Phonetic implementation of phonological categories in Sign Language of the Netherlands

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Translation:

My arm is connected; connected to the shoulder.
My hand is connected to the arm.
And my fingers are connected as well.
These things have been scientifically established.

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Phonetic implementation of phonological categories in Sign Language of the Netherlands

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1 Introduction

1.1 The subject matter of this thesis

This thesis investigates a number of aspects of the phonetic-phonological structure of Sign Language of the Netherlands (SLN). I will follow the widespread convention in sign language linguistics of using the terms ‘phonetics’ and ‘phonology’ to refer to the study of the production and perception of signs and the study of the underlying cognitive system, respectively.

The goal of this thesis is twofold. The first goal is to find out to what extent there is phonetic variation in the realization of the movement component of SLN signs. Variation in the realization of both static aspects of the form of signs (the configuration of the arm, hand and fingers) and dynamic aspects (their movement) is mentioned occasionally in the linguistic literature, yet there are few studies which address phonetic variation in detail. The second goal is to develop a model that can generate the different phonetic variants on the basis of a single phonological specification that is stored in the lexicon for each sign. No phonetic implementation model for sign language has been proposed before that relates the phonetic variants to their phonological representation.

This study adds to our knowledge of sign language structure by showing that patterns of phonetic variation can provide evidence both for the occurrence (or absence) of a particular phonological feature in sign language and for the way these features are defined. Alternations in the size of the movement appear not to be limited to changes within each of the three phonological parameters handshape, orientation, and location, but cross the boundaries between the parameters. These variation data are interpreted as evidence against a categorical distinction between ‘hand-internal movements’ and ‘path movements of the hand through space’. In certain contexts, path movements can surface phonetically as finger movements, and hand internal movements can surface with an accompanying change in location of the whole hand. To account for these and other alternations a principled distinction is proposed between articulatory and perceptual representations of signs. What is commonly held to be the underlying representation in phonology is stated in perceptual terms. The phonological representation therefore rarely (if ever) includes reference to the joints of the arm and hand, even though joint states can in principle be perceptual phonological categories in a sign language, given the visibility of the articulator. I claim that in SLN joint states are never perceptual categories.

In particular, I argue that there is no phonological feature referring to the metacarpophalangeal joint (also known as MCP or base joint); this is the place where the fingers connect to the hand. This joint thus has the same role as the wrist or the elbow: it can *articulate* certain perceptual specifications, but whether it is actually involved in an articulation also depends on other factors, such as speech style, register, and phonological context. In other words, the state of this joint is not a perceptual target.

This thesis also appeals to a broader linguistic audience. Evidence is provided that although the content of the phonetic variables involved differs between sign language and spoken language, the same kind of linguistic and (micro-) sociolinguistic variables as in spoken languages lead to intra-speaker variation in sign languages. These variables include the phonetic context and the distance between speaker and addressee.

I show in this thesis that data from phonetic variation lead to a change in our conception of the units that are phonologically relevant. The result of such phonetic research then bears not only on the specific representation of features in certain lexical items, but also on the nature of those features. I argue that it is not the shape and movement of the whole hand that matters in sign languages, but rather a more abstract perceptual representation of the active articulator. The hand does not have a privileged role as an articulator, as is implicitly or explicitly claimed in most of the sign language literature. The size of the phonetic articulator (i.e. whether it involves the finger tips, fingers, the whole hand, and/or the arm) is shown to vary depending on both linguistic and stylistic context.

This view of sign language phonology as consisting of perceptual categories comes at a particularly interesting time, given two developments in the field of phonology. First, increasing attention has recently been paid to the phonetic implementation stage of the grammar, starting with the analysis of English intonation patterns by Pierrehumbert (1980): how are phonetic surface forms generated on the basis of underlying phonological representations? The present thesis shows that a similar phonetic implementation component is part of the grammar of sign languages. Second, with the rise of Optimality Theory in linguistic research (Prince & Smolensky 1993) interest in the interaction between phonetics and phonology has received renewed attention (Boersma 1998, Hayes 1999, Hale & Reiss 2000). Specifically, the current debate centers around the question of how ‘phonetic’ phonological representations should be. The phonetic implementation model for SLN that is proposed here follows the spoken language model of Boersma (1998) in making a strict distinction between articulatory and perceptual representations in sign language. What is commonly held to be the underlying representation in phonology is stated in perceptual terms.

In the rest of this chapter, I provide a brief overview of the phonological study of sign language in the past forty years, in order to acquaint linguists outside the sign language field with the subject at hand and with the main trends in the history of sign language research (§1.2). Some of the open questions which are raised by previous research are discussed in §1.3. The research questions which this thesis aims to answer are stated in §1.4. §1.5 presents a brief general discussion of the language that this thesis is concerned with, Sign Language of the Netherlands. §1.6 outlines the structure of the rest of the book.

1.2 Background: sign language phonology

Phonology is the field with which modern sign language research started. In 1960, William Stokoe published the monograph *Sign language structure*, proposing that the form of signs in American Sign Language is built up from several smaller components, just as the form of spoken words can be divided in syllables, phonemes, or features. Stokoe distinguished three main "aspects" in signs: "designator" (or articulator; abbreviated as "dez"), "tabula" (or place of articulation; abbreviated as "tab"), and "signation" (or movement; abbreviated as "sig"). These aspects were later termed "parameters" (Klima & Bellugi 1979). Values of these three aspects (such as the place of articulation value 'chin') are distinctive phonological units, and Stokoe proposed to call these values "cheremes" as an analog to phonemes in spoken languages. ("Cher" is derived from ancient Greek χειρ 'hand'.)

As an example, take the SLN sign FATHER, illustrated in Figure 1.1.[1] In Stokoe's terminology, this sign can be analyzed as having a '1' *designator* (extended index finger), the *tabula* in this sign is the side of the mouth, and the *signation* is downward.

Figure 1.1

The SLN sign FATHER

In the 1970s, Stokoe's research led to a large number of sign language studies in the United States; much of the work from this period is summarized in Klima & Bellugi (1979) and Wilbur (1979). Similar research did not start until the mid-1980s in the Netherlands, and for the first few years this research was rather descriptive in nature, and primarily linked to ongoing dictionary projects; this development is summarized in §3.3. To a large extent this first wave of sign language research was oriented towards showing that sign languages are 'normal', in the sense of being fully-

[1] By default, glosses, given in small capitals, refer to SLN signs. If signs from other sign languages are referred to, this is explicitly mentioned in the text and marked by a subscript after the gloss. An index of glosses from all languages can be found at the end of the book. Most illustrations in this book present the initial and final state of the articulator, without arrows indicating the movement. Information about the manner of movement (such as repeated movements) is not included in the illustrations. In most cases the pictures were taken at an angle in order to get the best view of the state of the articuators. Almost all pictures were specifically made for the book; they do therefore not represent realizations made by the specific sign model.

fledged human languages (cf. Woll in press). That is, in many respects sign languages are like spoken languages (Frishberg 1975, Friedman 1976, Battison 1978, Mandel 1981). This 'normal' status of sign languages as fully-fledged human languages is especially interesting for phonology, since that is the part of grammar which is closest to the phonetic systems. The starting point of all phonological research on sign languages has been that the phonetic channel or medium is clearly different in spoken and signed languages: spoken languages are produced by the vocal tract and essentially perceived by the ears, whereas sign languages are (mainly) produced by the hands and face, and perceived by the eyes. Most phonological research, starting with Stokoe (1960), has aimed at demonstrating that despite this clear phonetic difference, there are significant similarities at a higher level of abstraction (phonology). Thus, parallels have been argued to exist between many of the units of spoken language phonology and those of sign language structure, such as features, segments, moras, syllables, and feet. Only a few models have explicitly tried to avoid such comparisons (see for example the Visual Phonology model of Uyechi 1996).

Phonological studies between 1975 and 1985 brought to light the kind of phonetic distinctions that are linguistically relevant in sign languages, including not only manual aspects such as hand and finger movements but also non-manual aspects such as facial expression, head position, and upper body position. Manual aspects are involved in both free morphemes (lexical items) and bound morphemes, whereas non-manual aspects are typically compared to prosodic markers in speech, indicating for example the difference between declarative and interrogative sentences (cf. Schermer 1990 and Coerts 1992 for SLN). The importance of several dimensions of the manual part of sign forms was demonstrated, which Stokoe either did not consider or thought to be of secondary importance, such as the orientation of the hand in space. Various constraints on combinations of formal elements were proposed (most notably constraints on two-handed signs, Battison 1978).

Since 1985, a number of phonological models have been proposed, typically using feature geometries as in spoken language research, and positing some kind of sequential structure in signs. Stokoe's (1960) claim was that the main difference between sign and speech is the way in which units are organized. In spoken language this organization is sequential (phonemes follow each other in time), whereas in sign language the cheremes are realized for the most part simultaneously.[2] Several models since have emphasized that there is also sequential structure in sign language phonology (e.g. Newkirk 1981, Liddell 1984, Liddell & Johnson 1986, 1989, Sandler 1989). According to all of these models, signs are composed of sequences of static aspects and movements, although the formal devices that the above authors use to represent this distinction vary.

There are two common trends in the various phonological models. Firstly, almost all evidence comes from studies on American Sign Language (henceforth ASL). There have been several smaller studies on other sign languages, mostly

[2] There has been much discussion on this and related comparisons between signed and spoken languages in the literature; I will review some of this discussion in Chapter 3.

descriptive in nature, but thorough and competing analyses only exist for ASL.[3] Secondly, there have been relatively few studies with a phonetic rather than phonological focus. One could call all descriptive phonological studies ‘phonetic’ in the sense that most transcription and notation systems include fine distinctions that may turn out not to be phonologically distinctive. Even so, very few phonological studies discuss in detail how they arrived at the abstraction that their phonological model represents. The data collection on which the analysis is based is rarely discussed in detail, nor is the process of deriving an abstract phonological form from a concrete phonetic form. I presume that this is in part due to the fact that most of these analyses concern ASL, and researchers may have often assumed that other researchers know what ASL signs look like. However, determining ‘what a sign looks like’ is already a categorization process, and it should be possible to make this process explicit. This thesis aims to add to our knowledge of sign languages in both these areas. It provides a description of a part of the phonetic and phonological patterns of a relatively poorly-studied sign language, Sign Language of the Netherlands. In addition, the thesis aims to demonstrate how phonetic variants can be seen as tokens of the same phonological type (i.e. the information stored in the lexicon).

The trend in sign language research in the 1990s was to look for differences and similarities between sign languages, as more and more sign languages other than ASL were being studied in detail.[4] One of the most intriguing questions in sign linguistics at large has been why it seems to be the case that different sign languages are more alike than different spoken languages. That is, many people have wondered with reference to various aspects of sign language structure why there is so little cross-linguistic variation among sign languages. It is not the case that all sign languages are historically related to one common ancestor. The similarities are often linked to the specific sociolinguistic situation of Deaf communities, in which there are always a relatively large number of non-native signers.[5] For example, Fischer (1978) points to a number of shared linguistic and sociolinguistic traits between sign languages and creole languages. Another source of cross-linguistic similarities could be found in using shared concepts to create iconic signs (e.g. Currie, Meier & Walters 2001, Woll 1983). In the past few years, there has been increasing awareness that the above impressions of cross-linguistic similarities may need to be modified now that more sign languages are being analyzed in detail (Zeshan 2000).

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[3] Studies on the phonology of other sign languages than ASL include Greftegreff (1992) on Norwegian Sign Language, Bouvet (1992) on French Sign Language, Miller (1996) on Quebec Sign Language and Nyst (1999) on Uganda Sign Language, among others.

[4] At the most recent conference on Theoretical Issues in Sign Language Research (TISLR7, Amsterdam, July 2000) research on 48 different sign languages was presented, a huge number, given the list of 103 different sign languages in the world in the 13th edition of the *Ethnologue* (Grimes 1998). The research on these languages varied from small-scale initial descriptions to in-depth linguistic analyses.

[5] A distinction is made in the sign language field between “deaf” and “Deaf” (Woodward 1982b). The former term refers to people that are deaf by audiological definition: they cannot hear. The latter term refers to people who are deaf by cultural definition, that is members of the Deaf community, who are typically fluent in sign language and who share both linguistic and cultural norms and values. For a discussion of this distinction, see for example Lane (1984) and Reagan (1995).

With respect to SLN, *Commissie Nederlandse Gebarentaal* (1997) claims that “the main elements from which signs are built up have been well described” (1997: 29; my translation).[6] This is a rather bold claim. Although Schermer, Fortgens, Harder & de Nobel (1991) present an overview of some of the parameter values (especially handshapes) that were found in the KOMVA[7] dictionary project to be phonetically relevant, they clearly present this as an initial description and not as a thorough phonological analysis.[8] Both the transcription system that formed the basis for the categories used (NSDSK 1988; see Appendix C) and the few subsequent analyses are explicitly based on or derived from ASL studies.[9]

I would rather claim that we lack a great deal of basic phonological knowledge. We do not have much insight yet into the distinctiveness vs. predictability of many of the feature values that are distinguished by the KOMVA notation system, nor do we have a clear idea of the restrictions on combinations of feature values. Furthermore, there has been little work on the influence of iconicity on the phonological system of SLN, and on variation in the phonetic realization of the various parameter or feature values.[10] And finally, for SLN as well as for ASL, there has been little discussion of the role of functional explanations for phonological patterns. Some of these questions have been addressed in more recent work on SLN, e.g. van der Hulst (1995ab, 1996), van der Kooij (1994, 1997, 1998), Crasborn (1995, 1996), and Crasborn & van der Kooij (1997, to appear). This thesis focuses on the topic of phonetic variation, which will be discussed in more detail in the following section.

1.3 Open questions: phonetic variation in movement and handshape

Phonological models that have been developed since the mid 1980s emphasize the distinction between different types of movement proposed by Stokoe (1960). Movements of the hand through space (path movements or changes in location) are distinguished from hand-internal movements (changes in handshape and orientation;

[6] “De belangrijkste basiselementen waaruit de gebaren van de NGT zijn opgebouwd zijn inmiddels goed in kaart gebracht.”

[7] The acronym KOMVA stands for “verbetering van de **kom**munikatieve **va**ardigheden bij dove kinderen en dove volwassenen” (NSDSK 1988; ‘improvement of communicative abilities of deaf children and deaf adults’).

[8] The first version of the phonological model developed for SLN by van der Hulst (1993) aimed mainly at taking a stance in theoretical phonological debates and suggesting new ways to look at simultaneous and sequential structure in sign languages in general, without focusing in any detail on the possible differences between ASL and SLN.

[9] Two specific cases concern the possible position of the thumb in fist handshapes (Schermer et al. 1991: 81; cf. Mandel 1981) and limitations on the possible forms of two-handed signs (Schermer et al. 1991: 74ff; cf. Battison 1978)

[10] ‘Iconicity’ refers to the resemblence between the form of a sign and its meaning or referent, as in onomatopoeia in spoken languages.

also called ‘local movements’).[11] This distinction has proved useful in making generalizations about the kinds of movement that can co-occur in a sign. For example, in SLN hand-internal movements of either kind (a change in handshape or orientation) may co-occur with path movements, but handshape changes typically do not co-occur with orientation changes.

The distinction between local and non-local dynamic components is mirrored by a distinction in static components. In feature geometry models, handshape and orientation are often grouped together separately from location (Sandler 1989, van der Hulst 1993). The argument for this distinction is that handshape and orientation sometimes spread together in phonological processes.

The entity ‘hand’ thus plays a central role in these descriptions. It is the shape of the hand, the orientation of the hand, and the location of the hand that need to be specified for each sign, and changes in these three parameters lead to movement.[12] Thus, in a change of location of the whole hand, the wrist moves through space, and movement has to take place at the elbow or shoulder (or even the whole upper body could move to change the location of the wrist and hand).[13] In addition to this somewhat abstract use of the term ‘hand’, many authors have used very concrete articulatory terms to refer to the distinction between ‘movement of the hand’ and ‘movement within the hand at a single location’. Brentari (1998) starts her discussion of movement with the following two definitions: “path movements are articulated by the elbow or shoulder joints, resulting in a discrete change of place of articulation in the sign space on the body or in the external space in front of the signer”, while “local movements are articulated by the wrist or finger joints, resulting in a change of handshape or orientation of the hands, or a trilled movement” (pp. 129-30). Liddell & Johnson (1989: 222) wrote that “the major classes of segments […] reflect activity of the hand taken as a whole. It is common for signs simultaneously to exhibit movement at the finger, wrist, or elbow joints.”[14] Sandler (1993) states that the movement parameter in sign language phonology

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[11] A third type of movement consists of ‘secondary movements’, which are rapid repeated (and uncountable) movements of the fingers and wrist. These secondary movements have been convincingly argued to be repeated versions of either path movements or local movements by many authors (Stack 1988, Sandler 1989, Liddell 1990, van der Kooij 1994).

[12] This is valid independent of the formal device one uses to capture this movement. Some authors have argued that path movements constitute a *segment* (Liddell 1984, Sandler 1989, Perlmutter 1990) or *feature* (Brentari 1998), while others have claimed that movement is the predictable phonetic result of a *change in static features* (Stack 1988, van der Hulst 1993, Wilbur 1993).

[13] Note that the reverse is not true: it is not the case that the hand always moves if there is movement at the shoulder or elbow. Compensatory movements of the upper body, the forearm, and wrist can be used to make the hand stay in the same place with the same orientation.

[14] The articulatory terminology used by different authors is a little confusing, especially when it comes to describing the articulation of orientation changes. An overview of the relevant parts of the anatomy of the arm and hand is provided in Appendix A. One of the articulations that is often involved in orientation changes is what I will call ‘rotation of the forearm’. This is a rather complex movement, involving rotation of the radius around its length axis at the proximal radio-ulnar joint, while its distal end moves around the ulna. The result is that both the forearm and the hand rotate. This is sometimes referred to as ‘movement of the elbow joint’ as in the quotation from Liddell & Johnson (1995) above, and sometimes it is referred to as ‘rotation of the wrist’.

comprises “either (a) movements of the fingers or palm at a single location or (b) movement of the whole hand along a path from one location to another” (p. 243). Descriptions of local movements often include reference to movement at the wrist joint, such as that by Perlmutter (1992), who states that secondary movement is “movement of the fingers or wrist whose key characteristic is that it can occur while the hand executes a path movement” (p. 211).

While the hand seems to play a central role in analyses of sign language phonology, in the recent literature there have been several observations on different realizations of signs that call into doubt the central status of the hand. Most notably these observations concern variation in the movement component. Van der Hulst (1995a: 28) notes that “when the hand moves in a subspace this may be the result of joint flexion at the shoulder, the elbow, or the wrist. If we focus on the finger-part of the hand, we might even say that at least certain kinds of ‘path’ movement can be articulated with the joints that connect the finger to the palm part of the hand. […] The question arises whether these articulatory choices are potentially distinctive or merely function to vary from normal sign to ‘whispering’ and ‘shouting’”. In another paper, van der Hulst discusses “winging” or “flattening” movements of the extended fingers at the MCP joints as in AUGUST (Figure 1.2), and surmises that “even though these movements are hand-internal, they can perhaps be seen as hand-internal versions of path movements […], thus as small versions of movements that can in principle be carried out through higher joints” (van der Hulst 1995b: 13). In other words, it may be the case that location changes are sometimes realized as handshape changes.

Figure 1.2

Finger movement in the SLN sign AUGUST

Despite her claim that “[t]he hand is central to the articulation of a sign” (p. 19), Uyechi (1996) discusses varying articulations of two ASL signs that she considers to involve a change in orientation, but that can surface as handshape changes or location changes: PAST_{ASL} and $\text{INCOMPETENT}_{\text{ASL}}$. In the default form, PAST_{ASL} is realized as wrist flexion, but it is sometimes articulated with either elbow flexion or

MCP flexion.[15] Elbow flexion is normally used to articulate a change in location, whereas MCP flexion is normally interpreted as a change in handshape. INCOMPETENT$_{ASL}$ is normally realized with forearm pronation and wrist extension, so that the orientation of the finger and palm changes, but according to Uyechi the sign is sometimes realized by extension at the MCP joints, with minor movement of the forearm and wrist at the end of the sign. Uyechi states that “it is not clear if the variants are predictable or in free variation” (p. 142), but it appears that variants of these signs in which the movement takes place at the interphalangeal joints of the fingers are not attested. She suggests that a theory of “visual phonetics” could account for this variation.

In summary, both van der Hulst and Uyechi suggest that movement at the MCP joints in surface forms of signs should not always be interpreted as a change in handshape, but rather as a change in location or orientation. Brentari (1998) goes even further, by stating more generally that “a sign is often executed by more than the one set of joints specified by its underlying prosodic features, or by a set of joints other than those that execute the movement in the default case” (p. 133).[16] She distinguishes “proximalized” from “distalized” articulations of signs, the former using joints relatively proximal to the torso (the shoulder being the most proximal), the latter using joints that are relatively distal to the torso (the most distal being the distal interphalangeal joints of the fingers). Brentari presents a somewhat ambiguous account of such alternations. On the one hand, the variants are considered to be ‘phonetic’ and to be dealt with by a theory of ‘phonetic enhancement’, such as that proposed by Stevens & Keyser (1989) for spoken language. On the other hand, Brentari suggests that the various articulations differ in sonority (which in her model is partly a phonetic characteristic and partly a phonological construct), and she states that in the Prosodic Model she proposes “this type of spreading can be straightforwardly handled by the addition of an association line to the adjacent prosodic features node, plus translation statements that instruct the joints how to realize the movement, which may vary in a language-particular way” (1998: 135). The addition of association lines is clearly a phonological process, while the translation statements seem to belong more to the phonetic implementation component of the grammar. These translation statements are later spelled out as follows: “[i]n the default case, setting features are executed by the shoulder, path features by the elbow, orientation features by the wrist, and aperture features by the finger joints. […] However, the joint specification of the input form may be altered for a variety of reasons, so that a different joint may actually execute the movement” (1998: 219).

[15] The anatomical and physiological terminology that is used in this thesis is discussed and illustrated in Appendix A.

[16] The term ‘prosodic’ in this context refers to the movement parameter of signs. In spoken language phonology, ‘prosodic’ is typically used to indictate properties of a form that span larger domains than the phonological segment, such as the syllable. In sign language phonology, movement of the hands is sometimes analyzed as a change from one segment to the next (see the discussion in Wilbur 1993, for example), and thus movement also spans more than one segment. In addition, the role of facial expression is sometimes said to be ‘prosodic’ in resembling that of intonation in spoken languages.

The above references to phonetic variation in the articulation of signs raise three sets of questions.

1. Questions regarding the description of the variation phenomena.
Although Brentari claims that "it is well known" (1998: 133) that such variation in the use of joints exists, they have hardly been discussed in the sign language literature.[17] Even in Brentari (1998), by far the richest source of discussion of movement in sign language phonology and phonetics, data on proximalized and distalized articulations play a secondary role. How frequent are such variants? Are they really exceptional articulations of signs with otherwise standard joint actions? Are they specific to ASL or a common feature of all sign languages? Does the variation really constitute 'free' variation, or is it fully or partly predictable from some (as yet unknown) set of linguistic or sociolinguistic factors? In other words, what is the source of the variation? Does the difference in selection of joints indeed correlate with the sign language variants of 'shouting' and 'whispering'?

2. Questions regarding the implications of the data for phonological models.
Assuming the variation in movement is indeed abundantly present in normal adult signing, the question arises to what extent these various alternations really do cross the boundaries between the traditional categories handshape, orientation, and location. The traditional conception of these categories is that they are properties of the whole hand: a change in location is a change in location of the hand, a change in orientation is a rotation of the whole hand (and not merely the fingers), and a change in handshape is movement of the fingers (while the 'palm part' of the hand does not move). If the alternations do have an impact on phonological category boundaries, then does this mean that our conception of these categories needs to be adjusted? Can we still maintain that the 'hand' is the central entity in sign language phonology?

3. Questions regarding the mechanism that relates the surface variants to their phonological specification.
Thirdly, how can this variation be generated on the basis of the phonological representation of signs? Does such a process involve phonological operations in combination with phonetic processes, as Brentari implies? Can the phonetic (part of the) process be considered universal, or is it indeed a set of language-particular statements that imply the existence of a language-specific phonetic component of the grammar? If the variation crosses phonological category boundaries, then on what basis do perceivers recognize the boundaries?

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[17] An early reference to differences in articulation of signs is the paper by Supalla & Newport (1978). They mention that signs with the same *manner* of movement (which may be either continuous, hold, or restrained) can be articulated by either the wrist or elbow joint, or both. They do not make claims on the question what conditions the variation.

1.4 Research questions and methodology

This thesis aims to answer the three questions listed in (1.1).

(1.1) Research questions

1. Does phonetic variation in the realization of handshape changes, orientation changes or location changes cross the boundaries of the parameters handshape, orientation, and location in Sign Language of the Netherlands? For example, can a handshape change be realized as a location change?

2. If the answer to the first question is positive, is the distinction between changes in location and changes in handshape and orientation still valid?

3. How can the grammar, including a phonetic implementation component, generate the different variants that are found?

The data that I will analyze in order to answer these questions come from several sources. Firstly, they consist of narrow phonetic transcriptions of citation forms of signs that are stored in the SignPhon database, which was specifically designed for this purpose by Harry van der Hulst, Els van der Kooij, Marja Blees, and myself (Crasborn, van der Hulst & van der Kooij 1998, to appear, Crasborn 1998). Technical and linguistic details of this database are presented in Appendix B; I discuss the selection of data that were transcribed in the database in Chapter 3. The corpus of video recordings that was created for this project also included signs in sentence context. Although these contextual forms were not transcribed, they were often used to obtain a preliminary impression of the range of phonetic variability for a given sign.

Secondly, informant judgments on the well-formedness of signs and of different realizations of signs were used.

Thirdly, narrow transcriptions of both perceptual and articulatory aspects of signs were made of the data from the variation studies presented in Chapter 4.

1.5 Sign Language of the Netherlands

Most of the data in this thesis are from Sign Language of the Netherlands (SLN). The Dutch name for the language is *Nederlandse Gebarentaal* (NGT). Following earlier publications on the language, I refer to it by its English abbreviation (Schermer 1990, Coerts 1992). SLN is used as a preferred language by approximately 16,000 people (0.1% of the Dutch population) who form the Dutch

Deaf community, which consists mostly of Deaf people, but also includes hearing children of Deaf parents, for example.[18]

SLN has historically been greatly influenced by Old French Sign Language, just like American Sign Language (ASL), by far the best-studied sign language. Forms of SLN have probably been in use for at least a century. The recent history of the language is a very turbulent one. I briefly summarize this here because of its impact on the lexicon of the language.

Until the 1980s, sign language was regarded by educators as a threat to the full integration of deaf people into the larger (hearing) society, and children were taught in school not to sign but to use spoken language. Considerable time and effort was invested in teaching children to lip-read and to speak. This educational policy is referred to as ‘oralism’.

Linguists have stressed in the past decades that language is not learnt through explicit instruction, but rather is automatically acquired if there is enough language input. Furthermore, the claim is that the acquisition of a mother tongue is crucial for cognitive development as well as for learning additional languages. In the Netherlands this led in the 1980s to the educational policy called ‘total communication’, where all possible modes of communication were combined: signs, gestures and facial expression, as well as speaking and lip-reading. In practice this came down to the use of ‘Sign Supported Dutch’ (in Dutch: *Nederlands met Gebaren*, abbreviated NmG), a system in which lexical and morphosyntactic elements of Dutch are spoken, and supported by signs. The use of signs was therefore subordinated to the structure of Dutch, and took the form of signing content words while reflecting little or nothing of the morphology of the spoken language.

It was not until the 1990s that most deaf schools started offering ‘bilingual’ programs, where SLN and Dutch are used separately, and the use of SLN is primary. This has considerably raised the self-esteem of the Deaf community, as can be judged by the number of cultural productions for example (sign language videotapes, theater productions, etc.). Another factor in this development was the plan of the Dutch government in 1997 to officially recognize SLN as a minority language. A committee was established and assigned the task to find out what official recognition would involve. This led to the much-acclaimed report that appeared in 1997 (*Commissie Nederlandse Gebarentaal* 1997). One of the 66 recommendations of the committee that was adopted by the government was the establishment of a common (‘preferential’) base lexicon to be used in all schools. There are five large deaf schools in the Netherlands. One of the first studies on SLN in the 1980s focused on the regional lexical variation that this situation has led to (KOMVA 1989). It turned out that there are three main ‘dialects’: one in the north, one in the west, and one in the south. The southern deaf school has used the strict oralist method longest, and the SLN variant used in that area mostly differs from the western variant in the greater use of fingerspelling. The main regional distinction is

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[18] The number of users is a rough estimate. A recent report estimates that there are 17,500 *potential* users of SLN, including 5,500 hearing people (*Commissie Nederlandse Gebarentaal* 1997).

thus between the western and northern variants. The present study mostly uses data from the western dialect. For sake of ease, variation within the western dialect is ignored (cf. *Commissie Nederlandse Gebarentaal* 1997), and data produced by informants from three locations are used: Rotterdam, Voorburg, and Amsterdam. The present study focuses on inter- and intra-signer variation rather than regional variation.

Increasing acceptance in the Netherlands of SLN as the primary language of the members of the Deaf community has led to a recent expansion of the lexicon that is still going on at full speed.[19] One of the causes is the expansion of domains in which the language is used. For example, *Commissie Nederlandse Gebarentaal* (1997) specifically signals the need for new lexical items for legal and government-related concepts. The data used in this thesis come mostly from the basic lexicon of high-frequency signs, which are probably not new in comparison with other lexical items (see §1.4). The characterization of phonological and phonetic patterns in the core lexicon may not apply to all new signs. Some new signs in SLN are loans from other sign languages; as such, one might expect that differences in the phonological systems between these languages and SLN can cause such loans to have atypical phonological characteristics (until they are adapted to the system of the target language).[20] However, many (if not most) newly formed signs are borrowed from our conception of the visual world: the hands imitate some property of the semantic concept. This is called ‘iconicity’ or ‘iconic motivation’. The influence of iconicity on the regularities in the form of signs will not be treated in great depth here. I discuss it in Chapter 3 because even the core lexicon still bears marks of the iconic etymology of many signs. For an extensive investigation of this topic see van der Kooij (in prep.). An overview of all research on SLN in the past 15 years can be found in Crasborn, Coerts, van der Kooij, Baker & van der Hulst (1999).

1.6 Overview of the thesis

The rest of this book is structured as follows. Chapter 2 presents an overview of studies on different types of sources that lead to phonetic variation. For each category I briefly discuss the sign language studies that have been carried out, if any. This will provide a background for the discussion of phonetic variation in Chapters 3 and 4. I then present an overview of the literature on different conceptions of phonetic implementation in spoken language, and I motivate the

[19] This growth of the lexicon is a very interesting topic for future research, as I will discuss in Chapter 6 (§6.4).

[20] Languages from which vocabulary is borrowed can consist of other sign languages, such as ASL, but can also be spoken languages. Loans from spoken Dutch can consist of mouthed Dutch words that differentiate between otherwise identical signs, or from fingerspelled constructions (see Schermer 1990, Boyes Braem & Sutton-Spence to appear, and papers in Brentari 2001). Fingerspelling is a manual representation of the letters of the writing systems of spoken languages, and the Dutch fingerspelling alphabet includes handshapes that do not occur in the rest of the lexicon.

selection of the Functional Phonology model (Boersma 1998) to analyze phonetic variation in sign language.

In Chapter 3, I discuss previously published phonological descriptions and analyses of SLN, and propose a modified set of phonological features for SLN. The goal of this feature set is to describe the phonological structure of SLN signs, while taking into account what is already known about phonetic variation, and to put forward hypotheses about phonetic variation. Phonetic variants are produced on the basis of phonological features in the lexical specification of signs. The selection and formulation of the features is geared towards their incorporation in the Functional Phonology model: they are defined in perceptual terms, and I show how they differ from articulatory definitions. The main innovations of the feature set concern the nature of the handshape and orientation specifications. I will conclude the chapter with a set of predictions about phonetic variation in the realization of movement.

The predictions on phonetic variation will be tested in Chapter 4. Focusing on the realization of movement, I start out by analyzing different realizations of one single sign in various contexts and produced by various signers, to establish the overall size of the phonetic space used by movements. In several steps, I then narrow down the investigation to the comparison of signs realized in different styles, viz. 'loud' (long-distance) and 'soft' (short-distance) signing.

Chapter 5 demonstrates how the different variants found in Chapter 4 differ in articulatory realization but display significant perceptual similarities. I account for this articulatory variation by showing how a fixed 'underlying' perceptual representation is turned into a variable articulatory realization, which in turn is categorized in perceptual terms. This is the schematization of the communication process that the Functional Phonology model makes explicit. A first attempt is presented to define the complex sets of phonetic constraints that we need for the analysis of sign language using this model. Finally, I discuss several other instances of phonetic variation, such as alternations between one-handed and two-handed versions of signs and the articulation of wiggling finger movement. I demonstrate how in these cases too, the shared characteristics among the different variants are perceptual abstractions that are not directly correlated with specific articulatory variables.

Finally, in Chapter 6 I summarize the findings and proposals of the previous chapters, and discuss both their theoretical and practical implications. I end by outlining some questions for future research that the present study has raised.

2 Phonetic variation: an overview of the literature

2.1 Introduction

Lexical items in sign language, as in spoken language, can be realized in various ways: different phonetic variants are considered to be tokens of the same phonological type. In this chapter I will review the relevant literature on two aspects of this phonetic variation. First, in §2.2 I will discuss factors that can lead to variation in phonetic form, indicating to what extent each factor has been identified in sign languages. This discussion is guided by a classification of *independent* variables such as the social characteristics of the signer, not of *dependent* variables such as different types of phonetic features: the former can readily be adopted from research on spoken languages, whereas it remains to be seen what the variable phonetic categories are in sign language, given the differences in perception and production channels between the two types of languages. The goal of this overview is to show the nature of the parameters that vary in sign language, and also to emphasize the scarcity of studies which systematically address phonetic variation in sign languages. Moreover, this discussion will make clear some of the differences between phonetic properties of sign languages and spoken languages. This background will put in perspective the variation in handshape, orientation and movement that is the focus of this thesis.

In the second part of this chapter (§2.3) I will discuss the ways in which phoneticians and phonologists have modeled phonetic variation in spoken language, which is often conceived of as a separate stage in the production process called 'phonetic implementation'. On the basis of this overview of the literature I will outline a model of phonetic implementation for sign language (§2.4) to account for the variation that will be studied in this thesis. An important part of such a model is an inventory of the phonological features that are needed to characterize the lexicon. This feature set is proposed in Chapter 3. Hypotheses about phonetic variation will be formulated on the basis of this model. These hypotheses will be tested in Chapter 4.

2.2 Sources of phonetic variation

By phonetic variation I mean the existence of multiple distinct surface forms of a given lexical item. The term 'phonetic' can be interpreted in different ways. I use it to refer to variation that is not the result of phonological or higher grammatical processes. This use is in accord with the way many phonologists have conceived of phonetic properties: any property of the form of a word that does not lead to semantic distinctions, whether at a lexical, morphosyntactic or discourse level, is termed phonetic.[21] All sign languages studied to date have a complex nonconcatenative morphological system, and syntactic and discourse structure also have an influence on the form of the lexical items themselves. For example, different inflections of verb forms can lead to differences in the location and the direction of movement, different aspectual modulations of verbs can lead to differences in the size and shape of the movement, and the specific roles in the discourse of a given utterance can influence the orientation of the upper body and the location of the space in which the signing takes place (e.g. Wilbur 1987).

Because of this complex morphology it is important in sign languages to tease apart the factors that can modify the surface appearance of a lexical item (more so than in spoken languages such as Dutch, which has little nonconcatenative morphology). The present study focuses on lexical items that are not morphologically derived or inflected, but the processes that are proposed to account for the variation should be applicable to both simple and complex morphological forms.

2.2.1 Overview

An overview of the different factors that can be distinguished is presented in Figure 2.1. This overview is compiled on the basis of phonetic and sociolinguistic research on spoken languages.[22] The numbers in the diagram refer to the sections where the factors are discussed.

[21] According to this definition, the distinction in the position of the 'unselected fingers' discussed in van der Kooij (1997) is phonological, since there is a semantic load conveyed by the distinction. This issue of what should and should not be termed phonological will be discussed further in §2.3 and Chapter 3; see also van der Kooij (in prep.) for discussion.

[22] This overview is not intended as a definitive classification; it only aims to structure the overview of the literature below. Many other distinctions are possible, such as the subdivision of physiological properties into physical markers and psychological markers (e.g. Laver & Trudgill 1979). Another distinction that is often made is between paralinguistic and extralinguistic behavior. Both provide information about the speaker, but only the former has an (intended) communicative function. For other classifications, see also Hymes (1974) and Bell (1984).

linguistic §2.2.2	**non-linguistic** §2.2.3		
sequential phonological context	**properties of the speaker / signer** §2.2.3.1	**properties of the addressee** §2.2.3.2	**properties of the situation** §2.2.3.3
prosodic structure	social properties *age, gender, social class, ethnic group, region*	physiological properties *fatigue, emotional state*	practical circumstances *distance between the participants, visual or acoustic noise*
	physiological properties *body size, voice quality, fatigue, emotional state, hand dominance*	social properties *age, gender, social class, ethnic group*	social circumstances *topic of conversation, social context, relation between signer and addressee*
	personal style		

Figure 2.1

Factors responsible for phonetic variation of signs

An important set of variables that is left out in this survey concerns the extent to which signer and addressee are both part of the Deaf community. Membership of the Deaf community is defined by a set of variables that includes whether a person does or does not have a hearing loss (and to what degree), but more importantly whether a person has Deaf parents, learned sign language early in life, and has social ties with the rest of the Deaf community (Baker-Shenk & Cokely 1980, Reagan 1995). When a native signer signs to someone outside the Deaf community, some form of code mixing often occurs between the sign language and a spoken language. Studies of such contact signing have mostly centered on morphosyntactic variables, and even though phonetic and phonological changes may occur as well, these situations are left out of consideration in order to not complicate the issue.

The different factors will now be discussed in turn in the sections indicated in the table.

2.2.2 Linguistic factors

The definition of phonetic variation as not carrying semantic distinctions, or in other words as not being phonologically distinctive, still leaves open the possibility that there are *linguistic* factors that lead to differences in the surface forms of signs. There are at least two such linguistic factors.

Firstly, the sequential phonological context can lead to 'coarticulation' or 'assimilation' effects. In speech, coarticulation is typically studied within the word. For example, the articulation of different vowels after a given consonant leading to modifications in the articulatory gesture for the consonants (Laver 1994). In sign languages studied to date there is very little sequential structure in lexical items, and coarticulation is therefore predicted to be found mostly when two or more signs are realized in sequence. Such coarticulation in sign languages has been studied for American Sign Language (ASL) by Wilcox (1992) and Cheek (2000), among others. These studies investigated changes in the articulation of handshape induced by different sequential contexts, the former looking at fingerspelling of two or more letters in sequence, the latter looking at sequences of two signs. The results for both types of studies indicated that subtle timing differences exist in the movement of the fingers towards their target state depending on the following and (primarily) the preceding handshape. These context effects are gradual and not categorical: the observed changes should be characterized as (phonetic) coarticulation and not (phonological) assimilation.[23]

Another coarticulation effect that has been mentioned in the literature concerns whether a sign is articulated with one or two hands. Leaving aside lexical items in which the so-called 'weak hand' serves as a place of articulation, signs may be articulated with one hand or with two hands. This is a phonological property of signs; although few minimal pairs exist differing only in this feature, it is not predictable whether a sign is one-handed or two-handed, and therefore this information should be stored in the lexical representation of the sign. In two-handed signs, one hand is more or less the mirror image of the other hand: it has the same

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[23] Liddell & Johnson (1989) suggest that the location of the preceding or following sign may determine whether the movement direction of a sign in ASL is reversed (this is analyzed as metathesis), or whether the movement is reduced to a small contacting movement. They further suggest that the height of the location of neighboring signs plays a role in determining whether or not a sign is articulated in a lower location than in its citation form. In a pilot study of the sign DEAF_{ASL}, which has downwards movement on the cheek, Lucas (1995) found that variants with upward movement or contacting movement were not correlated to specific sequential contexts, but rather to the syntactic function of the sign (adjective rather than predicate or noun) and to the style (informal rather than formal). This finding was replicated in Bayley, Lucas & Rose (2000), who found moreover that if the following sign was not made at the location 'cheek' (but rather higher or lower) the occurrence of the contact variant of DEAF_{ASL} was increased. However, the authors do not make clear why only these three possible realizations of DEAF_{ASL} were considered, and not finer distinctions in either the size of the movement and the precise beginning and end locations. The implicit claim seems to be that the three variants are phonologically distinct, having a different segmental structure when analyzed in the model of Liddell & Johnson (1989). It is precisely this view on segments that is contested by several other researchers (for an overview, see Wilbur 1993). Even though many of them would agree that the three forms that were considered can be phonologically distinctive in many sign languages, it is not clear why other variants were not taken into consideration. Lucas, Bayley, Rose & Wulf (to appear) further found that a high location of the preceding sign decreased the chance of a number of signs being articulated lower than on the head (the citation forms), while a preceding or following pause increased the chance of the occurrence of such a variant. In this study there was no discussion of the selection of the variants either, and the distinction that was studied appears to be limited to 'head' vs. 'lower than the head'.

handshape and location, and the movement may be synchronic or asynchronic (alternating). It has been observed in Australian Sign Language (Auslan) that signs that are normally one-handed can become two-handed when preceded or followed by a two-handed sign (Johnston & Schembri 1998), but it is not clear what conditions this change nor whether it is gradual or categorical. A complicating factor in this spreading of the weak hand is that it can also be used distinctively by morphosyntactic and discourse-level constructions, although it has not yet been investigated for SLN in which circumstances such constructions are used.[24]

Miller (1997) discusses a phenomenon that he calls ‘prosodic imbrication’ (in French “imbrication prosodique”, p. 148). In signs in Quebec Sign Language (LSQ) that have a repeated alternating movement of the two hands, the last cycle of movement of one hand can sometimes be deleted, that hand instead executing another sign. This process may be constrained by phonological structure, but it also could be argued to be an instance of coarticulation (Chris Miller, personal communication).

The standard conception of coarticulation is that it is a smoothing out of different consecutive articulatory gestures, which can be mathematically modeled by having the gestures overlap in time. These different overlapping gestures often are physiologically independent from each other. For example, in speech, movement of the jaw or tongue is largely independent of the movement of the velum or lips. In the realization of the simultaneous parameters handshape, orientation, location, and movement in sign languages, one can hypothesize the existence of ‘simultaneous coarticulation’. The articulators that produce the different parameters are not independent, and it seems plausible that, for example, the realization of a specific location value such as chin can influence the realization of an orientation value such as fingertips pointing sidewards. Such interactions between parameters have received little discussion in the literature (Battison, Markowicz & Woodward 1975, Battison 1978, Greftegreff 1992). In the following chapters I will present evidence for the claim that there are various limitations on combinations of values for the three static parameters handshape, orientation, and location. These limitations are not phonotactic restrictions on the sign, but limitations inherent in the manual articulators, which articulate a more limited set of phonological distinctions than is sometimes assumed. Although there are restrictions on what the articulator can do, then, there is no significant sense in which this can be called ‘coarticulation’.

A second linguistic factor responsible for phonetic variation consists of differences in prosodic properties of signs. Prosodic variables that have been identified in spoken languages include for example the position in the sentence leading to differences in timing: overall, units (such as segments or syllables) tend to be longer at the end of a sentence than at the beginning of a sentence (Cruttenden 1986). For sign languages, there has been relatively little research on prosodic

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[24] A further case of coarticulation that has been observed in Auslan concerns the phonetic realization of the location of a sign. The location of some signs that are made in neutral space can differ as the result of morphosyntactic processes, but apparently the location of these signs can also be influenced by the height of the hands in the preceding sign (Johnston 1997).

structure and phonetic correlates of different prosodic categories. It is therefore not easy to evaluate the kind of variation that results from prosodic structure and demarcate the remaining phonetic variation.

Wilbur (1999) reviews some of the studies that have been performed on focused elements, showing that the main correlate of such non-lexical stress is increased acceleration of the hand movement. Although there are some phonological differences in what has been termed the ‘manner’ of the movement, the ones such as ‘tensed movement’ having an effect on speed, duration, size or acceleration are limited to a small number of signs. It is still under debate whether all manner features have an effect throughout the lexicon (see §3.4.2 below).

Miller (2000) argues on the basis of data from LSQ that many of these movement characteristics, such as the number of repetitions (none, one, many), the size of the movement (small, large), the shape of the movement (straight, arc-shaped, circular), and the distinction between unidirectional and bidirectional, can be analyzed as the phonetic correlates of a difference in prosodic structure. Some of this prosodic structure seems to be part of the lexical item, and replaces traditional features referring to these movement properties, while other parts of this prosodic structure involves units larger than the sign.

Finally, Coulter (1993) found that in ASL the height of the hands in signs with the same phonological location varies, being higher for stressed signs and lower for sentence-initial and sentence-final signs. The limited scope of this study, using only lists of the number signs one through five, makes these results hard to interpret.

2.2.3 Non-linguistic factors

A larger variety of factors influencing the phonetic realization of words can be found in *non-linguistic* properties. Halliday, McIntosh & Strevens (1964) distinguish variation according to use (register) from variation according to user (dialect). In the subsequent sociolinguistic literature on spoken languages, most attention has been given to user-bound variables such as gender, age, social class, and ethnic group, which refer to characteristics of groups of speakers rather than individual speakers (Chambers 1995). Aside from these social variables, phonetic characteristics of language production are also likely to be determined by physiological properties of speakers, such as the size of their body, leading to differences in voice quality in speech.[25] Other researchers have emphasized the importance of the relation between the speaker and the addressee, stressing that the speaker will tailor his speech to the amount of information that the listener needs for comprehension (Lindblom 1990). Lindblom stresses that these listener needs are in fact a complex set of factors. Although some authors in the past have posited a finite number of registers or style levels (e.g. Joos 1968, Selkirk 1972), Lindblom and probably most researchers

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[25] These are obviously not variables that can be used by the linguistic system, but it is not a priori clear how these variables affect the appearance of the same phonological unit by different signers in the perception of sign language. There is probably a sign language counterpart of ‘speaker normalization’, although this issue has to my knowledge never been addressed.

nowadays hold that variation in register for the most part consists of differences in quantity (of many different parameters) rather than quality, and are the result of a continuous range of styles along multiple dimensions.

In the diagram in Figure 2.1 I have divided these different factors into properties that are associated with the speaker, properties associated with the addressee (independent of the speaker and the situation) and properties associated with the situation. The latter include practical aspects of the interaction such as the distance between speaker and listener as well as social aspects such as the social-emotional relation between speaker and listener and the topic of conversation.

2.2.3.1 Properties of the speaker / signer

All the **social variables** defining different sociolinguistic groups in spoken languages have also been found to play a role in sign languages, although most of this research has been carried out only on ASL, and parallels for other sign languages are mostly based on informal observations. Sociolinguistic studies of SLN are restricted to regional variation. Most of the dependent linguistic variables involved in these studies concerned lexical items and morphosyntactic processes, but not sub-lexical phonological or phonetic variables.

As for *social class*, there are fewer distinctions in Deaf communities than in spoken language communities: there are fewer educational distinctions, since most Deaf people in the western world do not have easy access to higher education. For ASL, Lucas, Bayley, Rose & Wulf (to appear) found a distinction in social class for African American but not white signers in the lowering of signs made on the head, as discussed above. White signers favored lowered forms, middle-class African American signers slightly disfavored lowered forms, while working-class African Americans strongly disfavored lowered forms.[26]

Much more influential are Deaf-specific variables, such as being Deaf, having Deaf parents, and having acquired sign language early in life (Woodward 1973). Some of these variables could be considered aspects of social class, since family background is one of the properties traditionally associated with social class distinctions (Sutton-Spence & Woll 1999). The variables studied by Woodward (1973) and in most later studies were all of a lexical or morphosyntactic nature. Lucas and colleagues have started a large sociolinguistic study on ASL targeting many different social groups including Deaf-specific subgroups in which phonological phenomena are included as well (Lucas 1995, Lucas et al. to appear, Bayley et al. 2000).

The role of differences in *age* of the signer is hard to evaluate for many sign languages, including SLN, as currently, different age groups have widely differing educational backgrounds. It was not until the early 1990s that bilingual SLN-Dutch programs started in deaf schools in the Netherlands. Before the early 1980s, signing was discouraged or even forbidden in most classrooms. This likely had an influence

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[26] Sutton-Spence & Woll (1999) claim that in the USA there appears to be a distinction reminiscent of social class between Deaf people who attended Gallaudet, the world's only university for Deaf students, and those who did not. It is not clear whether this difference has any effect on sign language production.

on the knowledge and use of signing by Deaf people, older people using more contact varieties and younger people using more Dutch-independent SLN. Apart from differences in education, age differences are also enhanced by the fact that most deaf children have hearing parents, and therefore do not receive sign language input before they go to school; for this reason acquisition of sign language is often delayed in comparison with hearing children of the same age.

