of these signs that they are all related to the lower part of the body, either to the inside (the organs and functions thereof) or to the outside (clothes typically worn on the lower part of the body).

It is here proposed that the above semantically-driven locations (which do not necessarily provide a complete set) are accounted for in terms of phonetic pre-specification. If the meaning aspect 'lower part of the body' is involved, the location on the body is typically made on the lower part of the trunk. As this tendency concerns a larger set of signs it may be possible to formulate rules that predict the lower or higher part of the trunk on the basis of a meaning aspect that these signs have in common. Formulating these rules requires a semantic analysis of these signs that goes beyond the scope of this paper. Another set of signs show more isolated exceptions to the general tendencies. In these cases, the iconic phonetic location is unique to specific signs and no patterns exist.

We found two types of *unique* phonetic locations. As we showed in Table 5, the phonetic default location for one-handed signs with palm contact is the center of the chest (OF, TO FIND/TO CONSIDER, TO WANT, AFRAID). The sign SOLDIER, however, is made high on the ipsilateral side of the chest. We argue that this is due to the iconic base of the sign: the carrying of a gun. Likewise, the sign KIDNEY consists of a pointing sign toward the lower side of the trunk. The location in this sign is semantically-motivated in the sense that the pointing hand has a deictic function, pointing to the actual location of the kidneys. Similar signs are LIVER, STOMACH, APPENDIX, etc. Because in these cases the motivated relation of formal location to its referent is idiosyncratic, we propose to adopt a phonetic pre-specification of these specific locations.

Yet another set of semantically motivated locations on the trunk is the set of signs in the semantic field of feelings. These signs tend to be made in the center of the chest. Of the 299 signs made at the center of the chest, 119 (i.e., almost 40%) were related to 'feeling'. Examples are: DISAPPOINTED, PATIENT, SATISFIED, IRRITATED, SAD, ANGRY, TO LOVE, AT EASE, TO BE BOTHERED WITH SOMETHING, EGOISTIC, TO PITY, HAPPY, AFRAID, GUILTY, SORRY. It is clear, however, that there are signs not pertaining to the semantic field of feelings that are made

in the center of the chest. Given that the center of the chest is already the default location, at least for one-handed signs, it may that the central location for signs associated to feeling is due simply to the phonetic default.[15] There are, however, some signs that provide evidence for the reality of the semantic tendency just noted. As was illustrated in Table 5, one-handed signs with radial contact tend to be located at the contralateral side of the trunk. Of these radial contact signs, there are at least three signs that also have the meaning component of 'feeling,' resulting in a potential conflict between the phonetic and the semantic tendency. These signs are: RELIEVED, IMPATIENT and RESTRAIN ONE'S FEELINGS. These signs all contact the center of the chest. This can be understood as evidence that there really is a semantic tendency, and that it is stronger than the phonetic tendency.

4. Conclusions

In this article, it has been argued that there is no need to 'burden' the phonology with long lists of place features. Hence, it is possible to agree with the more economical earlier proposals of Stokoe and Battison. However, the richness of phonetic locations must be accounted for and here it has been argued that this can be done in two ways: phonetic implementation rules that specify default locations and semantically-driven phonetic pre-specifications that universally override the phonetic default rules.

The lexical entry for a sign can thus contain a phonetic pre-specification alongside a phonological structure. Phonetic pre-specification can either be unique to a particular sign, or be an instance of a rule expressing a phonetic tendency that may have some degree of generality and may play a role in lexical innovation, i.e., the formation of new signs (cf. Brennan 1990). In addition to a potentially illuminating role in the study of lexical innovation, the current analysis allows the formulation of hypotheses regarding the historical development of signs. If semantic motivation reduces over time, phonetic implementation rules are predicted to take over.

Notes

1. This, of course, leaves open the possibility that the phonological form of a particular morpheme consists of one single feature, such as the feature [nasal] for

the expression of 'first person' in the South American language Terena (Akinlabi 1996).

2. A phonetic property that is predictable in one language, may, of course, later be found to be distinctive in the context of an analysis of another language. It is assumed here that a phonetic property is non-distinctive until shown otherwise.
3. Contrary to other research on iconicity in sign language, it is not assumed here that the vocabulary of a sign language can be partitioned into non-overlapping sets of iconic signs and non-iconic or arbitrary signs. Van der Kooij (2002) demonstrated for NGT that semantic motivation (including iconic motivation) may occur at all levels of description, also at the lowest level of features. This implies that signs consisting of otherwise arbitrary features may contain a semantically motivated form element, e.g. an iconically motivated location feature.
4. In this article iconic motivation is understood as a subtype of semantic motivation. In iconic motivation, the relation between the linguistic form and its referent is analogous or diagrammatic. The form may refer to its referent directly or through metaphor. Included here are also deictic signs referring to body parts (e.g. KIDNEY) and cases in which the semantic motivation of the form is mediated through some other level of symbolization. (e.g. 'loan' handshapes; handshapes representing number or letters from a surrounding spoken language). In the latter case one may argue for calling these form-meaning associations morphemes.
5. These may themselves have an infinite array of phonetic realizations.
6. It is, of course, highly questionable that the form shape of spoken languages is exclusively arbitrary. To claim that would ignore many meaning-driven phenomena that usually go under the heading of onomatopoeia and sound-symbolism. If the present proposal to pre-specify certain phonetic properties as extra-phonological is tenable, a similar proposal might well be motivated for certain aspects of the 'phonology' of spoken languages.
7. Van der Hulst (2000) offers a comparison of structures in the signed and the spoken modalities. In the present article no attention will be given to parallels, deep or superficial, between sign language and spoken language phonological structures.
8. A different sort of formal link between location and movement is proposed in Uyechi (1996). She developed a geometric model in which the size of the lexical movement is relative to (the size of) the location.
9. The 78 distinctive locations results from multiplying the six major locations in this list by the potential setting specifications (in Table 2) within these major locations.
10. The 82 distinctive locations are taken from Liddell & Johnson (1989). For some locations in the table, diacritics are added to specify the precise setting of the articulator within the location.
11. If the hands cross the midsagittal plane, this is specified by the feature [cross] in the manner node. An example of such a sign in NGT is AUSTRIA.