Gender differences in sign language use have been identified in ASL in the use of one vs. two hands in some signs (Woodward & De Santis 1977), and in the use of the elbow location vs. hand location (De Santis 1977, quoted in Lucas et al. to appear). Gender differences also arise due to specific situations. Lemaster & Dwyer (1991) describe the situation in Dublin, where distinct vocabularies are used by those who attended boys' and girls' schools; this distinction has been getting smaller with the decreasing separation of the sexes in schools. This distinction related to the educational system is also found in Belgium, according to Sutton-Spence & Woll (1999).

Rudner & Butowsky (1981) found that in the USA there is a distinct *gay subcommunity* within the Deaf community that uses a set of lexical items not known by the wider Deaf community, but they did not address phonological or phonetic features specific to this group. Kleinfeld & Warner (1996) found that there are different phonological forms of the sign LESBIAN$_{ASL}$, which differ by the precise part of the hand that makes contact with the chin. Since different attitudes are associated with some of the different forms, it is not quite clear whether this variation is not actually lexical in nature. From a phonologist's perspective, one might ask whether these forms are not actually phonetic in nature, since there has been no explicit proposal for different phonological feature values referring to different contact areas on the strong hand.

The first study of *ethnic* differences in the use of a phonological variable consisted of signs that could be articulated both on the face and on the weak hand. Woodward, Erting & Oliver (1976) found that black ASL signers used more 'hand' variants, whereas white signers used more 'face' variants. It is implied that these are two phonetic realizations of the same sign, even though the location distinction is phonologically contrastive in ASL. Aramburo (1989) found that there are lexical items used in and known by the black Deaf community that are not known by most white signers. Sutton-Spence & Woll (1999) note that in British Sign Language (BSL) a specific 'style of signing' has been adopted by some black Deaf people, without commenting on the nature of this style. To my knowledge, in SLN there is no specific ethnic group that stands out from the Deaf community in any way, social or linguistic.

Regional variation in the use of lexical items has been established for many sign languages, including BSL (Deuchar 1984, Kyle & Woll 1985), Russian Sign Language (Grenoble 1992), ASL (Croneberg 1965, Shroyer & Shroyer 1984), and Indian Sign Language (Jepson 1993). As discussed in Chapter 1, there are regional differences in the SLN lexicon (Stroombergen & Schermer 1985). Ignoring small differences within the western region, it is fair to say that there two main dialects: one in the north of the Netherlands and one in the west (*Commissie Nederlandse Gebarentaal* 1997). In the same publication, it is claimed that there are no other dialect differences, for example at the phonological or syntactic level.

I surmise that differences have only been found in the lexicon in part because the lexicon is the easiest place to find differences: different phonological forms are easily recognized by linguists, they are easily recognized and memorized by language users, and given the size of the lexicon they are predicted to be more abundant than syntactic or morphological differences. Regional differences have a large chance of developing given the limited amount of language contact between different regions, which probably is caused in part by the lack of a commonly used writing system for SLN and by the virtual absence of SLN on Dutch television. Thus I predict, pending the necessary further research, that regional variation also exists in parts of the language other than the lexicon.

Physiological properties of the signer that may influence the phonetic form of signs include permanent properties of the articulators that parallel differences leading to distinctions in voice quality in speech. Voice quality is determined by anatomical differences between people and by temporary factors such as fatigue and emotional state (cf. Scherer 1986). In Laver's (1994) terms, such distinctions in speech are informative but not communicative: they inform us about the identity of the speaker and his emotional state, but they carry no linguistic or paralinguistic content and they are largely not under volitional control. A process called 'speaker normalization' takes place during auditory perception of speech to factor out speaker-dependent variation.

In sign language, the length and thickness of people's fingers, hands, and arms will vary, as well as other properties such as the flexibility of people's fingers (determined by the detailed anatomy of bones, muscles, tendons, connective tissue, etc.). One example of differences in flexibility is the extent to which people can extend only their pinkie from a fist. In SLN this hand configuration is called the 'I' hand, and it is used distinctively (albeit in a small number of signs). Of a random small set of people that I have asked, not everyone could fully extend their pinkie, and some people could not extend their pinkies equally on both hands. Individual differences in motor control are also likely to influence the articulation of signs. These factors influence the signal even if the phonetic targets are identical to those of other signers. As signing is rarely if ever perceived without seeing the signer's face at the same time, and because facial recognition is so effective, it is questionable whether physiological properties of the signer contribute to person identification. It is possible that some of these permanent physiological distinctions between signers contribute to people's image of a signer, which could be used to mimic someone's signing 'style'. As in speech, perceivers possibly derive information about a signer's level of fatigue and emotional state from their manual articulation. There has only been a single study addressing the influence of emotional state, which does not come as a surprise given that overall there are few linguistic-phonetic studies. Reilly, McIntire & Seago (1992) tried to compare the production and perception of sentences signed with five different emotional states, in two conditions: in the first signers wore a mask that covered their face, in the second their face was visible. The five emotions were neutral, happy, angry, sad, and surprised. Perceivers were able to correctly recognize the different emotional states even in the mask condition. However, these results are hard to interpret because different stimuli were used for the two conditions, and because the signer was simulating the different emotional states. The only significant difference in the production (averaged over six signers) was that the utterances in the angry condition were shorter than in the other four conditions.

One issue that has repeatedly been mentioned in the literature is hand dominance (Battison 1978, Blevins 1993, Sandler 1994, van der Hulst & Sandler 1994, van der Hulst 1996b, Brentari 1998). In lexical items in SLN and in most if not all other sign language studied there is no phonological distinction between using the left hand or right hand to articulate a one-handed sign (or to play the active role in asymmetrical two-handed signs). The choice of hand depends on non-linguistic hand dominance.[27] I know of no research investigating the question whether left-handed signers (the smaller group) are harder to perceive than right-handed signers (the larger group); phonologists writing about one-handed vs. two-handed signs typically claim that it makes no difference at all.

Apart from these physiological factors, there are some more mundane practical properties of the signer that can vary from situation to situation, such as the extent to which the articulators are covered by clothing. A sweater with wide sleeves will obscure the movements of the articulator more than wearing a sleeveless shirt or a shirt with very tight sleeves. Whether such factors actually affect perception or production remains to be studied. In speech, it has long been known that people hearing loud noise through their headphones will raise their voice, even if the listener does not have such noise (the general effect of talking louder in the presence of noise is called the 'Lombard effect', cf. Lane & Tranel 1971). In this thesis I will claim that the perceptual specification of lexical items typically concerns only the fingers (their movement, location, and configuration), and not the 'palm' part of the hand, let alone the forearm or upper arm. However, this leaves open the possibility that the involvement of the whole upper extremity in the articulation of these specifications contributes to the perception of the features specified. For example, it may be that a location specification [temple], which refers to a target for the fingertip, is perceived not only by the actual location of the fingertip but also by the orientation and location of the forearm.

The form of a sign will also differ depending on whether a signer is standing or seated, or leaning towards a wall or table for example. I have seen situations in which a signer is leaning with one side of his body contacting a wall, severely limiting the movement of one limb. Overall, it seems fair to say that the external position of the sign language articulators (which can be perceived in sign but mostly not in speech) increases the number of practical factors that can affect or distort the appearance of the signal.

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[27] In discourse, however, signers may use their non-preference hand as the active hand for specific grammatical or discourse purposes, cf. Miller (2000) on LSQ.

Thirdly, signers may have a **personal signing style** that is not clearly influenced by their membership of any social group nor by physiological variables such as handedness and body position. Just as some speakers speak louder or faster than others, differences in speed, size, or acceleration of movements in sign language that are not phonologically distinctive are predicted to vary across idiolects. Signers tend to have clear impressions about 'how' someone signs and what other sign languages look like, using qualifications such as 'smooth', 'crisp', 'fluent' etc. It has also been brought to my attention that Deaf families may have a specific signing style that other people recognize as belonging to that family (Niek Terpstra, personal communication). To my knowledge such differences have never been systematically investigated. In my experience, such qualifications of other people's signing have always concerned individuals, rather than groups of signers as defined by any of the social variables discussed above. However, qualifications that signers attach to different people's signing are also used in describing what other sign languages look like. For example, some Dutch Deaf people have told me that ASL 'looks different' from SLN, even though the inventory of phonological features values is more or less the same in ASL and SLN. Similarly, ASL signers have told me that Japanese Sign Language looks different to them. It seems plausible that such differences are partly tied to prosodic aspects of the movements, including differences in duration of movements and pauses, the investigation of which has only recently been receiving much attention (Miller 1997, Sandler 1999, Wilbur to appear).

2.2.3.2 Properties of the addressee

Lindblom (1990) argues that a speaker will tailor his speech to the needs of the listener, in such a way that the listener gets enough information to understand the message, but at the same time minimizing his articulatory effort as much as possible. It seems reasonable to expect that physiological properties of the addressee such as fatigue or a specific emotional state influence the estimate of how much articulatory reduction is possible before perception is hindered. Social properties of the addressee such as age or social class may also lead the signer to act differently, given the existence of styles such as 'motherese' in spoken languages. Note that it is not really the objective value of these parameters that matters, but rather the estimation of these properties by the signer. None of these factors have been explored in sign language research.

2.2.3.3 Properties of the situation

Practical circumstances that may influence the language production constitute one of the largest differences between the spoken and the signed modality. Some of these are predictable from the difference in perceptual systems, hearing vs. sight. For speech it is crucial that the addressee be located close enough to the speaker to be able to hear the signal, but it is not necessary that the participants in the conversation are actually able to see each other. In order for signing to be perceived it is necessary that the signer be not only within a reasonable distance of the addressee, but he also has to be located within the addressee's visual field. Although the human visual field extends about 160 degrees horizontally and 120 degrees vertically, only objects in the center of the visual field can be easily perceived.

It follows that the nature of ‘noise’ in the two modalities will differ as well. Noise that can interfere with the perceptibility of speech can be any loud acoustic signal, such as a train passing by. Visual perception of signing can be impeded by visual noise such as very strong back light or a blinking fluorescent light, but also by low light conditions such as a poorly lit room or an unlit room at night.

As far as I know, none of these practical circumstances have been studied for any sign language.[28]

Social circumstances that may influence language production and which are not the direct result of variables associated with signer or addressee generally fall under the cover term ‘register’. This term comprises what other people term ‘register’, ‘style’, ‘genre’, or ‘discourse type’ (Atkinson & Biber 1994, Biber 1995). All these different terms “refer to any language variety associated with particular situational or use characteristics” (Atkinson & Biber 1994: 351).

The register may differ depending on the *relation between the speaker and the addressee*. For example, if the addressee has a much lower social status than the speaker, the register may be less formal, typically leading to more reductions. Likewise, differences in age, gender or social class may lead to differences in register. The *social context* and the *topic of conversation* may also influence the register. People tend to speak differently at weddings than at funerals, and discussing a plane crash may involve a different tone of voice than the announcement of a child birth.

There are a few sign language studies looking at differences in register, even though the different factors listed above have not been clearly distinguished in all of them. Mauk (1999) performed a quantitative study of movement size of nine ASL signs in two different conditions: when the signer was trying to sign in a relaxed manner, and when the signer was pretending to sign to somebody far away. A significant difference in size of hand movement was found, the movements being larger in the distant signing condition. No size differences were correlated to the different phonological locations of the test signs (in neutral space vs. on the torso vs. at the chin). With respect to the joints used to articulate the size difference, Mauk found that the wrist contributed significantly less to the size change than the elbow and shoulder, although it was never the case that wrist movement was completely *replaced* by shoulder movement, for example.

Schermer et al. (1991) remarked that formal styles are characterized by enlarged signs and the increased use of two-handed variants of one-handed signs. Lindemann (1999) interviewed two ASL signers about private talk in sign language. The signers indicate that the size of the signing is reduced in private talk, something that has

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[28] There is one specific type of signing used to communicate with deaf-blind people, whose visual impairment could be equated with the situation of no available light for Deaf people. This is called ‘four-handed signing’ or ‘tactile signing’, in which an adapted version of a regular sign language is produced while the deaf-blind addressee continuously touches or holds the hands of the signer (e.g. Reed, Delhorne, Durlach & Fischer 1995, Mesch in press). It is not yet quite clear how and to what extent the signing in such situations changes, and to what extent these changes are person-specific.

been noted by others as well (Koenen, Bloem & Janssen 1993, Uyechi 1996).[29] One of Lindemann's informants also remarks that the location of the overall signing space may be lower or off-center in private talk, calling this "whispering with the body". Unfortunately, Lindemann does not discuss the precise effect of the changes in size: is every part of complex sign movements reduced proportionally, and does the decreased movement size affect the realization of the static parameters handshape, orientation, and location?

Uyechi (1996) does make one specific claim: if the movement of a two-handed sign is enhanced, the distance between the two hands is enhanced proportionally (and vice versa for reduction). Different realizations of the phrase DEAF PRESIDENT NOW_{ASL} were found, as the phrase was 'shouted' as a slogan in a protest march. In the citation form, the two-handed sign NOW is articulated by moving both hands down for about the same distance as the two hands are apart. Uyechi claims it would not be correct to 'shout' the sign by just increasing the size of the downward movement of the hands while not simultaneously increasing the distance between the hands. The reverse holds for 'whispering', Uyechi argues, although she does not present any data in support of this claim.

Baker-Shenk & Cokely (1980) mention several features that distinguish 'formal' from 'informal' signing, adding that most research on ASL until then had focused on informal signing. Formal signing includes more use of two-handed variants of signs and larger and slower signing than informal signing. Informal signing is also characterized by more assimilations between signs, as well as by a centralization of locations, so that locations on the head are realized lower in space and the size of the movement is reduced. The choice of lexical items may also be influenced by register differences.

Kettrick's (1983) ASL informants noted that a straight posture is important in formal styles, whereas posture may vary in casual styles. In casual signing the size and duration of movements may be reduced, and deletions such as one-handed articulations of two-handed signs occur. Kettrick notices that in many formal situations such as presentations to a large audience a formal style of signing overlaps with the need to communicate over distance, since signers cannot use microphones. Informants' intuitions indicated that the increase in size is due to the distance. Kettrick's conclusion is that this implies that speed is not likely to be lower in short-distance formal signing, since "reduced speed is directly proportional to increased distance". This is only true, however, if the duration of the sign is constant, which remains to be established.

In the same study, Kettrick replicates a finding of Battison et al. (1975). They studied the occurrence of thumb extension in handshapes that are not phonologically specified for thumb, but found no differences in comparing signing in a lab setting to a deaf friend vs. to a hearing teacher, or when the signers were not aware of being recorded. Instead, they propose a variable rule involving a complex set of

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[29] Chris Miller (personal communication) notes a related phenomenon: in many LSQ conversations, the addressee provides highly reduced back-channel signing in a very small lowered signing space. In this case, the reduction serves so as not to take the floor in the conversation.

phonological contexts that favor or disfavor thumb extension. Kettrick argues that the data supporting this proposal are not very robust. Her own experimental study shows that thumb extension is likely to be an assimilation process: it happens most frequently if the preceding sign has an extended thumb, and it happens more often in fast than in slow signing. There were also individual differences in the frequency of thumb extension that were not explained. Since it is implicit in the study that thumb extension also occurs if there is no thumb extension in the neighboring signs, it remains possible that some of the phonological factors that Battison et al. discussed do play a role.

Zimmer (1989) compares the signing of one subject in three situations: a lecture, an informal talk, and a television interview. The most striking difference between the three is the large size of the signing space and the somewhat lower speed of the movements in the lecture as opposed to the other two situations. Individual signs have a longer duration in the formal context, and also ‘final holds’ (lengthening of the end state of the sign) are longer. Head and body movements that are used for discourse purposes such as reported speech are larger in the formal context as well. Handshape assimilations as discussed by Liddell & Johnson (1986) occur more frequently in the informal registers, whereas hand-switching (also known as ‘dominance reversals’, Frishberg 1985) is used more frequently in the lecture.

There are a few studies looking at language contact situations where native ASL signers sign to hearing non-signers or hearing sign language learners. Myles-Zitzer (1990) found that signing directed to non-fluent hearing learners of ASL was slower and included larger movements. Reductions of signs from two-handed to one-handed articulations occurred only in addressing a native signer. Lucas & Valli (1992) also note that signs are larger in such ‘foreigner talk’.

Finally, several anecdotal references exist of Deaf children wishing to tell secrets, which they may do by hiding their strong hand behind a book or their weak hand, and using either fingerspelling or highly reduced regular signing (e.g. Lindemann 1999); I have observed this in SLN as well. Here too, the focus in the description is on the social context and the overall behavior, without describing in detail how signs are modified. Karen Emmorey (personal communication) informs me that in ASL fingerspelling is also used to tell secrets. Since fingerspelling mostly consists of movements of the fingers and changes in orientation of the hand, the space used can be very small and easily hidden from people other than the addressee.

2.2.4 Conclusion

In summary, it is fair to say that there has been very little systematic research on phonetic variation in signing, and the research that has been done is almost exclusively based on ASL. Although all of the different linguistic and extra-linguistic variables have been found to correlate with linguistic variation, the effects of these variables on *phonetic and phonological* parameters have not been demonstrated in each case.

Phonetic features that have been found to vary in ASL include whether a sign is articulated with one or two hands, the duration of the sign, the size of the movement and the size of the distance between the hands in two-handed signs, the size of the overall signing space, and various aspects of handshape (most prominently pinkie and thumb extension).

One of the phonetic features that has been frequently mentioned in the literature is the size of movements, often expressed in terms of the overall space in front of the body in which the hands move. Movement size is not a distinctive phonological feature, and it is implicit in most phonological models that the phonetic or surface size of a movement is partially dependent on the combination of phonological parameters: a downward movement of the hand will be larger on the chest than on the cheek, for example. In addition, register differences surface as differences in size.

No study specifically addresses the question whether altering the size of a movement has an effect on the realization of other parameters. The possibility of an effect of size on the appearance of phonological features has been raised by Uyechi (1996). She discusses different versions of the ASL sign PAST$_{ASL}$, which seem to occur interchangeably. Uyechi analyzes this sign as having a phonological change in orientation. In the first realization this movement is articulated by elbow flexion, in the second by wrist flexion, and in the third by MCP flexion (Figure 2.2).

i. PAST$_{ASL}$-1 ii. PAST$_{ASL}$-2 iii. PAST$_{ASL}$-3

Figure 2.2

Three realizations of PAST$_{ASL}$ (Uyechi 1996: 141)[30]

A phonetic description of these forms would be that in the first variant, there is a change in location combined with a change in orientation, in the second variant there is only a change in orientation, while the third variant features a change in handshape. These three forms could well be three different phonological forms, then, with three different kinds of movement: a change in location, a change in

[30] Illustration reproduced with permission from CSLI Publications; © 1996 by CSLI Publications, Stanford University, Stanford, CA 94305.

orientation, and a change in handshape. Uyechi claims that they are different realizations of *one* phonological form, and proposes to account for the phonetic variation by positing that the phonological category “hand prism” (her equivalent of handshape) can be expressed by different articulators.

If changes in movement size are really as frequent as suggested in the literature on variation reviewed above, then important questions arise: how frequent are the alternations in movement categories as cited by Uyechi, and do they call for a modification of the phonological distinction between changes in location, orientation, and handshape? These questions will be answered in the chapters to come.

2.3 Modeling variation: phonology and phonetics

In the past four decades the view of phonologists and phoneticians on how phonetic variation should be modeled has undergone dramatic changes. Chomsky & Halle (1968) emphasized that a lexical representation abstracts away from different phonetic forms, and that many properties of the surface form (which typically cannot be captured by phonetic transcription) are supplied by “universal rules” (p. 295). These include “the different articulatory gestures and various coarticulation effects” (p. 295). Phonological rules are posited to generate allophonic variants, such as aspiration of voiceless plosives in prevocalic but not postvocalic position in English. Thus, Chomsky and Halle envisage a model of the form of language as in Figure 2.3.[31]

underlying lexical representation

↓ ------------- *phonological rules (phonology)*

phonological surface representation

↓ ------------- *universal phonetic rules (phonetics)*

phonetic surface representation

Figure 2.3

Phonological and phonetic representations in Chomsky & Halle (1968)

Chomsky & Halle acknowledge that there is much information in the signal that is not linguistic but rather expresses things such as the mood of the speaker. They seem to imply that such differences are universal as well: they are predictable on the basis of the linguistic structure of the sentence, and even if they differ among

[31] Whether the final result of this model is an articulatory representation or its acoustic result is not relevant at this point.

languages, this is independent of the phonological representation. This view is repeated in Chomsky (1995), who refers to "the fixed repertoire of phonetic properties and the invariant principles of universal phonetics" (1995: 27). He also states that "performance systems are presumably at least in part language-specific, hence components of the language faculty. But they are generally assumed not to be specific to particular languages: they do not vary in the manner of the cognitive system, as linguistic environments vary" (1995: 2).

As phonology is most commonly seen as the study of language-specific and categorical aspects of sound structure, little attention has been given in the phonological literature to the phonetic implementation stage in the first fifteen years since Chomsky & Halle (1968). Although several modifications were proposed to the phonological stage of the model within the theory of Lexical Phonology (Kiparsky 1981, Mohanan 1986), little attention was given to the phonetic implementation stage of the derivation. Lexical Phonology introduced the distinction between lexical and postlexical stages of the derivation of words, as well as different levels of lexical derivation. Depending on the level of derivation, lexical representations are influenced by different parts of the morphological structure of words, but they cannot be influenced by the phonological form of neighboring words. Postlexical processes, on the other hand, take into account the surrounding phonological context, including the phonological form of neighboring words and the prosodic structure of the sentence, but they are not sensitive to morphological structure.

In sociolinguistic studies various devices have been introduced to analyze phonological variation between different social groups or different styles. The concept of 'variable rules' (Labov 1972) aimed to use standard phonological rules as discussed by Chomsky & Halle (1968) to describe optional variation, by stating that the specified contexts in which the rule applies each favor the occurrence of a process, although they are not a necessary criterion for application of the rule. Later, weighted rules were proposed to obtain a hierarchy among different contexts for a rule. For example, Battison et al. (1975) studied the variable occurrence of thumb extension in ASL. Several aspects of the linguistic context favored thumb extension to different degrees: not being an indexical sign favored thumb extension most (and was therefore assigned the largest weight in the rule's context), while a central location favored thumb extension least (this was assigned the smallest weight in the rule).

Within Optimality Theory (OT, e.g. Prince & Smolensky 1993), there are several ways to account for variation in spoken language. Van Oostendorp (1997) uses different rankings of the same constraint set to generate variation, stating that "the more formal the style level, the higher-ranked the faithfulness constraints" (p. 209). Anttila (1997), Hayes (2000), and Boersma & Hayes (2001) show that variation can also arise by not ranking a subset of constraints. These studies demonstrate how phonetic variation in part can be analyzed within OT models.

Other recent research on phonetic implementation has shown that phonetic implementation processes are typically not automatic and universal but language-specific (for example Keating 1985, Kingston & Diehl 1994, Pierrehumbert 2000). This line of investigation was inspired by the study of intonation in the 1980s (e.g. Pierrehumbert & Beckman 1988) as well as by detailed phonetic studies of various languages. Moreover, it has recently been argued that many phonological phenomena show the gradient behavior that is traditionally associated with phonetic processes generated at the phonetic implementation level (Hayes 2000, Beckman & Pierrehumbert to appear, Gussenhoven 2000). Seen from another angle, the content of many processes at the categorical postlexical level of the grammar closely resembles phonetic implementation processes which are supposed to be non-categorical, automatic, and universal. Furthermore, it has been argued that the lexicon contains detailed phonetic information (Bybee 2000, Pierrehumbert 2000, Dell 2000). The development of Optimality Theory has stimulated a related line of research that has focused on incorporating phonetic constraints into the phonological grammar (e.g. Jun 1995, Hayes 1999, 2000, Steriade 1995, 2000, Boersma 1998). Although in these studies detailed phonetic alternations have also been discussed, most attention has been paid to analyzing traditional phonological patterns using functionally motivated sets of constraints.

Given all these recent developments, it is not surprising that there is no consensus on a model that can incorporate all aspects of phonetic and phonological structure, even though there is growing consensus about the need to closely integrate phonetic and phonological analyses (cf. Pierrehumbert, Beckman & Ladd 2000). The advantages of such an integration are that all aspects of phonetic and phonological patterns can be analyzed within a single unified model, and that functional explanations for the observed patterns can be integrated in the model. In the rest of this section I will discuss the 'Functional Phonology' model of Boersma (1998), which I will adopt and modify for the purposes of the analysis of sign language. There are three reasons for choosing this particular model as a basis for a sign language phonetic implementation model.

The first reason is that, in its current form, the Functional Phonology model clearly outlines the different parts of the communication chain, differentiating between functional principles pertaining to speakers and those pertaining to listeners. Since these different parts are so clearly identifiable, it will be relatively easy to see which parts have to be modified for sign language. The fact that these modifications are necessary follows from the differences in 'phonetic channel': unlike in spoken language, in sign language the articulators are the hands, upper body, and face, and their behavior is perceived by the eyes. The possible classes of phonetic events will therefore be different, just as the constraints referring to them.

The second reason to choose the Functional Phonology model is that it closely integrates phonological and phonetic phenomena, being able to describe both categorical phonological distinctions and gradual phonetic distinctions in one model, in line with the current trend in phonological research referred to above. In so doing, it is by far the most complete model in the literature. Boersma (1998) presents the model not as a phonetic implementation model, but as a full account of both phonological and phonetic aspects of language. In the present thesis, I will only use it to account for some instances of phonetic variation in sign language, and not to account for all of the traditional phonological generalizations; this is left for future work.

The third advantage of the Functional Phonology model is that by formalizing basic non-linguistic functional constraints on the perception and production mechanisms, the model has great explanatory power that goes beyond a mere formalization of the facts.

An overview of the model is presented in Figure 2.4. In the discussion below I will focus on the speaker side of the model; a detailed description of the whole model can be found in Boersma (1998).

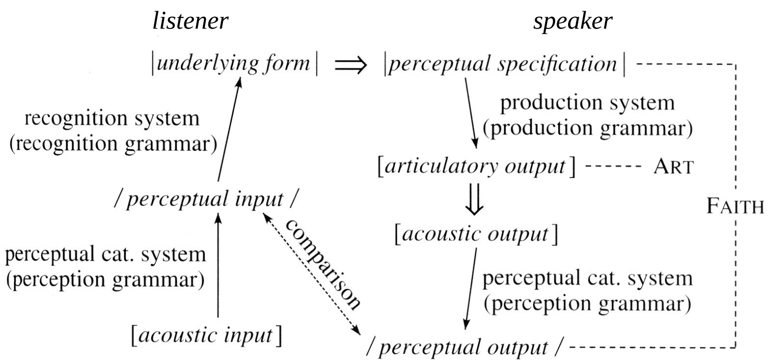

Figure 2.4

The Functional Phonology model

The model makes a principled distinction between the listener (left side) and the speaker (right side). Some parts of the grammar (such as the articulatory constraints) are only relevant for the speaker, some parts (such as the recognition grammar) are only relevant for the listener. When a speaker wants to utter a word, the production grammar generates multiple articulatory representations on the basis of a perceptual specification in the lexicon. A set of articulatory constraints evaluates the effort involved in these articulations. The combination of articulatory gestures has an automatic acoustic effect, which in turn is perceived (categorized) by the perception grammar. The acoustic input to the speaker and to the listener closely resemble each other (disregarding for example the information that bone conduction and other feedback cues provide to the speaker), and so the perception grammar is at work for both speaker and listener: a speaker can hear his own speech, just as the listener can. The difference between the perception of the speaker and the listener, however, is that the speaker compares the perceptual output to a known perceptual input, whereas the listener does not now in advance which item in his lexicon to compare the perceptual input to. In the case of the speaker, then, faithfulness constraints compare the perceptual output directly to the perceptual input. The listener first has to perceive the acoustic output (accomplished by the perception grammar) and secondly has to associate it to a form in his lexicon (the task of the recognition grammar; Boersma emphasizes that these may not be completely sequential processes).

Multiple articulations are generated from each perceptual specification, leading to multiple perceptual outputs. As in some other recent OT analyses (e.g. Hayes 2000), the ranking of perceptual and articulatory constraints determines the winning candidate, and the constraints express functional principles of limitation of effort for the speaker and minimization of confusion for the listener.

This brief sketch of the communication process suffices to make clear how complex this model is: it incorporates phonetic and psycholinguistic components traditionally not addressed by phonologists.

A clear distinction is made between perceptual representations and articulatory representations. A perceptual specification is stored in the lexicon. The production grammar generates articulatory outputs on the basis of this perceptual specification every time a word is spoken. The perception grammar categorizes the acoustic result of each articulation, which can be compared to the target perceptual specification. Thus, detailed knowledge of each of these components is required for a full development of the model. For sign language, unlike spoken language, the field of phonetics has barely been explored. For this reason, it is not realistic to present fully worked-out analyses of sign language as Boersma does for spoken language. However, we can use the overall architecture of his model to clearly distinguish the different stages of sign production. In the next section, I will outline the basic characteristics of such a phonetic implementation model for sign language, that will make it easier to see the nature of phonetic variation in sign language.

2.4 An outline of a phonetic implementation model for sign language

The sign language analogue of Boersma’s production model is presented on the right side of Figure 2.5.

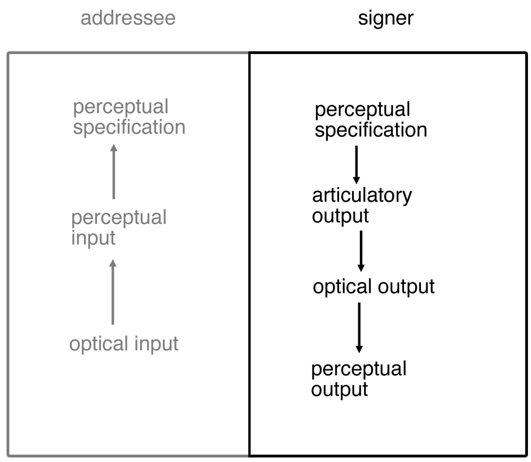

Figure 2.5

A sign language production model

In Figure 2.5 we see the same overall scheme as in the speech model in Figure 2.4; only the representations are present. The perceptual specification (the 'underlying form') can be articulated in different ways. These different articulations have automatic optical results, which can in turn be categorized to a perceptual output. The optical result is 'automatic' in the sense that there are no mental processes involved in the reflection of light waves from the articulators to the eye: this process is predictable on the basis of physical laws, even though this is a complex process and even though the optical input will differ for perceivers looking from different angles and under different light conditions (cf. footnote 36 below).

At first sight, a major difference between the two modalities should exist since we can directly perceive the articulators by vision but not by audition. This difference is enhanced by the fact that the sign language articulators are external to the body: they are less hidden from view than most of the spoken language articulators. If this is so, then why would there be a difference between the perceptual specification and the articulatory output?

In part this difference between vision and audition is only apparent. Indeed, the sign language articulators are more external to the body than the vocal articulators, and in principle they can be seen. However, the perception of the arms and hands is in no sense 'direct' (see Dretske 1990 for a discussion on this term in visual perception research). We can only see part of the arms and hands at a time, seeing the sides of the articulator that are closest to us. Depending on the state of the shoulder, elbow, and wrist, the wrist could be hidden from view, for example, and we unconsciously infer that it is still there, and possibly what position it is in.

More pertinent to sign language forms, I argue that there is indeed a difference between perceptual and articulatory *representations* in sign language (just as in spoken language) because it is only a small part of the articulator that has perceptual relevance. This is also the position implicit in most sign language work, which has claimed that various properties of the hand are phonologically relevant, whereas the arm serves only as an aid in the realization of some of those properties of the hand.[32] For example, take the SLN sign SAY, as it appears on one of the SLN dictionary CD-ROMS (NSDSK 1996), illustrated in Figure 2.6.[33]

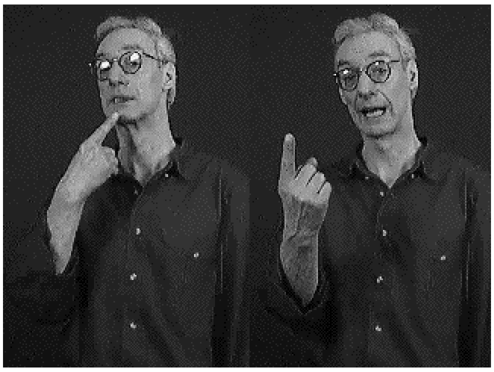

Figure 2.6

The dictionary form of the sign SAY

A simple phonological analysis of this sign would say that an extended index finger whose palm side faces the body moves from the chin forwards. Further phonological decompositions can be added to analyze the extended index finger for example or the way the movement is represented, but none of these would include information about the state of the wrist, elbow or shoulder joint. These joints work together to articulate the location 'chin' for this particular 'handshape' (extended index finger), but a description of their position and movement is not included in the phonological description.

In this thesis, I will assume that the relevant level of articulation included in the model is the state of the upper extremity joints over time.[34] Whether or not this is actually the level that the motor control system controls is not relevant at this point. It may be the case that at some level it is rather muscle groups or individual muscles

[32] The arm has been referred to in phonological models in two ways. Firstly, in all models of all sign languages different locations on one arm (such as the upper arm, the elbow, the inside of the elbow, etc.) can serve as a place of articulation. In this case, the arm functions like the upper body and the head, which are typical places of articulation in sign language. Secondly, in a very limited set of signs the forearm can serve as part of the active articulator together with the hand. For example, Stokoe (1960) included a category 'forearm prominent' in his phonological analysis of ASL.

[33] The two video frames are reproduced with permission of the Dutch Foundation for the Deaf and Hard-of-hearing Child (NSDSK) and BSL Computer Consultancy.

[34] The 'upper extremity' is the anatomical term for the arm and hand together; similarly, the leg and foot together are referred to as the 'lower extremity'. See Appendix A for a discussion of some of the anatomical and physiological terminology pertinent to sign language.

that need to be activated. The level of joints is relevant to the model because it is differences in joint states that have an optical effect that can be perceived.[35]

For the above realization of the sign SAY, the different representations in the model would be as in (2.1). The arrows in the articulatory description indicate movement from beginning to end position. The different joints and their reference positions are described in Appendix A.

(2.1) Representations of one realization of SAY

- Perceptual specification
  handshape: extended index finger
  orientation: palm side facing the location
  location: at the chin
  movement: straight ahead

- Articulatory output
  shoulder: rotated inwards 45 degrees, extended 20 degrees
  elbow: flexed 135 degrees → flexed 100 degrees
  forearm: supinated 90 degrees
  wrist: flexed 40 degrees → extended
  index MCP: flexed 15 degrees
  index PIP: extended
  index DIP: extended
  MCP, PIP & DIP of middle, ring & pinkie: flexed 90 degrees
  thumb CMC: flexed 20 degrees
  thumb MCP: flexed 45 degrees
  thumb IP: extended

- Optical output
  —

- Perceptual output
  handshape: extended index finger
  orientation: palm side facing the location
  location: at the chin
  movement: straight ahead

Because of its extreme complexity, the optical output is left unspecified here; since it is the automatic result of the articulatory output, I equate it with all of the

[35] It could be argued that, especially in the face, muscle tension can also be perceived, but I claim that for the manual component of signs muscle tension always has an effect on joint states or on movement speed as well, and that these are the primary visible correlates of muscle tension. This will become relevant in Chapter 3, where I argue that tenseness is phonologically specified for the whole sign, and not for handshape or movement individually.

properties of the articulation that can be perceived.[36] Thus, it includes information on many properties that the perceptual output has abstracted away from, such as the orientation of the upper arm, the location of the elbow, the position of the thumb, etc. Also note that the categories present in the perceptual output cannot be directly mapped onto articulatory categories. For example, the perceived movement category in this sign is ‘forward movement’, and not ‘elbow extension’. Whether elbow extension actually leads to an optic effect that can perceived as forward movement depends on the state of the shoulder. If the shoulder is hyperextended, then the direction of movement of the hand will be downward rather than forward.

There is no principled reason why articulatory categories themselves cannot be perceptual categories. In fact, the visibility of the sign language articulators would lead us to expect that sign language makes frequent use of phonological distinctions such as ‘wrist bent 90 degrees’, in which the articulatory and perceptual categories would coincide. As was already noted above, in most phonological descriptions to date the focus has been on the hand. It is not surprising then that the features describing handshape have often directly referred to the states of various joints of the fingers. For example, the perceptual description of the handshape is ‘extended index finger’, which could be seen as a direct paraphrase of ‘all index finger joints extended’. I will argue in the coming chapters that even for handshape, the overlap between perception and articulation is only apparent. Data from variation in the production of SLN are adduced in later chapters which lead to the conclusion that perceptual features of handshape abstract away from the states of the different joints of the hand, and furthermore, that finger joints can be used to articulate features of orientation and location.

The source of phonetic variation in this model is the production grammar: on the basis of one fixed perceptual specification it can generate many different articulatory representations. In the above example of SAY, the illustration in Figure 2.6 constituted one single realization of the sign. Again, this is due to the nature of sign language articulation and perception: we can see the articulators on an illustration, so that we get quite some (but not all) information about perceptual and articulatory details of the sign at one point in time. With the exception of the lips, lower jaw and sometimes the tongue tip, the configuration of most spoken language articulators is invisible even in a photograph, let alone in an IPA transcription, and we cannot hear the state of the articulators either. The sign SAY can have an infinite number of different articulations, though, most of which are correctly recognized as SAY and some of which may not be correctly recognized. As an example, let us focus on one aspect of its perceptual specification, viz. the handshape.

The perceptual specification says ‘extended index finger’, while nothing is said about the other fingers. For sake of ease, I will ignore the position of the thumb here,

[36] Note that very different optical inputs will result from each articulation for different perceivers, since the angle with which they view the signer will necessarily differ for all perceivers. I will assume for now that the low level visual processes that abstract away from these highly complex and variable optical inputs at this point are irrelevant to the model and common to all visual perception processes. Ultimately, it is the task of the perception grammar to achieve such normalization processes, which resemble speaker normalization that will also have to be accounted for by the perception grammar.

and focus on the position of the other three fingers. In the literature on handshape, one of the earliest generalizations was that only one set of fingers can be specified for shape (the selected fingers), the shape of the non-selected fingers being predictable (Mandel 1981). This predictable state of the unselected fingers was spelled out as 'either all closed or all extended' (for example, see Mandel 1981), and its value was argued to depend on perceptual clarity: if one finger is selected, both its selection and its shape (extended, curved, clawed, etc.) will be easiest to perceive if all the other fingers are invisible.[37] For articulation, however, it will be easiest to minimize the amount of flexion for each finger, the easiest form being one in which the fingers are in rest position. The actual rest position of the fingers will depend on the state of the wrist, among other things, but I will assume for now that it in rest position all finger joints are bent at about 30 degrees. Full closure of the fingers (such that they are folded into the palm) would mean approximately 90 degree flexion at all joints of the middle, ring, and pinkie fingers. Some of these possible articulations are included in the scheme in (2.2). The following conventions of the Functional Phonology model are adopted here and in Chapter 5: perceptual specifications are given between vertical lines, articulatory outputs are given between square brackets, and perceptual outputs are given between slanted lines. (In Chapters 3 and 4, conventional square brackets are used for the phonological perceptual features.)

(2.2) Different articulations of one realization of SAY

| extended index |
↓
PRODUCTION GRAMMAR
↓

[index extended, other joints flexed 90 deg]	[index extended, other joints extended]	[index extended, other joints relaxed]

[optical output]
↓
PERCEPTION GRAMMAR
↓

/ extended index /	/ four fingers extended /	/ extended index /

There are three possible articulations of the fingers in this case, two of which are categorized as a perceptual output that matches the perceptual specification. One of these two (the leftmost) matches the exact form in Figure 2.6. The three different

[37] In signs with a so-called 'aperture' specification, the selected finger(s) are always flexed to a certain extent, in combination with an opposed thumb. In these cases, the non-selected fingers (typically the middle, ring and pinkie fingers) are often extended, but not always. For ASL, Mandel 1981 argues for a phonological distinction between extended (as in FIND_{ASL}) and non-extended (as in BIRD_{ASL}) non-selected fingers in such 'aperture' signs. Van der Kooij (1998) argues that in SLN there is no such phonological distinction.

forms are illustrated in Figure 2.7, as seen from the perspective of an addressee facing the signer.

i. extended index   ii. all four fingers extended   iii. index extended, proximal phalanges of other fingers visible

Figure 2.7

Three articulations of | extended index |

The choice between these different possibilities is carried out by two sets of optimality-theoretic constraints: one set of constraints evaluates the articulatory effort involved in the articulatory outputs, while a set of faithfulness constraints evaluates the extent to which the perceptual output matches the perceptual specification. As in other OT analyses, the respective ranking of the constraints (in columns) in the two sets determines the winning output; the constraints are ranked from highest (left) to lowest (right). Constraint violations are indicated by asterisks, while shaded cells indicate that a constraint is not active in deciding the status of the candidate listed in that row. 'Fatal' constraint violations are marked with an exclamation mark, and a pointing finger in the leftmost column indicates the winning candidate.[38] In order to have the winning output match the form in Figure 2.6, a constraint ranking is proposed in (2.4); the constraints in the tableau are defined in (2.3). In this and further tableaux, each row lists one specific pair of articulatory output and a matching perceptual output, because they are complementary aspects of phonetic form which the constraint set evaluates.

[38] For readers who are not familiar with Optimality Theory, introductions include Prince & Smolensky (1993), Archangeli (1997), and Kager (1999).

(2.3) Constraint definitions

FAITH(selected fingers): the value in the perceptual output for selected fingers should be identical to that in the perceptual specification
FAITH(unselected fingers): the value in the perceptual output for unselected fingers should be identical to that in the perceptual specification
*ART(unselected fingers: closed): do not make a gesture that leads to closed unselected fingers
*ART(unselected fingers: extended): do not make a gesture that leads to fully extended unselected fingers

(2.4) Tentative constraint ranking for the dictionary articulation of SAY

| extended index finger, unselected fingers fully closed |	FAITH (selected fingers)	FAITH (unselected fingers)	*ART (unselected fingers: closed)	*ART (unselected fingers: extended)
☞ [index ext., other finger joints fl. 90 deg.], /ext. index/ = Fig. 2.7i			*	
[index ext., other finger joints extended], /four fingers extended/ = Fig. 2.7ii	*!	*		*
[index extended, other joints relaxed], /ext. index/ = Fig. 2.7iii		*!		

In this set of ranked constraints, the faithfulness constraints comparing the realization of the unselected fingers outrank the articulatory constraints that aim to minimize the amount of movement. The winning candidate, then, is the top one, in which articulatory effort has been put into making a maximum distinction between the shape of the selected finger and that of the unselected fingers. Variation can be the result of a different constraint ranking. In careful articulations as in Figure 2.7, which is taken from an SLN dictionary, FAITH constraints will assume a relatively high rank, in order to minimize perceptual confusion. In less careful articulations, FAITH constraints will be ranked relatively low, leading to a winning candidate that minimizes articulatory effort while still leading to the correct perception of the selected finger (the index) and its shape (extended). This is illustrated in (2.5).

(2.5) Constraint ranking for a less careful articulation of SAY

| extended index finger |	FAITH (selected fingers)	*ART (unselected fingers: closed)	*ART (unselected fingers: extended)	FAITH (unselected fingers)
[index ext., other finger joints fl. 90 deg.], /ext. index/ = Fig. 2.7i		*!		
[index ext., other finger joints extended], /four fingers extended/ = Fig. 2.7ii	*!		*	*
☞ [index extended, other finger joints relaxed], /ext. index/ = Fig. 2.7iii				*

The tentative nature of the above example will be clear. In order to carry out serious analyses in this model that compare different phonetic variants of the same phonological form, we need a great deal of knowledge that is currently missing, including the following.

(2.6) Requirements for a functional phonology analysis

- a set of perceptual features that can serve as perceptual specifications
- a description of the production grammar: which sets of joint configurations are used to articulate a given perceptual specification?
- a description of the perception grammar: how are all perceivable events in the signal categorized as a perceptual output?
- a set of articulatory constraints: which level of articulation do they refer to, and how fine-grained are they?
- a set of faithfulness constraints that evaluate the match between perceptual specification and perceptual output

This is obviously a tremendous task. In this thesis, my main aim is to establish what the set of perceptual features is (Chapter 3), and what different phonetic manifestations of these features may be, both in perceptual and articulatory terms (Chapter 4). A set of features and feature values will be proposed in the next chapter. This set corresponds to a part of what is traditionally conceived of as a phonological model: it is a list of features, but does not include their hierarchical organization as in feature geometries (see Clements 1985, McCarthy 1988, van der Hulst 2000). Some data from articulatory variation will be presented as early as in Chapter 3, in order to motivate some of the choices for features. In Chapter 4 I will describe several studies that were performed to obtain an overview of different articulatory realizations of different types of movement, viz. changes in handshape, orientation, and location. In Chapter 5 I will show how these variable articulations can be accounted for using the phonetic implementation model outlined above. The goal will not be to provide a very detailed formalization of all the variation found, as this would involve too many arbitrary choices in establishing the different components of the model. Rather, the goal is to illustrate the nature of the variation: in line with the model proposed by Boersma (1998), I claim that phonetic variation of lexical items consists of articulatory variants of a single perceptual specification.

3 A set of perceptual features for SLN

3.1 Introduction

This chapter proposes a set of phonological features for SLN. This set has partly been developed in work together with Harry van der Hulst and Els van der Kooij; I will loosely refer to this collaboration as the 'Leiden model' of sign language phonology.[39] The changes and additions to the model presented in this chapter concern the representation of the articulator node and the nature of the orientation specification. The focus in the discussion will be on incorporating into the model what is known about phonetic variation, and adapting the set of features in such a way that it is in line with the general model of phonology and phonetic implementation presented in Chapter 2.

At this point, I will not systematically discuss the entire range of phonological models that have been proposed in the literature, most of them based on ASL data. Overviews of and comparisons between different phonological models can be found in Corina & Sandler (1993) and Brentari (1995, 1998). For more elaborate discussion of the Leiden model as a whole and of how the model relates to other proposals, see van der Hulst (2000) and van der Kooij (in prep.). The reason for leaving out such a discussion here is not that the other models have been construed on the basis of ASL data, and that comparisons would therefore be impossible. The overall impression of comparing different sign languages so far is that there is relatively little cross-linguistic variation in comparison to spoken languages. At the very least, therefore, ASL-based models are a good starting point for looking at any sign language's phonology (e.g. Sandler 1989, Perlmutter 1992, Brentari 1998).

However, the aim of this thesis is not only to determine the set of features of SLN phonology, but also to make accurate claims about phonetic variation. The Functional Phonology model that was outlined in Chapter 2 closely integrates phonetic and phonological levels, and thus has quite different assumptions and goals than many other phonological models. This thesis does not aim to make proposals about the organization of the features into a hierarchical structure, as the typical feature geometry models do, but rather it aims to be explicit about the way features are defined. These definitions should enable us to correctly predict the surface form of a given sign or feature value in different contexts. A comparison of the relative merits of the different models as evaluated by phonological criteria does therefore not touch on the goals of this chapter; I refer to the elaborate discussion in van der Kooij (in prep.) on different phonological models.

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[39] References include van der Hulst 1993, 1995ab, 1996ab, 2000, van der Kooij 1994, 1996, 1997, 1998, Crasborn & van der Kooij 1997, to appear, Crasborn 1995, 1996, 1997.

This chapter is structured as follows. First, in §3.2, some assumptions about the goals of phonology are discussed, as well as the way exceptions to phonological generalizations can be represented. Further, the methodology used in gathering the data used in this chapter is presented. In §3.3, an overview of previous phonological descriptions of SLN is given. In 3.4, I present a set of features that can account for the form of signs in the SLN lexicon. The focus will be on the representation of orientation (§3.4.3) and handshape (§3.4.4). At the end of the chapter, in §3.5, a number of predictions the present model makes about phonetic variation are outlined.

In this chapter the phonology of SLN is described primarily in traditional terms, and not in terms of the Functional Phonology model I introduced in Chapter 2. There are several reasons for this. Firstly, in this way some background will be provided for readers who are not yet familiar with sign language phonology. Secondly, it will make clear what exactly the variation data presented in Chapter 4 have to contribute to our understanding of phonological structure. Thirdly and most importantly, Functional Phonology is extremely complex and a lot of knowledge from fields other than linguistics is required to define the relevant representations and constraints. This can only be accomplished in part in this thesis. An important goal of the chapter will be to make a distinction between articulatory and perceptual definitions or descriptions, in order to replace existing articulatory features with perceptual features.

3.2 Preliminaries

3.2.1 Goals of a full phonological model

I subscribe to the standard goals of a phonological model, which in my conception are two-fold. First, a phonological model should be able to characterize phonological patterns in the lexicon. These patterns include the contrastivity or distinctivity of certain phonetic features of words, relative markedness of the different features, and phonological aspects of the distinction between native and loan vocabulary (including iconicity). Second, a phonological model should describe the knowledge of language users regarding the form of language. This knowledge includes the lexical patterns mentioned above, but it also includes information on other aspects of language production and perception. It is open for discussion what this knowledge is, and whether or not it should instead be called ‘phonetic knowledge’ (e.g. Kingston & Diehl 1994). For example, does phonological knowledge include information about the range of phonetic forms that are associated with a lexical phonological specification (phonetic variation)? The Functional Phonology model implies that it does, by integrating phonology with the range of processes involved in perception and production, describing both traditional ‘phonetic’ and traditional ‘phonological’ phenomena with the same machinery.

Even if one does not consider it to be a goal of a phonological model itself to predict the types of phonetic variation that occur, a model should still be compatible with a model of phonetic implementation that does generate the variation (cf. van der Hulst 2000). This compatibility has two sides: firstly, the nature of the phonological representation should not prohibit certain variation by including details of the forms that are found to vary, and secondly, the combinations of features should contain sufficient information to lead to fully specified surface forms. For example, in the sign SAY, illustrated in Figure 3.1, the location of the finger tip at the start of the sign is on the chin. If the phonological specification would only include the location [face], the phonetic implementation component would not have enough information to determine the initial location of the finger, leading to surface forms where the finger tip is near the eyebrows, for example. If, on the other hand, the specification would read [initial contact with the chin], we would not predict the surface forms that do not include initial contact (but where the finger tip is only near the chin).[40]

Figure 3.1

SAY

As the goal of this thesis is to describe and account for patterns of variation, the emphasis in this chapter is on outlining the set of features that is needed to describe surface forms. Traditional phonological criteria such as distinctivity, representational simplicity, and avoidance of redundancy will be used in creating this set, but I will not attempt to construct a feature geometry organization of the features.

In this thesis, I also do not aim to reformulate the phonotactic generalizations as they have been proposed in the literature in terms of the Functional Phonology model. This is left open for future research, and I refer to Boersma (1998) for a discussion of how the model can account for phonotactic patterns in spoken languages.

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[40] In the present and the following chapters, I will refer to phonological features in straight brackets, even though they are part of the perceptual specification which is given between straight lines in the Functional Phonology model, cf. Chapter 2.

3.2.2 Exceptional features and feature values

The features that I propose include many ‘exceptional’ values, which only occur in a few signs. These values often have a clear etymological background, being remnants of iconic motivation or fingerspelling. In this section I motivate why they are assigned the same status as all other features, that is, why they are included in the set of phonological feature values.

One of the core distinctions that a phonological model should express is that between signs that occur or might occur and signs that could not occur: only signs that are well-formed should be representable, whether they exist or not. In other words, the model should not overgenerate. Within the set of signs that we find, however, there are more and less frequent forms. Some features occur frequently and in combination with many different other features, while others are limited to one or a few signs. Many of the features or feature combinations that do not occur frequently in sign language can be argued to be *iconic* in nature (van der Kooij in prep.). In this section, I first discuss exceptions due to the different ways in which spoken language is represented in sign language, and second I discuss iconic exceptions.[41]

Users of SLN have two main means of representing words from spoken Dutch. Firstly, they can articulate a spoken word as hearing Dutch speakers do (typically without sound); this is perceived by lip reading, and can often serve to disambiguate SLN signs. Schermer (1990) shows that many of these ‘mouthings’ have become part of the lexicon, being the distinguishing phonological element between two variants of a sign such as SIBLING (meaning ‘brother’ when accompanied by [bRU:R], and ‘sister’ when accompanied by the mouthing [ZYS]). All of these mouthings occur only once in the lexicon, and each is therefore ‘exceptional’. A second way to represent (written) Dutch is by means of the hand alphabet, with which Dutch words can be fingerspelled. Some of the 24 handshapes that are used to spell the 26 letters of the Dutch alphabet are regular SLN handshapes found in many lexical items as well. Some of the handshapes, however, occur only in the lexicon in so-called ‘initialized’ signs. In such signs, a letter from a Dutch gloss of the sign is represented by the handshape of the sign. For example, the F handshape only occurs in signs such as FAMILY and POOR-JOKE, in which the first letter of a Dutch translation (respectively ***f****amilie* and ***f****lauw*) is represented. Such handshapes are exceptional, then. In most if not all cases, the regular set of features that is needed to describe other handshapes has to be expanded by ‘exceptional’ values to describe those fingerspelling handshapes.

A second main group of exceptions is related to the frequent iconic nature of signs, which has received much attention in the sign language literature (Frishberg

[41] A third small group of exceptions is found in the counting system of SLN and lexical items incorporating counting handshapes. In particular, the selected fingers value [3] is needed to specify the form of the numbers THREE and EIGHT (and many derivatives thereof, such as EIGHTEEN, THIRTY, etc.). In the Groningen dialect of SLN, which is not further studied here, other exceptional handshapes occur in the counting system, featuring contact between the tip of the thumb and the tip of the pinkie, ring, and middle finger.

1975, Mandel 1976, 1977, DeMatteo 1977, Armstrong 1983, Taub 1997). In many signs, there seems to be a non-arbitrary relation between some part of the referent or concepts that are associated with the referent, and a part of the form of the signs; this has been referred to as ‘motivation’ or ‘iconicity’. The topic has received so much attention because iconicity in sign languages is so pervasive in comparison with spoken languages.

Several linguists have recognized the presence of iconicity, but at the same time they argued that since it does not seem to play a (facilitative) role in sign language acquisition or processing, it is not a relevant topic for linguistic research other than in etymological studies (Klima & Bellugi 1979, Poizner, Bellugi & Tweeney 1981). Iconicity, they argued, was a relic of the process of creating new lexical items, rather than an integral and accessible part of the lexical knowledge that signers possess (cf. Frishberg 1975 and Radutzky 1989, who established the decrease of iconic information in signs over time).

More recently, it has been argued that in studying word formation processes and the phonological structure of signs, iconicity needs to be an integral part of the investigation (e.g. Brennan 1990). It is misleading to speak of ‘iconic signs’, however. Signs typically are not iconic as a whole; rather a part of the sign resembles a part of the referent. It is never the case that all aspects of the referent are encoded, so to speak, in the linguistic form; our conceptual knowledge is much too rich for that. Some motivated form-meaning pairings of formal elements are not unique to a single lexical item but occur over and over again in the lexicon (e.g. Taub 1997, for ASL). An example is the temple as the location associated to signs expressing mental states or activities in both SLN and ASL. In this case the formal element [location: temple] could be seen as a bound morpheme meaning ‘related to mental activity’. Brennan (1990) argues that word formation processes in British Sign Language (BSL) show that much of the iconic information present in frozen lexical items *is* accessible to signers. Mandel (1977) and Taub (1997) discuss the precise way in which the selection of iconically represented information takes place.

As an example of an iconic sign, consider the sign BICYCLE, illustrated in Figure 3.2. In this sign the alternating movements of the hands resemble the alternating movement of the pedals or the feet. Many aspects of the concept ‘bicycle’ are not visible in the sign, such as the fact that they typically have two wheels, a saddle, and handlebars. Conversely, some aspects of the form of the sign do not mimic any aspect of the concept of bike: the size of the movement is not as large as the movement of the pedals, and the location in front of the upper body is not the location of the pedals in real life.

Figure 3.2

BICYCLE

One could consider such iconic signs to be ‘loan signs’, resembling loans from other languages: they are loaned from (our conception of) the visible world, just as words may be loaned from another language. In discussing phonology it is more appropriate to talk about exceptional *features* rather than treating the whole sign as exceptional. The iconic features in the sign BICYCLE are the movement features [alternating] and [circular] (mimicking the movement of the pedals or feet), and possibly the features representing the shape and orientation of the hand. None of these features are exceptional, though. By contrast, in a sign like KIDNEY, the location feature [side of the lower trunk] (which is close to the actual location of the kidney) is exceptional, while its other features, representing the contacting movement with an straight index finger, are not exceptional. In this way, these ‘iconic loans’ resemble loans from, say, spoken French in spoken Dutch. Most phonemes in Dutch lexical items borrowed from French are a regular part of the Dutch phoneme inventory, and do not lead to exceptions. Some phonemes though, such as the postalveolar fricative that appears in words like *gêne*, *beige* and *genre*, are exceptional phonemes in Dutch.

Many aspects of ‘iconic’ signs thus resemble regular phonological patterns and can most likely be represented by a model that aims to represent only the most frequent signs. Sometimes, however, some property is not representable by the standard set of features, and has to be considered an exception. The question then is how such exceptions should be accounted for, and whether a phonological model should be able to represent them or not.

Since iconicity is such a pervasive phenomenon, it is not surprising that some exceptions that seem to be iconic in nature occur in more than one sign. However, I would like to suggest that it is even the case that some features which are considered to be standard phonological features and which occur regularly can be argued to be iconically motivated in all signs in which they occur. This appears to be the case with the feature [alternating], which describes the out-of-phase movement of the two hands in otherwise symmetrical signs. This feature surfaces in most phonological models and to my knowledge it is needed for every sign language described to date.[42]

The evidence for the claim that a feature such as [alternating] is indeed iconic in all signs is a rather delicate matter. The claim rests on the assumption that iconicity not only applies to the actual etymological origin of the sign, but also to the possibility for sign language users of pervasively seeing iconic aspects of the sign without knowing its actual etymology. This comes close to folk etymology, although this term is used mostly for spoken languages, where in my experience this phenomenon occurs much less frequently. Many hearing adults learning sign language report the eagerness of Deaf people to explain why a sign looks the way it does, whereas this is not a common phenomenon for adults learning a spoken language. I would argue that this fact may justify claims about iconicity by (hearing) researchers who do not have etymological evidence for the iconic status of signs: the presence of iconicity is not only a construction of the linguist studying the language, but is also experienced by the users of the language themselves. Etymological data are hard to find since in general historical data for sign languages are very scarce, because of the paucity of documentation of the early stages of most sign languages.[43]

Iconicity in sign language phonology is sometimes used to explain exceptional patterns (e.g. van der Kooij in prep.). The prediction that is explicit or implicit in resorting to iconicity in this manner is that the exceptional aspects of a sign's form will gradually wear out, so that the sign conforms more and more to the phonological patterns of the whole lexicon.[44] It may turn out that this process is relatively slow in sign language compared to changes in loanwords in spoken languages, because of the relatively great awareness of sign language users of the iconic status of the exceptional features. This remains to be studied; see Frishberg 1975 for a discussion of iconicity and historical change in ASL. Users of spoken languages are sometimes aware of the foreign origin of many words as well; it is not a phenomenon that is limited to sign language. What is different in sign language is that users tend to interpret signs as iconic loan signs even if they are already phonologically fully regular. Thus, it is possible that after language change has affected exceptional forms so that they come to conform to the rest of the lexicon, users will still invent iconic origins for the sign, or may have access to the original iconic motivation for the form.

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[42] Miller (1997) derives alternating movements from other prosodic properties of signs; see also footnote 65 and the discussion on page 86 below.

[43] The present high speed expansion of the SLN lexicon, which is being stimulated by the development of new teaching programs and the planned recognition of SLN as a minority language, offers a wonderful opportunity for phonologists to study the use of iconicity in the creation of new words and in subsequent phonological change. The creation of sign language poetry and its appreciation among Deaf signers can also be a good source of data on the use of iconic aspects of signs by sign language users. To my knowledge, no study has specifically addressed the use of iconic aspects of signs in poetry.

[44] Although this general expectation may be valid, Brentari & Padden (2001) argue that some ASL signs that incorporate exceptional handshapes from the fingerspelling alphabet (thus being able to indirectly 'borrow' words from written English) are quite stable, and should be considered to form a separate, but stable, subpart of the ASL lexicon. It is possible that (a subset of) exceptional iconic forms behave alike.

The actual analysis of iconic exceptional features can still be debated. In the case of [alternating], one can distinguish several semantic concepts, which stem from a superficial inspection of the 153 alternating signs in the SignPhon corpus (5% out of a total of 3076): alternating movement of the human body (e.g. SIGN, BICYCLE, WASH-HANDS, TYPE), exchange or repeated movement of physical objects (e.g. RESTAURANT, GROCERIES, ROLL), or the exchange or repeated movement of concepts (e.g. MATCH, TELL).

The feature [alternating] is needed in the phonological model because there is no other phonological property on the basis of which it is possible to predict the alternating movement. Nor is it the case that the form of the sign can be predicted on the basis of the semantic specification of the sign (which is the common lay conception of iconicity and even of sign language in general): not all signs which *can* be directly or indirectly associated with a concept related to alternating movement (such as actual alternating movement and exchange of information or objects) actually do have alternating movement. For example, in SLN the sign CAR can be argued to be iconic, in that the alternating movement of the hands mimics the stereotypical alternating movements of the hands on the steering wheel while driving. However, the phonologically and semantically related sign DRIVE-A-CAR does not have this alternating movement. Many other signs which could be fruitfully associated with the alternating movement of the hands do not have alternating movement either. One example is INFORMATION, which could be linked with the exchange of different pieces of information, conceptualized as the hands which move to-and-fro with respect to the body in an alternating pattern.

In SLN, then, there are some iconic phonetic features of signs that occur in only one sign, whereas others occur widely throughout the lexicon. I submit that this enforces the conclusion that the constant iconic 'load' of a feature itself is not an argument to deny the feature a phonological status in the lexicon, contrary to the claim made in van der Kooij (in prep.) and van der Hulst (2000). However, in the case of an exceptional phonetic form that cannot be accurately distinguished from other signs on the basis of any combination of phonological features, the iconic nature of the exception can be used to explain how the exception came to exist. This is an etymological issue and not a phonological one.

Other evidence is needed, then, to determine whether a feature is really exceptional or not. In many cases I do not have firm evidence from (either type or token) frequency indicating that a form really is exceptional, because the SignPhon corpus only contains a little over 3,000 signs. In most cases, the exceptional status of the sign only concerns part of the sign, for example an uncommon place of articulation. From the point of view of a traditional phonological model, it is not desirable to adopt a feature to account for every exception. Rather, van der Hulst (2000) and van der Kooij (in prep.) suggest that it is preferable to assume that these exceptional feature values are stored in the lexicon as phonetic surface representations. Van der Hulst refers to this option as "lexically specified phonetic implementation" (2000: 37), as the phonetic shape of such feature values is already present in the lexicon, while other phonological features are not assigned a concrete phonetic form until the phonetic implementation stage of the derivation. It would seem, then, that such exceptional signs are partly made up of an abstract phonological specification, and partly of concrete phonetic information.

Van der Hulst remarks that he has “opened the door to simply phonetically pre-specify[ing] *all* signs in the lexicon, leaving their phonological representation uncompositional, and thus effectively absent. In some sense, perhaps, the phonology of sign truly balances on the edge between a compositional and a non-compositional phonology” (2000: 38; emphasis in original). The lexical specification in the present proposal does not have internal structure, such as feature geometries proposed. However, this is not to say that this specification is non-compositional. Each sign is still composed of a value for each perceptual (phonological) feature, in agreement with Stokoe’s (1960) initial claim that the form of signs is not a holistic entity but composed of multiple subparts.

From the point of view of a production model such as the speaker side of the Functional Phonology model, the many exceptions in sign language lead to a much less dramatic conclusion than the one van der Hulst suggests: there is not much of a difference between sign languages and spoken languages in this respect. This may be true for most Optimality Theory models available today. Every sign has to have a representation (the input in OT), and the distinction between ‘normal’ and ‘exceptional’ features is not a binary one. I assume that all relevant aspects of the sign are stored in the perceptual specification, including the exceptional ones, and that we need no distinction between regular and exceptional features for the production model. The task of the phonological model below is to express which perceptual features should be considered to be relevant aspects of signs. Knowledge on the part of the user about common vs. uncommon forms is not expressed directly in the representation of the sign, but has to be characterized in another way. Markedness constraints in OT are obvious candidates, but using these seems to imply that there is a constraint against every exceptional feature (cf. Boersma in press). Future research will have to determine to what extent this is problematic.

Regardless of how exactly knowledge of frequency of occurrence of phonological forms is modeled, an important aspect of not using standard phonological features for such modeling is that more subtle intuitions about frequency and prototypicality can be modeled than just a binary distinction between ‘regular’ and ‘exceptional’ (or ‘loan sign’). It has been argued for spoken language that users have fine-grained intuitions about frequency of phonological features (Frisch 1996, Frisch, Broe & Pierrehumbert 1997), and there is no reason to expect signers to behave differently.

In the phonological model I present in §3.4, I will indicate which features seem to occur only in exceptional cases. In most cases an iconic motivation for the exceptional status can be proposed. A far more thorough examination of the relation between phonological exceptions and iconicity in SLN can be found in van der Kooij (in prep.).

3.2.3 Methodology

The analysis of SLN phonology proposed in this chapter is based on phonetic descriptions of signs, i.e. the analysis of surface forms of signs. Most of these surface descriptions were stored in the SignPhon database that was designed for this purpose (Crasborn, van der Hulst & van der Kooij 1998, to appear, Crasborn 1998). The structure of the database is described in Appendix B. The contents of the database were analyzed in terms of frequency of phenomena, cooccurence relations between different features, and variation in surface forms between informants and sentence contexts. Typically, the initial analysis is informed by analyses of other sign languages, in practice mostly American Sign Language (ASL).

The data come from several sources. Firstly, existing data sources were used. These comprised the outcomes of several dictionary projects in the Netherlands (NSDSK 1988, KOMVA 1989, 1993, GLOS 1999, GIDS 2001) and lists of transcribed signs from courses at the University of Amsterdam.

Secondly, informant judgments on variation were elicited, and informants contributed signs that were not yet found in any of the existing sources.

Thirdly, to get an impression of the forms that occur in the core lexicon of the most frequent lexical items, we recorded a set of over 3,000 signs. Since there are no frequency lists of SLN and collecting such data is a huge task, we were forced to estimate this frequency indirectly. From the CELEX corpus, the 20,000 most frequent Dutch words were selected, sorted by frequency (Baayen, Piepenbrock & Gulikers 1995). This corpus is based on written Dutch texts. The list was inspected and several items were removed according to the following criteria (among others; see Appendix B), in order to end up with a list of 5,000 Dutch words which could be used to elicit SLN signs.

(3.1) Items removed from the CELEX list

- articles and prepositions
- inflected words (only singular forms were kept of nouns and only infinitives of verbs)
- proper names (since name signs are often phonologically irregular being derived from fingerspelling)

The remaining word list was offered to a signer, word by word, on paper. The task for the signer was to translate the word into a SLN sign, and to make up a sentence containing the sign. In that way, the elicited forms were also available in a random sentence context; for verbs, this often resulted in inflected forms. Furthermore, the whole set of sentences ensured that for most signs multiple forms were available. Recording sentences also made the situation in which the signing was produced less artificial.

Rough translations of the sentences were made of each recording session, mostly by a native Deaf signer other than the informant. These translations consisted of a compromise between a gloss transcription and a fluent translation. When I refer to ‘the SignPhon corpus’ below, I mean the whole set of video recordings and not merely the citation forms that were transcribed. The citation forms were transcribed in SignPhon by a hearing research assistant according to the conventions laid out in the SignPhon manual (Crasborn et al. 1998).

Each recording session consisted of between 50 and 100 cue words. Four different informants were involved in different sessions over three years, but each stimulus was only translated by one informant. To ensure the homogeneity of the SLN dialect all informants came from the west of the Netherlands. As mentioned in Chapter 1, an important finding of the KOMVA lexicon project was that in terms of the lexicon SLN has two clearly distinct dialects (e.g. Schermer 1990): one in the north (where there is one Deaf school), and one in the west (where there are three Deaf schools). The southern region (one Deaf school) very closely resembled the western dialect. The age of the informants at the time of the recordings was between 18 and 35; all of them were female, and all acquired SLN in early childhood.

3.3 The history of phonological descriptions of SLN

3.3.1 Tervoort

A few years before the work of William Stokoe in the USA (Stokoe 1960), Tervoort (1953) described in quite some detail the communication system of deaf children at the school for the Deaf in St. Michielsgestel in the Netherlands.[45] He clearly distinguished a phonological level of analysis from morphological and syntactic analyses, but paid most attention to the latter two (p. 203). For that reason, he did not propose an inventory of phonological features, although it is clear throughout the discussion that he had perceived that distinctions in place of articulation, the shape of the hand, movement of the hand, and orientation all play a role in describing the form of signs. This surfaces most clearly in his discussion of variation of the forms of signs within and between the five informants he studied (see Tervoort 1953: 137-144, and the full description of all signs in part 2 of that book). In describing different variants, he refers to whether the sign is made with one or two hands, what the manual movement was like (direction, shape, finger vs. hand movement), in what direction the fingers were pointing, whether there was body or head movement or not, etc. Thus, although in his descriptions of various phenomena he employs a wide range of distinctions that have later been claimed to be phonological distinctions, Tervoort did not aim to make an inventory of the possible different formal aspects that can be combined to constitute a sign.

[45] There is at least one other Dutch source in which the signing of Deaf people is referred to as a natural language, on a par with spoken languages. Révész (1941) distinguishes sign languages that arise naturally in communities of deaf people from gestures used by hearing people, on the one hand, and from sign languages used in specific circumstances by hearing people on the other hand. The latter group includes the signing of Cistercian monks and several North American Indian and Australian aboriginal communities. However, unlike Tervoort, Revesz does not describe the sign language used by deaf people in any detail.

Tervoort refers to the phonological level as ‘mimology’ (“mimologie”, p. 203), while Stokoe (1960) later coined the term ‘cherology’. Neither term has been used very widely in the literature since. Most researchers use the terms ‘phonology’ and ‘phonetics’ for the sign language equivalents of those research areas for spoken language.

Although phonology was not the focus of Tervoort’s study, we can find sophisticated discussion of several controversial issues that have occupied sign linguists in the late 80s and 90s: the distinction between conventional and ‘natural’ (iconic) signs, and the relation between mouthing, facial expression and manual signs. Even though Tervoort was one of the first to establish the status and structure of sign language in its own right, beyond its use as a tool in teaching children to speak and read spoken languages, he was remarkably open-minded in considering all the different parts of the communicative behavior of the deaf children he worked with, including the non-manual aspects of signing.

3.3.2 KOMVA

The first phonological descriptions of SLN since Tervoort (1953) were made in the context of a dictionary project, the so-called KOMVA project, which was started in the early 1980s (Stroombergen & Schermer 1985, KOMVA 1988, 1989, 1993, NSDSK 1988, Schermer 1990). More than 15,000 signs were recorded in total, from five different geographical areas in the Netherlands. Each area was marked by the presence of a school for the Deaf, and a relatively high percentage of Deaf people in the areas around those schools. In order to describe these signs for the dictionaries, a notation system was constructed (NSDSK 1988). This system was “phonetically based” (Schermer 1990: 28), in the sense that it did not involve a thorough phonological analysis of the language. However, it explicitly builds on phonological analyses of American Sign Language (Stokoe 1960, Friedman 1976, Battison 1978, Klima & Bellugi 1979, Mandel 1981), and in constructing the notation system, observations about minimal pairs in SLN are used as well. Distinctions that are adopted from ASL research include those between selected and non-selected fingers (Boyes Braem 1981, Mandel 1981) and presence vs. absence of an aperture relation between the thumb and the fingers. An overview of the notation system is presented in Appendix C.

In the context of the KOMVA data collection, several papers were published analyzing the handshape parameter (Harder 1989, Harder & Schermer 1986, Schermer, Harder & Bos 1987, Schermer 1990). Frequency distributions for the different handshapes are presented in these works, but only for the most frequent handshapes. It turns out that the seven most frequent handshapes occur in the strong hand in 65% of all signs. Distributions of handshapes were then compared for the strong hand vs. the weak hand and for the different regions.[46] It was found that in

[46] In two-handed signs in which only one hand moves, the strong hand is the moving hand and the weak hand is the non-moving hand. The strong hand typically is also the preference hand for other tasks, and also the hand that is typically used for one-handed signs. However, the hands may shift roles for

the Eindhoven region only 46% of all signs feature one of these seven most frequent handshapes; the reason for this lower percentage is that in this region many signs are initialized. In initialized signs, the handshape marks the first letter of the Dutch word most commonly associated with the sign, by means of the hand alphabet (Janssen 1986). Although six of the seven most frequent handshapes are also used in the Dutch hand alphabet, the use of the remaining eighteen fingerspelling handshapes in signs in the Eindhoven area is responsible for the different frequency distribution in that area.

The most frequent handshapes for SLN were also compared with those of other sign languages, such as ASL and British Sign Language. Apart from these frequency distributions, attention was paid to variation in handshapes within and between different regions.

Although the notation system and related analyses make use of clear subdivisions between categories, which is made possible by the adoption of a closed set of notation symbols, the descriptions do not yield much insight into the phonological structure of SLN other than the classification itself. The researchers remark that it is not clear whether all of the handshapes distinguished by the notation system are actually used distinctively in the language. Several handshapes are found to function as variants of each other (Schermer, Harder & Bos 1987, Harder 1989, Schermer 1990). The most commonly varying feature distinguishing these handshapes is the position of the thumb. Thus, the B, B0, and B1 handshapes (illustrated in Figure 3.3 below and in Appendix C), which differ only in thumb position, are in some cases used for the same sign in different realizations, and in some cases the variants are used depending on the other phonological or phonetic characteristics of the sign. The same holds for the A, AS, and money handshapes, which also differ only in thumb position (see below). Other features distinguishing related handshapes are spreading of the extended fingers (5 vs. B/B0), and the state of the middle, index and pinkie fingers in some handshapes (T0 vs. baby-O, T vs. baby-closed-beak). These variation data led the Dutch researchers to adopt further features to describe the handshapes, following Boyes Braem (1981).

One factor is presented that accounts for variation in thumb position between different signs: contact of a specific side of the hand with the body or the other hand (Schermer 1990, Schermer et al. 1991).[47] Although this is not put very explicitly, the claim seems to be that when the thumb would block contact with the body or the weak hand, it is folded over the fingers or into the palm (S, B), whereas otherwise it is not (AS, B1, B0). ‘Block’ should be interpreted as a position in between the rest of the hand and the contact surface. It is not clear if the above generalization accounts for all signs with one of the handshapes that are claimed to vary, and whether all those signs are invariant between the different regions. Given the emphasis on inter-region variation, it is implied that the thumb position differences

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grammatical or discourse purposes, and moreover, the choice of the strong hand (left or right) is not lexically distinctive.

[47] These claims seem to be adopted from analyses of ASL (e.g. Wilbur 1979), although the authors do not refer to any work on ASL in this discussion.

still differ between regions for some signs. Schermer (1990) mentions that there is also idiosyncratic variation in this respect: one signer from the Amsterdam region often used the B0 handshape where the other signers from this region used the B1 handshape, significantly skewing the frequency distribution. More importantly, the generalization still leaves the contrast between the two posited handshapes B0 and B1 unexplained.

It is implicit in the KOMVA publications that the related handshapes are in free variation within the regions: apart from the factor ‘contact’, there is no hint as to further factors determining the variation among the different forms. It is explicitly claimed, however, that the related handshapes that are mentioned above cannot freely vary in *all* signs that feature them: it has to be determined for each sign whether they can or not. The signs with varying handshapes are all claimed to be iconic, and this is advanced as the explanation for why the variation is possible (Harder 1989). No further discussion of this proposed explanation is presented.

Given this variation in handshapes, it is not clear how accurate the frequency distributions are: most of the handshapes that are included in the set of seven most frequently occurring ones are involved in one or more alternation pairs with each other: B0, B, 5, money, and S (but not T and 1). If all the variation data were taken into account, would the set of most frequent handshapes be different or not, and would the order within the set be different or not? These questions have not been answered in the literature that resulted from the KOMVA project.

A more fundamental problem also exists. It may be referred to as ‘the database paradox’ which is inevitably connected to phonetic transcription systems. To find out which distinctions in handshape are relevant, one has to be able to transcribe them in some way: it is impossible in practice to record and describe all the minute differences that occur between handshapes in different signs, in the same sign uttered by different signers, or by one signer on different occasions. But in order to make a transcription system, one already has to know which distinctions are *potentially* relevant and which are not. Thus, a phonological analysis ideally precedes the creation of a notation system, and not vice versa.

Although the KOMVA transcription system was built on the experience of researchers describing ASL, little analysis of phonological and phonetic variation had been carried out for this language, with the effect that researchers in the early 80s were essentially still using the categories proposed by Stokoe (1960), and adding subdivisions within those categories. Many of the distinctions made in the KOMVA transcription system are not explicitly motivated. This holds to a stronger extent for the many distinctions that are *not* made; that is, why are subtle differences such as in thumb position as they can be observed in surface forms not assigned a separate category and symbol? The choices now appear to be arbitrary in many cases. For example, consider the difference in thumb position mentioned above. Four handshapes are distinguished in the KOMVA system that all have the four fingers fully extended and adducted (non-spread); these are illustrated in Figure 3.3.

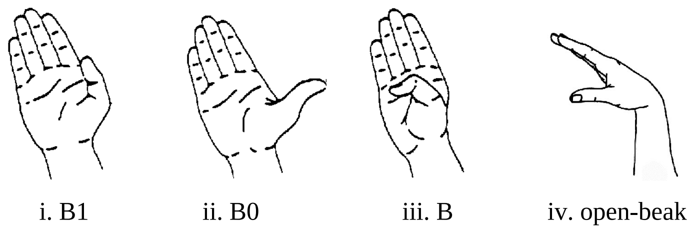


Figure 3.3

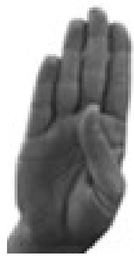
Four handshapes distinguished by the KOMVA notation system, varying in thumb position only

In fact, the last handshape is not included in the same group as the first three, even though thumb position is the only differing phonetic aspect. The open-beak handshape is included in the group of handshapes in which the thumb is opposed to the fingers. The interesting question now becomes, why are only these four thumb positions distinguished? Why not also distinguish one or two or sixteen others that are physiologically equally possible and also occur in the surface forms of signs? Take for example the following, all found in the SignPhon video corpus.

i. thumb 45deg abducted. (between 4a and 4b)

ii. thumb IP joint flexed, thumb tip against proximal phalanx of index

iii. thumb a little opposed (between B0 4b and open-beak 4d)



iv. thumb hyperflexed, IP joint extended (not flexed as in 4c)

Figure 3.4

Four ‘allophonic’ handshapes not distinguished by the KOMVA notation system

The handshapes in Figure 3.3 each form a category, but these categories and their boundaries are not defined and the reason for choosing the handshapes in Figure 3.3 as prototypes of their category are not made explicit. Of course, once these categories are assumed, one will be able to categorize almost any thumb position found in real life, but that need not be interpreted as evidence for the correctness of the categories. I surmise that this unclear definition of why certain categories are included and others are not is part of the reason why no further claims could be made about the occurrence of the different variants, or in other words, why they seemed to be in free variation. Neglecting small variations in articulation makes it hard to determine the context that determines the occurrence of a given variant. The same holds for variation in location which *was* found and the variation that was *not* found (i.e. distinctions that were not made).

I propose that the handshapes in Figure 3.4 are equally plausible realizations of certain articulator specifications as the handshapes in Figure 3.3. The model outlined at the end of Chapter 2 aims to generate both allophonic variation and phonetic variation. However, the two do not occur at two sequential stages (respectively the phonological surface representation and the phonetic representation).

Aside from the research on the handshape parameter, most attention has been paid to the non-manual part of signs and especially 'mouthing' (or 'word pictures'), in the work of Schermer (1990). It is concluded there that mouthings can serve to distinguish minimal pairs, such as in the SLN signs BROTHER vs. SISTER, which only differ in the mouthing that accompanies the manual part. These mouthings have been the topic of recent debate in the literature (e.g. Ebbinghaus & Heßmann 1990, Boyes Braem & Sutton-Spence to appear), but will not be dealt with in this book.

3.3.3 The first phonological model

The first phonological model for SLN was proposed in a series of papers in the 1990s by van der Hulst (1993, 1995ab, 1996, 2000). The difference between the KOMVA work and the model that van der Hulst proposed is that, like other phonological models, the latter makes claims about the distinctivity of the various features as well as about the hierarchical organization of features. Building on the phonological descriptions of SLN of the KOMVA publications and on descriptions and analyses of ASL phonology, van der Hulst explicitly aims to create a bridge between the phonologies of spoken languages and sign languages. The claim is made that what sign and spoken languages have in common at the phonological level is the way their features are organized. The most important of these common properties in features and their organization are listed below; they are discussed in detail in van der Hulst (2000) and Dresher & van der Hulst (1998).

(3.2) Properties of feature organization

- feature trees are binary branching
- branching structures show a head-dependent asymmetry
- changes can be analyzed as a sequence of (static) features: there are no dynamic features[48]

These common properties are used to parse the phonetic space, which is different for speech and sign. The different properties of the different phonetic modalities are therefore hypothesized to be responsible for any apparent differences in phonological structure, whereas phonology per se is truly 'a-modal'. The above characteristics are abstract properties of the proposed phonological structures, in the sense that they have no direct phonetic correlates. Rather, they concern the higher-level linguistic categorization of the phonetic categories that are relevant in the specific modality at hand. This contrasts with many other proposals in the literature, where it is suggested that parallels between sign and speech structure can be found at a somewhat more concrete level, e.g. syllables (Edmondson 1986, Wilbur 1990,

[48] I will discuss the representation of movement in §3.4.2, including the question whether features such as [alternating] and [circling] should be considered as dynamic or static features.

Miller 1997) or segments (Liddell & Johnson 1986, Sandler 1989, Perlmutter 1990).[49] Because of this focus of the model most attention has been devoted to the organization of the features and the character of the different feature *nodes*, rather than to the precise content of each set of features.

The reasoning behind this approach is that the level of the features is most directly influenced by properties of the specific phonetic channel, often referred to as 'modality'. The oral-aural modality (speech) is distinguished from the gestural-visual modality (signing). Higher organizational units are more plausibly aspects of 'language', independent of modality, and thus this approach is closely linked to the traditional generative paradigm as described in Anderson (1981). In Anderson's view, the linguist should focus on describing and analyzing properties of language that are not related to other domains of human life, such as social psychology, physiology, acoustics, etc.[50] By contrast, van der Hulst (2000) explicitly leaves open the possibility that the universal phonological properties listed above are general cognitive characteristics that can also be found outside language. In a similar vein, Kingston (1999) points out that similarities between sign language and spoken language can also be due to shared properties of motor control and perception: cross-modal universals need not necessarily point to the discovery of 'pure linguistic structures'.

Applying the above properties to sign language features, van der Hulst (2000) proposes the model that is presented in Figure 3.5. the nodes in italics indicate properties of the sign that can exhibit movement.

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[49] There seems to be a rather wide consensus on the analogy between the phonological domain of movement in sign language with the syllable as a phonological domain in spoken language (Sandler 1989, Liddell & Johnson 1989, Perlmutter 1990, Brentari 1990, Miller 1997). The various models differ in their further analysis of this analogy. Sandler (1989), Liddell & Johnson (1989) and Perlmutter (1990) further decompose the sign syllable into segments, and propose an analogy between consonants and location segments vs. vowels and movement segments. On the other hand, Brentari (1998) and Miller (1997) have suggested that multiple movements should be conceived of as multiple syllables, either simultaneously (primary and secondary movements; Brentari 1998) or sequentially (multiple repetitions of a movement gesture; Miller 1997).

[50] As discussed in Chapter 2, the role of phonetics in phonology has recently received a great deal of attention in the literature on Optimality Theory. Arguments for a stand similar to Anderson's can be found in Hale & Reiss (2000). For a more general discussion of formal vs. functional approaches to linguistics, see Newmeyer (1998).

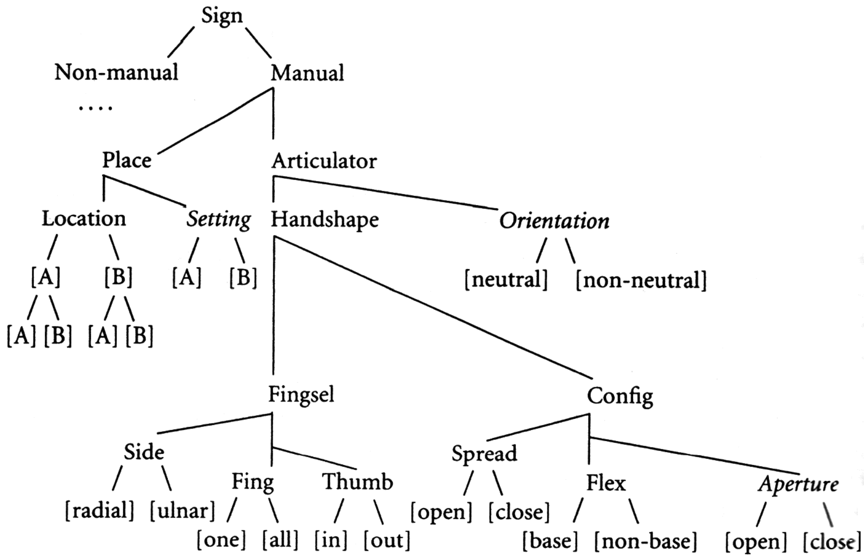

Figure 3.5

The model proposed in van der Hulst (2000)

Three of the main sign parameters are visible in three major groups of features: handshape, orientation, and location. One might compare these groups to the 'major class nodes' in spoken language feature geometries (Corina 1990, van der Hulst 1993). In the structure in Figure 3.5 non-manual features form an important node as well; they are the traditional 'fifth' parameter next to location, handshape, orientation, and movement. In some versions, manner of movement played a similar role as a major class node (van der Hulst 1993, 1996).

In various publications, different versions of the model were proposed (van der Hulst 1993, 1995b, 2000). They differ mainly in what is identified as the head of the whole structure. In the original proposal, the head of the sign was proposed to be the place node (van der Hulst 1993). The question of what the head of the whole structure is is a complex one, since there are different criteria for headedness that can be employed, such as being invariant over time, being perceptually salient, or representing broader phonetic distinctions than a sister node.

Thus, one could argue for the major place node being the head of the whole structure because it does not branch: location changes never go from one major place of articulation to another, but always move within major locations (from setting value 1 to setting value 2; cf. van der Hulst 1993). One could also argue that movement characteristics such as shape, repetition, and tenseness, which are subsumed under the manner node, are perceptually more salient than static aspects like place and handshape, and therefore constitute the head of the sign (van der Hulst 1996). However, this perceptual salience seems to be a rather intuitive matter;

support from the literature on visual perception is rarely discussed. A similar argument from perceptual salience has been made for putting the articulator in the head position (van der Hulst 2000).

The above account of the different versions of the model is not intended to invalidate the use of the different headedness criteria. Such criteria can serve as useful guidelines in looking for evidence for different behavior of the various nodes. A structure without restrictions would not do so, since every possible combination of nodes would be possible. In the proposal for a feature set below I do not argue for a specific hierarchical structure within the feature set; I merely group features by phonetic similarity for clarity's sake.

3.4 A proposal for a feature set for SLN

The present feature set is based on the one proposed by van der Hulst that was discussed in the previous section. Some of the modifications that I suggest were first presented in Crasborn & van der Kooij (1997, to appear). First, §3.4.1 gives an overview of the feature set that I propose, and provides references to the relevant literature that the proposals are related to. §3.4.2 discusses the representation of movement. After that, in §3.4.3 and §3.4.4 I provide evidence for two important innovations in this model, regarding orientation and handshape. These proposals aim to incorporate some of the variation data that I have observed, and to reduce the overgenerating capacity of the model. This specifically involves predictions about possible combinations of features, an area which has not received much attention in the literature.

Constraints on combinations of features have been proposed for two specific areas: two-handed signs and combinations of movements. Some of the most robust phonological generalizations, which have been found to be valid in many different sign languages, concern movement and handshape in two-handed signs. Battison (1978) found for ASL that in signs in which both hands move, the handshapes of the strong hand and the weak hand are always the same (the 'symmetry condition'), and moreover, that if the handshapes are different, then the weak hand does not move and its handshape is one of a limited set of most-frequent handshapes (the 'dominance condition'). These two constraints also apply to SLN (Schermer et al. 1991, van der Hulst 1993, 1996, Crasborn 1995, van der Kooij 2001). Van der Hulst (1993, 1996) argues that this difference between the strong and the weak hand, where the weak hand manifests a subset of the (handshape) characteristics of the strong hand, is a typical manifestation of a head-dependent asymmetry.

A second phonological generalization which seems to hold across many different sign languages is that the possibilities for combining different movements in a single monomorphemic sign are limited. Thus, signs may consist of maximally two (simultaneously occurring) movements from the set location change, handshape change, and orientation change, and one of them must be a location change (Stack 1988, Uyechi 1996).[51]

These two types of constraints do not affect combinations of static feature values for one hand, then. An example of such a constraint would be a statement that a given orientation value does not occur at certain locations. It is precisely this sort of restrictions on feature combinations that underlies the changes in the model that are discussed below. The impetus for these revisions was the observation that there are obvious articulatory restrictions on the flexibility of the upper extremity, and that just on the basis of intuition some positions seem more complex articulatorily than others. For example, when the hand is at the location 'in front of the chest', it requires more effort to make the index finger point ipsilaterally than contralaterally.

3.4.1 Overview

A structured overview of the features I propose for SLN is presented in Figure 3.6 below. Only the terminal nodes in this diagram are features; the hierarchical structure is only used for clarity. The values for each feature are listed in Table 3.1. Next to references to earlier research on SLN, I briefly put my proposal in a broader context of sign language research. Two aspects of the model that will be discussed extensively below concern orientation (§3.4.3) and the articulator node (§3.4.4; I will not discuss these nodes in detail in this section) .

[51] It has been pointed out to me that despite the claims of these authors, there are quite a few signs in ASL that go against these generalizations. For example, LOCK$_{ASL}$ and CAN'T-DO-IT$_{ASL}$ both have changes in the three parameters handshape, orientation and location; signs such as PERPLEXED, ORANGE and BITTER all have a combination of a handshape change and an orientation change. In SLN, signs with a combination of handshape and orientation changes occur only in a few exceptional cases of fingerspelling derived signs such as BLUE (***bl****auw*), POOR-JOKE (***fl****auw*), and COWARDISH (***laf***).

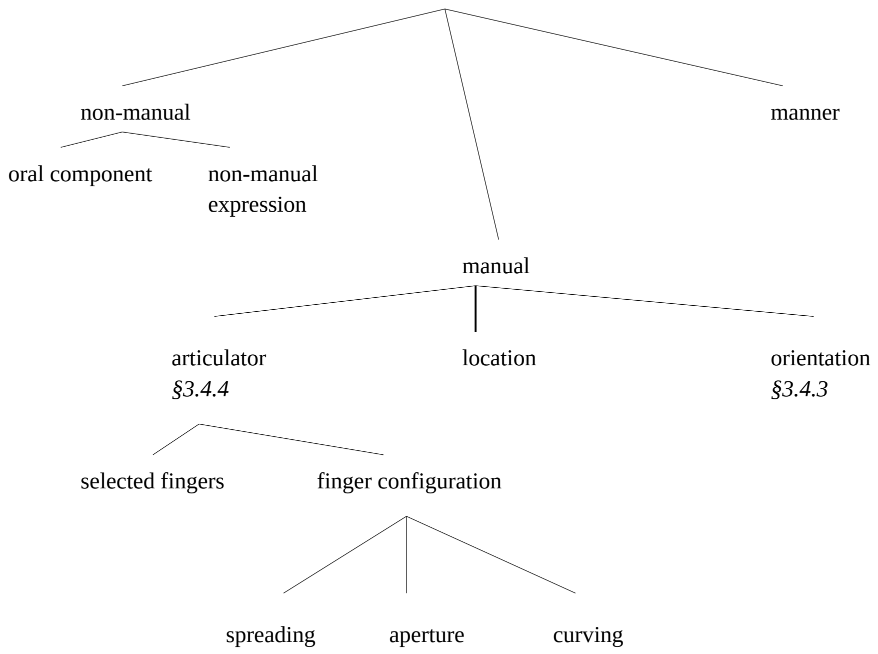

Figure 3.6

Phonological features for SLN

Table 3.1 is organized as follows: the first column lists the feature node in the tree in Figure 3.6, the second column lists the feature value, and the third column gives examples for each feature. Feature values that appear to occur relatively infrequently (‘exceptional feature values’) are presented in italics.

feature	**feature value**	**example**
oral component: mouth gesture	*fah*	FINALLY-UNDERSTAND
oral component: mouthing	*broer*	BROTHER
non-manual expression	*angry look*	ANGRY
	eyes squinted, head tilted sidewards	FAR-AWAY
	eyes squinted, lip rounding	EXPENSIVE
manner	tense slow	JEALOUS, FAR-AWAY
	tense fast	ANGRY, FAST
	repeated, unidirectional	NOTHING, AFRAID
	repeated, bidirectional	GREEN, WALK
	alternating	BICYCLE
	two-handed symmetrical	SATURDAY
	two-handed linked	BREAK, RELATIONSHIP, SHOW
	straight	SAY
	zig-zag	ITALY, ART
	L	SYSTEM, CHINA
	plus	SWITZERLAND
	arced	MUCH, NEXT
	circular	ROOM
orientation	root	CHICKEN
	tips	indexical signs, CONTENT
	ulnar	INTERPRETER
	radial	PROGRAM
	palm	APPLAUSE
	dorsum	PROOF
	longitudinal axis: clockwise	FIRST
	longitudinal axis: counterclockwise	TWENTY
	radial-ulnar axis: clockwise	OPEN
	radial-ulnar axis: counterclockwise	CLOSED, DRUNK
	palm-dorsum axis: clockwise	ERECTION, MORNING
	palm-dorsum axis: counterclockwise	READY, FINISHED, EVENING

Table 3.1

Phonological features and feature values for SLN

feature	**feature value**	**example**
major location	*none / neutral space*	ALWAYS, STRONG
	neutral space horizontal plane	ROOM
	neutral space: frontal plane	WHO, STOP, RESULTS
	neutral space: midsagittal plane	BICYCLE, SIGN
	neutral space: high horizontal plane	SKY, SOCIETY
	chest center	AFRAID, TIRED
	chest ipsilateral	CANADA, PEOPLE
	belly	HUNGRY
	side of the body	KIDNEY
	weak hand – radial	WORK, PHONOLOGY
	weak hand – palm	PROGRAM, PROOF
	weak hand – dorsum	GAY, SWEDEN
	weak hand – tips	MUSHROOM
	wrist	DOCTOR
	lower arm	SURGERY
	below chin	ENOUGH
	chin <front>	SAY
	cheek	DAY
	nose	NOSE
	ear	HEAR
	eyes	SEE
	forehead	UNDERSTAND
	side of head	THINK
setting[52]	high, low	WEEK
	low, high	GROW
	away, close	PROOF
	close, away	ABSTRACT (adj.)
	contralateral, ipsilateral	DIFFERENT
	ipsilateral, contralateral	SATURDAY
	proximal, distal	PURPLE
	distal, proximal	PRETEND
	dorsum, palm	HALF, ERROR
	palm, dorsum	CONTINUE, BREAD

[52] The setting values are listed in pairs because they only occur in combinations of two values; this is further discussed on page 89.

Table 3.1 (cont.)

feature	**feature value**	**example**
selected fingers	one	IDEA, ICONIC
	two	EXPECT
	all	THANKS, PROOF
	ulnar	ICONIC, YES
	radial	IDEA, BREAK
	thumb	SELF
	middle finger	POSH, EROTIC
	ring finger	LAZY
	forearm and hand with all fingers spread	TREE
curving	straight	SAY
	curved	COMPLAIN
aperture	open	FRIENDS
	closed	CHOOSE
	adducted	ASSIGNMENT
	rubbing	MONEY, SKILLED
spreading	unspread	HOLIDAY, DRAW
	spread	CONFUSED, ROOM
	crossed	WEIRD
	waving movement	BEAUTIFUL, COUNT
	wiggling movement	HOW-MANY, MICROWAVE

Table 3.1 (cont.)

The two different *non-manual components* are exceptional not only in that they occur in few signs, but also in that each and every one only seems to occur in a single sign. This raises doubt as to whether they should really be considered part of the phonological representations. I suggest that they do, for several reasons.

Firstly, manner features such as [tense] often characterize both manual behavior and non-manual behavior. For example, the tenseness in fast tensed movement in ANGRY is visible not only in the hand and finger muscles (see below in §3.4.4), but also in the tenseness of the facial muscles. Woll (to appear) suggests that there may be even more parallels between the manual and non-manual components. I interpret these parallels as further evidence for including non-manual aspects in the model.

Secondly, there is the more traditional argument in favor of the phonological role of non-manual aspects: there are minimal pairs differing only in the mouth component (Schermer 1990). Examples of such minimal pairs are BROTHER vs. SISTER, which differ in mouthing (respectively *broer* and *zus*), and TIRED and

FINALLY-UNDERSTAND, of which only the latter has the oral component transcribed as 'fah' (a non-existent word in Dutch) and a backwards tilting head movement.

Thirdly, non-manual aspects are used at a morphosyntactic level of structure, to express differences in sentence type and to express agreement relations (Schermer et al. 1991, Coerts 1992). The model in Figure 3.6 aims to describe lexical items, and for that reason I have not included separate branches covering different aspects of morphosyntactic features such as eye gaze, turning of the upper body, eyebrow position, etc. (cf. §3.2). Although all these arguments argue in favor of including non-manual features in a phonological model, nevertheless all lexical non-manual features are idiosyncratic: each occurs only in one sign. I suggest that they should be treated just as exceptional manual properties with an iconic origin: they need to be specified in the perceptual specification in the same manner as non-exceptional features. It is up to the grammar (i.e. the different constraint sets and their interactions) to characterize their exceptional status.