12. NGT, at least at a lexical level, has several regional varieties or 'dialects' that originate from Deaf educational institutions located in various sub-regions of the Netherlands.
13. GUYOT is a proper name and refers to the name of the Deaf Institute in Groningen.
14. The subscipts Groningen and Voorburg indicate the geographical region where the sign originated or is used.
15. In principle, the signs in the default location could also be semantically motivated to be produced here. Of the 299 signs made in the default location on the trunk, almost 40 % could be related to 'feeling'. This leaves 60% unaccounted for by semantic motivation. Thanks to an anonymous reviewer for bringing up this important point.

References

Akinlabi, A.
1996 Featural affixation. *Journal of Linguistics* 32, 239–289.

Battison, R.
1978 *Lexical Borrowing in American Sign Language*. Silver Spring, Md: Linstok Press.

Boyes Braem, P.
1981 Distinctive Features of the Handshape in American Sign Language. Doctoral dissertation, University of California, Berkeley.

Brennan, M.
1990 Word Formation in British Sign Language. Phd thesis. University of Stockholm.

Brentari, D.
1990 Theoretical foundations of American Sign Language phonology. Doctoral dissertation. Unversity of Chicago, Chicago.
1998 *A Prosodic Model of Sign Language Phonology*. Cambridge, MA: MIT Press

Crasborn, O.
1998 *SignPhon software* (version 2.22). Nijmegen: http://www.let.kun.nl/sign-lang/signphon2.html
2001 Phonetic Implementation of Phonological Categories in Sign Language of the Netherlands. PhD thesis, University Leiden Centre for Linguistics.

Crasborn, O., H. van der Hulst and E. van der Kooij
1998 SignPhon 2 manual. Working draft. Leiden University.
2001 SignPhon: A phonological database for sign language. *Sign Language and Linguistics* 4, 1/2, 215–228.

Crasborn, O. and E. van der Kooij
1997 Relative orientation in sign language phonology. In: J. Coerts & H. de Hoop (eds.) *Linguistics in the Netherlands 1997*. Amsterdam: John Benjamins Publishing Company, 37–48.

Hulst, H.G. van der
1993 Units in the Analysis of Signs. *Phonology* 10, 209–241.
1996 On the other hand. *Lingua* 98, 121–143
2000 Modularity and modality in phonology. In: N. Burton-Roberts, P. Carr and G. Docherty (eds.). *Phonological Knowledge: Its Nature*. Oxford: Oxford University Press, 207–244.

Kooij, Els van der
2002 Phonological categories in Sign Language of the Netherlands; Phonetic implementation and iconicity. PhD thesis. Leiden University. [Published by LOT, Netherlands Graduate School of Linguistics; http://www.lot.let.uu.nl]

Liddell, S. K. & R. Johnson
1986 American Sign Language Compound Formation Processes, Lexicalization and Phonological Remnants. *NLLT* 4, 445–513.
1989 American Sign Language: The Phonological Base. *Sign Language Studies* 64, 197–277.

Perlmutter, D. M.
1992 Sonority and Syllable Structure in American Sign Language. *Linguistic Inquiry* 23, 407–442.

Sandler, W.
1989 *Phonological Representation of the Sign: Linearity and Nonlinearity in ASL Phonology*. Dordrecht: Foris Publications.

Schermer, T. and C. Koolhof
1990 The reality of time-lines: aspects of tense in Sign Language of the Netherlands (SLN). In S. Prillwitz & T. Volhaber (eds.) *SLR'89*, 295–305. Hamburg: Signum.

Stokoe, W. C.
1960 Sign Language Structure. 2nd edition 1978. Silver Spring, MD: Linstok Press.

Uyechi, L.
1996 *The Geometry of Visual Phonology*. Stanford, CA: CSL Publications [from 1994 dissertation].

Variability in verbal agreement forms across four signed languages

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In signed languages, "agreeing verbs" change orientation and/or direction of movement according to targets established by an agreement rule and assigned to locations in signing space. Such verbs do not always match the targets. To determine the nature and source of the mismatches, this study investigated variability in three agreement forms across 70 to 80 verbs in four signed languages. One main finding is that two kinds of constraints determine whether the phonological form of a verb matches the target(s) imposed by the agreement rule: constraints on the degree and on the complexity of articulation. Another finding is that variability was systematic across particular targets for three agreement forms, across all verbs and signed languages. Taken together, the findings suggest that the constraints may be encoded within the phonological system of a sign language. The constraints are further discussed in terms of gestural scores within the framework of Articulatory Phonology: the constraint on degree of articulation is seen as an upper bound on a tract variable, while that on complexity is evaluated in terms of number of phasing relationships. Within the framework of Optimality Theory, which determines optimal output for a given agreement form, ranking of one markedness constraint above a faithfulness constraint determines the output according to degree of articulation, while ranking of a faithfulness constraint over another markedness constraint selects the output according to complexity of articulation.

1. Introduction

In signed languages, there is a set of verbs called "agreeing verbs" that change orientation and/or direction of movement according to "targets." Targets are established through agreement with the subject and direct object of a sentence in person and number features. Person features include first per-