Manner features or feature values are typically understood as specifying the manner of the *movement* in the sign (e.g. van der Hulst 1993). I argue in the discussion of the articulator in §3.4.4 that tenseness not only has an impact on the (path) movement in a sign, but that it can also affect the realization of the (static) finger configuration in some cases. For example, in ANGRY the presence of [tense: fast] results in the MCP joints being extended or even hyperextended instead of slightly flexed (a 'claw' handshape). I noted above that tenseness also affects non-manual features. Together, the scope of the [tense fast] feature over various aspects of the sign is expressed by its high location in the feature tree: the manner features specify the whole sign, and not just the movement. It still remains to be seen if this wide scope of the tenseness features also holds for other manner features, and in consequence, whether the manner features should be considered to form one single group. I have occasionally observed that repetition of the manual movement is mirrored by repeated forward head or shoulder movement, whereas alternating movements seem to be accompanied by sidewards head movement. Similar data on similarities and alternations between manual and non-manual aspects can be found in Woll (to appear) and Brentari (1998). I will come back to these alternations in Chapter 5.

There are two features for repetition, [repeated unidirectional] and [repeated bidirectional]. There is no lexical distinction between two, three or more repetitions. Following Miller (1997), I hypothesize that the number of repetitions in SLN is determined largely by the prosodic structure of the whole sentence. Apart from prosodic structure, the number of repetitions can also be affected by morphosyntactic operations; these fall outside the lexical scope of this thesis as well. The feature [repetition] can only be specified once for the whole sign. If there are combinations of changes in location with changes in orientation or articulator, the repetition is only found in the latter. Although this has not been made explicit so far, a difference between the Leiden model and Stack's (1988) model, which originally proposed that all movement can be considered to be a transition from feature A to feature B, is that in the former there is no phonological difference between the two types of movement at all. Although Stack also suggests that these movements are the same with respect to the featural content, she claims that the difference is expressed by a specific syllabic template for ASL. Since it is predictable that in combined movements the repetition features only apply to the handshape or orientation change, I suggest that there is no reason to represent this fact in the phonological specification. I hypothesize that there is an articulatory explanation for this generalization: it is much ‘cheaper’ to repeatedly move a smaller articulator than to move a large articulator. This articulatory cost still needs to be made explicit and quantified.

I adopt two different features for two-handed signs in which both hands move, viz. [two-handed symmetrical] and [two-handed linked], to express the distinction between signs in which the hands move with respect to each other (as in SATURDAY) and signs in which the hands move in tandem (as in RELATIONSHIP). Both type of signs contrast with signs such as PROOF, in which one hand is the location and the other hand moves with respect to the location. The latter type of signs is represented by a series of location value [weak hand – *side*], where the side of the weak hand that faces the strong hand is specified (palm, radial, dorsum, or tips).

The trajectory of the location change is typically straight, circular, or arc-shaped. Circular movements are parallel to the specified body location or a plane in neutral space, whereas arced movements are perpendicular to the location. Zig-zag and plus-shaped movements are rather exceptional in SLN, but feature values are needed to specify a few signs.[53] There has been considerable discussion in the literature on arced movements. Van der Kooij (1994), Uyechi (1996) and Miller (1997) all propose that not all movements that look arced are specified for the feature [arced] in the underlying representation.[54] One phonetic-phonological context that leads to an arced path is so-called ‘double contact’, as in the sign DEAF (Figure 3.7). In double contact signs, the articulator contacts the location at two different settings. These signs can be seen as disyllabic, with two movements to contact; the arc is simply the transitional movement (e.g. Uyechi 1996, Perlmutter 2000). This arc is then predicted not to surface in simple setting changes, which will show straight movement. I will not discuss this issue further here.

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[53] Some people have proposed that movement shapes such as ‘plus’, ‘zig-zag’, and ‘L’ are composed of sequences of simple movements (e.g. van der Hulst 1995b, Brentari 1998). For example, the plus shape could be decomposed into downwards movement and sidewards movement. I will not discuss this issue here.

[54] Nagahara (1988) even claims that arc-shaped movements are the default in sign language, as movement at a single joint automatically leads to curved trajectories of the end of the articulator. To articulate a straight path, a complex coordination of more than one joint is necessary. This ‘articulatory simplicity’ of some arc-shaped movements plays an important role in Chapters 4 and 5 of this thesis. While I agree with Nagahara that arc-shaped movements are the result of moving only one joint, I do not agree with his claim that such arcs are phonological categories. In terms of the model I propose, such arcs do not typically occur in the perceptual specification. However, they can be the perceptual output that the perception grammar constructs from the simplest articulation of a perceptual specification [straight movement]. For further discussion of this topic, see Chapter 5.

Figure 3.7

DEAF

Orientation features will be discussed in detail in §3.4.3 below. The main claim of the model that will be defended there is that one set of orientation features suffices to account for both degrees of freedom that the hand has in orientation. There are no separate features that refer to palm orientation vs. finger orientation, and there are no separate features describing which side of the hand contacts the location. The features specify the side of the selected fingers that points to the final setting if there is a setting change, and otherwise to the major location.

The list of *major location* feature values is rather long, and may not be complete. Van der Kooij (in prep.) provides a full list, based on a more thorough analysis of the SLN lexicon. She shows that many of these features only occur in one or a few iconically motivated cases (such as [ear] and [eyes]). On the basis of this claim, I propose that these exceptional locations should be treated in the way outlined in §3.2.2: they are exceptions, and their exceptional status needs to be expressed by the grammar of the language (i.e. the constraint rankings). In terms of their perceptual specification they are not different from other locations like [chest], which are regular phonological features (yet iconically motivated in some signs).

The different features referring to neutral space refer to four different planes; these are illustrated in Figure 3.8. There are two horizontal planes: one at stomach height, which is the most frequent location, and one at shoulder height, which seems to occur only in exceptional iconic cases. There are also two vertical planes, perpendicular to each other: the frontal plane, which is parallel to the front of the body, but at the outer edge of signing space (about one forearm and hand’s length out from the body), and the midsagittal plane, which divides the body in two symmetrical halves.

Figure 3.8

Four planes in neutral space

These four planes are needed to describe different locations in neutral space. The fact that they are planes, and not points or lines, can be seen in circular movements. In these movements the circle is parallel to the plane. The two horizontal planes also express the difference in height between signs like ROOM (low) and SKY (high). The planes are further needed to correctly describe different orientations in different signs in neutral space. Orientation and location are closely related, as I will argue in the section on orientation below.

Finally, one might want to adopt a location feature [neutral space] which is not a plane; in a sense it is not a location at all since there is no concrete point with respect to which a relative orientation feature can be interpreted (see §3.4.3 below). The articulator is raised high enough to be visible to the perceiver (the elbow is flexed at about 120 degrees), but any articulatory action to further modify the location or orientation is absent (the wrist is fully extended). It occurs in signs like ALWAYS, NOTHING and STRONG. I argue that in these signs there is no specification for location or orientation at all. Since there is no location specification in these signs, there can be no movement towards a specified location either. The movements in the two examples above can still be accounted for, however. Circular movements apparently occur in which the plane described by the circling is not a plane parallel to the specified location but rather a plane that is perpendicular to the end of the articulator. For STRONG it is not clear whether there is a movement at all. It has a feature [tense fast], which is also visible in the tenseness of the facial expression (eyebrows furrowed, puffed cheeks); possibly this has a default movement associated with it that consists of a tensing of the arm muscles without actually moving the end of the articulator or causing a very small repeated movement.

Setting features are only invoked when there is a location change. They occur in the pairs given in Table 3.1, and all can surface in either order. The distinction between setting features and major location features expresses the generalization that there is no movement between major locations in morphologically simple signs, but only movement within each major location. These setting features do not express a standard movement size. The actual size of the movement is something that is dependent on the size of the major location, among many other factors (cf. Uyechi 1996). For example, in signs with a feature change from [high] to [low], the movement is smaller in combination with the location [cheek] (e.g. CRY) than in combination with the major location [chest] (e.g. TIRED). This difference is one of the aspects that is generated by the production grammar in the Functional Phonology model; this will be further discussed in Chapter 5. The features occur in pairs, which could be considered as the two values of binary features, indicating that a setting change can only be the result of the combination of the two members of a pair. Thus, changes from [ipsilateral] to [down] are not possible. This issue is also discussed in §3.4.2 below. The pairs [high, low], [close, away], and [ipsilateral, contralateral] are applicable to all locations. Two pairs of setting values are needed to characterize movement on the weak hand: [distal, proximal] and [palm, dorsum]. The pair [distal, proximal] refer to movement in the length axis of the weak hand, from the wrist (proximal) to the tips (distal) and the other way round. The pair [palm, dorsum] refers to movement perpendicular to the length axis of the hand. These terms 'palm' and 'dorsum' are a bit unfortunate because their interpretation depends on the side of the weak articulator that is the location; future research may lead to a more comprehensive terminology. If the location is the radial or ulnar side of the weak hand, then the movement is indeed between the palmar and dorsal sides (as in HALF). If the location is the palm or the dorsum of the hand, then the movement is between the radial and ulnar sides (as in BREAD). The term 'palm' thus always refers to 'closer to the body or the active articulator'; the term 'dorsum' thus always refers to 'further away from the body or the active articulator'.

Some of the *articulator* features will be discussed in detail in §3.4.4. The central claim that will be defended there is that there are only two features referring to finger *curving*, and that the orientation applies to a part of the (selected) fingers and not to the hand. I do not have a proposal about the organization of the features for *selected fingers*. I refer to van der Kooij (in prep.) for discussion of this node, which is rather complex. The value [one] is used for both extended index and extended pinkie (in combination with respectively [radial] and [ulnar]). The value [two] is used for the index and middle fingers (in combination with [radial]), and for the combination of thumb and pinkie. The value [middle finger] only occurs in combination with the configuration [curved].

One of the exceptional features I include is [ring finger], which only occurs in combination with the feature [curved] in SLN, as in the sign LAZY. Etymologically, the sign stems from a combination of three fingerspelling handshapes (L-U-I), which raises the question whether not the other fingers (thumb, index, middle, and pinkie) are selected rather than the ring finger. Either way, in the western dialect of SLN studied here, it appears to occur in this sign alone. In the Groningen dialect of SLN, however, the ring finger does occur as the selected finger in other signs, such as ORANGE, WATER, and ALREADY. In all cases, the ring finger is flexed, and the unselected fingers are extended.[55] Both the contact of the ring finger tip in WATER and the repeated flexing movement of the ring finger in ORANGE are evidence for the ring finger being selected. In LAZY, there is no evidence for what the set of selected fingers is beyond its etymology. Cross-linguistically, the finger selection [ring] seems not to occur very often either. The ring finger does not occur as a category in dictionaries of Thai Sign Language (Suwanarat, Ratanasint, Rungsrithong, Anderson & Wrigley 1990), Swedish Sign Language (Hedberg 1997), Italian Sign Language (Radutzky 1992), Finnish Sign Language (Malm 1998), or New Zealand Sign Language (Kennedy 1997). In ASL the ring finger mainly figures in the counting system, where the number $\text{SEVEN}_{\text{ASL}}$ involves contact between the thumb tip and ring finger tip.

Another exceptional feature is [lower arm and hand], which marginally occurs in lexicalized classifier constructions where the arm denotes a tall cylindrical object, as in TREE.

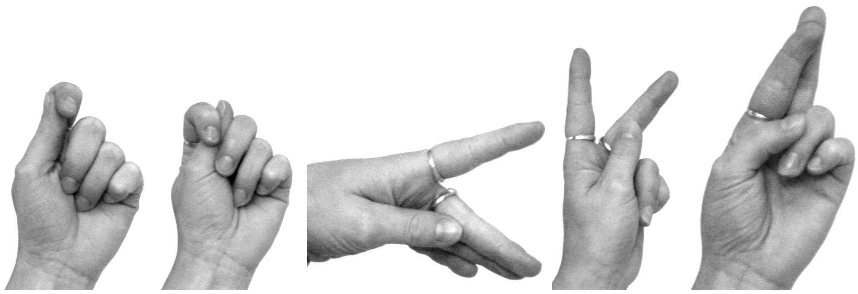
The index and pinkie fingers are not included in the list by name, since there is some variation in the realization of a feature value like [one]. For example, pointing in SLN (as in indexical signs) typically happens with the index finger, but if the pointing is directed to the ipsilateral side the thumb is sometimes used. I suggest, then, that an extended thumb or index are articulatory variants of a perceptual specification that says that one extended finger is involved. Miller (2001) observes that both in LSQ and in other sign languages, there are many different contexts in which there is variation between the selection of the index vs. the middle finger. Much of this variation appears to be conditioned by considerations of articulatory ease.

Curving of the fingers is expressed by two features, [straight] and [curved]. There is no contrast in different degrees of curving in SLN. All cases with markedly ‘hooked’ configurations, as for example in JEALOUS and ANGRY, coincide with tense movement, and are therefore proposed to be the result of the specification of [tense fast] or [tense slow]. Although there are some movements that change the finger configuration, as in TOILET and DEPENDENT, van der Kooij (in prep.) proposes that this movement is not contrastive in SLN but is the result of a combination of [curved] and a setting change. The sign TOILET, which does not have a path movement, is one of the exceptions to this generalization; it can be represented by the feature sequence [straight, curve].

Aperture features include [open] and [closed], and also the feature [adducted], in which the thumb makes contact with the middle phalanx of the index finger instead of the distal phalanx or the finger tip, the index finger grasping the thumb tip. This is known in SLN as the ‘money’ handshape, which occurs in about 5% of the core lexicon (Harder & Schermer 1986; e.g. Figure 3.9i). Although this handshape is the sixth most frequent in that study, the specific combination of finger curving and thumb state is still exceptional in only occurring in combination with [selected

[55] This phonological difference between the western and the Groningen variants of SLN shows that the differences between the dialects are not only lexical, contrary to the claims in *Commissie Nederlandse Gebarentaal* (1997).

fingers: one; radial] in SLN. There are obvious reasons for this: to grasp the thumb tip with other fingers, the index would be in the way both for the signer and for the perceiver. Although the handshape occurs so frequently, superficial inspection of the occurrences in the SignPhon corpus suggests that almost all of them are motivated. They either occur in concepts relating to 'money' (which in itself is likely derived from a gesture referring to money in the surrounding hearing culture) or they are handle classifiers referring to the handling of small thin objects like a sheet of paper. However, a feature definition such as 'grasp' may be too specific, as the 'money' handshape can be seen as a manifestation of a more general property 'adducted thumb' (Chris Miller, personal communication). The definition [adducted] can also be used to describe the position of the thumb between the flexed index and middle fingers, as in the ASL T handshape, and the position of the thumb in the K and P handshapes of the SLN fingerspelling alphabet (see the illustrations in Figure 3.9i–iv).



i. money ii. ASL T iii. P iv. K v. R

Figure 3.9

Exceptional handshapes

Finally, a movement value [rubbing] is needed to specify the movement of the thumb across the finger(s) in signs like MONEY and SKILLED.

The last feature, [spreading], has a number of values that specify the position of fingers side by side. When there are two or more adjacent selected fingers, they can be either unspread (MCP joints adducted, as in HOLIDAY) or [spread] (MCP joints abducted, as in ROOM). In exceptional cases the value can be [crossed], characterizing the hyperadduction of the selected index and middle fingers and often slight curving of the middle finger so that it crosses over the dorsal side of the index finger. This handshape is known as the letter 'R' in the SLN hand alphabet (illustrated in Figure 3.9v). Movement features are adopted to characterize the (exceptional) 'waving' found in the sign BEAUTIFUL, and the (frequent) wiggling found in signs such as HOW-MANY.[56]

A number of features that occur in some models are claimed not to be distinctive, and do not occur in the list in Table 3.1. For example, there is no feature referring to contact between the articulator and the body or the weak hand, which has multiple values in other proposals (e.g. Friedman 1976). Van der Kooij (1997) shows that in SLN there are no minimal pairs differing only by contact and, moreover, that actual cases of contact can be predicted on the basis of the combination of features and their alignment with the skeleton that accounts for location and movement. Likewise, the position of the unselected fingers may not be distinctive but predictable on the basis of a number of other factors (van der Kooij 1998).[57] Finally, the size of the movement is not lexically distinctive (following the claim by Uyechi 1996 for ASL), although it is used together with other non-lexical movement manner features in morphological processes such as aspectual modulations of predicates. In Chapter 4, phonetic variation in the size of the movement will be further explored.

3.4.2 The representation of movement

Movement has been represented in the Leiden model as a change from one feature value to the next (van der Hulst 1993). The claim of Stack (1988) and others that there are no movement segments describing the movement has been incorporated since the earliest version of the model (van der Hulst 1993). All movement results from a change in features (or feature values). These feature contours are ordered by association to a bipositional skeleton which consists of only one kind of segment (termed X slots; cf. some theories of syllable structure in spoken languages that do not use C and V segments, e.g. Levin 1985, van der Hulst 2000). The features in the proposed list above include both dynamic values to represent movement (such as [circular] and [longitudinal clockwise]) and sequences of static values (such as [away, close]). In this section I will review some of the literature on movement, and examine to what extent the hybrid approach taken here forms a problem.

A large part of the sign phonology literature has centered around the representation of movement. Stokoe (1960) claimed that signs consist of simultaneous structure alone. In Stokoe's analysis, sequences of articulator states in signs are due to movement features such as 'downward movement', 'opening handshape', and 'forearm rotation'.[58] Liddell (1984) and Liddell & Johnson (1986, 1989) argued that sequential structure plays a more important role than Stokoe

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[56] This phonological waving movement resembles the waving movement that is found as the articulation of both static and dynamic orientation feature values in §5.4.2 (page 287ff).

[57] In the example of an optimality theory analysis on page 57, I included a constraint that refers to a feature for unselected fingers. This analysis would have to be modified if there is no such feature to refer to. I will leave this issue for future research.

[58] Some changes in handshape were described by Stokoe (1960) as sequences of handshapes, but these were considered to be secondary properties of movement.

recognized. They proposed to divide primary (or path) movements over different segments, because it is necessary to refer to the begin and end locations in morphological processes such as verb agreement. They distinguished location (H, for 'hold') segments from movement (M, for 'movement') segments.[59] Movement segments can have distinctive properties, such as shape and tenseness, and lengthening processes can affect the final state of the sign alone. Verb agreement can be represented by associating different location values to the initial and final stages of a verb. The proposal to introduce sequential structure and movement segments was later supported by Sandler (1989) and Perlmutter (1992). By contrast, Stack (1988) argued that M segments are redundant: all movement can be considered to be a transition from A to B. All local movements (small repeated changes in handshape or orientation) can be analyzed as repeated versions of the secondary movement categories 'handshape change' and 'orientation change'. Distinctive properties of changes in location, such as an arced trajectory, can be considered to be properties of the whole sign. Stack's claims have been adopted for SLN by van der Kooij (1994) and in later versions of the Leiden model, and also by researchers working on ASL (e.g. Wilbur 1993, Uyechi 1996, Miller 1997).

Many linguists have been attracted by the analogy between segments in sign and speech (Sandler 1989, Liddell & Johnson 1986, Perlmutter 1990). The LML sequence proposed by Sandler (1989), for example, is claimed to resemble a CVC (consonant–vowel–consonant) syllable. This analogy raises a number of conceptual and empirical issues; see also the discussion in Edmondson (1986, 1990) and Wilbur (1993) on this issue. First, the prototypical spoken language syllable is CV rather than CVC, whereas the prototypical sign language syllable would be LML and not LM. Secondly, although it is true that the *possible* coda consonants in spoken languages typically form a subset of the *possible* onset consonants (with occasional exceptions), the limitation on the content of the L segments in sign is rather different: the features of the second L segment must be almost completely identical to that of the first L segment. This makes the sign 'syllable' look more like a contour segment in spoken languages: only one feature node branches (van der Hulst 1993, Corina 1993). Thirdly, the movement segments in sign language are redundant in the various models. They have many of the same features as the neighboring location segments. In the cases where distinctive information is carried by the movement segments, this information is limited to aspects of the movement such as the shape of a location change and tenseness. The direction of movement, as well as the initial and final states of the movement, are represented by features attached to the location segments. This has led several researchers to propose that such movement features are a specifying property of the whole syllable rather than a separate movement segment, and that the whole sign syllable can be described by an initial and a final position, which is assigned a label such as 'X' (Stack 1988, van der Hulst 1993, Hayes 1993, Wilbur 1993, Uyechi 1996). The various proposals still

[59] Instead of 'hold' segments, other researchers have proposed location segments (L; Sandler 1989) or place segments (P; Perlmutter 1990). Although the interpretation of this non-movement segment differs from model to model, they all dominate location features.

make different claims about the comparison of these ‘positions’ to spoken language constructs. Van der Hulst refers to them as ‘skeletal slots’, Wilbur talks about ‘timing units’, etc.

The function of an underlying template containing two skeletal slots is twofold. Firstly, it expresses the generalization that there is no more than one feature sequence in a morphologically simple sign: nodes branch to no more than two features. Secondly, it expresses the generalization that combinations of movements (changes in location, articulator, and orientation) are synchronized: they may occur simultaneously, but not sequentially. If they do occur sequentially this indicates that the sign is complex. For example, signs can be morphologically complex, as in the compound PARENTS (MOTHER+FATHER).[60,61] However, both these generalizations could also be expressed by adopting dynamic features for all movements. A sign with one such feature would then be ‘simple’, and complex signs such as PARENTS would consist of a sequence of dynamic features. The synchronizing of multiple movements would be considered as the simplest realization, requiring no further specification.

Although most researchers agree on representing the content of the movement by a sequence of features (whether or not they are associated to location segments or skeletal slots), Brentari (1998) proposes an explicitly different view. She distinguishes between ‘inherent features’ which refer to static parts of the sign, and ‘prosodic features’, which refer to the movement(s). Almost all of these prosodic features are dynamic, and Brentari argues that prosodic features should be separated

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[60] A further issue concerns the conception of the status of skeletal slots. Van der Hulst (1993) proposes that there is an underlying phonological template consisting of two skeletal slots. Yet on the other hand, it is clear that this bipositional skeleton is the default, and it may not be part of the underlying representation at all (van der Hulst, personal communication). In various versions of the Leiden model, a feature [repetition] is proposed, and it can be argued that at some point in the derivation of the sign this repetition is spelled out by a multiplication of the skeletal frame. One could consider this to be part of the phonetic implementation stage. In the list of features in Table 3.1 (page 83), I distinguish unidirectional from bidirectional repeated movements. The number of repetitions in either case is not distinctive. On the basis of Miller’s (1997) work on LSQ, I hypothesize that the number of repetitions is determined by the prosodic organization in which the sign is a constituent. Miller refers to each repetition as a syllable, and therefore I propose that a sequence of two skeletal slots could also be considered a syllable (cf. Brentari 1998). For now, I use this term only as a useful way of referring to a sequence of skeletal slots and associated feature values. This conception of the syllable as a movement phase resembles Perlmutter’s (1990, 2000) proposal for the syllable in ASL, but there are two important differences. Firstly, I do not distinguish between different types of skeletal slots, whereas Perlmutter distinguishes between movements and positions, depending on whether or not there is a change in location. Secondly, Perlmutter (2000) proposes that the repetition of the movement in many signs be expressed lexically, as a sequence of segments. He proposes a set of constraints on the possible form of a syllable in ASL, and these constraints are used to parse a sequence of segments into syllables, or alternatively, to describe what a possible syllable looks like. By contrast, I argue that the repetition is spelled out post-lexically, and that simple monomorphemic signs are characterized by one syllable (i.e. two skeletal slots). The prosodic structure of SLN including this issue of movement repetition is one major area of future research; this is further outlined in Chapter 6.

[61] Some of the feature values describing the movement manner in the list on page 83 could also be argued to be phonologically polysyllabic. For example, the movement shape [cross] could be represented by a sequence of two syllables with a setting change, first [high,low] and second [contra,ipsi]. I will leave this possibility for future research to investigate.

from inherent features. One of the arguments that she advances for this claim bears on the core topics of this thesis, namely the existence of variation in the realization of movements. Brentari claims that the various phonological movement features, which she defines partly in articulatory terms to begin with, have a (set of) default joint(s) with which they are articulated, and that there are proximalized and distalized articulations for all movements. However, it is not clear why static features would be incompatible with an account of such movement alternations. Both static and dynamic features can be realized in multiple ways, I propose, and both can in principle be reconciled with proximalization and distalization of movement. In the next two chapters, I will test the hypothesis that the alternations are *articulatory* variants of *perceptually* constant targets.

Regardless of the validity of Brentari's specific theoretical claims, her claims about the existence of such proximalized and distalized articulations remain very important. Assuming that these alternations do indeed exist in ASL, I hypothesize that they can also be found for SLN.[62] I further hypothesize that the descriptions of the movement features that Brentari uses are overly articulatory in nature. Even though she refers to many movements with articulatory terminology (extension, supination, abduction), she proposes that there are also 'default joints' for the execution of these movements (Brentari 1998: 30). In the model that I propose, the selection of joints is not something that occurs in the underlying specification, which is perceptual in nature. The articulations are generated on the basis of the perceptual specification together with many contextual factors; this will be further spelled out in Chapter 5. With this model, it is in principle possible to predict which articulation occurs when, even though in practice the large number of variables involved will be hard to handle in this stage of the research.[63]

In contrast to Brentari (1998) and the implicit claims in other models, I propose that in the production grammar there are no default joints that are used for the articulation of the various perceptual movement specifications. It seems rarely to be the case that only one joint is involved in the execution of the movement. This hypothesis is further spelled out in §3.5, and will be tested in Chapter 4.

I propose that these movement alternations are not the result of a phonological process but of a phonetic one, and these alternations therefore do not constitute evidence for two distinct phonological groups such as Brentari proposes. This leaves open the validity of other arguments in favor of this separation. Moreover, I will demonstrate below that distalization and proximalization also occur in the articulation of what Brentari calls 'inherent features', describing static parts of the articulation, such as handshape.

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62 The data that Brentari attributes come from Parkinsonian signers (cf. Brentari 1998: 220-224, Brentari & Poizner 1994)) and from young children acquiring ASL as a first language (Brentari in press, Meier, Mauk, Mirus & Conlin 1998). I hypothesize that similar processes in SLN can also be found in nomal adult signing. This hypothesis will be further spelled out later in this chapter (see especially §3.5)

63 Brentari proposes to explain the proximalized and distalized versions by enhancement theory (Stevens & Keyser 1989), although it is not quite clear how phonetic *reductions* (distalized movement) can be explained by this theory.

In the light of the above overview of ways to represent movement, how should the features that account for movement in the list in Table 3.1 be classified, as dynamic or static features? In fact, both occur. Many feature values in the list can occur in sequence, and should thus be conceived of as static: a sequence of setting features is the representation of a location change, and a change in aperture values is the representation of an aperture change. Dynamic features in the list include the manner values describing the movement shape, such as [zig-zag], [arced], and [circular], and also the orientation values describing changes in orientation, such as [longitudinal axis: clockwise]. Each of these dynamic features characterizes a movement on its own, without an accompanying change from feature value A to B elsewhere in the sign.

As I outlined above, in Stokoe's original analysis of ASL phonology, almost all movement was analyzed by such dynamic features. Even though almost all models since then have introduced sequential structure for representing movements to various degrees, no model has appeared without some kind of dynamic features. The clearest example is circling movement, which few people have attempted to analyze as a sequence of stages, even though this overall dynamic feature [circle] is typically mapped to a skeleton that does contain sequential structure.[64] Moreover, models like the Leiden model that do analyze some movements as a sequence of features, such as straight path movements (changes in setting values), will have to come up with a set of constraints on the possible sequences of feature values. This is typically done by subdividing a feature tree in various subbranches such that only certain terminal nodes may branch. Binary features then insure that only a limited number of changes can be represented. For example, the articulator node has several branches, and the branch labeled 'aperture' dominates a binary feature, [± open] (or [open] and [closed]). The movements that can be represented then are closing ([open],[closed]) and opening ([closed],[open]). By contrast, the terminal finger selection node cannot branch at all. In the case of setting there are more features, and more possible combinations (see 10). I have grouped them into pairs to indicate that there is never a setting change from [high] to [contralateral], for example, but only from [high] to [low] and the reverse. In the present proposal for a feature set, this grouping has no formal status, although these features could be considered to be binary, and then we could formulate an external constraint stating that movement can only be the result of a feature contour. This would then be comparable to limitations on contour segments in spoken languages, cf. van der Hulst (1993) and Corina (1993).

One could argue that such constraints on feature sequences are more straightforwardly accounted for by assuming dynamic movement features, as in Brentari (1998), but I do not consider this to be a markedly different proposal. For some movements, the division into an initial and a final state is a bit artificial as there is no further evidence for their decomposition. In SLN, this would be true for circling (ROOM), wiggling (HOW-MANY) and rubbing (MONEY).[65] Once again, I do

[64] See Miller (1997) for a tentative decomposition of circles into four sequential states.

[65] It appears that in ASL rubbing movements are sometimes derived from sequences of two contact specifications. In this case a feature sequence analysis would be more parsimonious, and one could argue

not consider this to be a problematic issue. Most models so far use combinations of dynamic and static properties of movements in their features, and this practice is copied here: for some movements like circling and rubbing I propose dynamic features. I propose that wiggling is the phonetic result of a specification for [alternating] combined with [repeated bidirectional]. Likewise, I adopt the claim that at some point in the phonetic implementation of the structure, the features will have to be linearized by association to the skeleton (van der Hulst 1993; or a sequence of segments in some other models). I assume for now that this is the task of the production grammar in the Functional Phonology model.

3.4.3 Orientation[66]

3.4.3.1 Introduction

In the first linguistic analysis of sign language phonotactics in 1960, Stokoe did not consider orientation to be a separate parameter of signs: it seemed at the time that the way the hand was oriented in space did not systematically distinguish pairs of signs (Stokoe 1960). To cover the few signs that were distinguished only by palm orientation, such as CHILD$_{ASL}$ and THING$_{ASL}$ (Klima & Bellugi 1979: 48), Stokoe used a diacritic on the symbol for hand configuration in his notation system. In the literature since 1960, orientation has been systematically attributed the status of ‘parameter’ (Battison et al. 1975, Battison 1978, Sandler 1989).

Since the hand (or the fingers) are three-dimensional objects, specifying two of the three degrees of freedom fully specifies its orientation. This is illustrated in Figure 3.10.

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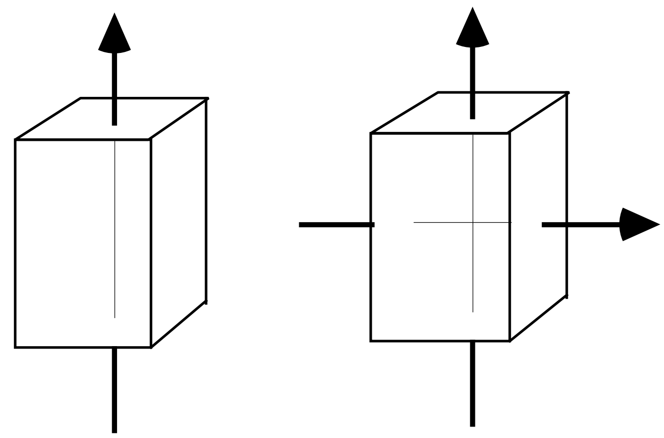
that such an analysis by extension could be valid for other sign languages as well. Miller (1997) takes the opposite view from Brentari, making the strongest claims about the decomposability of movement in LSQ. Miller argues that all movement features, including shape and [alternating], can be represented as sequences of static values and/or are derived from prosodic structure in terms of feet, syllables and moras. In the absence of a comparable prosodic analysis of SLN, I will make no specific claims about the nature of movement features.

66 This section is partly based on work done together with Els van der Kooij; this was published as Crasborn & van der Kooij (1997). The two core claims of that paper, viz. that only one degree of freedom of orientation needs to be specified and that this specification is relative instead of absolute, are maintained in the present analysis. For sake of readability, I will use ‘I’ instead of ‘we’ in the discussion of those ideas below; see van der Kooij (in prep.) for similar discussion.



i. One degree of orientation is fixed; the object can still rotate about one axis

ii. Both degrees of orientation are fixed

Figure 3.10

Orientation of three-dimensional objects

If the orientation of one axis is vertical, as in Figure 3.10i, the orientation of the top and bottom of the object is fixed. They will be facing up and down, respectively, no matter how the object is rotated about the axis. Rotation about this axis still causes four other sides of the object to change orientation, or in other words, rotation around two other axes. If the orientation of a second axis orthogonal to the first one is specified, as in Figure 3.10ii, than the orientation of the whole object is fully specified. The same applies to the orientation of the hand in signs: there are two degrees of freedom, and if both are specified, the whole orientation of the hand is known.

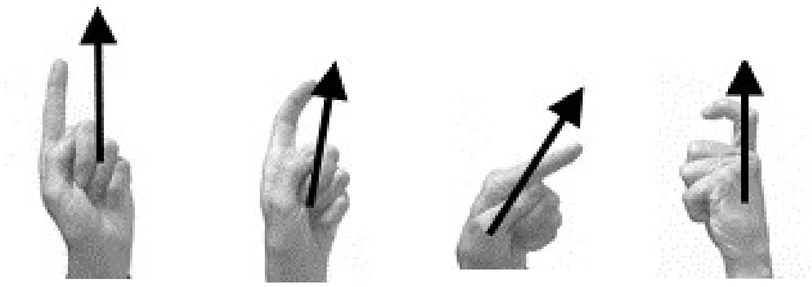
Orientation has been described in three different ways, which I will refer to as *absolute, relative*, and *articulatory*. *Absolute* orientation refers to the orientation of the hand in space, or, more informally, the direction that the sides of the hands are facing (Sandler 1989, Brentari 1990). These directions in space can be described in terms of up-down, left-right, and forward-backward. As the hand is a three-dimensional object, specifying the orientation of two sides of the hand describes its full orientation. As far as I know, without exception, and without explicit motivation, the palm side and the finger side have been chosen in sign language literature. Intuitively, these seem to be the two sides of the hand that we use most in daily life tasks as well as in many gestures of hearing people.

To give an example, the sign HOLIDAY in SLN would include in its lexical specification that the palm faces contralaterally and the fingers are pointing upwards. This is illustrated in Figure 3.11. The sign is made with a B hand (all fingers extended and adducted) which touches the ipsilateral side of the chin twice.

Figure 3.11

Absolute palm and finger orientation in HOLIDAY

To facilitate the description for signs with different finger configurations, finger orientation has frequently been interpreted as 'extended finger orientation', describing the direction in which the fingers point in a sign *if the fingers were extended* (Greftegreff 1992). This is particularly useful for handshapes in which the selected fingers are curved in such a way that the fingertips point in the same direction as the palm (as in Figure 3.12ii and iii). Describing the orientation of the palm and fingertips would then not capture the two degrees of freedom needed to fully specify the orientation of the hand. Another way of characterizing this view of finger orientation is by saying that it is not the direction in which the fingers point that is relevant, but rather the direction in which (the distal end of) the metacarpal bones in the hand point. It is really the orientation of the hand that is described in those cases. In the illustrations in Figure 3.12 one can see that the extended finger orientation indicated by the arrow does not always point in the direction that the finger tips do: it does so only in 3.12i, where the finger is fully extended.



i. 1 ii. 1-curved iii 1-bent iv. 1-hook

Figure 3.12

'Extended finger orientation' in different handshapes

The above way of describing orientation is termed 'absolute', because it refers to the 'absolute' three-dimensional space around us, without reference to any linguistic construct or property of the sign.[67]

Alternatively, orientation can be described by specifying how the hand relates to the place of articulation (Friedman 1976, Mandel 1981); this I will call *relative* orientation. For the sign HOLIDAY, one would then say that it is the radial (or thumb) side of the hand that is related to the place of articulation, namely the (left side of) the chin.

Surveying the literature, confusion is likely to arise: various terms have been used for relative orientation. Among these terms are *focus*, *facing*, and *point of contact*. Focus often refers to the part of the hand that is pointing in the direction of the movement (Mandel 1981). Facing often means the part of the hand that is oriented towards the location (e.g. Liddell & Johnson 1986), and point of contact is the part of the hand that touches the place of articulation (e.g. Mandel 1982, Liddell & Johnson 1986). These different concepts are partly overlapping in content. In the present model, the three aspects are all subsumed under *relative orientation*. As will become clear later on, the interpretation of relative orientation depends on the specified movement and location aspects of the sign.

A third way to describe orientation is in *articulatory* terms, by referring to the state of one or more joints of the arm. For example, Stokoe (1960) distinguished 'prone' from 'supine' states of the forearm, and these were the only distinctions in orientation that were included in his model. In HOLIDAY, the orientation could be

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[67] It appears to me that some authors implicitly refer to the orientation in 'signing space', rather than in the whole space surrounding the signer: it is unlikely that anyone would claim that the orientation stays constant when the signer shifts his upper body. Rather, the signs 'shift along' when the signer is lying down, for example, or when the upper body rotates left or right to take on different roles in discourse. Although this signing space is a linguistic construct, it remains an unstructured three-dimensional entity. The orientation values that are used are still 'up' or 'forward', and they do not refer to a specified part of the sign, such as a body location.

described as ‘neutral’, that is in between prone and supine. Nagahara (1988) drives this approach to its extremes, using articulatory parameters for all phonological features, including location. Apart from these two authors, articulatory descriptions of orientation have received little attention. More frequently, articulatory terminology has been employed in the description of repeated changes in orientation, such as wrist flexion (‘nodding’, e.g. Liddell 1990) and forearm rotation (‘twisting’, e.g. Liddell 1990).

In the phonological models proposed in the literature, absolute orientation has been the dominant perspective. In the few models where relative orientation has been proposed, this has always been in addition to a full absolute orientation specification, e.g. Liddell & Johnson (1989). The only place where relative orientation has been given emphasis is in Greftegreff (1992), in her discussion of indexical signs. These are signs in which the hand (generally, index finger extended only) points to a location in space which has been assigned a grammatical role. Greftegreff argues that variation in handshape of these signs, from variants where the index finger is fully extended to variants where it is bent to various degrees at all joints, makes untenable the position that it is the (palm and finger) orientation of the *hand* in space which is crucial in these signs. Rather, the pointing of the fingertip in the direction of the (grammatical) locus is what matters, allowing the actual orientation of the hand to vary from utterance to utterance.

3.4.3.2 Arguments for specifying only relative orientation

I want to expand the argument made by Greftegreff, by putting forward the hypothesis that it is always relative orientation only that is specified in the representation of the sign. In most cases, one specification suffices, relating a side of the hand to the end of a path movement (i.e. the second setting specification).[68] In a small set of signs, a second value is needed that specifies the side of the hand that faces the major location. There are two types of arguments in favor of this proposal. In the first place, specifying both relative and absolute aspects of orientation leads to redundancy in the phonological representation. This is especially so if contact features would also be present in the representation (see van der Kooij 1996, 1997 for discussion). To properly characterize the phonotactic patterns of the language, one should strive towards eliminating such redundancy, and opt for either one of the two types of orientation features, but not both. In the second place, there are several arguments in favor of relative orientation. These have to do with variation in

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[68] In a subset of signs, including PEOPLE and DEAD, the specification of only one value is sufficient provided that it relates to the major location rather than the end setting. The second degree of freedom is then the predictable result of the simplest articulation of the specified location and orientation parameters. The question then arises whether it is predictable whether the specified orientation value faces the end setting or the major location, or whether this information needs to be stored in the lexicon. One way to test the claim that only one orientation value is specified might come from coarticulation studies. As the non-specified degree of freedom is predicted to be the result of the easiest articulation of the various aspects of the sign that are specified, one would predict that in different phonological contexts, for example a distinction in the height of the location preceding the target sign, different realizations of the non-specified degree of freedom would occur.

handshapes, variation in orientation, and morphosyntactic phenomena. I will discuss these three issues in turn.

The handshape variations described by Greftegreff (1992) for indexical signs appear to occur widely in other signs in SLN, too. For example, the SLN sign PEOPLE in the citation form is produced with a B-bent handshape (see Figure 3.49i below). However, one frequently encounters variants where the handshape is quite different, looking more like a curved B-hand (all fingers slightly bent at all joints, or like a handshape in between B and B-bent (i.e. more than 0 and less than 90 degree flexion at the MCP joints). The same goes for many signs with B or 1 handshapes in which the fingertips touch the location, such as I and SHOW. It seems, then, that it is not an absolute or concrete specification of handshape and hand orientation that is called for in the representation of such signs, but rather a more abstract representation that leaves open more degrees of freedom in the actual surface form. For orientation, this representation would have to contain the relationship between the fingertip of the hand and the place of articulation. For the handshape, it seems that in many signs what needs to be specified is knowledge of the selected fingers. The finger configuration is what varies in different utterances, so this should be left open in these pointing signs, as far as the perceptual specification is concerned. From a traditional phonological point of view, one would say that underspecification plays a crucial role in this proposal. If we take the view of the Functional Phonology model, one would say that the perceptual target that is specified concerns a minute part of the articulator: the finger tip. In such a case the production grammar that generates the articulatory specification has to specify the state of *all* joints in the upper extremity, including the finger joints. Like the state of the wrist and other arm joints, the state of the finger joints is predicted to vary in different contexts, such that the easiest articulation is used. Variation in finger configuration will be discussed more extensively in §3.4.4.

Another source of variation is the actual, or phonetic, absolute orientation of the hand. Here, too, for many signs one finds an overwhelming number of variants from utterance to utterance. For example, the sign IDEA (index finger extended, moving from ipsilateral temple outwards) may be produced with many different palm orientations. In the 'dictionary form' (KOMVA 1993) the palm orientation is diagonally downwards-contralateral. However, both in connected signing and in productions in isolation the palm orientation may vary from almost straight down to contralateral to backwards. What remains constant under all these utterances is the relation between the tip (or pad) of the index finger and the place of articulation (the ipsilateral temple). Thus, while the absolute orientation values differ for each variant, the relative orientation is constant for all variants. I interpret this as another source of support for representing signs like IDEA with a relative orientation value, and not an absolute one.

A third source of evidence for the importance of relative orientation comes from morphosyntactic agreement. In agreement verbs, the beginning and end locations of the path movement and the orientation of the hand may differ depending on the arguments of the verb (Bos 1993, Meir 1995). As pointed out by Meir, it is not the absolute direction in space nor the direction of the movement that marks the relation between subject and object. Rather, it is the fact that the palm of the hand faces the object of the verb, and consequently, that the back of the hand faces the subject. Absolute orientation is not a useful notion in the description of verb agreement.

Concluding, then, there are three arguments favoring the use of relative orientation as opposed to absolute orientation. The arguments from variation in the production of signs appear very powerful. Although they are based on informal observation, it is clear that variation in absolute phonetic orientation is omnipresent. As the Functional Phonology model for SLN describes the relation between the lexical specification and the surface form, we further need to know the contexts in which each variant occurs. The question also arises how exactly the actual handshapes (more appropriately, the actual finger positions) and orientations are derived from the other values in the representation together with the context. In other words, we need knowledge on the phonetic implementation of the phonological specification of signs.

3.4.3.3 Values of the orientation feature

I propose six feature values in the phonological model to account for the orientation of all signs.[69] These refer to six sides of the specified articulator. What this articulator is, and therefore the exact phonetic locus of these sides on the articulator, depends on the specification of the selected fingers.[70]

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[69] In addition to the three 'qualitative' arguments for relative orientation in the previous section, the list of actual values provides a further, quantitative argument: instead of 12 orientation features (6 each for the finger and palm orientation), a relative orientation specification can suffice with only 6 features. In some cases of absolute orientation specifications, such as used in the KOMVA system, intermediate values between the 12 orientation values can also be used, leading to a very large set of possible distinctions.

[70] Brentari (1998: 46) further distinguishes between the palm side of the fingers and the palm side of the hand (i.e. the metacarpals), and likewise between the dorsum side of the fingers and the hand. I claim that for orientation, this distinction does not exist: at most, they refer to the same side of different articulators, and then this difference would be represented under the selected fingers branch of the articulator node. It is not clear to me if the two features would be needed to refer to different locations on the weak hand in SLN. My impression is that the exact location in signs like SWEDEN and GAY is variable, extending from the dorsum of the hand to the dorsum of the proximal phalanges. Furthermore, I do not know of any SLN signs like ASL EASY_{ASL}, where the location is the dorsal side of the fingers only. Therefore, there are no location features referring to different parts of the weak hand either.

value	**examples**
tips	CONTENT, indexical signs
root	CHICKEN, person classifier
ulnar	INTERPRETER
radial	PROGRAM
palm	APPLAUSE
dorsum	PROOF

Table 3.2

Feature values for orientation

The feature value [tips] refers to the fingertips, irrespective of the state of the articulator proximal to the tips. If the selected finger is fully extended, then [tips] resembles the ‘extended finger orientation’ as discussed above, since the distal end of the metacarpal bones in the hand points in the same direction as the finger tip. If the selected fingers are curved, whether by a phonological specification of [configuration: curved] or as the articulatory result of the absence of that perceptual specification, then [tips] rather resembles palm orientation. If the value [tip] is specified for an extended thumb, then the orientation resembles the orientation [radial] for a selected index finger, for example. However, all the values in Table 3.2 differ from these traditional orientation features in that it can only be interpreted with reference to the location (the final setting) that is specified for a sign. This location differs from sign to sign. By contrast, the frame of reference for absolute orientation features is independent of the sign or any of its features, it can always be interpreted by reference to the three dimensions of space around the signer.

The feature value [root] refers to the side of the articulator that is opposite to [tips]; [root] appears to be little used in SLN. It is needed to describe the orientation in lexical items such as CHICKEN and classifier constructions such as CAR-MOVE-BACKWARDS and PERSON-LOCATED-HERE.

The features [ulnar] and [radial] are named after the two bones in the forearm, ulna and radius. The distal end of the ulna is connected to the carpal bones of the hand at the ‘pinkie side’ of the hand, the distal end of the radius is on the ‘thumb side’. The radial (or ulnar) side of a selected finger need not necessarily be completely parallel to the radius (or ulna); this depends on the state of the wrist and forearm. The terms are used for convenience, and derive from the anatomical reference position where the wrist and all finger joints are fully extended.

The features [palm] and [dorsum] also refer to the palm and back side of the specified articulator, and they are not necessarily parallel to the palm and dorsum of the *hand*. The term ‘dorsum’ instead of ‘back’ is chosen to avoid confusion with the ‘root’ side.

The examples in Figure 3.13 illustrate the uses of these terms for one combination of articulator feature values. The values are exemplified in the signs illustrated in Figure 3.14.

i. Radial ii. Ulnar iii. Tips iv. Root v. Palm vi. Dorsum

Figure 3.13

Different sides of the articulator for [selected fingers: 1, radial] and [curving: straight]

i. radial: SUPPOSE-THAT (location: chin)

ii. palm: EASY (location: chin)

iii. tip: FINLAND (location: chin)

iv. ulnar: OBEDIENT (location: temple)

v. root: CHICKEN (location: chin)

vi. dorsum: ENOUGH (location: below chin)

Figure 3.14

Examples of orientation values

In addition to only specifying one of the two degrees of freedom of the specified articulator, these feature values differ from orientation features proposed by others in four ways. First, they refer to a side of the hand rather than a direction in space, and this side of the hand faces the final place of articulation (i.e. they are relative rather than absolute). They only have an impact on the realization of a sign in combination with the specified second setting, if any, and in the absence of a change in setting, the value for major location. In other words, the orientation feature values cannot be pronounced on their own.[71] In the absence of a feature value for location, no orientation feature is specified either; see page 89 for a discussion of signs without a location feature value.

Secondly, unlike most proposals for orientation features, the values in Table 3.2 do not refer to the *hand*, but rather to the specified articulator, i.e. the combination

[71] In a broader sense this is true for all features: one cannot articulate a location without an articulator, and one cannot articulate the feature [selected fingers: 1, ulnar] without also articulating a certain location (cf. Friedman 1976). However, there is still a difference in the perceptual impact: absolute orientation features are identical for all locations and all hand configurations, while the impact of relative orientation features differs for different articulators and different locations. This 'perceptual impact', or maybe more appropriately the 'optical output' in the model proposed in §2.4, consists of the rotation of the 'flat' (or metacarpal) part of the hand in three dimensions in space – in other words, the *absolute* orientation of the *hand*.

of feature values under the articulator node. In the model that I propose, then, the hand as a whole does not have a special status. This argument will be more fully articulated in the next section (§3.4.4) and in Chapter 6. The fact that the orientation feature does not apply to the hand but rather to the specified articulator (which can be smaller or larger than the whole hand) constitutes one piece of evidence for the claim that the hand has no privileged role as an articulator.

Thirdly, an important difference between the proposed feature values and feature values for absolute orientation is that there is no arbitrary choice to specify just any degree of freedom in orientation. In specifying absolute orientations, most models and transcription systems choose to specify palm orientation (either alone or in combination with finger orientation). This may not be completely arbitrary, given the special functions of these sides of the hands in handling objects. In principle, however, it would be just as satisfactory to specify the orientation of the back of the hand and the pinkie side. Since the space with respect to which the orientation is specified is fixed, viz. the absolute space around the signer, no side of the hand is privileged in any way. Orientation relative to the location implies that one side of the articulator *is* privileged: typically only one side is specified for a sign in the present model. The side of the hand that points to the specified final location is specified. In different signs, this side can be any of the six sides of the articulator, as the examples in Figure 3.14 illustrated. Two more examples are presented in Figure 3.15. In the sign ALSO (3.15i), the radial side of the articulator is specified, and in the sign HALF illustrated in (3.15ii) the root side is specified. Neither of these two sides would be highlighted by an absolute description of orientation in terms of palm and/or finger orientation. Yet in these two signs, these two sides of the hand always face the end location, whereas the orientation of the palm and finger may vary from one realization to the next.

i. ALSO: [orientation: radial], [location: chest], [setting: away,close]

ii. Initial and final position of HALF: [orientation: root], [location: weak hand–radial], [setting: dorsum,palm]

Figure 3.15

Further examples of specification of sides other than palm and fingertips

In SLN, [palm] and [tips] seem to occur most often.[72] I hypothesize that their high frequency is largely due to iconic factors. The palmar surface of the hand and fingers and the finger tips are most frequently used in daily life in grasping and touching objects of all sorts, as well as in pointing gestures; both domains form the basis for many signs.

Fourthly, these orientation feature values are different from ‘point of contact’ features that describe which part of the hand that faces or contact the location (Mandel 1981). Whether the side of the articulator that is specified for relative orientation actually contacts the location or not is variable, but it is not phonologically contrastive (van der Kooij 1997). If the combination [away; close] is used, then relative orientation is the same as the contact side, since the movement is in the direction of the location. With the combination [close; away] the movement is away from the specified location, and in the other six combinations of setting features the movement is parallel to the specified location.[73]

Since only one degree of freedom is specified, the other degree is still open. I propose that this other degree of freedom results from the easiest articulation of the specified degree of freedom. For the moment, this easiest articulation can be defined as the smallest distance measured in joint angles between the previous state of the articulator and the target state, with the more proximal joints weighing more than the more distal joints. This measure of articulatory effort will be further discussed in Chapter 5. To be able to ‘calculate’ this easiest articulation, we need to know what

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[72] Relative orientation is not coded in the SignPhon database, and therefore I do not have access to lexical frequency data.

[73] This distinction in movement direction, parallel vs. orthogonal to a location, is expressed in Brentari (1998) as the distinction between respectively ‘tracing’ and ‘direction’, the latter being “realized at a 90˚ angle with respect to a plane” (1998: 141).

the target articulation is and what the previous state of the articulator was. Evidently, the latter will depend on the perceptual specification of the previous sign. In the case of a sign in isolation the resting position of the hands will differ depending on the posture of the signer, among other things. This variation leads to what we might call coarticulation effects for hand movements (cf. Wilcox 1992, Cheek 2000).

For example, in the sign HALF (Figure 3.15ii), as in many unbalanced two-handed signs, bringing the strong hand towards the weak hand, which typically is in front of the body at about 20 cm from the midriff, will generally be done by flexing the elbow a little over 90 degrees and rotating the upper arm inwards at the shoulder joint. The previous position in this example is assumed to be a rest position: hands hanging down by the side of the body if the signer is standing, hands resting on the lap if the signer is sitting. To make sure that the ulnar side of the four straight selected fingers faces (or actually touches) the weak hand as in HALF, the forearm has to be rotated so that it is in neutral position. In this configuration, the finger tips will point diagonally forward-contralateral, and the palm side of the fingers will point diagonally backward-contralateral. This is articulatorily 'easy' since the wrist is in neutral position and the shoulder does not have to be flexed much from its neutral position: it is the easiest way to articulate the specified location. Two other possible articulatory configurations are illustrated in Figure 3.16. The articulator, location, and orientation in these signs are the same, but the articulatory effort as measured in angular distance from the previous position is much larger.

i. Tips pointing ipsi-back, elbow high

ii. Wrist hyperextended, fingertips of both hands in the same direction same direction

Figure 3.16

Two non-existent complex articulations of location [weak hand] and orientation [ulnar]

This specific example actually applies to most two-handed signs, because most two-handed signs are made at the same location in neutral space. Only in a few motivated cases such as EXAMPLE are the hands at a different location in neutral space. In EXAMPLE the major location is [weak hand: palm], but the orientation and location of the weak hand itself are separately specified ([location: neutral space: frontal plane], [orientation: palm]). Most articulations of this specification lead to a location of the hand at shoulder height in neutral space.

There appear to be some signs in neutral space with a highly variable orientation and location. Examples include ALWAYS, NOTHING, and DIFFICULT. All of these are made on the ipsilateral side of neutral space, but the height of the location seems to vary from waist to shoulder. I propose that these signs have a location value [neutral space], but no orientation specification. This implies that both degrees of freedom of orientation are determined by the production grammar, and that ease of articulation is the most important factor determining their realization. Indeed, in most cases the wrist and forearm are in a neutral position (wrist extended and forearm between pronated and supinated). The elbow is minimally flexed, and the shoulder is rotated inwards, just enough to bring the location of the hand within signing space. One could say that this is the default signing position, and that these signs are un(der)specified not only for orientation but also for location.[74] I leave this open for future investigation, together with the prediction that the sequential context plays a large role in determining orientation and location for this sign. One also finds this location in some articulations of signs that are derived from fingerspelling, such as BLUE and LAZY, which in other cases are made at the standard fingerspelling location (ipsilaterally in neutral space, at shoulder height; palm forward). This could then be analyzed as the deletion of a location specification.

One question that remains open for investigation is whether the two feature values [radial] and [ulnar] should not actually be replaced by a single value, which I shall call [lateral]. In most signs with one of the two values [radial] or [ulnar], the other value would actually be nearly impossible to articulate. For example, the standard form of HOLIDAY has the orientation [radial] (illustrated in Figure 3.11 on page 100). Articulating the value [ulnar] in combination with the same articulator and location features would require an extreme or even impossible supination of the

[74] Brentari (1998: 155) claims that the ‘fundamental standing position’ (arms hanging by the sides of the body, palms facing the thighs; cf. Luttgens, Deutsch & Hamilton 1992) that is used in anatomy to define the terms referring to positions and movements of the joints, should also be taken to lead to a ‘default orientation’. In positing this claim, Brentari refers to Crasborn (1995). This interpretation is not what I intended in Crasborn (1995), however, and the confusion illustrates the difference between perceptual and articulatory descriptions: although there may well be a default position for the forearm joints (0 degrees pronated and supinated, an articulatory notion), the actual orientation that results from this neutral position (a perceptual notion) depends on the configuration of the whole arm and hand. If there is something like a “fundamental signing position” (Brentari 1998: 31-33), I suggest that it is rather the state of the articulators as in the sign PAUSE (similar to NAME_{ASL}): the elbows flexed 105 degrees, and the shoulder rotated inwards 45 degrees. The reason is that this is the prototypical articulator configuration that we find in these signs without an orientation specification. Brentari (1998) proposes that the fundamental *signing* position deviates from the fundamental *standing* position by 90 degrees elbow flexion and a neutral state of the forearm (0 degree rotation). The circumstantial evidence that Brentari (1998: 31, footnote 15) mentions is that in various sign languages, including ASL and SLN, the verb SIGN uses this orientation: the palms of the hands face the midsagittal plane. I propose that these signs do have an orientation specification, viz. [palm] in combination with the location [midsagittal plane], while the default orientation can be inferred only from signs that have an orientation specification that refers to the weak hand (rather than to a location in space).

forearm. I have found no signs with locations on or near the face that need a specification for [ulnar]. Similarly, there are many signs on the weak hand that are articulated with the value [ulnar], but as far as I know only one with the value [radial], This last case is PROGRAM, in which the weak hand has four extended fingers pointing up, palm pointing forward (see Figure 3.17i). The four selected extended fingers of the strong hand have the palm pointing down, while the radial side of the hand repeatedly touches the weak hand while moving down. If we analyze this sign as a repeated end-contact sign, then the setting change would be from [away] to [close], and the relative orientation would be [radial]. In this case, too, the articulation of the specification [ulnar] would be nearly impossible. Moreover, we do find alternative versions of PROGRAM in which the palm is facing the signer, and then it is always the ulnar side of the hand that faces the location (see Figure 3.17ii).[75] These might be morphologically distinct forms, where the orientation of the weak hand is the distinctive phonological property, but the forms might also be in 'free' variation.

i. Palm of weak hand pointing outward, relative orientation of strong hand [radial]

[75] I am grateful to Els van der Kooij for drawing my attention to this example.

ii. Palm of weak hand pointing inward, relative orientation of strong hand [ulnar]

Figure 3.17

Two realizations of PROGRAM

This alternation would seem to be a phonological operation if we assume distinctive features [ulnar] and [radial], whereas they would be a phonetically predictable effect if we assume a feature [lateral]. This feature [lateral] is a higher perceptual abstraction of the two more concrete features [ulnar] and [radial], which would leave it up to the phonetic implementation model to determine the actual articulation that we find in a specific case.

There does seem to be a lexical distinction between [ulnar] and [radial] if the location is the chest, though, cf. the signs in Figure 3.18.

i. YUGOSLAVIA ii. ALSO

Figure 3.18

A contrast between [ulnar] and [radial]

Signs similar to YUGOSLAVIA include IDENTITY and TIRED; signs similar to ALSO include BROTHER and GET-ACCUSTOMED-TO. The supination of the forearm required by this combination of location and orientation seems only slightly less prominent than at head location, the only difference being the position of the shoulder and elbow. It is not clear to me at this point how the shoulder and elbow influence the freedom of the forearm. This remains to be investigated, but no matter how this difference between the chest and the head locations is explained, it does exist. I therefore maintain for now that we do need two different features, [ulnar] and [radial].

The alternation that we see in PROGRAM can still be explained by reference to the lack of a large perceptual difference that is expressed by these two sides. The palm and tip sides arguably express most perceptual distinctions in the lexicon, and replacing these by [dorsal] and [root] respectively would result in a larger chance of confusion. This can be expressed in the Functional Phonology model by a lower ranking of faithfulness constraints for the features [ulnar] and [radial] than for the features [tip] and [palm]. The fact that we do not seem to find the alternations for signs on the chest (which still remains to be established) is the result of the interaction between *GESTURE and FAITH constraints.[76] This formalization will be further discussed in Chapter 5.

A third version of PROGRAM suggests yet another analysis. In this version, the repeated movement to contact is lost, and the strong hand moves downward while constantly touching the sign. This variant could be analyzed as having the two setting values [high] and then [low], and the orientation value [palm]. The variation between [ulnar] and [radial] is then allowed by the fact that this dimension of the articulator is not represented in the first place. This analysis raises the question whether the other two variants should not also be represented as downward movement, with a separate exceptional feature for repeated intermediate contact. Note that so far the downward movement in the variants in Figure 3.17 has not yet been represented. The feature [repetition] applies to the specified setting change ([away, close]), and it has nothing to say about the downward movement. I leave this problem for future research.

3.4.3.4 Exceptions: signs with two relative orientation specifications

In earlier work, Els van der Kooij and I claimed that there was a group of exceptional signs that do need a specification for absolute orientation in space (Crasborn & van der Kooij 1997), contrary to the proposal in this thesis. The exceptions consisted of classifier morphemes and iconically motivated signs. The latter group typically consisted of the weak hand in lexicalized (frozen) classifier constructions. We suggested that it may be possible to also analyze this set of signs by using relative orientation specifications, depending on the location features that are adopted. I will outline the two groups of exceptions, and present the location features that are needed for a correct analysis. The present section addresses the orientation of classifiers, the next section addresses the orientation of the weak hand. I maintain that some of these signs are exceptional, because they require a full orientation specification, specifying both degrees of freedom of the articulator.

[76] The *GESTURE constraints are a more specific form of the general *ARTICULATION constraints mentioned in Chapter 2. For example, the constraint *GESTURE(elbow, 30) is defined as 'do not make a (flexion or extension) movement of more than 30 degrees at the elbow'. This constraint family will be further introduced in Chapter 5.

However, this further specification is also interpreted with respect to specified parts of the sign other than the end setting, namely the specified location.

For many classifier handshapes, the orientation of the hand seems to be part of the perceptual specification. Although classifiers in sign language are typically thought of as *handshapes*, certain classifiers also have a lexically specified orientation.[77]

For example, the human being classifier in SLN consists not only of the 1 handshape, but also of the information ‘finger pointing upwards’. In some cases the information is also included that the palm side of the index finger iconically represents the front side of the body. Modifying this information leads to a change in meaning, viz. a change in the posture or facing of the human being. Similarly, in SLN the classifier for relatively short and wide vehicles (cars, small boats) is distinguished from the classifier for relatively long and high vehicles (bikes, buses) by its orientation only. Both have a B handshape, the former with palm pointing downwards and the latter with the palm pointing sidewards. The legs classifier is a V handshape with the fingers pointing downwards. In all these cases, it seems that the absolute orientation in space is what matters; it is certainly not the relation of a part of the hand to a place of articulation, as classifiers typically have no lexical place of articulation: they are articulated at a certain location only when combined with other phonological characteristics in forming a predicate.[78]

The hand(shape) in these signs symbolizes a particular object, the referent. This referent in reality typically has a specific orientation. For example, if a handshape (the symbol) symbolizes a car (the referent), this car typically has a fixed, absolute, orientation in space: the bottom of the car is normally facing (or is parallel to) the surface of the ground. We see the same thing in the hand(shape) symbolizing a car: its palm typically faces downwards. The palm of the hand, then, is associated with the bottom of the car, and the back of the hand is associated with the top of the car. If the car classifier is used with the palm pointing in a different direction than downwards, this is interpreted as a change in meaning, too: the interpretation of the sign could then be, for example, that the car is located on a non-horizontal surface (for example, a hill), or that the car is lying upside down. Thus, the orientation of the hand is meaningful in these cases, and the meaning seems to be interpreted with reference to the absolute space around the signer, where the signer is typically standing perpendicular to the ground. A parallel case can be made for the other classifiers, and for classifiers that are lexicalized to become the weak hand in many unbalanced two-handed signs.

I propose that these classifier articulators can also be represented by the relative orientation features discussed above, provided that there are appropriate location features. The relative orientation feature for the car classifier then is [palm], and for

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[77] For a discussion of classifiers in sign language, see for example Schick 1990; see also footnote 79 on page 117.

[78] These forms are bound morphemes, then, in the sense of having to combine with other morphemes to be realized. In not having a specified location, however, they are also ‘phonetically bound’. Handshapes and orientations simply cannot be articulated without a place of articulation, for example.

the person classifier it is [root]. A lexical location specification is required after all, then, viz. [neutral space: horizontal plane]. In actual classifier predicates, the exact locus in that horizontal plane still has to be assigned by morphological processes.

This horizontal plane is parallel to the ground surface in most cases, but it is not just the physical space around the signer to which a part of the hands relate, say the ground surface that the signer is standing or sitting on, but rather part of a conceptually constructed, imaginary, space. If the signer moves his body in a different position, for example lying down instead of sitting, then the location and orientation of signing space will also change. The orientation of the classifier in that case will change with respect to the ground surface, but not with respect to the signing space. Another case where the ground surface is not the same as the conceptualized horizontal plane is the example of a classifier construction meaning ‘a car goes uphill’, where the classifier hand is tilted and moves diagonally upward-forward. One still wants to assume there that the bottom of the car (symbolized by the palm of the hand) is facing the ground surface, but we can only do that if we assume that the conception of the ground surface has changed such that it is no longer identical with the physical ground surface that the signer is located on. Such a change of the horizontal plane is a morphosyntactic process, and we can only describe it as part of the linguistic system by reference to linguistic categories.[79]

Although in this proposal only one of the degrees of freedom of the motivated classifier hands is specified, it is possible to use both degrees of freedom of orientation in morphosyntactic processes. Thus, one can produce a construction meaning ‘a car makes a left turn’ by changing the other degree of freedom of the hand (rotating the hand 90 degrees around a vertical axis), leaving the palm of the hand pointing downwards.

One can even use the classifier hand to refer to different sides of the hand, representing someone walking around the front of the car from left to right by moving a person classifier from the left side to the right side of the car classifier. Examples like these suggest that *all* sides of the classifier can be meaningful. The orientation of all of these sides may therefore be specified depending on the morphosyntactic construction involved. For that reason these classifiers remain exceptional phonologically. Given the complexity of these constructions and the controversy in the literature on the status of such classifiers, I leave the representation of such morphosyntactic constructions open. In the simplest cases of the use of a classifier to assign a locus in signing space to a referent, I suggest that only one degree of freedom is specified. I predict that the same articulatory factors as discussed above apply in the realization of the second degree of freedom. In the case of a car, these articulatory factors result in the default orientation ‘tips pointing forward’ or ‘tips pointing diagonally forward’, depending on whether the location is in the ipsilateral or contralateral half of the signing space.

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[79] One can also assume that classifier constructions such as a car going uphill is not a linguistic process at all, but rather the equivalent of ‘gesture’ in spoken languages. This has been a hotly debated issue in sign language linguistics in recent years (Liddell 2000, Schembri 2000).

3.4.3.5 The orientation of the weak hand

A second category of cases where absolute orientation seems applicable is in specifications of the so-called ‘weak hand’ in unbalanced signs. Unbalanced signs are signs in which one hand moves, and the handshape and orientation of the weak hand can be different from those of the strong hand (van der Hulst 1996). At least for all cases where the orientation of the weak hand differs from that of the strong hand, it seems at first sight that this orientation can best be characterized in terms of absolute orientation. For example, in these signs we do not find the kind of alternation in handshape and orientation discussed in §3.4.3.2. In many cases, the weak hand closely resembles a classifier in complex predicates. The signs in which these weak hand configurations occur may have originated from a classifier construction historically (cf. Brennan 1990 on BSL).

I propose that the orientation of the weak hand is not specified at all. In balanced (symmetrical) signs, the weak hand is not specified for either articulator or orientation; it is simply the mirror image of the strong hand.[80] The feature [two-handed symmetrical] accounts for the presence of both hands. I propose that in unbalanced two-handed signs, there is no specified degree of freedom for orientation either: it is predictable from the specification of a side of the weak hand as the location for the strong hand.[81] This proposal also holds for lexicalized classifiers in unbalanced two-handed signs. As was already noted above, the majority of unbalanced two-handed signs may originally have been such classifier constructions. It appears that these classifier-derived handshapes are rarely modified productively, such that more than one orientation value would have to be specified.[82]

Thus, there are several location features referring to different sides of the weak hand (rather than orientation features): [palm], [tips], and [radial]. The feature [dorsum] seems to only occur in a few exceptional cases, such as SWEDEN, HORNY and GAY (the latter is a borrowed from a gesture in the Dutch hearing culture; the origin of the first two is not clear). The interaction between the strong hand specifications and the weak hand specifications leads the phonetic implementation model to generate a specific orientation of the weak hand. This is illustrated in Figure 3.19 for two signs which have the same location value, viz. [weak hand: palm], but different orientations. In the verb SHOW in Figure 3.19i, the weak hand is marked in some way for facing the indirect object.

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[80] I argued in Crasborn (1995) that many of Battison’s type 2 signs should be included in the group of balanced signs. These signs have the same articulator features, and the only difference from fully symmetrical type 1 signs is that only the strong hand moves. The movement in most cases differs only in direction, viz. up-down if one hand moves instead of ipsilateral-contralateral or close-away if both hands move. Whether one or two hands move in these signs is predictable on the basis of the setting features. There are no lexical contrasts in this respect, but there are contrasts in whether both hands move down independently or while in contact. Since this separate vs. joint movement is also a distinction that is found in unbalanced signs, I propose that there is a feature [linked] that accounts for this difference. This feature is specified then for signs like BREAK, SHOW, RELATIONSHIP, etc.

[81] This rather resembles Mandel’s (1981) proposals for ASL.

[82] Modification of these lexicalized constructions typically has a funny or poetic effect (Wim Emmerik, personal communication).

articulator: 1, straight

location: WH – palm (facing the indirect object)

setting: *subject, indirect object*

orientation: tip

manner: linked

i. 1-SHOW-2

articulator: all, straight

location: WH – palm

orientation: dorsum

manner: repeated

ii. PROOF

Figure 3.19

Two signs with location [weak hand: palm][83]

In PROOF, the dorsum of the strong hand moves towards the palm of the weak hand. The location specification leaves it open where in neutral space this movement occurs, and therefore different variants are predicted. Some of these are illustrated in Figure 3.20. Since the hands contact each other, the left-right location will be in the middle, but the high-low and forward-backward location can still vary. Different amounts of elbow flexion will lead to different locations and absolute orientations, although wrist movement in particular can contribute to changing the absolute orientation of the palm. The prediction is that the most faithful outputs will be relatively high in space, and have the palms pointing upwards (Figure 3.20i): in that

[83] It is not quite clear at this point how it should be expressed that the palm of the weak hand faces the indirect object. these linked unbalanced signs such as show, the orientation specification indicates which side of the strong articulator faces the location; the setting change specifies the movement of both hands in tandem, rather than the movement of one articulator with respect to the other.

case the movement is from high to low and therefore more visible than if the movement were from back to front (Figure 3.20ii), or if the location were low in space (Figure 3.20iii). The latter output would require much less wrist flexion, and is therefore a winning output if *GESTURE constraints are higher ranked.

In all three realizations the movement is towards the palm of the weak hand; what differs is how easy it is to perceive this movement. The assumption I use is that, in general, up-down movement is easier to perceive than forward-backward movement. In the specific case of Figure 3.20ii, the movement of the strong hand is also obscured a little by the weak hand, which is between the perceiver and the moving strong hand. It does resemble most closely the typical citation form, though.

i. Perceptual output: high, up-down movement

ii. Perceptual output: high, forward-backward movement

iii. Perceptual output: low, up-down movement

Figure 3.20

Initial and final state of three hypothetical articulations of PROOF

3.4.3.6 Orientation changes

One question that still needs to be answered is how these orientation features can be used to represent orientation changes. The different versions of the Leiden model have adopted Stack's (1988) position that there is no need for movement segments, given two skeletal positions, and therefore that all movement can be considered to be feature change (van der Hulst 1993, 2000, van der Kooij 1994, Crasborn & van der Kooij to appear). Are all changes in orientation to be represented as a change in specification for relative orientation, then?

Looking at a sign such as TRANSLATE, illustrated in Figure 3.21, one could use the sequence [palm, dorsum]. This representation is possible because the 'axis of rotation' is parallel to the specified location. The axis about which the hand rotates in TRANSLATE runs from the root side of the hand to the tip side of the hand. The result of this rotation is that two dimensions of orientation change with respect to the specified location (the palm of the weak hand). The facing of the palm, dorsum, ulnar, and radial sides of the hand change, while the facing of the root and tip side remain constant.

Figure 3.21

TRANSLATE

More generally, it is true that if an object rotates around one axis, the orientation of both other axes perpendicular to the first one changes. The three axes are illustrated in Figure 3.22.

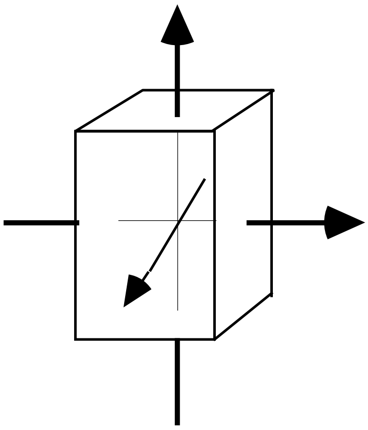


Figure 3.22

Changes in orientation in a three-dimensional object

For sign language, this can be paraphrased as follows: if the orientation of one specified degree of freedom of the hand changes, then two sides of the hand do not change orientation while the four other sides do. This is illustrated in Figure 3.23 for a change in 'palm orientation'.

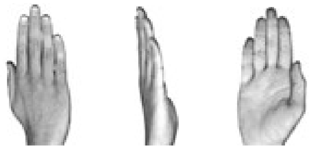


Figure 3.23

Change in palm orientation

The orientation of the root and tips stays constant in this gesture, while the orientation of palm, dorsum, ulnar and radial sides all change. Because of the focus of sign phonology on palm and finger orientation, three-way classifications have been made: there is a change in either palm or finger orientation, or a change in both. In reality, minimally two (and sometimes all three) dimensions of orientation change at the same time. Phonetically, there is nothing complex in a change in both finger and palm orientation (i.e. rotation about the radial-ulnar axis) compared to a change in either finger orientation or palm orientation alone. Nor do I know of any phonological property that would make a change in both palm and finger orientation more complex.

A representation in terms of a contour of feature values is impossible, however, if the axis of rotation is not parallel to but orthogonal to the specified location. In the sign DRUNK (Figure 3.24), the hand rotates about an axis that runs from the radial side to the ulnar side of the hand. Throughout the sign, the radial side of the hand keeps facing the specified location (and not the end setting as there is no setting change in this sign), namely the nose.

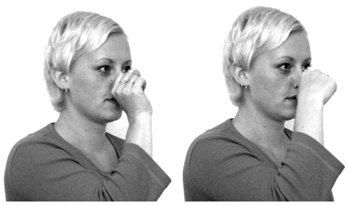


Figure 3.24

DRUNK

Thus, there are some signs with orientation changes around only one axis that cannot be described by a sequence of relative orientation features. In these signs the specified relative orientation value stays constant, or in other words, the axis of rotation is perpendicular to the end setting (or the place of articulation). Further examples include FAR-AWAY, LOCKED, SHY, and FIRST, and POLITICS (Figure 3.25).

Figure 3.25

POLITICS

The arrow indicates the axis about which the hand rotates, and just like the fingertips, which are selected for relative orientation, it points towards the palm of the weak hand, which is specified as the major location. The movement could be described by saying that the orientation of the palm in space is first down and then back, for example.

In the literature, changes in orientation are also often described by referring to articulatory gestures, such as forearm rotation and wrist extension (Stokoe 1960, Nagahara 1988, Brentari 1998). For example, in the case of POLITICS, one could say that the orientation is first 'prone' and then 'supine'. In the first ASL analysis, Stokoe (1960: 87) distinguished "twisting motion" of the forearm (pronating, supinating, and oscillating) from "carpal motion" (nodding or shaking wrist).

Changing hand orientation about one axis can indeed be accomplished by simple movement at just one joint (e.g. rotation of the forearm, flexion at the wrist, sidewards flexion at the wrist; cf. the definitions and illustrations in Brentari 1998: 155-157), but I claim that these articulatory categories are not a good way of describing the sign's phonological form. In the case of POLITICS (which is almost identical to $\text{MEANING}_{\text{ASL}}$), for example, the change in orientation is articulated by forearm rotation alone in case the wrist and MCP joints are fully extended, as in Figure 3.25. However, in an alternative articulation, where the wrist and/or MCP joints are flexed, a more complex combined movement of the forearm and wrist occurs, in such a way that the orientation and change in orientation of the selected index and middle fingers are the same as in Figure 3.25. This is illustrated in Figure 3.26.

i. Initial state: forearm prone, wrist slightly flexed, MCP joints flexed

ii. Final state: forearm supine, wrist extended and slightly adducted, MCP joints flexed

Figure 3.26

POLITICS, *alternative articulation*

While the forearm rotates, the wrist flexes and adducts in order to limit the change in orientation of the fingers to only one dimension (the same as in Figure 3.25). Hypothetically, the reason why this articulation is sometimes preferred is because it greatly reduces the articulatory effort involved: the shoulder does not have to be abducted as much as in Figure 3.25 in order to realize the desired orientation of the finger tips. The generalization about the movement in the different realizations is a perceptual one, then, referring to the change in orientation of the palm side of the selected articulator (or the back, ulnar, or radial sides). Although a change in position of the forearm is certainly involved, it is not the key feature of the sign that changes. Figure 3.27ii illustrates the final state of the sign in 3.26 that would result from only supinating the forearm.

i. Initial state: forearm prone, wrist slightly flexed, MCP joints flexed

ii. Final state: forearm supine, wrist slightly flexed, MCP joints flexed

Figure 3.27

Non-existent version of POLITICS

I propose to represent all changes in orientation by reference to the three axes about which movement can occur: the longitudinal axis, the radial-ulnar axis, and the front-back axis. These are illustrated in Figure 3.28.

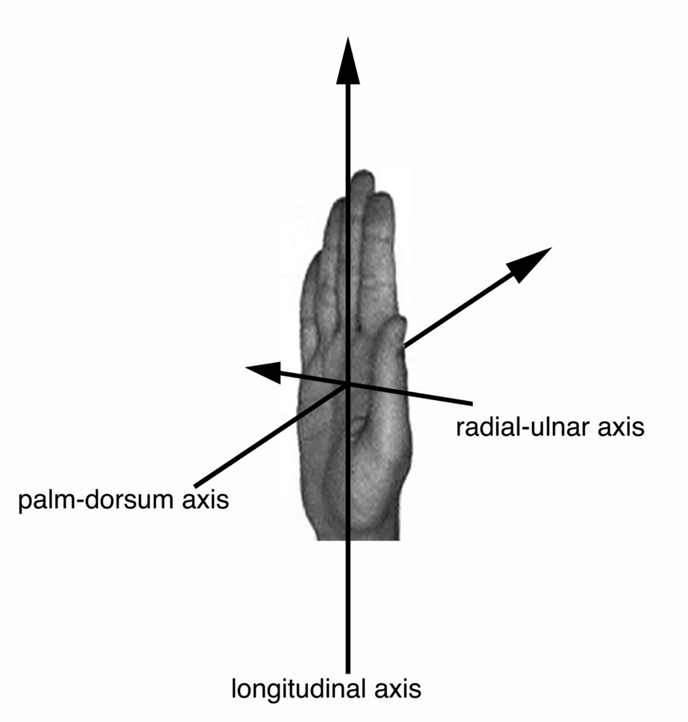


Figure 3.28

Three axes of rotation for articulator [all; extended]

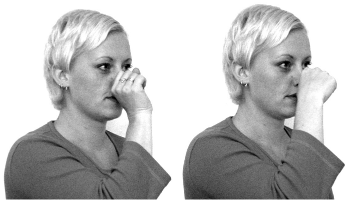
The definition of these three ways to rotate the articulator does not contain any information about the articulation that is used to produce them. Although the involvement of some articulations (such as forearm rotation) will be more frequent than others (such as MCP flexion), this information is not included in the lexical specification of signs, but rather a matter of phonetic implementation. In terms of the nature and definition of the orientation change features, this proposal differs markedly from the articulatory definitions in Brentari (1998); the two proposals resemble each other both in proposing six different features and in characterizing these changes as 'movements' rather than changes from one value to the next.

Each axis can rotate in two directions, clockwise and counterclockwise. The degree of rotation is not lexically distinctive. The size of the rotation is generally between 90 and 180 degrees. I hypothesize that the actual size is predictable, and that in part articulatory factors play a role in limiting the movement size. If a movement is articulated by wrist extension, for example, as in Figure 3.29ii, then the movement size will be limited by the initial position of the wrist. The directions 'clockwise' and 'counterclockwise' should be interpreted by looking in the direction of the arrows in Figure 3.28, and are always assigned from the perspective of the right hand. Examples are presented in Figure 3.29.

i. Longitudinal: clockwise, FIRST

ii. Longitudinal: counterclockwise, TWENTY

iii. Radial-ulnar: clockwise, OPEN



iv. Radial-ulnar: counterclockwise, DRUNK

v. Palm-dorsum: clockwise, ERECTION

vi. Palm-dorsum: counterclockwise, READY

Figure 3.29

Changes in orientation

The advantage of using these axes to specify orientation changes is firstly that there is no longer a privileged role for any side of the hand, and secondly that this movement can be interpreted without reference to absolute directions in space. For example, in the case of TWENTY, not only the palm orientation changes, but also the orientation of the dorsum and the radial and ulnar sides of the two selected fingers. Furthermore, the rotation will be the same no matter whether the relative orientation (in TWENTY [root] facing a [horizontal plane] in neutral space) is faithfully realized or not. As I argued in §3.4.2, there is no fundamental difference between the dynamic terms on the one hand and changes in static terms on the other. Dynamic terms such as 'clockwise' and 'counterclockwise' might be decomposed into sequences of values.

Given the limited range of lateral motion (adduction/abduction) of the wrist and the MCP joints (about 50 degrees for the wrist, cf. Luttgens, Deutsch & Hamilton 1992), it is not surprising that palm-dorsum rotation is so infrequent. In cases where the wrist and MCP joints are extended, this is the articulatory action that results in the perception of rotation around the palm-dorsum axis. Similarly, given the large range of motion of the forearm (about 160 degrees, cf. Luttgens et al. 1992), it is not surprising that the perceptual result typically associated with it when wrist and MCP joints are extended is so frequent (viz. rotation around the longitudinal axis). However, the gesture [forearm rotation] can also be used to articulate rotation about the palm-dorsum axis, if the extended fingers are at about a 90 degree angle to the forearm. This angle can be articulated by either wrist or MCP flexion, or both. For example, the sign MORNING, which is typically articulated by outward shoulder rotation (Figure 3.30) can also be articulated by supination of the forearm (Figure 3.31), depending on the state of the wrist and MCP joints.[84]

Figure 3.30

MORNING, *(primarily) articulated by outward shoulder rotation*

[84] In both signs, these articulations are typically accompanied by smaller movements of the other joints, which ensure that the orientation of the other degree of freedom remains relatively constant and that the movement is in the frontal plane. These additional joint movements play less of a role than in the example of POLITICS above (Figure 3.25), yet the effect is the same: different joints cooperate to attain perceptually similar effects.

Figure 3.31

MORNING, (primarily) articulated by forearm supination

In most changes in orientation in SLN, there is a change in orientation around only one axis. Changes in orientation around two axes are very rare, if they exist at all. A possible example is the sign QUICK (Figure 3.32).

Figure 3.32

QUICK, a change in orientation by rotation of the selected index finger about two axes

The sign QUICK contrasts with THOUSAND (Figure 3.33), in which there is only rotation about the palm-dorsum axis.

Figure 3.33

THOUSAND

It remains a question for future research whether there are more signs such as QUICK with a complex orientation change, and whether there is a more simple specification for this sign than a double orientation change. For now, I propose the specification for this sign includes a combination of [longitudinal axis: clockwise] and [palm-dorsum axis: counterclockwise].

3.4.4 Articulator

3.4.4.1 Introduction

Early descriptive works treated handshape as a phonemic unit: each handshape received a name or a symbol (Stokoe 1978 for ASL; Harder & Schermer 1986 for SLN).[85] It has been argued that the conception of handshapes as holistic phonemes is problematic. For instance, it remains unexplained why handshape sequences cannot involve any randomly chosen set of handshape phonemes. Because these changes are restricted, Mandel (1981) introduced a distinction between *finger selection* and *finger configuration*, and this distinction has been used in handshape models ever since (e.g. Sandler 1989, Corina 1990). The distinction makes it possible to express the generalization that only finger configuration can change in simple signs, and not finger selection. One or more fingers can be phonologically relevant, and features apply to this selection to determine the bending of these fingers at different joints and to different degrees. Mandel (1981) was also the first to state that the MCP joint can act distinctively in the phonology of ASL.

The description of finger configuration can be further subdivided into three categories; these are listed in (3.3). The MCP joint is distinguished from the PIP and DIP joints for each finger; the former is sometimes called 'base joint', the latter two 'non-base joints' (Uyechi 1996, Crasborn & van der Kooij to appear). The thumb only has one interphalangeal joint, which I will refer to as IP.

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[85] This section is based in part on work done in collaboration with Els van der Kooij; cf. Crasborn & van der Kooij (to appear); see also van der Kooij (in prep.) for a similar discussion.

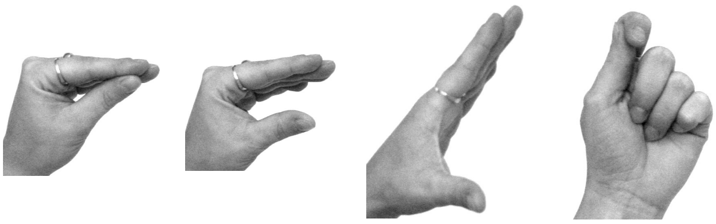
(3.3) Three aspects of finger configuration

1. *Spreading*: the abduction of two or more selected fingers at the MCP joint
2. *Aperture*: the opening relation between the selected fingers and the opposed thumb[86]
3. *Flexion of the fingers*: flexion at the MCP joints is distinguished from flexion at the PIP/DIP joints, and the degree of flexion has also been identified as phonologically relevant

The feature [spreading] can only be specified over sets of more than one selected finger, and it plays a limited role in contrasting different signs in the lexicon. The feature [aperture] has mainly been discussed in the context of hand internal movements (movements of the fingers and thumb). The feature [flexion] seems to be more important in distinguishing different handshapes, as a further distinction has been made within this category: flexion of the MCP joints is distinguished from flexion at the PIP/DIP joints.

Different degrees of aperture are illustrated in Figure 3.34; I propose that only the features [open] and [closed] are needed to describe all phonological contrasts in opening. Intermediate values (Figure 3.34i) are seen when there is repetition of movement, in both opening and closing movements. The intermediate value 'half open' also appears when there is no change in aperture and the specification is [open]. This configuration mostly occurs in handling classifiers for certain types of objects, such as books ([selected finger: all]) or sweets ([selected finger: 1]). In addition to opening, another dimension of aperture is 'adduction', which appears in the 'money handshape' (Figure 3.34iv) and in the exceptional case of the fingerspelling letter 'K' that occurs in initialized lexical items such as YOU-ARE-RIGHT (Dutch ***k****lopt*).

[86] Opposed refers to the thumb being both abducted and hyperflexed at its carpometacarpal joints, and often flexed at the metacarpophalangeal joints.



i. closed
value: [closed]

ii. half open
value: [open]

iii. open
value: [open]

iv. adducted
value: [adducted]

Figure 3.34

Examples of aperture specifications

The distinction in flexion of the fingers at the MCP joints vs. the PIP/DIP joints is illustrated in Figure 3.35. The flexion of *both* types of joints is not illustrated here; this leads to the category ‘curved’.

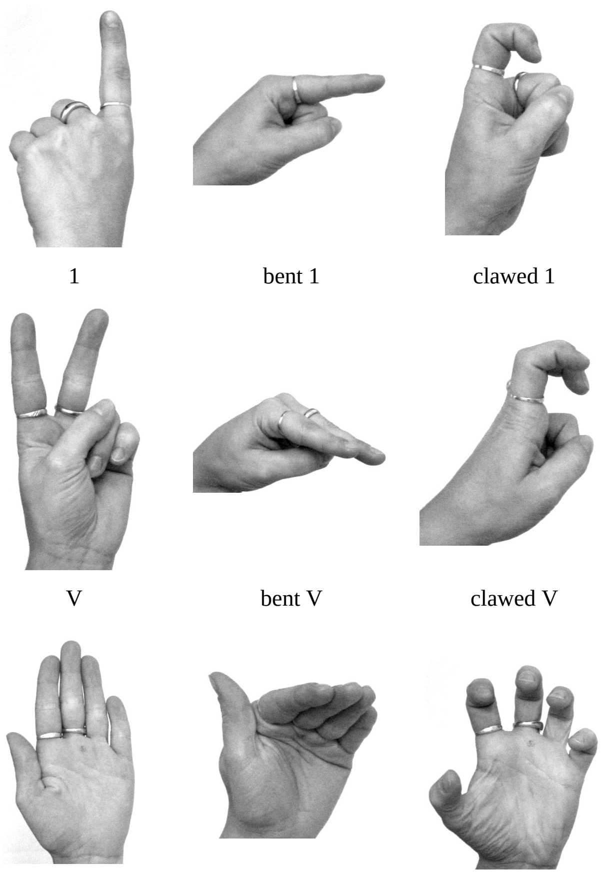


Figure 3.35

Flexion at different joints

In SLN these distinctions in finger position have been considered to be contrastive for handshapes with one and four selected fingers, either implicitly (NSDSK 1988, KOMVA 1993) or explicitly (Schermer et al. 1991). These distinctions have also been argued to play a role in other sign languages (e.g. Corina 1990 for ASL).

In the literature on ASL, the feature referring to the MCP joint position has been assumed to account for the difference between the ‘B’ and ‘bent B’ handshapes.[87]

[87] Different names have been used in the literature for handshapes with ±90 degree base joint flexion, such as ‘angled’, ‘flat bent’ and ‘bent’. I will use the term ‘bent’. It is questionable whether 90 degree

No model accounts for the fact that this feature also predicts the occurrence of the non-existing ‘bent V’ and ‘bent 1’ (among others) as distinctive handshapes. For SLN, however, the bent index finger is adopted in the set of occurring handshapes (Schermer et al. 1991).

A feature referring specifically to the MCP joint is also invoked to describe movement at this joint. For example, Liddell (1990) and Liddell & Johnson (1989), who refer to this change in handshape as ‘flattening’, have a feature in their model to account for this movement. Earlier, Friedman (1976) coined the term ‘bend-knuckles’ for this movement. Similar use of a feature referring to the MCP joint has been made by Sandler (1989), Uyechi (1996), and Brentari, van der Hulst, van der Kooij & Sandler (1996), among others.

One of the most recent overall models for the handshape parameter was proposed by Brentari et al. (1996), illustrated in Figure 3.36. The model uses the framework of dependency phonology (cf. Dresher & van der Hulst 1994). In this framework, phonological structures are binary branching, and the two nodes in any pair stand in a head-dependent relationship to each other. Each dependent node adds complexity to the representation of a head, thus expressing markedness. The main distinction in the model is between finger selection and its dependent finger configuration. I will not discuss the finger selection node here; see van der Kooij (in prep.) for discussion. The finger configuration node dominates spreading, aperture, and flexion. Under the flexion node, the dependent value [base] specifies the type of flexion and contributes to greater complexity of the sign. [flex, base] is realized as flexion at the MCP joints. However, in the motivation of this feature, no specific claim is made regarding its distinctivity. The aim of this section is to show that we do not need the feature [base], and to outline the implications of this conclusion.

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flexion is possible for all the MCP joints, and whether this maximally flexed position occurs frequently. In many tokens, about 80 degree flexion occurs. Below, I will disregard this detail, and refer to either ‘full MCP flexion’ or ‘90 degree MCP flexion’.

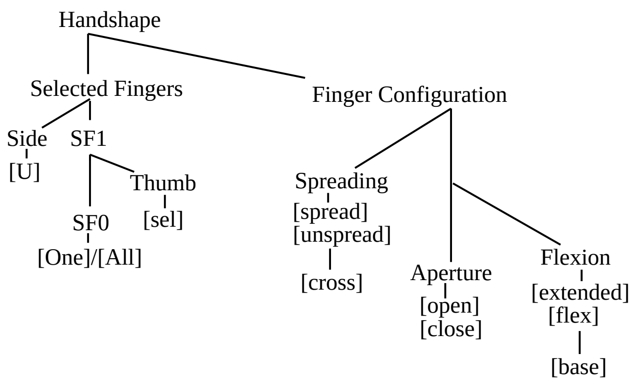

Figure 3.36

The 'One, All' model (Brentari et al. 1996)

There has been some anecdotal discussion of allophonic variation between handshapes differing in MCP joint flexion only. Friedman (1976) suggests that bent B (full MCP joint flexion, close to 90 degrees) occurs as an allophone of B as the end position of a movement at the MCP joint, and also in "nonlexicalized gestures such as one indicating the surface and sides of a table" (p. 20). Alternation in MCP joint flexion also occurs in fingerspelling of M and N (3 and 2 fingers selected, respectively). Boyes Braem (1981) also mentions that B-bent seems to function as a variant of the B hand. She links this observation to contact, either with the body or the weak hand. She also specifically mentions signs where the back of the hand contacts the face. As I mentioned in the discussion on orientation (§3.4.3.1), Greftegreff (1992) argued that for indexical signs the orientation of the finger tip is the crucial perceptual target, and the flexing of the index finger joints is subordinate to this. Wallin (1996) notes that for some classifiers with 1, 2 or 4 fingers selected, alternate versions exist that have full MCP joint flexion. He states that these are "allomorph[s] which [are] articulatorily conditioned" (p. 108), but does not discuss what he means by this, nor when these alternates occur.

There are three arguments that plead against a phonological status for the MCP joint position, which will be discussed in the next two sections. The first argument comes from the absence of minimal pairs (§3.4.4.2). The second is that we do not need a feature specifying MCP joint states to correctly describe the surface representations of citation forms of signs that either have MCP joint flexion in their citation form, or that have movement at the MCP joint (§3.4.4.3). The third argument against a phonological status for the MCP joint is that its state is predictable on the basis of other specifications (§3.4.4.4). There is abundant variation in the state of the MCP joints in different realizations of the same sign, and MCP state co-varies with changes in these other specifications. The variation can be dealt with in a more elegant way if there is no specification for the MCP joint itself, I will argue.

3.4.4.2 The absence of minimal pairs

One of the reasons to assume the existence of a phonological feature is that it systematically distinguishes between minimal pairs in the lexicon in a particular language.[88] In the finger flexion node at least two types of flexion have been distinguished (cf. discussion above); flexion of MCP joints and flexion at the PIP/DIP joints. PIP/DIP joint flexion is distinctive in signs containing all sets of selected fingers, as is illustrated by the following minimal pairs.

selected fingers	flexed	non-flexed
1	PROSTITUTE	ABLE
2	DEPENDENT	RENT
4	CHARACTER	RELIEVED

Table 3.3

Minimal pairs differing in flexion of the PIP/DIP joints

i. RENT

[88] The other traditional argument for the existence of a phonological feature is that the feature is needed to describe a phonological process. In studies of sign languages to date only very few processes have been described, and none of them involves finger configuration.

ii. DEPENDENT

Figure 3.37

The minimal pair RENT vs. DEPENDENT

For MCP joint flexion, however, there are no such minimal pairs. Of course it is impossible to conclusively demonstrate the non-existence of minimal pairs. There may be a pair of signs so far undetected, or a new sign might be coined that is distinguished by MCP joint position only. In principle, finding minimal pairs is the task of those who claim MCP joint flexion to be phonologically relevant. As mentioned above, this has not been done in the literature that I know of.[89] In Table 3.4, some conceivable minimal pairs of signs are given, one member being an actual citation form of the sign (the underlined form), the other being a conceivable but non-existing sign. In many cases this other member is a possible variant of the actual citation form.

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[89] Brentari (personal communication) mentions one possible minimal pair in ASL, viz. $\text{AGAIN}_{\text{ASL}}$ vs. SUE_{ASL}. If this this pair cannot be analyzed as a distinction in either orientation-location features or manner features, comparable to the pair DOG vs. WAIT, the present analysis would have to be adapted. Further, Brentari notes that base flexion distinguishes between the morphologically (or possibly iconically) related pair WALK_{ASL} and $\text{WALK-ON-TIPTOES}_{\text{ASL}}$. I leave these issues open for future research.

location	sign	handshape variants	status of variant
in space	CALL	B-bent or B	latter feels awkward
	LOOK	V or V-bent	actual ‘free’ variants[90]
	INDEX	1 or 1-bent	depends on what is pointed at
on the body	ALSO	B or B-bent	latter feels awkward
	BROTHER	V or V-bent	latter feels awkward
	NORMAL	1 or 1-bent	latter feels awkward
on the head	KNOW	B or B-bent	actual ‘free’ variants
	TRY	H or H-bent	actual ‘free’ variants
	SHY	1 or 1-bent	actual ‘free’ variants

Table 3.4

Actual citation forms and their minimally contrasting counterparts

Next to these imaginary minimal pairs, a few potential minimal pairs were found, examples of which are given in Figures 3.38 and 3.39. I will argue below that these pairs do not differ in handshape, but rather in their orientation and location specifications.

i. DOG

[90] Stating that a variant is ‘free’ is intended as a shorthand for ‘the source of the variation is not known’ (cf. Joos 1968). One possible source is discussed below, viz. differences in the realization of location.

ii. WAIT

Figure 3.38

The minimal pair DOG vs. WAIT

Both signs in 3.38 consist of a repeated downward movement in front of the lower chest, palms facing downwards. DOG has MCP joint flexion, WAIT is made with the MCP joints extended. Comparable pairs of signs are STOP vs. CALL (Figure 3.44 below), and BAKE vs. FUCK.

i. CAR-MOVE-FORWARD

ii. CALL

Figure 3.39

The minimal pair CAR-MOVE-FORWARD vs. CALL

CAR-MOVE-FORWARD is a classifier predicate consisting of a B hand, palm facing downwards, MCP joints extended.[91] The fingertips refer to the front of the car, the palm side of the hand represents the bottom of the car. The sign CALL is a so-called 'orientational verb', made with flexed MCP joints. The palm of the hand and the fingertips point in the direction of the object of the verb. The handshape of the classifier CAR differs from the sign CALL in MCP joint flexion only.

The questions are why we do not find minimal pairs as in Table 3.4, why some of these pairs are free variants, and how apparent minimal pairs such as DOG vs. WAIT and CAR-MOVE-FORWARD vs. CALL are to be phonologically specified. Below I will try to answer these questions by linking the occurrence of B-bent to other formal aspects and to semantic-morphological or iconic motivation of the shape.

3.4.4.3 No role for a feature [MCP] in the description of surface forms

3.4.4.3.1 Signs with MCP joint flexion in their citation form

The data used to investigate the potential contrast between signs with MCP joint flexion and signs without MCP joint flexion came from different sources. The main source is SignPhon (see §3.2.3 and Appendix B). Dictionary CD-ROMs made for educational purposes (NSDSK 1996, 1997ab) were also used. Both sources offered the opportunity to compare most of the signs in their citation form to a version of the same sign in context. we found a great deal of variation in MCP joint position when comparing these different contexts, that is, citation forms vs. forms in phrasal contexts. Because in most cases we could only compare the citation form to one instantiation of the sign in (a randomly occurring) context, we cannot make any significant generalizations as to the nature of the influence of context. However, the frequent occurrence of variation in MCP joint position across the lexicon, for both flexed and unflexed citation forms, demands an explanation.

[91] There is another lexical item that is more commonly used as the noun 'car'. The sign I refer to here is actually a classifier predicate with the meaning 'a car moves forward'. For sake of ease I gloss it as CAR-MOVE-FORWARD.

Both for signs with extended fingers (that is, without MCP joint flexion) and for signs with (full) MCP joint flexion in the citation forms, we find variation in the actual amount of MCP joint flexion in different realizations of the sign. In fact, the whole range of possible amount of flexion occurs, from –30 degrees (hyper-extended), as in PENGUIN, to almost 90 degrees (flexed), as in CALL. This contrasts with claims about other sign languages that there are two allophones of some handshapes, one with 0 and one with 90 degree flexion (e.g. Wallin 1996 for Swedish Sign Language).

Not only did we find variation in MCP joint position between signs in citation form vs. sentence context, but also variation in the realization of the MCP joint in different morphological contexts. The SLN compound sign PARENTS is composed of the signs FATHER and MOTHER. In citation form, sometimes both members of the compound are articulated with an extended index finger, as in Figure 3.39. In the citation form of the compound, however, the sign MOTHER is found with the index finger flexed at the MCP joint, whereas the part FATHER has the MCP joint of the index finger extended (see the illustrations in 3.40ii).

i. in isolation

ii. in the compound PARENTS (FATHER+MOTHER)

Figure 3.40

MOTHER

Different morphosyntactic contexts can also give rise to different MCP joint positions. For instance, in the verb sign VISIT (Figure 3.41), a B-hand moves from a location near the locus of the semantic source to a location near the locus of the semantic goal, the fingertips pointing in the direction of the goal’s locus. If the goal of VISIT is the first person, we always find MCP joint flexion, despite the fact that it *is* possible to touch the chest while bending the wrist, thus leaving the MCP joint position of the citation form unaltered.

i. 1-VISIT-2 ‘I visit you’

ii. 3-VISIT-1 ‘s/he visits me’

Figure 3.41

Two forms of the verb VISIT

In order to find out what might determine this variation and the specific MCP joint state in the citation form we examined signs that contain handshapes with MCP joint flexion in their citation form. we assumed that these signs in particular would be good candidates for an underlying specification of [base]. In total we found 225 different signs that occurred with bent handshapes, in either the SignPhon database or the Dutch dictionary CD-ROMs, or in both. (We did not consider handshapes containing an aperture specification, although below I will discuss the influence of aperture specification on MCP joint flexion.)

Examining these citation forms, We found that other formational aspects of the sign seemed to determine the actual state of the MCP joints: in none of them is a *phonological specification* of MCP joint flexion needed to determine the phonetic surface form. we distinguish three factors, listed in (3.4).

(3.4) Factors explaining MCP joint flexion in citation forms

1. Aperture specification
2. Relative orientation and location specifications
3. The presence of semantic motivation for the articulator shape

I will discuss these three factors in §3.4.4.4. we consider these to be the three main factors responsible for the occurrence of MCP joint flexion in the 225 citation forms that we found. In establishing this set, we left out handshapes involving aperture specifications, because the opposed position of the thumb clearly sets them apart from the remaining cases. The distribution of these signs over the two other factors is given in Table 3.5. The distinctions within the categories will be discussed below.

selected fingers	**space**	**body**	**relative orientation total**	**shape**	**delimiter**	**semantic total**	**rest**
1 (n=95)	47	48	95 (100%)	–	–		
2 (n=15)	10	5	15 (100%)	–	–		
4 (n=115)	37	28	65 (57%)	18	18	36 (31%)	14 (12%)

Table 3.5

Frequency of the different factors

From this table, we can conclude that relative orientation is an important factor for all sets of selected fingers, whereas semantic motivation only seems to play a role in signs with 4 fingers selected. In the category of 4-hands, 14 signs (12%) are put in the category 'rest'. All of these signs containing a B-bent were either a variant of the C-hand, or the source of the variation could not be established (i.e. 'free variation').

Of the two main factors in Table 3.5, the role of relative orientation is most frequent. Moreover, it is also important in that it plays a role in two other situations. Firstly, I will argue that the apparent minimal pairs illustrated in Figures 3.37 and 3.38 above can be analyzed as having the same articulator specification, but different orientation and/or location specifications. Secondly, I hypothesize that the same line of reasoning that I use to explain the bent citation forms can be applied to predict the MCP position state of *any* sign in different contexts, whether sentence context (coarticulation) or sociolinguistic context.

3.4.4.3.2 Signs with MCP joint movement in their citation form

A few signs have a change in MCP joint position in their citation forms, while the other finger joints do not change state. At first sight, these seem to resemble signs with movement at the PIP/DIP joints, such as DEPENDENT, TOILET, or PHOTO, which have a contour for the feature [curved]. I propose that contrary to these changes in the PIP/DIP joint, the changes in MCP joint position are not phonological contours in feature values, but are in fact realizations of a path movement (that is, a change in location), following the hypothesis in van der Hulst (1995).[92] An example of such a change is the sign OFFER.

Figure 3.42

OFFER

Other examples are LICK, SEPTEMBER, AUGUST, LATE, WARM-FOOD, WARM-WEATHER, PAST.

Uyechi (1996) argues that in ASL, the sign PAST_{ASL} has three different forms: one with MCP joint flexion, one with wrist flexion, and one with elbow flexion. They seem to be in free variation. The same sign in SLN (also glossed as PAST) does have different meanings signaled by the different articulations, referring to the recent, intermediate, and more distant past, respectively. I do not consider these data to contradict our proposal. In many constructions in SLN, the size of the movement can modify the lexical meaning of the morphemes involved. In so-called classifier predicates, changing the size of the movement is used to express changes in size of the objects, movements, etc. that the signs refer to.

[92] A similar proposal is made in Brentari (1998) to cover free variation of sign movements in general. However, Brentari does not specifically propose that *all* base joint movements should be considered as reduced path movements, as van der Hulst (1995) does. She seems to imply that all handshape changes can be 'phonetically enhanced' by articulating them with joints proximal to the MCP joints, but in general she is not very explicit about what the different (reduced and enhanced) forms of a given phonological parameter look like.

Uyechi suggests that the three forms of PAST$_{ASL}$ have three different phonological representations. They are, respectively, a handshape change, an orientation change, and a location change. My proposal makes it possible to see all of these movements as location changes, with constant location, relative orientation and finger selection specifications. What differs is not the phonological specification of the movement, but rather the size of the phonetic realization of this movement. Actually, this can be expressed in different ways, as the size of the moving articulator varies, as well as the size of the path that the endpoint of the articulator traces through space. The size of the movement is not only influenced by morphosyntactic operations, but also by extra-linguistic factors (e.g. Koenen et al. 1993). We can therefore formulate the hypothesis that different kinds of movements occur in different situations. This hypothesis will be further discussed at the end of this chapter, and tested in Chapter 4.

In Brentari (1998), a feature [base] is proposed for a full phonological analysis of handshape changes ASL. This analysis includes considerations of redundancy and predictability that are not taken into account here. Without a feature [base], but with the curving and aperture features proposed here, all handshape changes in SLN can be described. However, van der Kooij (in prep.) argues on phonological grounds that the feature [base] is not necessary for SLN at all.

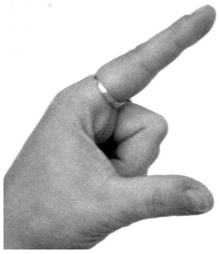
3.4.4.4 Factors involved in determining MCP joint position

In this section I will demonstrate how the three factors listed in Table 3.5 give rise to various configurations of the MCP joint. As I pointed out above, in principle this is analogous to determining the (prototypical) wrist or elbow state for a given sign in its citation form. Although the latter has never been done before, I consider it part of the task of phonology to discuss the phonetic implementation of signs as well, including the MCP joint state in different articulations. This is not only interesting in itself, but also a necessary step in demonstrating that MCP joint flexion is not phonologically specified, but predictable from other factors.

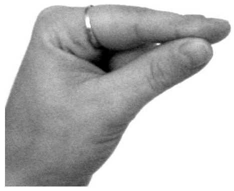
3.4.4.4.1 Aperture

One set of handshapes that involve flexion at the MCP joint are handshapes with an aperture specification. In the handshape model in Figure 3.36, two aperture features were introduced, [open] and [closed]. Aperture specifies the relation between an opposed thumb and the selected fingers (see Figure 3.34). In combining these aperture features with the two features for finger flexion we end up with a four-way contrast, as is illustrated in Figure 3.43 for handshapes with the index finger selected. The same contrast exists for handshapes with all fingers selected, and also, but less frequently, for signs with index and middle finger selected.[93]

[93] Actually, the SignPhon corpus that was available at that time contained 2,522 signs. In that set, only one sign with an aperture specification occurred that had two selected fingers, compared to 130 signs with one selected finger and 172 with all fingers selected.



i. [open]



ii. [closed]

iii. [closed], [curved]

iv. [open], [curved]

Figure 3.43

A four-way contrast in finger configuration

I propose that this four-way contrast can also be described by just one flexion feature: [curved]. If aperture consists of an [open] relation between the thumb and the pad of the selected finger(s), it is simply impossible to articulate this relation without flexing at the MCP joint. This redundant behavior of the MCP joint suggests that in these cases no phonological feature is needed to describe it. Moreover, in SLN the handshapes in 3.43i and 3.43ii, and the changes between them, are more frequent than those in 3.43iii and 3.43iv, for any set of selected fingers.[94] This is accurately reflected by the relatively unmarked representation of the handshapes in 3.43i and 3.43ii with one binary aperture feature only, and no flexion feature. The handshapes in 3.43iii and 3.43iv, which occur less frequently, are representationally more complex in having a flexion feature as well as an aperture specification.

3.4.4.4.2 Relative orientation

I will first show how the specification of orientation proposed earlier in this chapter leads to different MCP joint states, and discuss the impact this has on our conception

[94] In the same corpus of 2522 signs, 'flat' handshapes were 1.5 times as frequent as 'round' handshapes for signs with one selected finger, and 1.2 times as frequent for signs with four selected fingers.

of handshape. Second, I discuss the phonetic motivation that underlies these phenomena.

I propose with respect to MCP joint flexion that the relative orientation of the *fingers* with respect to the location is kept constant. This holds for all cases except for those with an aperture specification and the exceptions discussed below. The rest of the hand, or more precisely the part of the articulator proximal to the MCP joints (the flat part of the hand, the forearm, the upper arm), does not form a part of the phonologically relevant articulator, but rather is a part of the body that helps implementing the location and relative orientation of the articulator (the fingers).[95]

The apparent minimal pairs that were discussed above, such as STOP vs. CALL, actually differ in relative orientation, and not in articulator configuration (see the illustrations in Figure 3.44 below). STOP has a location somewhere in the signing space at shoulder height; the actual location varies depending on the morphosyntactic context. The relative orientation value is [palm]. The phonetic realization of the citation form of this sign has the MCP joints extended or even somewhat hyperextended, the palm pointing forward and the fingers pointing upward. CALL has the same location, but instead of [palm] the orientation specification is [tips]. In order to make the fingertips point forward at that height in space, the articulator has to be flexed somewhere, and we find that in the citation form in neutral registers, it is flexed at the MCP joints.

i. STOP

[95] Actually, denying a phonological role for the base joint implies the flat part of the hand in these signs *is not* part of the articulator. For that reason, it no longer makes much sense to talk about 'handshape'. We propose the term 'articulator' as more appropriate. The same argument also holds for articulator configurations in which there is an aperture relation specified. The phonologically relevant parts of the articulator are the thumb tip (or pad) and the fingers, but not the flat part of the hand. As in these cases there is little variation in base joint position, the difference between 'handshape' and 'articulator shape' is less obvious, but we hypothesize that handshape is an inappropriate term to refer to all articulator configurations.

ii. CALL

Figure 3.44

A difference in relative orientation: STOP vs. CALL

The same difference in relative orientation specification with the same location leads to the difference between WAIT and DOG (see the illustrations in Figure 3.38). For WAIT, the relative orientation value is [palm], so the palm side of the fingers point to their location in neutral space, a horizontal plane at waist height. In most contexts (linguistic and extralinguistic), this is most simply done by keeping both the wrist and the MCP joints extended. In DOG, however, the relative orientation is [tips], which point to the same plane. (Actually, in both signs the orientation relates to the second setting that is in that horizontal plane, the first setting being away from it.) In this case, if the shoulder and elbow are in the same position, this is most easily articulated with the MCP joints flexed. One could also imagine, however, contexts in which the flexion that leads to downward pointing of the fingers occurs at the wrist, or a combination of wrist and MCP joint flexion.

In other minimal pairs, such as CAR-MOVE-FORWARD vs. CALL (illustrations in Figure 3.38 above), what differs is not the relative orientation specification, but rather the location. CAR-MOVE-FORWARD is made at waist or stomach height, and CALL is made at shoulder height. Both signs have [tips] specified as their orientation. I will come back to the example of CAR-MOVE-FORWARD below.

In different morphosyntactic realizations of one underlying form, such as in the different forms of VISIT illustrated in Figure 3.41 above, we see the same phenomenon. The relative orientation value [tips] is constant, but the phonologically specified location, corresponding to the object or goal of the verb, changes depending on the context. In some forms, such as 2-VISIT-1, where the fingers have to point to the chest of the signer during the whole sign, this is almost impossible to articulate without also flexing the MCP joints in addition to flexing the wrist joints.

The same effect of relative orientation applying to the fingers alone can be seen in a subset of the handshape changes, in which MCP joint flexion changes during the sign, whereas the relative orientation of the fingers is kept constant while the location of the articulator changes in height. we have found examples of this phenomenon in some tokens of ELEVATOR, GROW, and HIGH, for example; this last sign is illustrated in Figure 3.45 below. Like the different morphosyntactic variants of VISIT, these examples illustrate the phenomenon under discussion particularly well: the relative orientation specification [palm] stays constant, but the physical location of the hand changes during the sign. The easiest way to maintain the correct orientation of the hand is by flexing the MCP joints, as they are the most distal joints in the articulator at which movement would not be interpreted as a configuration change.

Figure 3.45

Change in MCP joint state as a correlate of a change in location: HIGH

Next to locations in space, we find the same phenomenon in the citation forms of signs with body locations. For example, SWEET (Figure 3.46) has the location value [cheek] and the orientation value [dorsum].

Figure 3.46

SWEET

Similar signs on the body are I (orientation [tips], location [chest]), TIRED ([ulnar], [chest]), and ENOUGH ([back], [below chin]). The distribution of MCP joint flexion in citation forms over space vs. body locations can be seen in Table 3.5 on page 145 above.

In all the examples discussed, the flexion of the MCP joints is a phonetic phenomenon. There are no phonological features directly leading to a particular MCP joint state; instead the MCP joints and more proximal joints work together to achieve a phonologically specified location and orientation specification. This correctly predicts both that there is variation between different realizations of the same sign in the first place, and that this variation appears to be gradual: there are not just two values, e.g. ‘0’ and ‘90’ degree flexion. The variation is predicted to occur because from realization to realization the combination of joints that articulate one and the same location and orientation may differ; the precise location may also differ slightly from one realization to the next. Both predictions were borne out by the preliminary data on variation that I discuss in §4.2.

My main hypothesis is that flexion occurs as a result of the desire to minimize articulatory effort, by distalizing the articulation. Distalization is articulatorily easy because it reduces the energy expended in making the movement, all else being equal: the mass of the articulator that needs to be moved is smaller in the case of finger movement than for movement of the whole hand at the wrist or at the elbow and shoulder joints (cf. Willerman 1994, for a discussion of articulatory effort in speech articulation and an overview of different aspects of articulatory complexity).

In many cases, flexion at the MCP joint seems an efficient way of minimizing wrist flexion, and in some cases also shoulder and elbow movement, while still realizing the target output form for relative orientation and location. We predict that the same effect determines different realizations of the same sign, as well as differences between citation forms of different lexical items.

For example, consider differences in height. If the orientation target is palm down, we correctly predict that PENGUIN is likely to be articulated with hyperextension at the MCP joints, whereas FLOOR-LEVEL has close to 90 degree flexion at the MCP joints. In both cases, the same relative orientation target could be attained by keeping the MCP joints neutral (0 degree flexion), but by respectively hyperextending and flexing the wrist instead. Apart from the biomechanical cost of moving the fingers vs. the whole hand, to produce the same height (of the end part of the articulator) the whole arm needs to be respectively lowered and raised further as well. This makes the movement more costly as well.

Note that this distalization does not apply just to the wrist vs. MCP joint alternation. In the example of CALL above, I remarked that the elbow is flexed more than 150 degrees to bring the hand to the specified (shoulder) height in space. However, this height of the fingers could just as well be accomplished by abducting the shoulder, flexing the elbow in the same manner as in the standard articulation, and moving the wrist to an extreme position of adduction, as in the illustration in Figure 3.47.

Figure 3.47

Alternative articulation of CALL*, in which the elbow is raised to shoulder height*

Here, too, the aim of reducing articulatory effort predicts the actual articulation that we find, which is favored over alternative articulations such as the one in Figure 3.39. The same goes for the sign SWEET (Figure 3.46). To articulate this sign without MCP joint flexion would require extreme effort not only at the wrist but also at the shoulder joint: the wrist would have to be flexed maximally, and the shoulder abducted and extended to a fair degree to raise the forearm far enough to allow the back of the hand and fingers point to the cheek.

Two remarks should be made at this point. First, the notion that ease of articulation is enhanced by distalization should be made more explicit and thereby testable (as Boersma 1998, for example, does for the movement of the speech articulators). I will make a first attempt at doing this in Chapter 5. Second, I can only speculate what causes the distalization effect in a specific utterance of a specific sign. In other words, in the above examples I do not know what the factors were that promoted or allowed distalization, though presumably factors like the following ones play a role.

(3.5) Potential factors leading to distalization

- signing style (register)
- personal preference / style
- discourse contexts such as role shifting
- morphosyntactic contexts such as verb inflection and aspect
- position of the sign in the sentence
- the size of the signing space (in turn partly influenced by the register)
- the immediate phonetic-phonological context (coarticulation)

I predict that distalization occurs in sentence context more frequently than in the careful production of citation forms, and in more informal styles rather than in formal styles, etc. (cf. Lindblom 1990). These predictions are further discussed at the end of this chapter.

Finally, it is plausible that just as for reductions in spoken language articulation, the tendency to distalize the articulation can be formalized as an OT constraint system that determines the best articulatory realization of an underlying perceptual target (cf. Chapters 2 and 5). We also still need an account for the fact that in some cases there is a tendency for the articulator to have extended MCP joints. If the underlying specification of a sign is defined in perceptual terms such as ‘big flat surface’, then in some (sociolinguistic or other) contexts, MCP joint extension may result in an articulatory ‘candidate’ that leads to a better perceivable form than what articulations with MCP joint flexion would produce.

The same effect of location and relative orientation that was discussed in this section is at work in morphologically different forms of VISIT (see Figure 3.40). The alternations in MCP state there are not triggered by morphological context. They are due to the more general articulatory reduction phenomenon that can be found in non-derived phonological forms as well. The different phonetic surface forms are generated in the phonetic implementation process. This process is not sensitive to morphological contexts per se, but only to specific perceptual specifications associated to certain morphological forms. In the different forms of the verb VISIT, these varying perceptual specifications are the locations correlated to the subject and object of the verb.

3.4.4.4.3 Semantic motivation

There are a number of signs in which the MCP flexion in the citation form is hard to predict on the basis of either an aperture specification or a combination of orientation and location specification. This group includes BALL, WORLD, GROUP, BREASTS, BUTTOCKS, EARTH, IN-FRONT-OF, and BEHIND. These signs are predicted to be realized without MCP joint flexion in their citation form. However, we regularly find them articulated with full MCP joint flexion, both in citation and context forms. These signs might be considered exceptions that can be understood by taking their semantics into account: they are iconically reflecting aspects of our visual conception of the world. We distinguish two types of semantic motivation of MCP flexion: the MCP flexion can either be used to mimic the shape of certain objects (as in BALL and BREASTS), or it can be associated with the semantic notion of ‘delimited’ (as in LEAST or BEHIND).

In all examples of iconic signs that we found, there were four selected fingers; for ease of reference I will therefore refer to the forms as B vs. B-bent. For both categories of iconically motivated MCP flexion, 18 signs were found (cf. Table 3.5).

The first category consists of signs in which the B or B-bent is used to outline or depict the shape or surface of some referent object. These forms can be productive or lexicalized. Examples of the latter are given in Table 3.6.

handshape	examples
B	MOUNTAIN, HOUSE, TABLE, GARDEN, ROOM
B-bent	BALL, WORLD, BREASTS, BUTTOCKS, EARTH

Table 3.6

B or B-bent is used to outline some surface (iconic use)

In the signs in the second group, MCP joint flexion is motivated by the round shape of the represented object, or the round object metaphor that is used to represent the concept, such as in GROUP. In both cases, the denotatum is conceived of as having a round three-dimensional shape.

When the signs in the first group are made higher in the signing space or closer to the body, B-bent can be used, conforming to the articulatory implementation process outlined above. In signs that are made higher in space consistent with their meaning, such as HIGH and GROW, B-bent is standard.

The second category of iconic signs consists of cases in which the articulator is used as a delimiter; this is the metaphorical / morphemic use of the B-bent shape. A possible metaphorical motivation for the B-bent handshape was proposed for expressions of time and spatial relations in Italian Sign Language (LIS; Pizzuto, Cameracanna, Corazza & Volterra 1995). Temporal relations are expressed spatially in LIS and in all other sign languages studied to date. According to Pizzuto et al., the B-bent handshape contrasts with the B-hand in that the B-hand has neutral meaning, symbolizing a non-specific event, whereas the B-bent specifies a delimited event in time or space. Examples cited include A-LITTLE-BEFORE$_{LIS}$, BEHIND$_{LIS}$ and AHEAD$_{LIS}$.[96] Also in SLN, some time and space related signs are articulated with B-bent shapes, e.g. BEFORE, AFTER, BEHIND (so in both temporal and spatial contexts). Further, in Koenen et al. (1993) it is implicitly claimed that LEAST differs from LESS in having MCP flexion; in this case the source for the 'delimiter' metaphor would be that 'least' inherently concerns a more delimited amount than 'less'. One of my informants claimed that the difference is rather one in movement, LEAST being articulated with a smaller and more tense movement.

However, we had reason to doubt this 'delimiter' meaning component associated to the B-bent. Firstly, our informants could not confirm for SLN the meaning component of 'delimiter' that was claimed to be associated to the B-bent shape in LIS. Moreover, the Italian researchers found that just as in SLN, the B-bent shape in LIS is used in expressions of time and spatial relation in only two dimensions: the front-back and the high-low dimension. In the lateral dimension (ipsi-contra or right-left), only B-hands occur. Moreover, in SLN there seems to be 'free' variation between B and B-bent in signs referring to time and space made in the front-back

[96] See also the Thai Sign Language dictionary (Suwanarat et al. 1990) where it is stated that all signs with a "bent-B refer to a measurable quantity" (p.258). Examples include money, time delimiters, and equality (fingertip orientation).

(e.g. IN-FRONT-OF) and high-low (e.g. BIG) dimensions. However, we do not find variation in the lateral dimension, that is, these signs are never made with a B-bent shape. My hypothesis is that the same phonetic factors play a role in these signs as in other signs.[97] For instance, the sign SMALL, consisting of an approaching movement with the palms facing each other, is only attested with B-hands. If B-bent were to indicate a delimited event in time or space, as the sign SMALL would require, we would have to assume that phonetic ease of articulation overrules this iconic realization of the 'delimiter' meaning.

Another indication that phonetics is stronger than the alleged semantic motivation can be observed in the use of car classifiers. The car classifier, illustrated in Figure 3.39 above, consists of a flat hand with all fingers selected and extended. As we have seen, this shape of the articulator roughly resembles the spatial proportions of the prototypical car. The palm side of the hand refers to the bottom of the car, and the fingertip side of the hand refers to the front of the car. Because of its strong semantic motivation one would expect this shape not to be sensitive to or more resistant to the phonetic forces I discussed. We do however find the more or less lexicalized signs CAR-CRASH and TRAFFIC-JAM with either B and B-bent shapes in the SignPhon corpus and in SLN more generally. In the sign TRAFFIC-JAM, illustrated in Figure 3.48 below, the strong hand is behind the weak hand, and moves towards the body, at chest or shoulder height. The closer the moving hand comes to the body, the harder it should be to maintain its relative orientation of the palm pointing to the ground surface. Flexion of the MCP joints contributes to making this possible, but at the same time makes the flat surface of the articulator that iconically represents the car smaller.

Figure 3.48

TRAFFIC-JAM

In conclusion, it might be the case that realizing specific perceptual targets is more important in motivated signs than minimizing articulatory effort as compared to non-motivated signs, but this too might depend strongly on the specific discourse or sociolinguistic context.

[97] Possibly there is also an influence of restraint, tenseness or movement shape. These are left as hypotheses for future study.

3.4.4.5 Other sign languages

A brief survey of dictionary data from German Sign Language (Microbooks 1998), Thai Sign Language (Suwanarat et al. 1990), Finnish Sign Language (Malm 1998) and New Zealand Sign Language (Kennedy 1997) seems to support the claims made above: in most cases MCP joint flexion in the citation forms seems to be the articulatorily easiest implementation of a certain combination of orientation and location features, or is the result of an aperture specification. I do not consider it crucial for the argument to know whether or not there is a phonological role for the MCP joint in any other sign language: it is simply the null hypothesis that a given phonetic property does *not* play a role in the phonological system. In view of the factors determining the position of the MCP joint state described in this section, I predict that in other sign languages MCP joint position is not phonologically distinctive either.

3.4.4.6 Conclusion

I have argued that MCP joint flexion is not expressed directly by a phonological feature in SLN. The arguments that I have advanced for this claim were, firstly, that there are no minimal pairs that contrast only in MCP flexion, and secondly, that for all signs that have MCP joint flexion or movement in their citation form, this effect can be generated in the phonetic implementation of those signs. Two phonological aspects were discussed that lead to phonetic implementations with MCP joint flexion: aperture and relative orientation.

Signs with an aperture relation between the thumb and the fingers are impossible to articulate without MCP joint flexion; furthermore, we do not find contrasts in MCP joint flexion combining with the aperture feature [open]. I have proposed that relative orientation features apply only to the finger part of the articulator, and not to the whole hand. The MCP joints, just like the wrist and other joints of the arm, adapt to realize the combination of orientation and location features. For some signs this leads to MCP joint flexion in the citation form. Variation in MCP joint position is predicted to occur: the signer may, under circumstances that are not yet very clear, choose to let more of the ‘work’ be done by the wrist joint instead of the MCP joints. Although I have little data so far on this variation, the underlying phonetic explanation that I proposed, namely that distalization limits articulatory effort, makes specific predictions about this variation that can be (experimentally) tested in the future. The same kind of work on the phonetic implementation of the state of the MCP joint should in principle also be done for the rest of the articulator.

For a set of apparent exceptions where the MCP joint flexion in citation forms appeared to be semantically motivated, I hypothesized that these too are often the result of a combination of orientation and location specifications. This hypothesis will have to be tested in future research.

All signs which have MCP movement were hypothesized to be phonological location changes in their perceptual specification. This hypothesis is further discussed in §3.5 below, and will be tested in Chapter 4.

Although the data that I used and the proposals that I have made concerned only SLN, the phonetic and semantic nature of the phenomena involved suggest that it may be fruitful to look at other sign languages in the same way. A first impression of data from German Sign Language, Thai Sign Language and New Zealand Sign Language did not reveal cases that contradict the claims made for SLN.

Since the proximal interphalangeal (PIP) joints of the fingers is the most proximal joint in the hand that is phonologically specified, the term ‘handshape’ is a misnomer. For this reason, I have adopted the more neutral term ‘articulator’ in the model proposed in Figure 3.6. Typically, as I have discussed here, the articulator is smaller than the hand, but the articulator can also be larger than the hand. Tentative examples include TREE and BABY (the same forms with the same meaning exist in ASL), MEAN and DAY$_{ASL}$. Signs in LSQ in which the articulator is larger than the hand include NOON$_{LSQ}$ and ONLY-ONE$_{LSQ}$ (Chris Miller, personal communication). It is possible there are many more cases than we had hitherto thought, having been misled by the prominence of handshape in all descriptions.

A disadvantage of using the term ‘articulator’ is that it raises the impression that articulatory variables such as joint states or specific body segments are needed for its definition. I have attempted to make clear that this is not the case: the active articulator in sign languages, like the passive articulators (the places of articulation), are perceptually defined categories, the articulation of which may vary. This variation includes that of the size of the articulator. For example, a ‘flat’ articulator can be realized by four fingers that are extended at the IP joints, or it can be realized by the whole hand plus extended fingers.

3.5 Predictions about phonetic variation

In this chapter I have proposed a set of phonological features for SLN that are defined in perceptual terms. The implication of using perceptual features is that the articulation of an underlying specification may vary.[98] Two innovations of the feature set that was proposed bear on the possibility of articulatory variation. Firstly, as the state of the MCP joint is no longer specified in the lexical representation of signs, we predict that the state of this joint may vary in different realizations of signs. Secondly, as only one degree of freedom of orientation is specified, we predict that the second degree of freedom will be determined by the signer’s aim to reduce articulatory effort in the realization of all the perceptual targets specified in the lexicon.

[98] This implication only holds if the joint states are not themselves perceptual categories. This possibility cannot be excluded, given the visibility of the articulators caused by their exterior position. I claim that for SLN there are no cases of joint states that are included in the perceptual specification. Research on other sign languages is needed to check this possibility more generally. I predict that all sign languages are like SLN in this respect, given the functional motivation for excluding precise articulatory targets in the lexicon: language users are more flexible if there are multiple ways (various articulations) to achieve the same end (the perceptual target).

In Chapter 2 I presented several cases of phonetic variation that are mentioned in the literature. Most notably, the claim of van der Hulst (1995) and Brentari (1998), among others, that proximalized and distalized articulations occur is of relevance here, since they explicitly refer to articulatory actions (rather than to phonological constructs such as segments).[99] In the rest of this thesis I will focus on the role of the MCP joint in those proximalized and distalized articulations. I hypothesize that distalized and proximalized articulations can be seen both in the static and in the dynamic aspects of the sign.

Proximalization and distalization of the static aspects take place, in part, in the transitional movement towards the initial position of the sign. The transition from the initial to the final position is the lexical movement. (One could consider the transition towards the initial position to be a sign language form of coarticulation.) However, proximalization and distalization do not necessarily have to be the result of the previous state of the articulator. Simultaneous combinations of features may lead to distalized forms, since there are articulatory limits on maintaining certain articulator states, such as extreme positions of each joint which are limited physiologically by the flexibility of the ligaments and tendons. We saw examples of this in the discussion of MCP flexion, where I argued that this joint sometimes flexes in order to realize certain orientation specifications so that extreme states of the wrist, elbow and shoulder can be avoided. For example, in the sign PEOPLE illustrated in Figure 3.49i both the MCP joints of the four fingers and the wrist are flexed to articulate the orientation [tips] for selected fingers [all] at the location [chest]. Here the distal MCP joints are used to aid the proximal wrist, forearm, elbow and shoulder in the articulation of these perceptual specifications. The alternative articulations in Figures 3.49ii and 3.49iii require (more) movement at joints proximal to the MCP joints, and are therefore more costly.

[99] Although Brentari argues that these articulatory variants are the result of a phonological process, they are phrased in concrete articulatory terminology, and not in terms of phonological features.

i. 45 deg wrist flexion, 90 deg MCP joint flexion

ii. 80 deg wrist flexion, 45 deg MCP flexion

iii. shoulder extended and abducted, 80 deg wrist flexion, 15 deg MCP joint flexion

Figure 3.49

Initial state of three realizations of PEOPLE

Variation in transitional movement due to different preceding contexts is hard to test because so many different contexts are possible and because we know so little about other (supralexical) prosodic influences on lexical items. Potentially, prosodic factors interact with coarticulatory factors, for example in that coarticulation is less restricted within a prosodic domain than between prosodic domains. To properly investigate coarticulation more knowledge about the prosodic structure of SLN is needed.

It is much easier to elicit and describe variation in the articulation of lexical movement, since this can also be studied in single signs in isolation. The next chapter aims to perform such tests. The reduction of the typical size of the articulator from the whole hand to the fingers alone, as proposed in §3.4.4, suggests that changes in orientation can be articulated by the MCP joints, since it is proposed that MCP movement is not interpreted as a change in articulator configuration. Van der Hulst (1995) and Brentari (1998) further suggest that this movement can be found as the reduced articulation of a change in location. This implies then that signs with MCP movement in the citation form are already ‘reduced’ for some reason; this remains to be investigated.

It first needs to be established whether the suggestions that MCP movement is the realization of a change in orientation or location is valid for SLN as well. If this is confirmed, one would predict that it will also be possible to find enhanced (proximalized) articulations of signs that have MCP movement in the citation form, such as AUGUST, in which there is movement of the whole hand and not just the fingers. In the case of AUGUST such an enhanced form might be articulated with the elbow or wrist joints instead of the MCP joints.

This leads to the following two hypotheses on the role of MCP movement:

- Some changes in location can be articulated by the MCP joints.
- Some changes in orientation can be articulated by the MCP joints.

If we extend this line of thinking, then we can also ask whether some changes in orientation that we see in citation forms are reduced articulations of location changes as well. How much does the orientation of the hand need to change in order to be perceived as a change in orientation instead of a change in location? Note that in the reduced articulation of a location change by MCP movement, as in AUGUST, the orientation about the ulnar-radial axis changes. Why would such movements not be interpreted as changes in orientation, then?

Data on enhanced and reduced articulations may shed light on these questions. If enhanced versions of signs that have apparent 'orientation changes' in the neutral citation form emphasized the rotation of the articulator (by increasing distal movements and reducing proximal movements), then it would be justified to assume a perceptual specification of an orientation change. If, by contrast, these movements are enhanced by limiting the orientation change and enhancing the location change (by reducing distal movement and enhancing proximal movement), then it would be justified to represent this movement as a location change.

This leads to the following two hypotheses on the realization of orientation changes:

- Some changes in orientation can be realized as location changes.
- Some changes in location can be realized as orientation changes.

These hypotheses will be investigated in the next chapter. I start out by aiming to get an impression of the extent of variation in terms of articulatory categories, and subsequently I try to focus on the different movement components and the various factors that cause the variation to take place.

4 Phonetic variation in the realization of movement

4.1 Introduction

In this chapter I present several studies I have carried out on phonetic variation in signs. The question that the chapter aims to answer is how variable the realizations of changes in location and orientation are, and what the role of the MCP joint is in articulating these changes. I start out from a very broad perspective, to get an impression of both the factors involved in causing the variation and the range of variation that exists (§§4.2 to 4.4), and end with a detailed study of alternations between specific phonological properties (changes in handshape, orientation, and location) in a specific pragmatic context (loud vs. soft registers; §4.5).

The focus of these studies is on the manual component of the signs, because this makes up the largest part of the form of most signs, and because it has been best described in the phonological literature (cf. the model presented in the previous chapter). Sometimes there are also changes in various non-manual components, especially in body position and the amount of mouthing. I will comment on these if clear patterns are apparent in the data.

Compared to the large body of literature on phonetic variation in speech, which typically concerns quantitative analyses of large-scale articulatory or acoustic measurements, the studies presented below are of a more qualitative and rather exploratory character. This is not surprising in the context of research of sign language phonology and phonetics, where only a few studies have focused on phonetic variation (cf. the overview of the literature in Chapter 2).

4.2 A first impression of phonetic variation: SAY

4.2.1 Introduction

The goal of the study was to obtain an overall impression of the phonetic variability of one single sign, without controlling for possible conditioning factors such as signer, surrounding phonological context, position in the sentence, etc. All of these factors will presumably have an influence on the realization of the sign, and therefore the forms are predicted to vary in their precise phonetic realization. The only thing that was constant was the practical context: videotaped elicitation of linguistic material by a hearing researcher. The register chosen for this context will therefore be invariant across all items.[100]

The sign that was selected was SAY, as it occurred in the video corpus gathered for the SignPhon database between October 1996 and August 1997. At that time, the corpus consisted of about 2,000 citation forms of signs and, for each sign, one sentence containing that sign. The sign SAY as it occurs in one of the Dutch dictionary CD-ROMs, which was illustrated in Figure 2.6 on page 52 is repeated in Figure 4.1 (NSDSK, 1996).

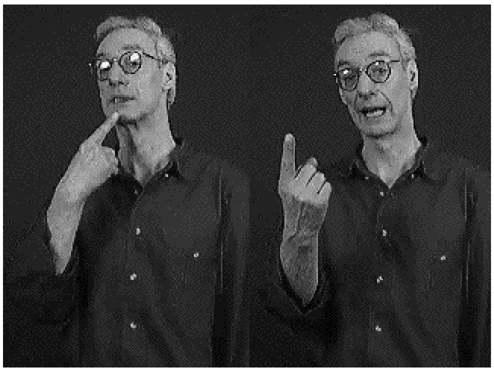


Figure 4.1

Begin and end of SAY

As there is no other reference form, I will use this form as a basis for comparison. It is important to note that no special status was assigned to the specific dictionary form illustrated above; it is only referred to every now and then for clarity.

The phonological specification for the sign is presented in Figure 4.2.

[100] Strange though it may seem, and as was apparent from the overview of variation studies in Chapter 2, a study such as this one has never been carried out before.

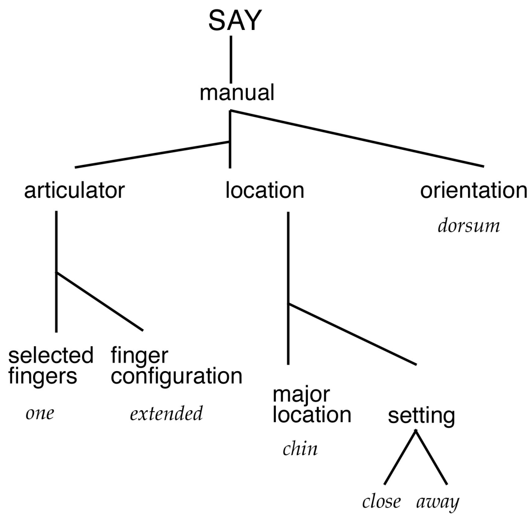


Figure 4.2

Phonological specification of SAY

There were several reasons for choosing SAY. First, given its meaning, it was likely that SAY occurs frequently in the sentences recorded for SignPhon, so that a large number of tokens would be available for comparison. Second, SAY is a simple sign both phonologically and morphologically. In the citation form as illustrated above, it contains only an unrepeated change of location of the strong hand, with no specific manner specifications for speed (or tenseness), size, or shape, and no other properties such as handshape configuration (let alone change in configuration) or simultaneously occurring orientation change. It is also simple morphologically, in that it only inflects for the indirect object, in which case the end location changes according to where in the signing space the indirect object was located[101]. However, inflection in isolated sentences such as those elicited for SignPhon will not be very frequent, as there is no discourse context in which possible referents could already have been localized.

Apart from the linguistic criteria for selecting SAY mentioned in the previous section, SAY is an interesting sign in that the configuration of its articulator resembles that in the ASL sign PAST_{ASL}, different articulations of which have been discussed in Uyechi (1996).[102] The state of the articulator in PAST_{ASL} is forearm vertical, hand at neck height, palm facing backwards, and the selected fingers fully extended. The difference between the signs consists of the direction of movement (backward for PAST_{ASL}, forward for SAY), and the precise phonological location (in

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101 See Wilbur (1997) for an introduction to morphosyntactic use of the signing space.

102 Unlike the verb 'say' in English, both the SLN verb SAY and the Dutch verb 'say' take an indirect object ('say something *to someone*'). SAY is almost identical to the ASL signs $\text{SAY-TO}_{\text{ASL}}$ and TELL_{ASL}.

front of the shoulder for PAST$_{ASL}$, chin contact for SAY). Different articulations of PAST$_{ASL}$ have been discussed in Uyechi (1996): it can be articulated by flexing either the elbow joint, the wrist joint, or the MCP joints. Uyechi stated that these three categorically different realizations appear to be in free variation, while the variants of a similar sign in SLN have different yet related meanings: a large movement refers to a more distant past than a smaller movement. In case a similar alternation in movement is found for SAY, the prediction would be that the change can be more gradual: since (as far as I know) there are no distinct meanings involved in the different realizations of this sign, one expects to find combinations of elbow, wrist, and MCP extension. However, although these realizations would not lead to 'morphological' differences in meaning in the sign SAY, they do possibly constitute completely different signs. That is to say, there may be lexical gaps that would explain why we do not find the alternative forms. All phonological models, including the model outlined in the previous chapter, distinguish between changes in handshape, orientation, and location. Since these are claimed to be *phonological* differences, it is implied that languages can use them to build different lexical items. From that point of view, then, we do *not* expect to find alternations for SAY exactly parallel to those described by Uyechi for PAST$_{ASL}$, as they would be interpreted as phonological (meaningful) contrasts instead of phonetic contrasts.

The crucial question to decide the issue of whether different movements are interpreted as different signs, is what the boundaries of allowed phonetic variation are. Consider orientation of the hand as an example. How much can the phonetic orientation of the hand change before it is interpreted as a change in (phonological) orientation? One can only answer this question if one has a well-developed view of the different phonological features for orientation, and of the phonetic space that is used to implement each of them. Evidence for phonological distinctions should come from a phonological analysis of the lexicon of the language in question. In Crasborn & van der Kooij (1997) and in Chapter 3, it was argued on the basis of distributional data that in most signs only one degree of freedom in the orientation of the hand needs to be specified. However, the phonetic space that can be used to realize this orientation specification was not investigated. Since only one of the two degrees of freedom is eliminated by a phonological specification, one predicts that the other degree is free to vary. This still leaves open a huge phonetic space (360 degrees rotation around one specific axis).[103]

The representation in Figure 4.2 makes the following predictions about variation in the phonetic realization.

[103] This space is further limited by articulatory constraints, which are discussed in Chapter 5.

(4.1) Predictions

1. Like the state of the wrist, the state of the MCP joints is not specified in the present model, and so it is predicted to vary, just like the state of the wrist joint.[104]
2. The outward movement specified by the setting change [close, away] can be implemented in different ways, and is thus not limited to elbow extension. If the palm side of the finger is touching or facing the front side of the chin, the forward movement can be articulated by extending the elbow (in combination with shoulder extension or alone), the wrist, or the MCP joint of the index finger, or by any combination of these. Furthermore, the realizations may differ in the amount of movement in any particular joint: the phonological representation does not commit itself to the size of the movement involved, it only predicts that there will be some movement. In this and further studies, I do not compare differences in movement size, but only differences in the use of the various joints, in terms of absence vs. presence of movement at a specific joint.
3. The orientation specification [dorsum] together with the location value [chin] and the setting sequence [close, away] predicts that the orientation of the fingertips (and also that of the root, ulnar and radial sides of the hand) can still vary. For example, the fingertips could point either straight upward (Figure 4.3i) or diagonally upward-sideward (Figure 4.3ii)

[104] The same is true for the other arm joints (forearm, elbow, and shoulder), but the contrast with the neighboring wrist joint stands out most: similar movement at these joints changes the orientation of the selected fingers in a similar way, without changing the location of the whole hand.

i. Fingertip pointing upwards

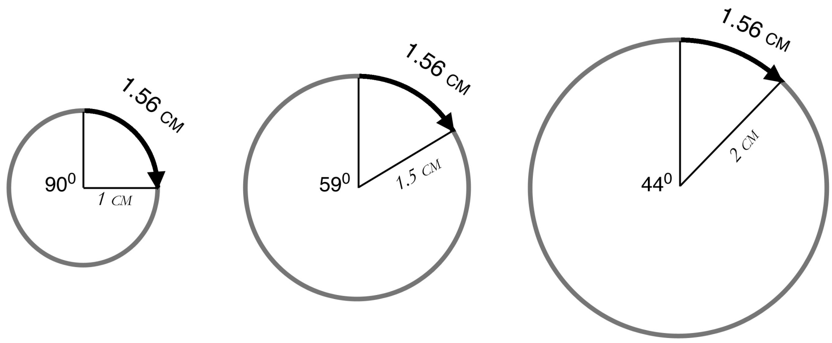
ii. Fingertip pointing diagonally upwards-sidewards

Figure 4.3

Variable orientation of the finger tip

Together, these predictions impose a further limitation on the phonetic space: the fact that the palm side of the finger has to face the chin limits the phonetic space for the movement from beginning to end location: given a fixed size of the movement of the fingertip, articulating the location change by MCP extension alone will change the orientation of the palm side of the articulator (namely the index finger) a lot, whereas more proximal movements of *only* wrist, elbow or shoulder have less influence on the orientation of the palm. This is only true if the size of the trajectory of the finger tip remains constant.

This can be stated in a more general way as follows: when moving the end of an axis for a fixed distance by rotating it around the other end, increasing the length of the axis that moves decreases the change in orientation of that axis. This is illustrated in Figure 4.4, where the vertical black axes rotate clockwise. In all three cases, the top end of the axis moves 1.56 cm (indicated by the arrows), leading to larger changes in orientation for smaller axes.



Radius length:	1 cm	1.5 cm	2 cm
Size of rotation:	90 degrees	59 degrees	44 degrees
Size of path:	1.56 cm	1.56 cm	1.56 cm

Figure 4.4

Changes in orientation for lines of different lengths

Applied to the sign SAY, the three axes of different lengths correspond to three parts of the articulator: the index finger, the hand with extended finger, and the forearm with extended wrist and extended index finger. In the three illustrations in Figure 4.4, the size of the change in location of the finger tip is constant, approximately 15 centimeters. The use of three different joints in the articulation of this change in location is different in each case: respectively the MCP joint, the wrist joint, and the shoulder joint. The more distal the joint, the larger the change in orientation. In this example, movement at the MCP joint, wrist, or elbow lead to changes in orientation of approximately 90, 45 and 15 degrees, respectively.

size of tip path: 8 cm
change in orientation: 80 deg.

i. MCP extension

size of tip path: 12 cm
change in orientation: 45 deg

ii. Wrist extension

size of tip path: 8 cm
change in orientation: 15 deg

iii. Elbow extension

Figure 4.5

Changes in orientation in different realizations of the change in location in SAY

It is expected then that the number of different realizations which were predicted to be possible in (4.1) on page 167 above is limited by the desire to keep the specified orientation constant. The larger the change in orientation, the greater the chance that a perceiver would misinterpret this sign as having both a change in location and orientation. In the specific case of SAY, there does not seem to be such a form that would constitute a minimal pair with SAY.

4.2.2 Methodology

I looked for occurrences of conjugated forms of the Dutch verb *zeggen* 'to say' in translations of the SignPhon video data.[105] The elicitation procedure that was used in all cases consisted of showing an informant a sheet of paper with a Dutch word on it. The informant was then asked to translate the sign into SLN, and subsequently make up a sentence or short story in SLN featuring the sign. This whole procedure was videotaped, and signs and sentences were digitized and stored as separate files. Fifty-one occurrences by three different signers were found (42, 5, and 4 items, respectively, for the different signers). Although the aim of the study was to get an impression of the extent of the variation that is possible for this one sign, and not to explain why the different variants occurred in that specific context, the two signers for whom relatively few items were found were discarded, to discount one possible source of variation. This left 42 items realized by the same signer.

In order to check the three predictions listed above, transcriptions were made of the following three aspects of each sign.

(4.2) Transcribed categories

1. The position of the MCP and wrist joint of the index finger at the beginning of the sign, in terms of 'small' vs. 'large' deviation from neutral position (0 degree flexion, i.e. fully extended). For flexion, 'small' was defined as 'between 0 and 30 degrees', and 'large' as 'more than 30 degrees'. For adduction, 'small' was defined as 'between 0 and 20 degrees', and 'large' as 'more than 20 degrees'.
2. The joint(s) which executed the movement. In the citation form, this was elbow extension.
3. The orientation of the palm and the tip side of the index finger, in terms of 45 degree angles. In the citation form, the tip of the finger pointed 'back-up', the palm side of the finger faced 'back-down'. These distinctions are illustrated in Figure 4.6 for the right hand ('ipsilateral' and 'contralateral' are opposite for the left hand and the right hand).

[105] These forms were 'zeggen' (infinitive and 1-2-3 pl. pres.), 'zeg' (1 sg. pres.), 'zegt' (2-3 sg.), 'zei' (1-2-3 sg. past), and 'zeiden' (1-2-3 pl. past).

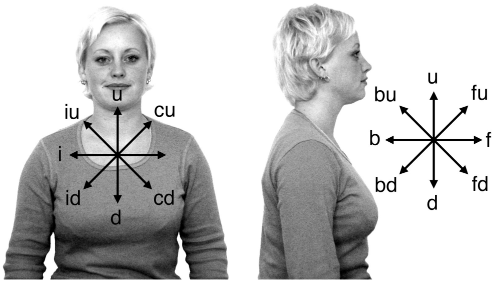


Figure 4.6

Absolute orientation distinctions with 45 degree intervals
Abbreviations: up (u), down (d), forward (f), backward (b), contralateral (c), ipsilateral (i)

4.2.3 Results and discussion

The results for the initial states of the MCP and wrist joints are listed in Table 4.1. The numbers at the end of each row indicate how many signs had the combination of MCP and wrist joint state indicated by the pluses and minuses; this final column adds up to the total number of tokens (42). The shaded row in this and the following two tables marks the forms that were like the citation form in Figure 4.1.

wrist		MCP	
flexion **less (+) or more (++) than 30 degrees**	**adduction** **less (+) or more (++) than 20 degrees**	**flexion** **less (+) or more (++) than 30 degrees, or hyperextension (–)**	**no. of tokens (total = 42)**
++	++	++	1
++	+	++	2
++	+	+	3
++	+	–	2
++		+	1
++		–	1
++			3
+	++	+	1
+	+	++	2
+	+	+	8
+	+	–	1
+	+		2
+		++	3
+		+	6
+			3
	+	+	2
		+	1

Table 4.1

Initial wrist and MCP positions

These data clearly show that the initial position of both the wrist and the MCP joint is highly variable. The citation form has wrist flexion and MCP flexion, and this combination occurs 6 times (14%) in the present corpus. In all but 1 case, the wrist is not fully extended, and in 30 out of 42 cases (71%), the wrist state is different from its position in the citation form. Various different positions occur, both in terms of flexion and in terms of adduction.

In 34 out of 42 cases (81%), the MCP joint was not fully extended (i.e. 0 degrees flexion), and in 28 out of 42 cases (67%), the MCP state is different from its position in the citation form.[106]

[106] The extremes found in this sign do not line up nicely with the traditional handshape categories '1' and 'bent 1'. The MCP state varies from about 25 degrees hyperextension (categorized as 'MCP hyperextension' in the table above) to about 60 degrees flexion (categorized as '>30° MCP flexion' in the table above). The KOMVA system distinguishes between full extension ('1') and about 60 degrees flexion ('1v') for SLN handshapes in which the PIP and DIP joints are extended.

The wrist and MCP joints work together in SAY to bring the articulator (the index finger, especially the distal end) to the initial location. Note that there is no a priori reason why these joints should be involved at all: with fully extended wrist and MCP joints the index finger can easily touch the chin, and depending on posture and body proportions this may or may not require abducting movement of the shoulder away from a position parallel to the side of the body. However, in all the items, including the forms in isolation (both the citation form and the form used by my own informant), there was some non-neutral state of the wrist and/or MCP joint.

Prediction 1 is borne out by the data, then. The phonological model therefore makes the correct prediction that the MCP joint position is not specified phonologically, giving it the same status as the arm joints such as the wrist. Of course, this gives us little information about what the forms actually look like, since the other joints of the arm work together with the wrist and MCP to articulate perceptual features like palm orientation and location. It is merely established that there is articulatory variation. The orientation feature is discussed below. Transcription of location showed that this parameter was the same for all tokens: the lower front part of the chin.

Although the realization of the feature place in terms of contact was not the main object of interest here, it is still noteworthy that in at least two tokens no physical contact between the fingertip and the chin was produced. Often, it was hard to see from a frontal view of the camera alone whether or not there was contact; this was one of the arguments for using 2 cameras at right angles for later recordings. This supports recent phonological work (van der Kooij 1997) in which it is suggested that contact is merely the optimal realization of location features (for the most part on the body), implying that for these signs less optimal non-contact realizations may occur.

The results for movement are presented in Table 4.2. The shaded row indicates tokens that have the same articulation as the citation form (elbow extension alone).

shoulder	elbow	wrist	MCP	no. of tokens (total = 42)
+	+	+		1
+	+			2
	+	+		8
	+	+	+	10
	+			9
		+		2
				10
3 7%	30 71%	21 50%	10 26%	

Table 4.2

Involvement of joints in the articulations of movement

We can see in this table that in 9 cases (21%) elbow extension was the only movement, as in the citation form. In 21 other signs (50%), elbow extension is involved in executing the movement along with another joint. In only 2 cases (5%) is the movement fully distalized, involving no elbow movement whatsoever. In 21 cases (50%), wrist extension is involved, and in 10 cases (24%), MCP movement occurs. Finally, it is remarkable that 10 versions (24%) were produced without any lexical movement at all. In the two signs that were transcribed as having only wrist movement and one sign with shoulder and elbow movement, it was not quite clear whether or not the movement involved belonged to the sign SAY or was the transitional movement towards the next sign.

Only one type of source of variation in movement was taken into consideration, namely linguistic context (potentially favorable to coarticulation). In 10 cases, a clear contextual effect seemed to lead to deviation from the citation form. In 3 of these, the only movement in the sign was the transitional movement from the initial location of SAY to the initial location of the next sign, with the handshape changing during this movement. (In the remaining 7 tokens without a movement resembling that in the citation form, it was not clear whether the context led to the absence of movement.) One could either say that the lexical movement was present, but that it overlapped with the transition towards the next sign, or that the lexical movement was simply deleted. The movement in these signs was transcribed as 'no movement', assuming that deletion took place. Although the transitional movement is predictable in the sense that it is determined by the location of the sign that followed, there is no explanation for why the deletion of lexical movement occurred. The prosodic structure of the sentence may be of influence here; this is one of the most under-explored areas in sign linguistics (cf. Miller 1997, Sandler 1999, Boyes Braem 1999, Wilbur to appear).

Just as variation in the state of the MCP joint affected the traditional handshape parameter, so the movements of the wrist and MCP joints involved in 21 signs (50%) changed the settings for the traditional parameters of handshape and orientation. For the model proposed in Chapter 3, this is exactly what one would expect, because of the underspecified nature of these categories. The model does predict a contrast, though, between the one specified degree of freedom (the palm side for SAY) and the other degree. In Table 4.3, absolute orientation values are listed for palm and tip sides of the last phalanx of the index finger, at the start of the sign, when the finger is closest to the chin. The shaded row refers to the token in which the orientation was identical to that in the citation form.

palm	finger tip	no. of tokens
b	bcu	2
b	c	2
b	cu	10
bcd	bcu	10
bcd	cu	1
bd	bu	1
bd	bc	3
bd	bcu	2
bd	bu	1
bdi	bcu	2
cd	cu	2
d	c	3
d	bc	3
		42

Table 4.3

Orientation of the palm and tip of the finger in space[107]

In the citation form of the sign, illustrated in Figure 4.1, the palm was pointing back-down, and the tip was pointing up-back; this only occurred once in the present corpus.

Although the data clearly confirm the prediction in that, indeed, the tip orientation is variable, the same is true for the palm orientation. Both seem to cluster around three different directions, each located in one of the eight quadrants of the space around the finger. The palm orientation is a combination of back, down, and contralateral (with 2 exceptions, where ipsilateral is combined with back and down), and the tip orientation is a combination of back, contralateral and up.

One possibility is that the orientation specification for this sign is [tip] rather than [palm]. Since the finger tip is less clearly a plane that can be parallel to the chin plane, but more like a point, this would correctly predict why both palm and tip orientation are so variable. On the other hand, the front side of the chin is not exactly a plane either, and this too might explain the variability in both dimensions. Moreover, because of the near cylindrical (symmetric) shape of the index finger, it may be that for this particular articulator, regardless of which sign it occurs in, the degree of variability that the users allow is rather large. If this is correct, the prediction is that the palm specification for flat (asymmetric) articulators (e.g. the

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[107] b = back, c = contralateral, d = down, i = ipsilateral, u = up. Combinations of two or three letters refer to 45 degree angles between the 90 degree 'cardinal' angles referred to by the letters. For example, 'bd' means an intermediate angle between straight back straight down. Sometimes, it was hard to categorize the form in these categories differing by 45 degree angles, leading to apparent discrepancies between the palm and tip values.

traditional B-hand) would lead to much less variability in the specified degree of freedom.

In 9 cases, the initial configuration of the articulator seemed influenced by coarticulation effects, in this case the location of the hand in the previous sign. In general, this location was fairly high in neutral space or on the head. This led to different configurations where the position of the index finger (and in some cases the whole forearm) was much less vertical than in the citation form (and in some cases even fully horizontal). In some of these cases this was due mainly to shoulder abduction (raising the elbow sidewards from the body). In other cases the orientation of the fingers was different due to wrist adduction and flexion alone (while the elbow was close to body).

For many other tokens, then, it is not immediately obvious that it is coarticulation with surrounding signs that causes the observed variation. The presence of coarticulation is hard to determine given that so little is known about prosodic characteristics of movement.

4.2.4 Conclusions

In summary, it was found that all three predictions listed in (4.1) on page 167 were confirmed. Firstly, the state of the MCP joint of the index finger does indeed vary between different realizations of this sign that has a specification for a straight (extended) articulator. In only 19% of the tokens was the MCP joint fully extended. It appears that the MCP joint is indeed not involved in articulating the perceptual category [straight], in line with the general predictions made in Chapter 3.

Secondly, it was found that the forward movement of the finger starting from the chin (the setting change [close, away]) can indeed be articulated by joints other than the elbow. Elbow extension alone was found in 5% of the tokens. However, in 50% of the cases elbow extension was involved in the movement in combination with shoulder, wrist, and/or MCP movement.

Thirdly, the orientation of the finger tip in space did indeed vary. Moreover, the orientation of the palm side also varied. This variation was not predicted, as the dorsum of the hand in this sign faces the end of the movement. This aspect of the perceptual specification, which was claimed in Chapter 3 to be the correct way to describe orientation, was in fact not transcribed. If the path from the initial to the final setting is arc-shaped, then it may still be that the side of the hand that faces the *direction* of the movement remains constant during the sign, even though there is a change in orientation. I propose that this is indeed the correct interpretation of saying that the orientation value faces the end of the movement: if the direction of the movement changes during the sign, as in all non-straight movements, then the orientation of the hand will change in the most faithfully articulated case. This is illustrated in Figure 4.7.

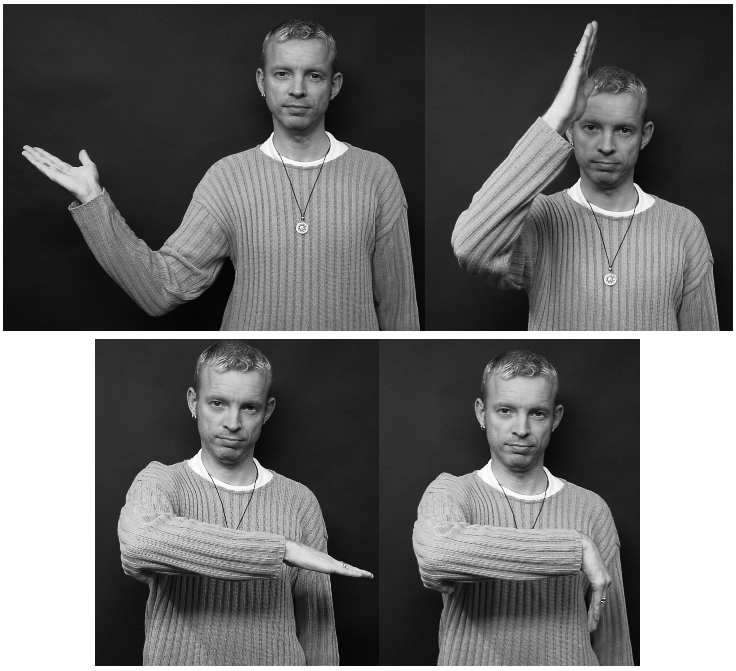


Figure 4.7

Hypothetical change in location in faithful articulations of [manner: arc-shaped] in combination with [orientation: palm]

In the present case of SAY, there is no specification [arc] that would require an arc-shaped path. However, if the movement is articulated by the wrist joint alone, for example, then the path will automatically be somewhat arced.[108] Although such an articulation could be perceived as a change in orientation (about the radial-ulnar axis), in no token in the present data was there only wrist movement. Movement at distal joints was typically combined with elbow and/or shoulder movement, leading to a relatively small change in orientation. It is the task of the perception grammar to classify only relatively large changes in orientation as changes in orientation, and to see smaller changes in orientation as by-products of changes in location.

In this pilot study we saw that there were already major differences in the articulation of one sign as signed by one signer in one register. The register was constant in that the forms were all realized in response to the same task (namely to make up sentences on the basis of a cue word), in a lab setting, signing to the camera. Variation was found in the articulation of the movement, the state of the MCP joint, and the orientation of the articulator (the index finger). A first hint of

[108] As was noted in Chapter 3, Nagahara (1988) interpreted this fact to mean that the default phonological path is arc-shaped.

coarticulation (or assimilation) effects was found, in that the locations of the preceding and following sign may have influenced the orientation of the hand and the presence of movement, respectively.

In contrast to the typical dictionary transcription (whether in KOMVA or HamNoSys notation), which commits itself to specifying all the parameters that were found to vary, the phonological specification proposed at the beginning of this section correctly generalizes over all these parameters, or in other words, *allows* the variation that was found. However, it is not the case that the model *predicts* the variation that was found, since that would involve both attributing a cause for the specific variation that was found as well as explaining why other variants were not found. The phonological specification has nothing to say about this aspect of the form of the sign. A phonetic implementation model is needed for this task. Such a model will be discussed in Chapter 5.

These conclusions of this study are based on one single sign performed by one single signer, and are therefore rather preliminary. As a next step, it was decided to focus on one of the categories of variation studied above, namely variation in movement, in line with the predictions about movement variation in §3.5. Can the alternation observed in the articulation of a location change be found for other signs as well? Wrist extension alone was only found in two realizations of SAY, and in both cases it was not clear if this was the lexical movement of SAY or merely the transition to the next sign. Another question, then, is how common it is for the wrist and MCP joints to execute the movement without contribution of the elbow and shoulder.

4.3 Variation in the realization of location changes and orientation changes: 12 signs

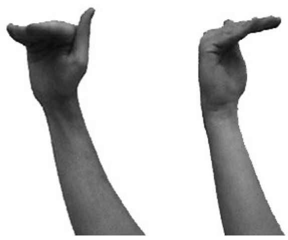
4.3.1 Introduction

The question that the second pilot study aimed to answer was whether the variation observed in the realization of the location change in SAY can also be found for other signs. The prediction was that for these signs, too, the location change can be articulated by the shoulder and elbow (leading to change in location of the whole hand), as well as by the more distal forearm, wrist, and MCP joints.

In the study of SAY, forearm movement was not transcribed separately from wrist movement. In no case was the forearm movement so prominent that it was necessary to include it as a separate category. Forearm rotation and wrist abduction / adduction often lead to the same effect, and it is very hard to record with one video camera whether there is movement at both joints or only one of them, especially if the signer wears long sleeves. In the present study forearm movement was included in the transcriptions, because of the focus of the study on the articulation of the movement, and also because the differences in phonological specification of the selected signs, and especially the possibility for some signs to inflect, made it more likely that this movement would figure in the realizations.

Rotation of the forearm alone can lead to a marked change in location of the end of the articulator, in the case where the wrist and/or MCP joints are not fully extended. The larger the deviation of the wrist and MCP joints from their neutral state of 0 degree flexion, the larger the movement of the end of the hand will be. This is illustrated in Figure 4.8, for a hypothetical sign in which all fingers are selected.

i. Wrist and MCP extended, 90 degree supination, tip trajectory: none



ii. MCP 90 degrees flexed, 90 degree supination, tip trajectory: 17 cm

iii. Wrist 45 degrees adducted, 90 degree supination, tip trajectory: 20 cm

iv. Wrist 70 degrees flexed, MCP 20 degrees flexed, 90 degree supination, tip trajectory: 31 cm

Figure 4.8

Forearm rotation leading to different sizes of trajectory of the tip of the middle finger

4.3.2 Methodology

Twelve signs were selected, six with and six without a handshape change. These signs are listed in Table 4.4, with their phonological specification and other information. The classification of these signs as having a location change was based on phonetic properties common to different citation forms found in dictionaries and in the SignPhon corpus. These properties were a change in location of the whole hand (or, in other words, movement of the wrist through space), and the absence of marked orientation changes (esp. a change in orientation about the longitudinal axis; see the illustration on page 127).

All 12 signs contain a change in location, and in the column ‘configuration change’ a change in finger configuration (handshape) is specified, if any. The changes are given in initial and final values for *finger flexion* or for changes in *aperture*. In the column ‘articulator’, the size of the articulator is listed (one, two, or all fingers selected). A check mark in the column ‘inflects’ indicates that the sign can be morphosyntactically inflected (or localized, in the case of STREET). The phonological specifications are listed in the rightmost seven columns. Some of the signs are illustrated later in this chapter (see the index of glosses on page **Error! Bookmark not defined.**ff).

gloss	inflects	configuration change	artic.	orientation[109]	location	setting	repet.
STREET	✓		all	tips	neu: horiz.	close, away	
TAKE	✓	extended, closed	all	dorsum	neu: horiz.	close, away	
INVITE	✓	aperture open, closed	one	root	neutral space	object, subject	
PROOF			all	dorsum	weak hand: palm	away, close	✓
CHOOSE	✓	aperture open, closed	one	root	neu: horiz.	object, subject	
DAUGHTER		extended, closed	all	dorsum	chest	close, away	
WARM-FOOD			all	palm	mouth	high, low	✓
ALREADY			all	ulnar	neu: horiz.	high, low	
FIND	✓	aperture open, closed	one	root	neu: horiz.	low, high / object, subject	
NICE		aperture open, closed	one	root	neu: horiz.	high, low	
SEE	✓		two	dorsum	eyes	close, away	
AUGUST			all	palm	chest high	away, close	✓

Table 4.4

Signs selected for second study[110]

The glosses were offered to two signers, whose task was to translate the word to a sign, and to make up about five sentences or short stories including the sign.

After problems experienced with making transcriptions on the basis of a frontal view of the signer on video tape alone, the present recordings were made with two video cameras, placed at right angles to each other, one facing the signer, and one aimed on the signer from the left. These two views were recorded simultaneously on one S-VHS tape.

The signs were transcribed in terms of the joints that participated in articulating the path component of the location changes. The handshape changes that are marked for some signs in the table above were left out of consideration. No further details of the articulation at a given joint were transcribed, such as the size or relative

[109] For the signs with an aperture specification, the orientation values refer to the fingers rather than the hand. As the selected finger(s) in these cases are fully flexed at the MCP joint, the value [root] of the finger is identical to the value [dorsum] for the whole hand.

[110] Abbreviations: articulator (artic.), repeated movement (rep.), horizontal plane in neutral space (neu: horiz.).

contribution of the joint in the total articulation, the direction of the movement, or the dimension in which the movement occurred (for shoulder and wrist).

4.3.3 Results and discussion

The results are presented in Table 4.5. The number before the '+' refers to number of realizations by one informant, the number after the '+' to that of the other informant.

gloss	**total**	**no mov**	**sh elb**	**sh elb for**	**sh elb wr**	**sh for wr**	**sh elb for wr**	**elb**	**elb wr**	**elb wr mcp**	**wr**	**wr mcp**
STREET	9+11		8+8	1+2	0+1							
TAKE	7+13		1+0		4+13		2+0					
INVITE	3+5		0+4	1+0	2+1							
PROOF	9+7							7+0	2+2	0+1	0+3	0+1
CHOOSE	15+6							8+6	7+0			
DAUGHTER	10+6		1+0		9+6							
WARM-FOOD	5+7				2+0					3+0		0+7
ALREADY	8+9	0+1	4+4	4+4								
NICE	16+7	0+1	10+2		6+4							
SEE	14+8	0+1						10+4	4+3			
AUGUST	5+6											5+6
FIND	13+13		0+4		5+8	7+0	1+1					
total	114+98	0+3	24+22	6+6	28+33	7+0	3+1	25+10	13+5	3+1	0+3	5+14
overall total	212	3	46	12	61	7	4	35	18	4	3	19

Table 4.5

Articulation of 12 signs by two signers
Abbreviations: no movement (no mov), shoulder (sh), elbow (elb), forearm (for), wrist (wr), MCP joints (mcp)

The number of responses by the two signers was highly variable for each sign, as can be seen in the second column. Overall, there were roughly the same number of responses by the two informants (114 vs. 98). Note that many other (combinations of) movements did not occur at all, such as only shoulder or MCP movement, or combined elbow, forearm and wrist movement.

The data clearly confirm the prediction that both proximal (shoulder, elbow) and distal (forearm, wrist, MCP) joints can participate in articulating a change in location. This is summarized in Table 4.6. The distinction between 'proximal' and ‘distal’ joint groups in the table is not based on any anatomical criteria, but solely on the effect they have in terms of traditional sign language parameters: shoulder and elbow movement change the location of the whole hand, whereas the joints distal to the elbow do not.

joint groups	**no of tokens.**	**joints**	**no. of tokens**
proximal	310 (67%)	shoulder	130
		elbow	180
distal	150 (33%)	forearm	11
		wrist	116
		MCP	23

Table 4.6

Involvement of proximal vs. distal joints in articulating location changes

It is clear, then, that in terms of overall involvement, the proximal elbow and shoulder joints are used twice as often as the distal forearm, wrist, and MCP joints together (310 vs. 150 tokens) . These data are not informative though if we want to consider the combinations of movements that were found. Location changes as in the group signs under study are traditionally seen as articulated by proximal joints alone, whereas the hypothesis of the present study is that combinations of proximal and distal articulations will also occur, as well as articulations by distal joints alone. The numbers in Table 4.7 confirm this prediction.

joint groups	**no. of tokens**
proximal	46 (22%)
proximal and distal	144 (68%)
distal	22 (10%)

Table 4.7

Location changes articulated by proximal vs. distal joints

Although purely proximal articulations do occur (22% of tokens), in the majority of cases distal joints are involved in realizing a change in location as well (68%). In 10% of all tokens, the distal joints were the only joints that articulated the change in location.

Finally, in 3 cases (1%) no movement was found at all. That is to say, all the movement seemed to be transitional movement from the previous sign towards the location of the target sign, and from that location to the location of the next sign.

4.3.4 Conclusions

The present data were not analyzed in terms of the sequential phonological context that might have caused coarticulatory effects, except for establishing that in some signs the only movement was transitional movement from and to the surrounding signs. For example, no transcription of the orientation of the sign was made, which could have indicated that coarticulatory effects were present. The sizes of changes in joint state were not transcribed either. In all, then, it cannot be concluded that the orientation of the hand actually did change due to the involvement of distal joints. An assumption in the studies above, which was not made explicit so far, is that moving the distal joints will inevitably change the absolute orientation *of the whole hand*, while not changing its location. This is indeed true if these are the only joints that move. However, if the distal joints move in conjunction with the proximal joints, there are two possible outcomes for orientation.

(4.3) Effect of movement at the distal joints

1. The distal joints *enhance* the change in whole hand orientation that is almost inevitably caused by moving shoulder or elbow alone, and that is typically found in combinations of shoulder and elbow movement
2. The distal joints move so as to *counteract* the change in whole hand orientation that would be caused by proximal movement alone.

How this works can be illustrated by drawing a line on a blackboard or a sheet of paper. If one only moves one joint, the line will be curved. To get a straight line (case 2 above), a well-synchronized action of more than one joint is needed.[111] Moving all joints synchronically may however also lead to a sharply curved line traced by the end of the articulator (case 1 above).

The impression from the tokens for all signs above is that there was no attempt to keep the orientation of the hand constant in both degrees of freedom, and that the degree of variability is similar to that found for SAY. However, this should be confirmed by looking at the data in the same detail as was done for SAY, transcribing changes in orientation as well.

With this reservation in mind, I conclude that, in general, it is possible for signs to be articulated by both proximal and distal joints, in various combinations, thereby obscuring the traditional boundary between location changes, handshape changes, and orientation changes as properties of *the whole hand.* This confirms the prediction made by the phonological model in Chapter 3, that the phonological specification (for location and changes in location, in the present data set) does not concern the hand as a whole, but rather a smaller or more variable part of the articulator.

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[111] Nagahara (1988) capitalizes on this point, arguing that the default movement in sign language is arc-shaped, because movement at a single joint inevitably leads to an arc-shaped path. However, the data in this study (cf. Table 4.5) show that the use of only a single joint in the realization of a sign is rather rare, the use of combinations of joints being the default case.

4.4 A pilot study on differences in register

4.4.1 Introduction

The results raise the question whether the same articulatory variation can also be found for other phonological aspects: is it the case that the variation observed for location changes also occurs for orientation changes and articulator configuration changes? Although orientation is regarded to be more abstract in the model outlined in Chapter 3 than has traditionally been assumed, and although only certain aspects of handshape were proposed to be phonologically relevant, changes in orientation and changes in configuration (curvature or aperture) are still argued to be phonologically relevant. The prototypical movement leading to a change in orientation is forearm rotation or wrist flexion (in either dimension). To what extent can such a change also be articulated by (more proximal) shoulder and elbow movement on the one hand and (more distal) MCP movement on the other? This is one question that the next study addresses.

Configuration changes as they are proposed in Chapter 3 are typically articulated by MCP movement (aperture) or MCP, PIP and DIP movement (curvature). One question is then whether these movements can be articulated by more proximal joints. From the point of view of the model in Chapter 3, a more immediate question is how the handshape changes with MCP movement alone, which were analyzed as reduced versions of location changes, can be realized. If they are location changes indeed, can they also be articulated by wrist, elbow, or shoulder movement? This is another question that the next study addresses.[112]

The following study has two aims. The first is to answer the questions just raised: can the phenomenon of distalization and proximalization be established for other parameters than location?

The second aim is to find a way to systematically elicit different articulations. In the two studies presented above, variation was largely due to coarticulation effects, since linguistic context was the only varying factor. In these studies, the size of the movement was neither transcribed nor measured. It is not clear, then, if the proximalization and distalization observed actually led to differences in movement size; this is not an inevitable phonetic effect. The end of the articulator can change location slightly by moving a proximal joint just a little, and conversely, the location change can be very large if a distal joint moves from one extreme position to another. If we take the opposite point of view, however, proximalization and distalization are effective ways of amplifying or reducing a movement of the end of the extremity. Another way to elicit data, then, rather than by changing linguistic context, is to explicitly ask signers to vary the size of the movements. In this way, larger differences may be elicited than were found on the basis of different interacting linguistic variables, so that we get a better overview of the boundaries of variation in the articulation of phonological categories.

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[112] Forearm movement is not a likely articulatory gesture in this case, since the axes of rotation of the MCP joints and the forearm joint are never parallel.

In the present study, signers were not asked explicitly to change the size of their signing, as this might lead to unnatural data. In Chapter 2, several anecdotal reports were cited mentioning changes of the size of the signing space in different situational contexts or registers (Uyechi 1996, Koenen, Bloem & Jansen 1993, Lindemann 1999). One factor that seems to influence the size of the signing space is what might be called 'shouting' vs. 'whispering', in analogy to variation in speech. Intuitions of my informants confirmed this size difference. The present study tried to explore the realization of the differences in size, asking signers to pretend they are using different registers. 'Whispered' signs were assumed to be realized smaller, 'shouted' signs were assumed to be realized larger. To test this methodology, a study was carried out with a limited number of signs and signers.

In many situations in real life, distance between the signer overlaps with another dimension, that of the level of formality or intimacy. For example, Zimmer (1989) describes three ASL styles differing in formality: a lecture (the most formal), an interview (intermediate), and an informal talk to a small audience (the most informal).[113]

Table 4.8 lists the predictions for proximalized and distalized forms in the shouted and whispered register, respectively, for the five possible combinations of movements. These predictions are based on the assumption that location changes are typically larger than orientation changes, which in turn are larger than handshape changes.

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[113] Presumably, the distance between the signer and the audience in the lecture situation was rather large as well, encouraging the signer to sign 'louder'. This overlap was not properly controlled for in the present study either, as will be discussed below.

normal register	**predicted whispered (distalized) form**	**predicted shouted (proximalized) form**
HS	–	ORI LOC ORI + LOC
ORI	HS	LOC
LOC	ORI + HS ORI HS	LOC + HS LOC + ORI
LOC + HS	ORI + HS HS	LOC + ORI
LOC + ORI	LOC + HS ORI HS	–

Table 4.8

Predictions about proximalized and distalized forms
HS = handshape change, ORI = orientation change, LOC = location change

Since handshape changes are already the smallest in terms of the typology of changes adopted here, there are no predictions about their whispered realization. The same goes for combinations of location and orientation changes, which are already the largest possible combination. There will likely be differences in the form of handshape changes when they are whispered (and combined location and orientation changes when they are shouted), but these differences will be in parameters such as movement speed, which are not measured in this study (see also the predictions in Table 4.9 below).

The predictions about signs which already have a combination of movements in the normal register (LOC + HS, LOC + ORI) are a bit awkward, as it is not clear whether these should be considered as one combined movement, or as two separate movement components that can be changed independently. They are included for the sake of completeness, but further analysis of these signs would be necessary to make more adequate predictions; for example, a distinction between repeated and non-repeated movements could be made. In the present study, only non-repeated combinations (of LOC + ORI, LOC + HS) are included.

Apart from proximalization and distalization, which are the targets of this study, other general predictions about the character of the signing under the two conditions can be derived from their goal, namely wanting to be seen by a large audience vs. wanting not to be seen by people other than the addressee, and from being located close to the addressee vs. being far away from the addressee. These predictions are listed in Table 4.9.

whispering	**shouting**
more distalized movements	more proximalized movements
more one-handed versions	more two-handed versions
smaller signing space	larger signing space
signing space closer to body?	signing space further from the body?
lower signing space (in front of abdomen instead of chest) or: signing space in front of neck /face or: signing space higher on chest	–
faster movements?	slower movements?
reduced non-manual behavior (smaller movements)	enhanced non-manual behavior (larger movements)
facial expression replacing signs (e.g. indexes)	–
more mouthing?	more mouthing

Table 4.9

Predictions regarding other aspects of the form of whispering and shouting

The use of *more one-handed* and *more two-handed versions* of signs obviously leads to fewer and more perceptual cues for many signs, respectively. Since the use of two hands is not lexically distinctive in SLN, and even many asymmetric signs allow for ‘weak drop’ in a standard register in SLN (cf. van der Kooij 2001, in prep.), one expects these alternations to occur abundantly.

The *signing space* is a concept with a long tradition in sign linguistics (Klima & Bellugi 1979). It refers to the space in front of the body where signs are made. The term is often used to describe the difference between sign language and gesturing of hearing people: gestures can be made as large as is physiologically possible, whereas signs are always made in a limited part of space in front of the upper body and face. The boundaries of this space in standard registers roughly extend one forearm and hand’s length from the body. The sizes can be observed by looking at the extreme locations of the hand in a sentence, and also from the distance between the hands in two handed symmetrical signs (Uyechi 1996). Indirect evidence may come from the size of path movements in a given situation compared to some (yet to be defined) standard. I know of no research that has tried to further quantify this concept, for example by measuring distances from the body, and measuring which percentage of signs in a stretch of discourse actually reach these boundaries. Differences in size of the signing space are expected to occur given the extensive (though often anecdotal) references to this aspect in the literature (Zimmer 1989, Kegl & Poizner 1994 [quoted in Bahan 1996], Uyechi 1996, Koenen et al. 1993, Lindemann 1999). Uyechi (1996: 62-66) explicitly argues that it is not just the movement that is enlarged, but the whole signing space, as in two-handed signs shouting also leads to a larger distance between the hands. Furthermore, she assumes that speed and tenseness of the movement will also vary (1996: 64n5), but at the same time claims that this is independent of the changes in size (1996: 64n4).

Enlarging and shrinking the signing space is not only visible in the size of the movements: differences in the realization of signs with a location in neutral space will also indicate these differences. Moreover, changing the size of the signing need not imply that movements are proximalized or distalized. The signing space can be made smaller by performing the movement with the same joints, simply by reducing the amplitude of the movement of the same articulator. Similar reduction of movement amplitude is seen in context forms of signs with handshape changes (SignPhon corpus 1999). Forms such as SUN, which in citation form have full extension of the extended fingers from a closed fist to hyperextension at both MCP and PIP/DIP joints, are often reduced in sentential context by starting from an open-S or O handshape and then extending the fingers to full extension (but not hyperextension). Changes such as these reduce the size of the handshape change, but do not cross the traditional phonological boundaries between changes in location, orientation, and handshape. However, on the basis of the variation studies discussed above, the prediction is that finger flexion movements can be made larger by adding wrist / forearm movement or elbow / shoulder movement, which are normally used to realize orientation and location changes, respectively. Similarly, location changes normally executed by the shoulder and elbow joints might be made smaller by using the forearm, wrist, or finger joints, depending on the orientation of the hand and possibly the handshape specified for the sign.

Although the *height of the signing space* in whispering has been observed to be lower in space than in standard registers (Karen Emmorey, personal communication; Sonja Jansma, personal communication), one could also imagine, depending on the situation, that the signing space would be made closer to the face (at chest or neck height). In that situation, smaller movements are much more visible, and smaller movements can be made than would be possible if the signing space shifted downwards (cf. Siple 1978). The height of the signing space is not predicted to differ in a shouting register, as the movements of the arms are predicted to be much larger in shouting. Raising or lowering the signing space away from the chest would then be very difficult physiologically. The perceptual benefits of raising or lowering the signing space away from the chest are not obvious either, as they either obscure facial signals or counteract the effects of making the movements larger.

Bringing the *signing space closer to the body* in whispering is an obvious way to better hide the signing from third parties. Although the general conception of signing space includes the area of space starting at the body and extending half an arm's length forward, almost all signs in neutral space are generally produced at least 10 centimeters out from the chest, and they can therefore be made at least 10 centimeters closer to the body in a whispering register. In shouting, however, it is doubtful whether moving the signing space further away from the body would be possible, assuming that this would even be advantageous for long-distance perception in the first place, as the signs are predicted to be made so much larger that the signing space already extends rather far away from the body.

Zimmer (1989) found that signing used in giving a lecture was *slower* than normal. In shouting, making larger movements while keeping the speed constant already takes more time, giving the addressee more time for recognition of any modified signs. Taking even more time could hypothetically impede rather than facilitate parsing of specific signs or the whole sentence. I have no specific predictions about the speed of signing in whispering. Signing fast could be one way to prevent others than the addressee from understanding, but on the other hand signing slowly could be a way to compensate for any reduction in size of the movements or deletion of location information, allowing the addressee more time to interpret the remaining cues. Ringeling (1984) found for speech that whispered words have a longer duration, but that length differences make little difference in the correct perception of different styles.

Non-manual behaviors, including facial expression and head and upper body movements, are expected to be less visible in a whispered register and more visible in a shouted register. Visibility can be reduced by making the movements smaller or reducing the number of movements. Visibility can be enhanced by making the movements larger. It has also been suggested, however, that in whispered registers there is a shift from manual to non-manual behavior (Bahan 1996, cf. Zimmer 1989, for informal style). For example, one can imagine that the exclusive use of eye gaze for pronominal indexation (Metzger 1998) would be more prevalent in whispered registers than in shouted registers.

In both registers, one expects that more *mouthing* is used than normally, as this provides an extra cue for the recognition of lexical items. In whispered registers, mouthing can possibly replace manual signs as another step in the reduction of the signal. In shouting, mouthing is just one more cue in addition to the enhanced manual articulation. The size of the mouthing movements (of jaw, lips, and tongue) is predicted to be smaller in whispering than in shouting. However, in order for the mouthing in whispering really to make a significant contribution to the perception of the signal, one would expect the size of the mouth movements to be larger than in the normal register.

4.4.2 Methodology

The stimuli consisted of 30 Dutch words, which were presented to two Deaf SLN signers (AH, native; AR, fluent). It was anticipated that the stimulus words would each elicit a specific target sign with the corresponding equivalent meaning. The words consisted of the list of 12 glosses used in the previous study, supplemented by 18 more to better balance the data between handshape changes, orientation changes, and location changes.[114]

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[114] The signs were selected on the basis of phonetic criteria applied to the citation form that was available. The phonetic definitions of changes in handshape, orientation and location looked at changes in shape, orientation and location *of the whole hand*. By contrast, the perceptual specifications in the table below incorporate the proposals made in Chapter 3. Thus, a sign with a phonetic handshape change such as DUCK is represented in the table as having a setting change rather than a configuration change.

Table 4.10 lists the signs used in this study, grouped by the movement type of the reference form of the sign.[115] It might be expected that different combinations of movements may undergo different types of changes with respect to the citation form in conjunction with a particular register. Although I have not made any such predictions, I included certain movement combinations in order to see if there is a difference after all. In that sense this is a pilot study, aimed at obtaining a first impression of what the different speech styles look like, and at generating hypotheses about phonological features to be tested in a follow-up study. The other columns represent the phonological representation of the sign. The following features are used in the table, with abbreviations between brackets.

(4.4) Features used in Table 4.10

- articulator, finger selection: none, 1, all
- articulator, finger configuration: curved, spread, open, closed
- orientation: palm (p), dorsum (d), tip (t), root/back (b), ulnar/pinkie (u), radial/thumb (r)
- orientation change: palm-dorsum clockwise (pdc), longitudinal clockwise (lc), longitudinal counterclockwise (lcc), radial-ulnar clockwise (ruc)
- location: top of head, mouth, neck, side, palm of the weak hand (wh-palm), neutral space (neu)[116], horizontal plane in neutral space (neu: horiz.), frontal plane in neutral space (neu: frontal)
- setting: close, away, high, low, ipsilateral (ipsi), contralateral (contra)
- path shape: arc
- other: repeated, two-handed (2-h), alternating (alt.), non-manual features

The default interpretation of ‘neutral space’ is a vertical plane parallel to the frontal plane of the body. Changes in features are delimited by semi-colons.

[115] Combinations of handshape change and orientation change are claimed to be non-existent phonologically (Stack 1988); see also Chapter 3, footnote 51 for discussion.

[116] The signs in this study that are marked for the location ‘neutral space’ are of the type discussed on page 89 above: they have a variable orientation and location in neutral space and were proposed to lack a perceptual specification for location and orientation; in the tables with feature values here this is indicated by [variable] in the orientation column.

gloss	articulator	orientation	location	setting	other
			handshape change		
DUCK	all	p	hips	away; close	2-h, repeated
NOTHING	1, closed; 1, open	[variable]	[neu]		repeated
SALT	all, closed, rubbing	t	neu: horiz.		repeated
AUGUST	all	p	neu: frontal	away; close	2-h, repeated, mouthing: ‘ augustus’
THIRSTY	1, open; 1, closed	t	neck		repeated
CRY	1	p	cheek	high; low	2-h
			orientation change		
BETTER	1, closed	d; ruc	neu: frontal		
DIFFICULT	none	[variable]; lc	[neu]		tense
TOMORROW	1	p; pdcc	cheek		
ELEVEN	1	d; lc	neu: frontal		
DECEASED	all	p; lc	neu: horiz.		2-h, alt., non-repeated
CAN	none	[variable]; lc	[neu]		head nod
			location change		
STREET	all	u	neu: horiz.	close; away	2-h
PROOF	all	d	wh-palm	away; close	repeated
WARM-WEATHER	all	p	neu: frontal	away; close	2-h, repeated
ALREADY	all	u	neu: horiz.	high; low	
SEE	2, spread	d	eyes	close; away	
SAY	1	d	chin	close; away	
RESTAURANT	2, spread	r	mouth	away; close	2-h, alt., repeated
CHILDREN	all	p	neu: horiz.	high; low	repeated + sidewards path

Table 4.10

List of target signs with their perceptual specification

gloss	articulator	orientation	location	setting	other
		location and handshape change			
TAKE	all; none	d	neu: horiz	low; high	
INVITE	1, open; 1, closed	d	neu: frontal	away; close	2-h, alt., repeated
CHOOSE	1, open; 1, closed	d	neu: frontal	away; close	
DAUGHTER	all, open; all, closed	d	chest	close; away	
NICE	1, open; 1; closed	d	neu: horiz.	high; low	
FIND	1, open; 1, closed	t	neu: horiz.	low; high	
CAT	1, open; 1; closed	b	cheek	close; away	
FLOWER	all, closed; all, open	p	neu: horiz.	low; high	
		location and orientation change			
THOUSAND	1	u; pdcc	neu: frontal	high; low	
LIVE	all	t; lc	neu: horiz.	low; high	2-h

Table 4.10 (cont.)

The words were presented to the informants one by one. The informant was asked to translate each word into SLN and make up a sentence or a short story including the SLN sign. The first time, no special instruction was given, and the procedure was just like that normally used when making recordings for the SignPhon corpus with which the informants were familiar. After this, they were asked to imagine signing to somebody very near to them, as if having a private conversation that others should not be able to follow. No mention was made about a specific situation with a specific number of people at a specific distance in a specific location in the room. The third time, the instruction was to imagine a situation where the person they were signing to was standing very far away, so far that s/he would have trouble seeing their signing. It was not checked for any of the conditions whether the produced signing was actually understandable by other signers.

For the predictions in Table 4.8, transcriptions were made of the target signs in isolation (the sentential forms were not used), with respect to the realization of the movement in terms of changes in handshape, orientation, and location, compared to the citation form. Movement of the fingers was considered to be a change in handshape, movement at the forearm or wrist joints was considered to be a change in orientation, movement at the elbow or shoulder was considered to be a change in location. As for combinations of changes, for example both in handshape and location, these were only considered to be combined movements if the size of each was more or less comparable in the context of the combination. Thus, very small changes in location of the whole hand (say, 1 cm) were disregarded when they cooccurred with a finger movement from fully open beak to closed beak, as in NICE.

For the predictions about other characteristics of shouted vs. whispered signing, listed in Table 4.9, an overall impression was gained from watching all the recordings in sequence (thus, including both citation forms and sentences).

4.4.3 Results and discussion

This section summarizes the results. After general comments on the procedure, the overall properties of the two registers are discussed and related to the predictions in Table 4.8. Then, in §4.4.3.4, the results bearing on the predictions about distalization and proximalization are discussed. §4.4.4 contains a summary of the findings, and recommendations for the follow-up experiment.

4.4.3.1 General comments

Both signers, in particular AH, did not find it very easy to pretend to be in a certain communicative situation, as was apparent from their comments during and after the recording session. This was especially the case for the shouting condition. Possibly, due to vague or inexplicit instructions, they sometimes confused shouting in the desired phonetic sense with emphasis in a semantic sense: stressing the meaning of the sign or making it more intensive. They remarked for words like ‘August’ that it is like a name, which could not be emphasized, there cannot be a month called ‘very August’. In general, however, they were able to modify signs like these as well in some of the predicted ways, even though they felt these modified versions to be strange. In the whispering condition, informant AH in particular remarked that some signs such as LIVE are inherently big and exuberant, and they look strange when they are made with a small movement.

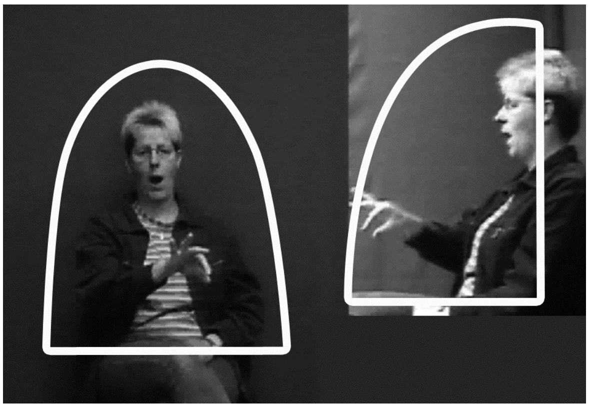
The presentation of the Dutch word did not elicit the desired sign in all cases. Different lexical items were produced for FLOWER, RESTAURANT, and AUGUST (AR), DUCK (AH), and LIVE (both signers). These forms were not taken into account, nor were additional forms produced by both signers for SALT, CAN and WARM-WEATHER.

For some other words, the target sign was produced, but in the neutral register it was realized differently from the form given in the classification above (see Table 4.10). The transcriptions of the shouted and whispered versions are based on the observed normal register realizations. THIRSTY, NOTHING (AH), and BETTER (AH) also had a location change. TOMORROW only had a location change, and not an orientation change. ALREADY also had a finger orientation change. SAY (AH) was realized with finger and wrist extension (handshape and orientation change, respectively, in addition to the location change. CRY (AH) was realized with a location change alone.

The sizes of the signing spaces in the standard styles are illustrated in Figure 4.9; in each video frame two camera angles are combined of the same state of the articulators. These are highly similar to descriptions in Klima & Bellugi (1979) for

ASL and in Koenen et al. (1993) for SLN: the lower boundary of the signing space is around waist height, and it extends to just above the top of the head, it measures about a forearm's length from the body forward, and is just a bit wider than the chest.

i. Subject AH



ii. Subject AR

Figure 4.9

Schematic outline of the standard signing space

4.4.3.2 Whispering: overall characterization

Both signers directed their whispered sentences to an imaginary addressee sitting very close to them or next to them: their head and shoulders were turned slightly sidewards (± 20 degrees) almost all of the time. In many signs and sentences the head was tilted forward by ± 45 degrees, thereby lowering the face towards the hands. Often the shoulders were moved forward slightly. None of these non-manual changes was particularly expected, although they do somewhat resemble the body posture sometimes seen in whispering hearing people. They have the effect of further shrinking the signing space by bringing the location of the head closer to the hands, and of obscuring the hand movements from the view of third parties.

In conformity with the predictions, many two-handed signs (including the non-target signs in the sentences) were made with one hand (4 and 6 out of 12, respectively, for AH and AR). Also, the signing space was reduced by being closer to the body, narrower (i.e. smaller in the left-right dimension), and lowered. Here there was a major difference between the two signers; this is illustrated in Figure 4.10.

i. Subject AH

ii. Subject AH. The smaller space is the restricted area that was most frequently used

Figure 4.10

Schematic outline of the whispering signing space

Signer AR made almost all signs in a very narrow area on the lap, with occasional realizations of head locations closer to the chin (see illustration below). Signer AH also reduced the size of her signing space, but mostly in the front-back and left-right dimensions: she still made use of the whole area in front of her upper body, and kept realizing facial locations on the face.

In the list of predictions, several locations of the signing space for whispering were imagined as good candidates to hide signing from others than the addressee. In the data, it was very clear that the signing space was as low and close to the body as possible. As the signers were sitting on a chair, this meant just above the lap. From the eye gaze direction it was clear that the signers were imagining an addressee to the side of them, and signing space was shifted to that side of the body, with the body turned slightly toward the addressee to hide the signing space further from anyone standing on the other side of the signer. The predictions about whispered signing space being closer to the face (higher on the chest or in front of the neck or face) were derived from the differences in visual acuity in different areas of the field of vision (see e.g. Bruce, Greene & Georgeson 1996, see Siple 1978 on the impact of visual acuity on sign language phonology). Since finer distinctions are visible in the center of vision, which is generally the face area in signing, raising the signing space would allow much smaller movements to still be visible while being less visible for other people than the addressee, being at larger distance from the signer. Possibly, the intuition of the signers is that making signs so high in space attracts more attention from third persons, and that small movements, lower in space than normal, are still visible. It is not known at what distance the signers located their imaginary addressee. In the signing of both informants, the lowered signing space was brought closer to the face by lowering the upper body ('hunching forward') and tilting the head forward, with the effect of reducing the distance of the hands to the center of vision.

It was hard to observe precisely just by looking at the video recordings whether or not the speed of the movements was different. However, the impression was that the speed did not change that much: most signs were shorter on average because of the small movements.

It is also hard to quantify the amount of mouthing that is used; no study is known to me that has attempted to do that. The overall impression was that there was no change in quantity; however, it did seem that the lip and jaw movements were reduced in size. No examples were found of facial expression or mouthing actually replacing whole signs, although, admittedly, this possibility presumes a more elaborate transcription of nonmanual behavior by a native signer, which was not attempted.

4.4.3.3 Shouting: overall characterization

Both signers moved their whole body and head forward and upward (by sitting up straight) slightly in most of the data; to a lesser degree, the head alone was stretched upward and forward. Compared to the standard condition, there were also larger head and upper body movements during the signs and sentences. In addition, both signers had a more vivid facial expression (larger movements) compared to the standard style. As in the whispered condition, it was not clear whether more or less mouthing was produced, but in any case, the movements of the tongue, jaw, and lips were much larger than in the normal signing style.

The signing space was markedly larger for both signers, stretching out further sidewards, forward, and upward; this is illustrated in Figure 4.11. Although there was no expectation about a change in location of the signing space, it was often found to be further forward and higher: whole sentences were produced some 30 centimeters out from the chest, and this tended to cooccur with the signing space being at head height or even above head height. In these cases, the size of the signing space was not much larger than in other sentences that were made at a more standard location in front of the upper body.

i. Subject AH

ii. Subject AR

Figure 4.11

Schematic outline of the shouting signing space

The size of the signing space is mainly visible from the size of path movements and from locations on the edges of neutral space (ipsilateral and high, for example). In addition, in two-handed symmetrical signs, the hands were much further apart than normal (cf. Uyechi 1996). Apart from the size increase in location changes, handshape changes were also markedly larger, with opening movements often ending in hyperextension of all finger joints, where in standard colloquial signing not even full extension is reached.[117]

[117] Many citation forms in the shouting condition were preceded by INDEX-1 and/or followed by PO ('palms up', a discourse marker; either one or two-handed, depending on the preceding sign).

As for the whispered data, impressionistic judgments about speed and duration, as well as about the quantity of mouthing, are hard to make. The size of the mouth movements was markedly larger than in the standard register.

4.4.3.4 Distalized forms in whispering and proximalized forms in shouting

Both in the target signs and in the rest of the sentences, frequent distalization was observed for the whispering condition. However, it was obvious that not *all* signing was completely reduced to wrist and finger movements. Apart from distalization of some movement components, some orientation and especially location cues were completely lost. All these effects apply more to the signing of AR than that of AH, as can be seen from the pictures in Figure 4.10.

The results relating to the predictions on movement articulation listed in Table 4.8 are summarized in Table 4.11. Dark-shaded cells mark cue words that were not realized as the predicted sign. In the cases where the neutral form of a sign was the intended lexical item, but realized with a different movement, the sign was moved to the appropriate category in the table below. The block of light-shaded cells concern the whispered versions of handshape changes and the shouted version of combined orientation and location changes, which were not predicted to change at all.

gloss	AH: whispering	AR: whispering	AH: shouting	AR: shouting
handshape change				
AUGUST			LOC + ORI	
DUCK				
CRY				
NOTHING				
SALT				
orientation change				
BETTER				
ELEVEN				LOC + ORI
CAN				LOC + ORI
DIFFICULT			LOC + ORI	LOC + ORI
TOMORROW				
DECEASED				
location change				
PROOF	LOC (reduced) + HS		first LOC, then ORI	
CRY	HS			
CHILDREN				
RESTAURANT			LOC + ORI	
STREET				LOC + ORI + HS
WARM-WEATHER		HS	LOC + HS	
SEE		ORI		
SAY				

Table 4.11

Whispered and shouted realizations of both signers

gloss	AH: whispering	AR: whispering	AH: shouting	AR: shouting
l o c a t i o n a n d h a n d s h a p e c h a n g e				
FLOWER				
DAUGHTER				
THIRSTY	HS	HS		
CHOOSE	LOC			
NICE	HS (minimal loc. ch.)	ORI + HS	LOC + HS + ORI	
TAKE				
CAT			LOC + HS + ORI	
INVITE				
FIND		ORI		
l o c a t i o n a n d o r i e n t a t i o n c h a n g e				
ALREADY		HS (minimal ori. ch.)		LOC + HS
BETTER	ORI			
THOUSAND		ORI + HS		
LIVE				
NOTHING				

Table 4.11 (cont.)

Recall that the predictions listed in Table 4.8 concerned only categorical (or qualitative) differences, where the relevant categories are handshape change (HS), orientation change (ORI), and location change (LOC). Differences of degree, such as small vs. large location changes, were not considered here. The predicted alternations (see Table 4.8) only occurred for some signs, and only in two cases did the signers use the same predicted form (whispering of THIRSTY, shouting of DIFFICULT).

The results grouped by prediction, are listed in Tables 4.12 and 4.13. The data for the two informants are combined here.

Normal register	Predicted whispered form	Tokens cf. prediction
HS	–	–
ORI	HS	–
LOC	ORI + HS ORI HS	– SEE PROOF, CRY, WARM-WEATHER
LOC + HS	ORI + HS HS not predicted: ORI not predicted: LOC	NICE THIRSTY, NICE FIND CHOOSE
LOC + ORI	ORI HS not predicted: ORI + HS	BETTER ALREADY THOUSAND

Table 4.12

Results by prediction: whispering

Normal register	Predicted shouted form	Tokens cf. prediction
HS	ORI LOC ORI + LOC	– – AUGUST
ORI	LOC not predicted: LOC + ORI	– ELEVEN, CAN, DIFFICULT
LOC	LOC + ORI LOC + HS not predicted: first LOC, then ORI not predicted: LOC + ORI + HS	RESTAURANT WARM-WEATHER PROOF STREET
LOC + HS	LOC + ORI not predicted: LOC + ORI + HS	– NICE, CAT
LOC + ORI	– not predicted: LOC + HS	 ALREADY

Table 4.13

Results by prediction: shouting

Given the small number of test items per group, and the fact that only two subjects were involved, little can be said about the predicted forms that did not occur. However, a close look at the changes that were found can yield insights into the mechanism that is at work: what is it exactly that handshape and location changes, for example, have in common?

No occurrences of handshape change as a whispered version of an orientation change were found in the six selected signs. For three of the signs, such a form is hard to conceive, since the handshape is a fist (CAN, DIFFICULT), or T-hand (BETTER). For the flat hand in DECEASED, the orientation change in the standard form takes place around the longitudinal axis of the hand, and flexion or extension at any of the finger joints happens around an axis orthogonal to this axis, resulting in a very different change in orientation. For both ELEVEN and TOMORROW, which have the thumb and index finger selected, respectively, a handshape version would have been possible; that is, it is conceivable that the thumb or index finger would extend or flex at the MCP joint, changing the orientation of the finger. For ELEVEN, this would result in a maximally 90 degree change in orientation; moreover, a very uncommon movement of the thumb would be necessary (abduction and extension). For TOMORROW, the palm orientation would have to change 90 degrees for MCP flexion to be a possible articulation. For both signs, however, little is gained in terms of reducing the resulting perceptual size of the whole articulation: the change in orientation in the standard form moves the body of the hand (the palm and flexed fingers), which is a more or less symmetrical ball-shaped form, around its axis, and compared to the movement of the extended thumb or finger this movement is very small. This is potentially a reason why the signers did not attempt to further reduce the movement: the perceptual effect would have been minimal.

In other whispered signs, we do see the involvement of a handshape change. In one whispered version of THOUSAND, the location plus orientation change was reduced to an orientation plus handshape change. The handshape change was a flexion of the extended finger at the MCP joint, thereby changing the orientation of the index finger. This change was enhanced by the forearm supination that is also found in the standard register. Some location changes were whispered by flexion or extension of the MCP joints. In all three signs (PROOF, WARM-WEATHER, CRY), the selected fingers were fully extended, and the relative orientation was either [palm] or [dorsum]. The opposite effect was found for a shouted version of AUGUST, where wrist flexion-extension and elbow flexion-extension replace flexion-extension of the MCP joints of the selected fingers; in both versions, the movement is in the direction of the palm and dorsum of the hand. All these items provide further evidence for the proposal in Chapter 3 that the MCP joints do not play a role in the phonological specification of the signs. One of the shouted versions of PROOF showed another interesting version of this alternation: the first cycle of the repeated movement towards the weak hand was a location change (elbow extension), the subsequent (two) cycles were orientation changes (wrist extension). Although this was not predicted for the shouted condition, here we find distalization *within* a sign, in the different cycles of the repeated movement.

A remarkable handshape change was found in both the whispered and shouted realization of ALREADY by AR (in the shouted version it was accompanied by a location change). The handshape change in these realizations is a very complex movement of the fingers. At the beginning of the sign, the four fingers were fully extended and slightly spread. They then flexed and abducted (sidewards flexion) at the MCP joints to different degrees, the pinkie most and the index least.[118] It is not immediately clear what part of the perceptual specification is being articulated by this finger movement. The ends of the fingers move not only downward (which was the location change), but also inward (contralaterally). Similarly, the orientation of the fingertips changes not only from upward to forward, but also inwards. The initial and final states of this movement are illustrated in Figure 4.12.

i. Standard form

ii. Alternative form

Figure 4.12

Initial and final states of ALREADY *in the standard and alternative forms*

This 'waving' movement at the MCP joints was not expected as the realization of the orientation change, since the relative orientation is [ulnar] in the standard form, and not [palm] or [dorsum] as in the other signs above, PROOF, WARM-WEATHER,

118 The terminology is a bit confusing at this point. The sidewards flexion movement of each digit was in the same direction, and might be termed 'ulnar flexion', just as the comparable sidewards movement of the wrist in that direction. In the anatomical litereature (e.g. Platzer 1975) the terms for such movement are geared towards the most common movement, spreading of all fingers at the same time. The middle finger is relatively immobile in this spreading movement, and the movement from the other fingers away from the middle finger is referred to as 'abduction' (or spreading), the opposite movement is called 'adduction'. In the case at hand here, in the waving motion in the sign ALREADY, the index finger moves towards the middle finger, and is thus called adduction. The ring and pinkie fingers abduct, while the middle finger itself also moves a little, in the direction of the pinkie (ulnar flexion).

and CRY.[119] This finger movement is not found as a standard handshape change in any language, as far as I know. It most resembles the movement in BEAUTIFUL in SLN, which in turn is not common, but it differs from this movement in that it does not end in full bending of the fingers into the palm.[120] Stack (1988) has suggested that the latter movement, which is also found in ASL signs like $\text{BEAUTIFUL}_{\text{ASL}}$, is the unrepeated version of wiggling finger movements as in HOW-MANY. The current data, if they are confirmed by other tokens, suggest that this movement may also be the articulation of a change in orientation, possibly in combination with a closing handshape change.

A reduction from location change to orientation change like that found in the first study on SAY occurs in the sign SEE, which only differs from SAY in location ([eyes] instead of [chin]) and finger selection (2 instead of 1). A similar reduction is found in a whispered version of FIND. The deletion of the handshape change in this sign is potentially due to other factors; in connected signing, the sign is sometimes realized with and sometimes without closing aperture change. The same is probably true for the one whispered version of CHOOSE, which had only a location change. For SEE, PROOF, WARM-WEATHER, and CRY, which unlike CHOOSE and FIND do not have an aperture specification, a combination of orientation change (wrist extension) and handshape change (MCP extension) would also be a possible whispered articulation, but this was not found.

In one whispered version of NICE (AR), the handshape change was combined with an orientation change (wrist extension) instead of a location change (elbow extension / shoulder movement). Although not listed with the predictions in Table 4.8, this change from location to orientation change is not different from the same alternation in SEE and other signs with movement in the direction of the dorsum of the hand.

Deletion of the location component of combined movements was found in whispered versions of NICE (AH), THIRSTY, and BETTER, so that the remaining movement is the handshape or orientation change of the standard form. Addition of large arced location changes occurred in ELEVEN, CAN, and DIFFICULT, which have an orientation change in the standard form. The movement in ELEVEN was upward, the movement in CAN and DIFFICULT was downward; the three signs are almost identical, apart from their handshape (fingers folded into palm with extended thumb in ELEVEN, thumb opposed (folded over the fingers) in the other two) and manner of movement (tense and slow in DIFFICULT). The prediction that such signs might be realized without their change in orientation is not correct, then; apparently this orientation change is part of their lexical specification which cannot be replaced by changing the location of the hand alone. The common property of these changes in orientation is that it is a rotation about the longitudinal axis of the hand, generally

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119 Actually, in CRY the relative orientation value is [palm], but the beginning and end locations [high] and [low] lead to a movement in the direction of the palm. It is this movement direction that is relevant in predicting alternative realizations of the movement.

120 This finger movement is found in 10 signs in SignPhon: MEDDLE-WITH, WAVES, DISLIKE, ARTIFICIAL, UNCOUNTABLE, RISE, SHAME, STEAL, TENDER and COUNT.

articulated by forearm rotation. Other signs such as SEE and PROOF which did show the alternation between orientation and location change all have movement around the transverse axis of the hand, generally articulated by wrist flexion/extension. Thus, there seems to be a difference between different sorts of orientation changes.

Signs that had only a location change in their standard form were shouted in two different ways: by adding an orientation change (RESTAURANT), a handshape change (WARM-WEATHER), or both an orientation and a handshape change (STREET). The latter was not predicted, since phonologically there are no signs that have a combination of three kinds of changes. The handshape change in this sign resembled the one in ALREADY discussed above. Here, the fingers started out being differentially flexed at the MCP joint (pinkie most flexed, index almost extended), and at the end of the sign all fingers are fully extended and a bit spread. Whereas in case of ALREADY it was not quite clear whether the finger movement was meant to realize the change in location or orientation or both, in the case of STREET, the purpose of the articulation is clearly a change in location.

A combination of changes in all three sign parameters as in STREET was also found as the shouted realization of CAT and NICE. In these signs, the handshape change was also present in the standard form. The addition of the orientation change resembles that in RESTAURANT and STREET, in that the path of the end of the hand (the finger tips) is enlarged even further than the path of the whole hand is changed by the larger location change.

To summarize, most shouted versions consist of an addition of movements to the movement present in the standard form. This can be either a more proximal movement (location change is added to an orientation change in ELEVEN) or a more distal movement (orientation changes are added to a location change in RESTAURANT). In whispered signs we find full changes from location change in the standard form to handshape or orientation changes in the whispered form.

4.4.4 Conclusions

Coming back to the two aims outlined in §4.4.1, we can draw two general conclusions.

Firstly, proximalization and distalization do indeed occur for all three movement categories, namely changes in location, orientation, and handshape. The possibility of the occurrence of alternations in the realization of movement seems to be partly influenced by the exact nature of the movement. Thus, there seems to be a contrast between orientation changes that are articulated in the standard form by forearm rotation (they cannot be reduced to handshape changes, modulo the examples of waving movement) vs. those that are typically articulated by wrist movement (they can be reduced to handshape changes). Furthermore, it was found that shouted signs are not exclusively proximalized, in the sense of adding a location change to an orientation or handshape change. It was found that they can also be distalized, in the sense of adding handshape or orientation changes to a location change present in the standard form. Even though a handshape change is prototypically smaller than a location change, when it is added to a location change the result can be a larger movement of the end of the articulator. Thus, the result of both these changes in shouting is enhancement of perceptual properties.

It is hard to derive firm phonological conclusions from the present data, given the small and unsystematic data set. On the other hand, given that it is in principle possible to reduce and enhance signing size *only* by making the standard movement components respectively smaller and larger, it is remarkable that so many items were found that do manifest the alternations between different phonetic types of movements. Apparently the movement alternations are not considered by the signers to be markedly deviant forms, but rather to be one good way to make signs smaller or larger. As a preliminary conclusion, we can say that the underlying representations of the signs do not include details about their precise articulation or about details of the perceptual specification, which varies between different registers. Rather, the representations should be stated in terms of higher-order perceptual abstractions, which refer less to a specific articulator than is commonly assumed.

The second aim of this study was to find out whether it is possible to systematically elicit different articulations, specifically large vs. small articulations. Asking signers to pretend they are whispering and shouting turns out to be an effective way to do this, judging from both the impressionistic survey of phonetic properties of the different registers and from the proximalization and distalization data. Both registers differed markedly from the standard register. However, two aspects of the specific elicitation method used make the data hard to interpret. First, the informants found it hard to avoid a semantic interpretation of 'shouting' and 'whispering', that is, emphasized vs. attenuated meaning of the sign. This is not a total surprise: since the role of many phonetic properties such as size, tenseness and manner of movement are underexplored in the literature, it is possible that some of these are involved in distinguishing different registers as well as in conveying morphological distinctions. For example, repeated movements which were found to be frequent in the shouted data are also used together with other phonetic properties (e.g. specific facial expression) to express intensified meanings in signs such as WARM-WEATHER in SLN. Thus, by asking signers to pretend they are using a certain register rather than creating an actual communication situation in which the register is predicted to occur, it is hard to control what exactly the signers are doing. A second problematic aspect of the setup that was used is that 'whispering' and 'shouting' led to many changes in the form of signs other than their size. Specifically, the change in location of the signing space may interact in complex ways with the way the movements of the signs may be enhanced or reduced. In order to get a clear picture of the enhancements and reductions, it would be better to try to elicit size differences without accompanying differences in other aspects of the sign's articulation.

In addition, one might question the use of the words 'shouting' and 'whispering', arguing that in speech whispering is not the same as soft speech (cf. Ringeling

1984), and that therefore the comparison may not be accurate.[121] Irrespective of the extent to which that is true, the comparison I want to draw does not focus on the phonetic similarities of the registers in the two modalities, but rather on the function of the registers. If the prototypical function of whispering is defined as addressing oneself to someone at close distance about a private manner, and the prototypical meaning of shouting is addressing oneself to someone located at great distance, then it is still possible that the *functions* lie on a continuum. The *phonetic means* that are exploited to implement the different points on that continuum may or may not be simple or unidimensional.

I suggest that two registers produced in this study which I have termed 'whispering' and 'shouting' are not actually the result of varying a single continuum of discourse function. The way I have outlined the imaginary situations to the informants makes use of two conditioning continua: distance and intimacy. Large distance is expected to lead to large signs, whereas signing about public matters to a large audience (which are two aspects of a non-intimate register) may also lead to changes in non-manual behavior and possibly changes in manual aspects of the signs. Conversely, small signs are expected to result from signers being located at short distance from each other, whereas signing about an intimate topic to someone physically very close to the signer (which are two aspects of an intimate register) may also lead to shifts in location of the signing space and non-manual properties such as body position. The next study that I will present aims to circumvent the conflation of multiple continua.

4.5 Alternations between movement types in loud and soft signing

4.5.1 Introduction

In general terms, the hypothesis that was tested in the last study presented here is that the kind of movement that is involved in the surface form of a sign is determined by the phonetic implementation module of the grammar rather than specified in the underlying specification. This is implicit in the Functional Phonology model introduced in Chapter 2, where the 'underlying specification' is put in perceptual terms, and the articulation of that specification varies.

'Movement kind' refers to three traditional parameters of signs: handshape, orientation, and location. Changes in these parameters result in movement. Although these categories are largely perceptual in nature, they do not refer to specific joint positions, let alone muscles. We found in the studies described above that there is quite some variation in which parameter actually changes in a given instance of a sign. Also, we saw that typically, combinations of changes occur in cases where the dictionary form or the proposed phonological representation only contains one change.

[121] Similarly, back-channel discourse by signer taking a subordinate role in conversational interaction (by reducing and lowering their signing space) may also be different in some respects from whispering.

The proposal in Chapter 3 was that the category distinctions themselves are correct, but that their definitions are not: it is typically the shape of the fingers and not of the whole hand that matters, the orientation of only one degree of freedom is relevant and it typically concerns the fingers not the hand, and likewise, the location of the selected articulator is relevant but this articulator is rarely the whole hand. In a sense, then, the parameter and feature definitions have been of a too concrete articulatory nature. They referred to a fixed part of the articulator, namely the hand, instead of a more variable part: the phonologically specified articulator can be a finger tip, one or multiple fingers, the whole hand, or even the whole forearm and hand. In the prototypical sign, the articulators seem to be the fingers, rather than the whole hand. The joints that actually move can still vary from one realization to the next. In this last study on variation, as in the previous studies presented in this chapter, the terms 'changes in handshape, orientation, and location' are used to refer to *the whole hand*, and not an abstract perceptual category 'articulator' as proposed for the perceptual specification.

One of the aspects of the sign that is varied in the articulation of signs, as described in the literature and confirmed by the pilot study described above, is the size of the movement. By varying only the loudness of the signing, different sizes of movement can be elicited while minimizing other changes in the articulation, and different kinds of movement are predicted to be used. The following two alternations were explored in the present study.

(4.5) Alternations explored in the present study

1. Orientation changes vs. location changes
2. MCP movement ('winging handshape changes') vs. orientation and location changes

Alternations between changes in location and orientation were selected because of their frequent occurrence in the previous study. It was suggested there that different kinds of orientation changes may differ in the way they are enhanced in large realizations. The present study therefore aims to investigate the different categories further. In particular, the question is whether there is a difference between orientation changes that are typically 'palm only' (rotation of the forearm, extended wrist), and orientation changes of 'both finger and palm' (wrist movement in either dimension: flexion-extension or adduction-abduction).

The alternation between winging (or 'flattening') movements and orientation or location changes is predicted by the model presented in Chapter 3, yet was only found once in the previous study (for the sign AUGUST). The question is therefore still open whether or not the involvement of MCP movement is really related to movement size. Comparing large and standard realizations of signs that have MCP movement in their standard register form, and small and standard realizations of signs that have a location change in their standard register form will aid in answering this question. By hypothesis, MCP flexion / extension only has an effect similar to location changes for those location changes in which either the palm or the dorsum of the hand faces the direction of movement (or alternatively, points in the direction of the end location). Likewise, large versions of signs with MCP movement in the standard form are predicted to be realized as location changes in which the palm or dorsum faces the end location. The nature of this effect will be further discussed in the analysis of the data, and in Chapter 5.

The following hypotheses were formulated to test the above alternations.[122]

(4.6) Hypotheses

1a. Signs with an orientation change alone in the neutral register form can be realized with an added location change in a loud register
1b. Signs with both a location change and an orientation change in the neutral register form can lose the location change in a soft register
1c. Signs with a location change alone in the neutral register form can be realized with an orientation change alone in a soft register

2a. Signs with MCP flexion or extension alone in their standard form can be realized as changes in orientation and/or location in a loud register
2b. Signs with a location change and the palm of the hand facing the movement direction can be realized by MCP flexion alone in a soft register
2c. Signs with a location change and the dorsum of the hand facing the movement direction can be realized by MCP extension alone in a soft register

As was found in the pilot study discussed in §4.4, the alternations between different movements are just one way of enlarging and reducing the size of the movement. The 'size' of the movement in this conception is determined by looking at the end of the articulator. It is also possible then to change the movement size by different articulations of one and the same movement type. For example, a change in location can be made smaller by reducing it to an orientation change (movement of the forearm or wrist), but the same effect will be attained by reducing the amount of movement at the shoulder and/or elbow joints, keeping the forearm and wrist constant. It is therefore not predicted that the movement alternations occur in every articulation in the non-standard register; rather, as the formulation of the hypotheses emphasizes, they are *possible* forms. As in the previous studies, the actual size of the movement of the end of the articulator was not quantified in this study either; it has to be inferred from the size of the different movement components.

Because of time limitations and practical considerations (see §4.5.2.6), it was not possible within this project to perform a quantitative study of the influence of register. Therefore, the aim is not to show that proximalized forms are found significantly more frequently in a loud register than in neutral and soft registers,

[122] It will be obvious that these are not the only possible hypotheses that are based on the size scale where handshape change is a small movement, location change is a large movement, and orientation change falls between the two. The present set was established as a first step in exploring some of the possible forms in which alternations of movement type occur and does not aim to exhaust the possible hypotheses.

whereas distalized forms occur significantly more frequently in a soft register than in neutral and loud registers. The predicted size effect of the registers was primarily used as a tool to elicit the predicted forms, to increase the chance that they would be found. Tendencies that are found with respect to the register differences will be highlighted and accounted for in Chapter 5, but it is obvious that more quantitative data are needed to confirm these tendencies.

4.5.2 Methodology

4.5.2.1 Problems in the selection of stimuli

In selecting the test items for the present study, a methodological problem has to be faced: what is the form of a sign that is used to compare the loud and soft forms to? 'Citation form' is not a well-defined concept and, moreover, it may by definition not correspond to a neutral register, but rather to something like 'careful speech'. For this study, the reference form that I took as the starting point can be defined as clear 'speech' of an item in isolation in a neutral register. I assume that this is roughly the same as the dictionary form. On the basis of this form, as uttered by one native signer, I selected stimuli to test each of the hypotheses listed in (4.6) above.[123]

The next problem is how to determine whether a sign has a certain type of movement. Although this seems to be a simple question, in practice it is hard to answer. The different types of movement have been distinguished on phonological grounds, yet only surface forms are visible. Determining the phonological form of a specific sign is largely a matter of intuition that has rarely been spelled out in the sign language literature. In fact, doing this comes down to proposing a set of phonetic implementation rules, including the generation of variation, and this is precisely the ultimate aim of this study.

To give an example, in almost every token of signs with a location change, either the finger orientation or the palm orientation (or both) changes to some degree. But how large does this change have to be in order to establish that the sign has a 'phonological orientation change'? Presumably, the larger the change the more likely the change should be interpreted as phonological, but the problem remains.

There are two arguments that may provide evidence for assuming a phonologically represented orientation change. Both of these arguments rest on the assumption that it has been established by phonological analysis of the lexicon as a whole that there is a feature (combination) referring to that orientation change. If this were not the case, then there would be no reason to look for the orientation change in the phonetic signal in the first place.

[123] Note that not knowing what the standard form is is only a problem in the design of an experiment, i.e. in assigning items to each group. If an item is realized differently in the neutral register by the signer, and the difference only concerns the distinctions in movement relevant for the study, then the sign can be assigned to a different group for that signer, and either the soft or the loud form can still be used (in case the standard form was like the predicted soft or loud form, respectively) for testing the hypothesis pertaining to that other group.

First, the sign may contrast with a sign that lacks such a change. Contrary to the typical case in spoken languages, it is the experience of many sign phonologists that real minimal pairs are hard to find, and they certainly do not exist for every feature for every sign: that would imply that the whole phonological space is used by the lexicon, or in other words, that there are no lexical gaps. Arguments based on minimal pairs often have to be made on the intuition that a form could be a possible sign.

This intuition is presumably partly based on the second argument, which is that the orientation change is not simply the result of the easiest articulation of the other parameters. For example, movement in the elbow joint only changes the location of the hand, and if it is only a small movement, as in the sign SAY (see §4.2), the orientation of the hand changes only slightly. More generally, movement in only one arm joint inevitably changes both location and orientation of the hand. This has remained implicit in all phonological work as far as I know: the precise articulation of signs is rarely spelled out in dictionaries or phonological studies, let alone compared to the proposed phonological representation. Furthermore, what the easiest articulation of a sign is remains to be studied: the number of joints in which movement occurs may well be an inappropriate criterion.

Since we do not know the lexical representation of any given sign, in this study stimuli were selected purely on a phonetic basis. First, forms were selected from SignPhon, which at the time contained phonetic transcriptions of over 3,000 different surface forms. These forms were then checked with another native signer. If in the form the wrist as a whole moved more than 5 cm through space, the sign was categorized as having a location change. If the orientation of the flat part of the hand changed (rotation of more than 20 degrees around any axis), then the sign was categorized as having an orientation change. If only the MCP joint (and not the PIP and DIP joints) of any finger moved more than 20 degrees, the sign was categorized as having MCP movement. These boundaries (5 cm and 20 degrees) were not taken from a specific claim in the literature (no specific claims were found in this respect), but were considered to be reasonable estimates of the maximum amount of movement that might appear as 'noise' in a reduced register.

No other phonological or semantic criteria were used in the selection of signs. Although the subjects in the previous study (§4.4) remarked that some signs are inherently hard to shout or whisper because of their meaning, it was assumed that this would not play a role in the present study because the informants did not have to pretend they were signing in a specific style (such as whispering): it was implicit in the task that they should adapt to the situation (see below).

4.5.2.2 Stimuli

The signs that were selected for the different hypotheses are listed in the tables below, grouped by hypothesis, together with their phonological specification. The following features are used, their abbreviations following in brackets.

(4.7) Features used in Tables 4.14 – 4.19

- articulator, finger selection: none, 1, 2, all
- articulator, finger configuration: curved, spread, open, closed
- orientation: palm (p), dorsum (d), tip (t), root/back (b), ulnar/pinkie (u), radial/thumb (r)
- orientation change: palm-dorsum clockwise (pdc), palm-dorsum counter-clockwise (pdcc), longitudinal clockwise (lc), longitudinal counterclockwise (lcc), radial-ulnar clockwise (ruc), radial-ulnar counterclockwise (rucc)
- location: temple, eyes, cheek, mouth, chin, neck, chest, hips, side, palm of the weak hand (wh-palm), neutral space (neu)[124], horizontal plane in neutral space (neu: horiz.), frontal plane in neutral space (neu: frontal), sagittal plane in neutral space (neu: sagittal)
- setting: close, away, high, low, ipsilateral (ipsi), contralateral (contra)
- other: repeated, two-handed (2-h), alternating (alt.), arc, non-manual features

[124] As in the previous study (section 4.4.2, page 192), the signs in this study that are marked for the location 'neutral space' are of the type discussed on page 89 above: they have a variable orientation and location in neutral space and were proposed to lack a perceptual specification for location and orientation; in the tables with feature values here this is indicated by [variable] in the orientation column.

gloss	articulator	orientation	location	setting	other
		r o t a t i o n			
APPLE	all, curved, open	t, pdc	mouth		
BLUE	all; L	[variable], lc	[neu]		
LICK	all	p, ruc	mouth		repeated
NEW	1, closed; 1, open	[variable], lc	[neu]		
OR	all	p, lc	neu: horiz.		
LOCKED	1, curved, closed	t, lc	neu: front al		
DECEASED	all	p, lc	neu: horiz.		2-h, alt., non-repeated
FORTY	all, spread	[variable], lcc	[neu]		
SELF	thumb	t, pdc	chest		
		f l e x i o n / e x t e n s i o n			
EAT	1, curved, closed	p, rucc	mouth		repeated
OPEN	all	u, ruc	neu: horiz.		2-h
HOT-FOOD	all	r, rucc	mouth		repeated
GAY	all	p, rucc	wh-dorsum		repeated
KNOCK	1, curved	d, ruc	neu: front al		repeated
SELECTION	1, open; 1, closed	p, ruc	neu: horiz.		2-h, alt., repeated
SLUICE	all	t, ruc	neu: sagitt al		2-h, alt., repeated
WARM-WEATHER	all	p, rucc	neck		repeated

Table 4.14

Test signs for hypothesis 1a: only an orientation change

gloss	articulator	orientation	location	setting	other
		rotation			
DRESS	all	u, lcc	side	high; low	arc
COME	1	b, rucc	neu: horiz.	away; close	arc
BULL	all, open; all, closed	r, lc	temple	close; away	arc, 2-h.
MUCH	all	r, lc	neu: horiz.	close; away	arc
NEXT	1	p, lc	neu: horiz.	close; away	arc
		flexion / extension			
BED-SHEET	1, closed	p, ruc	neu: horiz.	away; close	arc, 2-h
PUBLIC	all	d, ruc	neu: horiz.	away; close	arc, 2-h
OTHER-SIDE	1	t, rucc	neu: horiz.	close; away	arc
PREVIOUS	1	t, rucc	neu: horiz.	away; close	arc
WELCOME	all	b, pdcc	neu: horiz.	away; close	2-h

Table 4.15

Test signs for hypothesis 1b: both a location change and an orientation change

gloss	articulator	orientation	location	setting	other
TAX	1, curved, closed	t	wh-palm	close; away	repeated
DEAD	all	t	neck	contra; ipsi	
LOOK-AT-SOMEBODY	2, spread	p	neu: horiz.	high; low	repeated
READY	all, spread	u	neu: front al	ipsi; contra	2-h
PEOPLE	all	t	chest ipsi	high; low	repeated
TIRED	all	b	chest	high; low	head tilted sidewards, face: tired
GRANT	1, curved, closed	t	wh-palm	away; close	repeated
BETWEEN	all	p	neu: sagitt al	contra; ipsi	repeated
SEE	2, spread	d	eyes	close; away	

Table 4.16

Test signs for hypothesis 1c: a location change only

gloss	articulator	orientation	location	setting	other
DUCK	all	p	hips	away; close	repeated, 2-h
OBEDIENT	2	u	temple	high; low	2-h
FLUFFY	all, spread	t	mouth	high; low	repeated
PLAY-TRUANT	all	r	cheek	high; low	repeated
SADNESS	1	t	cheek	high; low	repeated
WARM-WEATHER	all	p	neu: front al	away; close	repeated

Table 4.17

Test signs for hypothesis 2a: MCP flexion only

gloss	articulator	orientation	location	setting	other
AUGUST	all	p	neu: front al	away; close	2-h, repeated, mouthing: 'august us'
KEEP	all	p	wh-palm	away; close	repeated
CHILDREN	all	p	neu: horiz.	high; low	repeated on ipsi-wards path
WAIT	all	p	neu: horiz.	high; low	2-h, repeated

Table 4.18

Test signs for hypothesis 2b: location change and palm pointing in the direction of movement

gloss	articulator	orientation	location	setting	other
INTEND	1	d	chin	close; away	tense
PROOF	all	d	wh-palm	away; close	repeated
GROW	all	d	neu: horiz.	low; high	
OFTEN	all	d	neu: horiz.	high; low	repeated
NEXT	1	d	neu: horiz.	close; away	arc
DISGUSTING	all, spread	d	neck	low; high	face: disgust

Table 4.19

Test signs for hypothesis 2c: location change and dorsum pointing in the direction of movement

4.5.2.3 Subjects

The subjects were six Deaf signers of SLN, who were judged to be good signers by the native Deaf research assistant. Five of the subjects started acquiring sign language before the age of three, while one subject used sign-supported Dutch (*Nederlands met Gebaren*, NmG) from age 3 and started to use SLN 15 years previous to the date of the experiment. All subjects judged their own signing skills to be good to excellent. Five subjects have always lived in the Voorburg area, one grew up in the Amsterdam area (for a discussion of the different SLN dialects see Schermer et al. 1991 and the discussion in Chapter 1).

4.5.2.4 Setup

The independent variable used in this study to elicit different registers was the distance between signers. I expected that a smaller than normal distance between signers would automatically lead the signers to make their movements smaller, whereas greater distance automatically leads to larger movements. Thus, by not having the signers pretend that they were signing in a particular register, possible interference of metalinguistic knowledge was reduced.

The distance between the signers (measured from the two nearest sides of the chair) were 80 cm, 300 cm, and 30 meters, respectively.[125] Since the lab in which the recordings were made was not large enough to construct the loud condition in reality, the subject and the research assistant looked at a TV screen presenting zoomed out camera views of each other (reduction to 10% of real size), while a screen between them made sure they could not see each other from the sides.[126] This is schematically illustrated in Figure 4.13. The boxes containing 'soft', 'normal', and 'loud' refer to the three different positions of the addressee ('addr.'). The two arrows indicate the two cameras that were used for the recording; the front and side views were mixed to a split-screen image on one tape, enabling a good view of the signing in all three spatial dimensions. The cameras that were used to provide the TV views of the signer and addressee, on TV1 and TV2 respectively, are not shown in the illustration.

[125] These numbers are approximations, as the actual distance between the signers also depends on their size and the way they are seated.

[126] The distance between the center of the chair and the TV monitor (screen diagonal of 37 cm) was 3 meters. The camera zoom was calibrated by making sure a 60 cm stick measured 6 cm on each TV monitor. The estimate of the long distance measuring '30 meters' is a simple multiplication of the zoom factor (10) by the actual distance to the screen (3 meters); this may turn out to be an inadequate estimate if information about visual perception is taken into account. The exact distance is not relevant here; the calculation only serves to make clear that the signer and the addressee did indeed have a hard time seeing each other's signing.

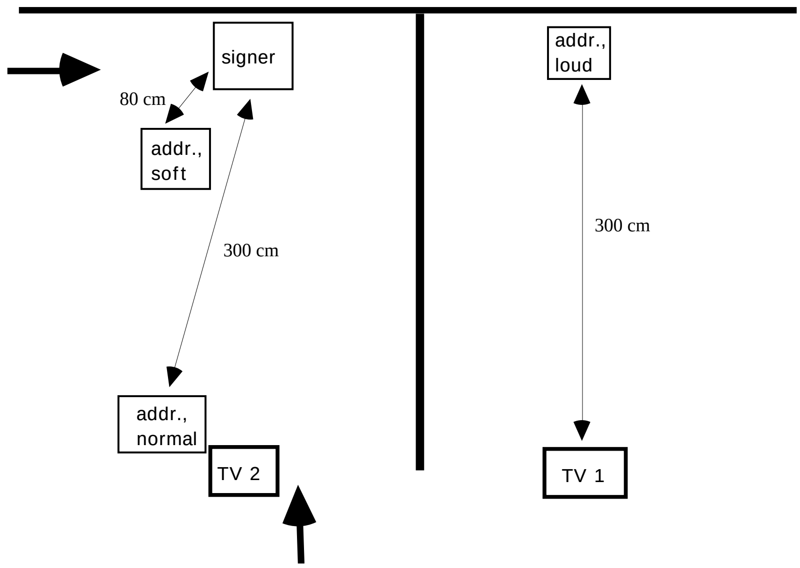

Figure 4.13

Schematic overview of the recording situation

4.5.2.5 Task

Signers were offered three lists in sequence, with the same set of words each time in a different random order. The task was to translate each word to a sign, and for each third sign, make up a short signed sentence or small story in which the sign occurs.[127] The task was explained to the subjects by the research assistant. No explicit instruction was given concerning the signing style. The 'normal' condition was recorded first, then the 'soft' condition, and finally the 'loud' condition. A 10 to 20 minute break during which both signers left the lab separated the three conditions.

Although the sentential forms were not used for analysis, there were two reasons to record the sentential forms. First, the interval of several seconds that the signers needed to think of a sentence disrupted any possible 'list intonation', which might involve a special prosodic pattern that could influence relevant parts of the form of the signs. The impression of the research assistant was that there generally was no specific 'list' effect for the groups of three glosses that were translated in sequence. In almost all cases, the signers returned the active hand(s) to the rest position, typically resting on the lap. Second, and more importantly, making sentences ensured that the signing better resembled a normal communicative situation, in

[127] The first informant (IV) was offered only two lists, and produced a sentence for every form; it was decided after that first session to record 3 citation forms of each item, and to restrict sentences to every third item on the list, in order to save time.

which forms typically do not occur in isolation. To further promote the impression of a normal communicative situation, the research assistant tried to give as much feedback cues as possible, from head nods and facial expression to whole sentences.

All signs were elicited three times in each condition in order to increase the chance that the predicted forms would be found (and at the same time enabling a first impression of the variability within each register). Since the hypothesized forms are *possible* realizations of the signs in a different register, eliciting more than one item increased the chances of finding the hypothesized forms if they are indeed possible forms.

The signs were offered to the subjects in the form of their Dutch glosses. Glosses were chosen that would likely elicit the relevant sign. This turned out to be an inadequate technique: multiple sign translations were used (see below), even though the research assistant went through the list before the recordings and occasionally suggested alternative translations during the recordings.

4.5.2.6 Transcription

Transcriptions rather than measurements were made, for both practical and principled reasons. On the principled side, the interest was in qualitative, not quantitative, differences. For the perceptual aspects, this is almost inevitable: the categories relevant for sign language, even at a low phonetic level, are high-level abstractions from the visible signal. For perception, then, transcriptions are inevitable. On the articulatory side, measurements can be made, but they would have to be categorized as well. Possibly, some degree of distalization or proximalization will be present in each token of all signs, and this is amenable to quantification by measuring joint movements. However, what is relevant from the phonological perspective taken here is whether these changes in the amount of movement in the different joints cross the boundaries of the traditional categories handshape, orientation, and location, defined in the articulatory terms as they are here. In this initial stage of variation studies, transcriptions are adequate. In the future it will be interesting to quantify the variation in movement size within and across registers. A priori, one might say that in sign language there is no difference between articulation and perception, since we see the articulators and not some indirect optical result of the movements of the articulators (this view would closely correspond to the ‘direct realism’ perspective on speech perception; cf. Fowler 1994, and Ohala 1996 for a different point of view). This view is also implicit in recent claims by Stokoe (Stokoe, 1991, Armstrong, Stokoe & Wilcox 1995) about the primacy of articulation (and not perception) in sign language. The outcome of the pilot study mentioned above as well as observations in the literature point to the idea that sign language phonological categories are higher perceptual abstractions from the observations of the articulators, and not definable in terms of joint positions and movements.

On the practical side, the hardware but not the software was available for measuring arm, hand, and finger movements. In particular, there was no convenient way to segment the data we would have acquired from an articulatory recording, as can be done for acoustic data using speech analysis packages such as Praat (Boersma & Weenink 1996).

Transcriptions were made of both perceptual and articulatory characteristics of the sign. Perceptual properties included the kind and the size of the movements found in terms of changes in location, orientation, and shape *of the whole hand*. Articulatory properties that were described included the states of the wrist and MCP joints, and movement at the shoulder (the whole shoulder and shoulder girdle was taken together as a unit), elbow, forearm, wrist (2 dimensions), MCP, and PIP/DIP joints (taken together). For all movements, five degrees of size were distinguished: none, minimal, small, normal, and large. These movements were judged with respect to the total range of motion of each (group of) joint(s).

For repeated movements, it was often found that the first cycle of the movement was larger than the subsequent cycles, which typically did not differ that much among themselves. In a substantial number of cases, there was even a difference in type of movement in the first vs. the later cycles, concerning exactly the categories of interest. In all cases, the transcriptions were made on the basis of the second movement cycle, because it is conceivable that at least in some cases the larger size of the first movement was identical to or overlapped with the transitional movement from rest position to the target initial location.

All transcriptions were made by a hearing research assistant. The first 50 items were jointly transcribed by the assistant and myself, in order to establish consensus on the different values that were used for each transcription category. After 500 items transcribed by the assistant, 10 random items were selected from those 500 and transcribed independently by the researcher. Comparison of the two transcriptions showed that the main difference for all movement categories was between absence of movement vs. minimal movement, and between small and normal movement. For the analysis presented in this book, 'minimal' was therefore classified with 'none' as absence of movement; the other three categories were classified as presence of movement.

4.5.3 Results and discussion

First, some general characteristics of the different registers are described. Then, the results for the three sets of hypotheses are presented and discussed in three subparagraphs.

The first impression of the Deaf research assistant after the recording sessions was that the overall differences between the different conditions were very clear, and that the experimental setup led to the desired effect. This was most apparent for the long distance condition, where both subjects and research assistant noticed right from the beginning of the recordings that it was close to impossible for the perceiver to understand their signing without adapting their movements. Some subjects tried to stretch their heads forward to get closer to the TV monitor. These are intuitions of the signers; no perception study was undertaken to find out to what extent the signs are identifiable from the distance constructed in the lab. The subjects did not make specific comments about the soft condition; being asked directly, they remarked that they didn't find it particularly unusual.

Looking at the sentences in the video recordings afterwards, it turned out that the difference between the normal and loud conditions was immediately visible, but that the difference between the normal and soft conditions was both very variable (between different sentences for each subject) and hard to perceive. Characteristics of the loud signing in the sentences typically included larger movements, raising of the signing space, forward leaning of the upper body, and multiple repetition of movements. In the soft condition, the direction of eye gaze and the head position often indicated that the signers were addressing the video camera rather than the other signer, even though feedback cues were provided throughout each session. Even when it was clear from the direction of eye gaze that signers were directing their signing to the other signer, there were no immediately obvious indications in the sentences of the close proximity of the signers.

A more objective view of the overall size difference between the different conditions is apparent from the transcribed size of the different movement components. The differences in movement size (small, normal, large) that were transcribed are all classified as the presence of movement in the subsequent analysis presented below, since the interest of this study is to see to what extent there is variation in the presence vs. absence of the different movement components.

The following averages were computed for four different movement components. These numbers are based on all transcribed signs, including the signs without movement.

	short distance (n=714)	**intermediate distance (n=753)**	**long distance (n=561)**
location change	1.200	1.191	1.458
palm orientation change	1.307	1.313	1.545
finger orientation change	1.193	1.174	1.383
handshape change	0.632	0.627	0.701

Table 4.20

Average movement size in the three registers for all signs
(0 = no movement, 1 = small, 2 = normal, 3 = large)

The data were submitted to a two-way analysis of variance, with register as a fixed and informant as a random factor. The analysis reveals significant effects for location ($F(2,10.582) = 9.3$, $p = .005$), for palm orientation, ($F(2,11.548) = 11.0$, $p = .002$) and for finger orientation, ($F(2,12.301) = 11.6$, $p = .001$), but not for handshape change, ($F(2,9.625) < 1$).

Subsequent post-hoc test for contrasts indicate that, for each of the three parameters that showed a significant effect, only the 'long distance' category differed significantly from the other two categories (Scheffé procedure, α = .05), which never differed from each other.

It seemed that the signers were on the one hand not close enough to each other to be forced to reduce their signing, yet on the other hand were not in a natural enough position (sitting, knees side by side) to sign as they would in regular situations. In cases where I have witnessed highly reduced casual signing this was typically when signers were not facing each other, but sitting or standing next to each other, such as at the bar in a Deaf club. In such cases, the signing space is typically rotated sidewards, moving the hand close to the addressee closer to the body, and the other hand forward and to the contralateral side. Although such a situation constructed in the lab might have been more effective in eliciting reduced signing because of its naturalness, it was not chosen not to have the subject sit side by side on purpose, in order to prevent changing the shape of the signing in other respects than just the size: locations and thereby movement directions would also have been affected.

Another possibility is that the recording situation was still too formal to enable natural signing, even though all subjects knew the research assistant well and even though the latter asserted that all of them were used to being videotaped while signing in non-lab situations.

To get an impression of the extent to which these methodological problems were responsible for some of the patterns in the data, complementary recordings were made. Two signers (subject JR and the research assistant) were asked to go through one of the lists, performing the signs first in a 'very small' way and then in a 'very large' way. A sentence was produced after each form in isolation. The signers signed to the camera; there was no addressee present. For the sentences in this data set, the small signing did show marked reductions in size of the movements, while the very large signing resembled the shouted signing described below. These data were not further analyzed.

4.5.3.1 Orientation changes vs. location changes

In this section and the sections below, the data for each sign in the neutral register are given side by side with the data for the soft or loud register. They are presented in tables, where the shaded columns mark the predicted form for each register. The data for all subjects are pooled. What cannot be inferred from these tables, then, is whether *a particular subject* showed a difference between the neutral and the other register. After all, it is possible that there are idiolectal differences between signers in terms of the categories that are distinguished here. Since only three repetitions were recorded, it is hard to establish inter-subject patterns. The overall patterns are of foremost interest. If it is the case for a specific sign that the only differences in movement type concern differences between subjects, then this is marked with an asterisk in the relevant cell(s).

After each table with results, some of the test items are illustrated to facilitate the comprehension of the discussion. It is important to be aware that the illustrations necessarily display only one single articulation of the sign. In the figure captions it will be indicated how the movement in the specific realization of the sign would be transcribed in terms of the movement categories distinguished in the present study.

The fact that some signs do not have data from all six subjects mainly stems from the inadequate technique of using glosses to elicit signs: in some cases the signers realized a sign other than the target. Apart from that, a number of signs were not recorded for the first informant (IV), and due to oversight, some were not recorded for certain informants.

			neutral				loud			
gloss	**S**	**I**	**o**	**o+l**	**l**	**other**	**o**	**o+l**	**l**	**other**
					rotation					
APPLE	4	24	9	3			8	4		
BLUE	4	20	11	1			6	2		
LICK	5	24	3			m 3 m+o 7		1		o+m 4 m+o+l 6
NEW	5	28	10	4			6	8		
OR	5	27	5	9			3	10		
LOCKED	5	27	14	1			10	2		
DECEASED	2	11		6				5		
FOURTY	3	16	2	5		no mov. 1	1	7		
SELF	2	9	3*	1*			3*	2*		
					flexion / extension					
EAT	1	6	2			no mov. 1	2	1		
OPEN	4	21	4	5		m+o+l 1		9		m+o+l 2
HOT-FOOD	2	8	4				4			
GAY	3	18	1	6	1	no mov. 1	2	6	1	
KNOCK	4	20	8	2			3*	6	1	
SELECTION	5	26		11	3		1	10	1	
SLUICE	2	9		1*		m+o 2* m+o+l 1*		2*		m+o+l 3*
WARM-WEATHER	2	9	3			m 2*	3			m+o 1*
Totals	–	303	79	55	4	no mov. 3 m 5 m+o 9 m+o+l 2	52	75	3	m+o 5 m+o+l 11

Table 4.22

Results for hypothesis 1a: signs with an orientation change alone in the neutral register form can be realized with an added location change in a loud register

Abbreviations: number of subjects (S), number of items (I), location change (l), orientation change (o), MCP movement (m), no movement (no mov.), all variants realized by a single informant (*)

Figure 4.14

LICK, realized with a change in orientation only

Figure 4.15

NEW, realized with a change in orientation only

Figure 4.16

LOCKED, realized with a change in orientation only

Figure 4.17

DECEASED, realized with a change in orientation only

Figure 4.18

FORTY, realized with a change in both orientation and location

Figure 4.19

HOT-FOOD, realized with a change in orientation only

Figure 4.20

SLUICE, realized with changes in both location and orientation

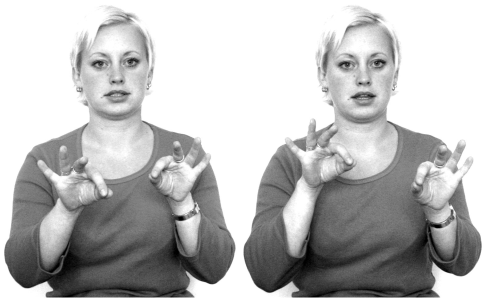

Figure 4.21

SELECTION, realized with a change in location only

There are three main generalizations about the table of results. First, it can be seen that the predicted variation does indeed occur: for all but a few forms (DECEASED, HOT-FOOD, WARM-WEATHER, SLUICE), both variants with and without a location change accompanying the orientation change occur. However, it was not predicted that the variation occurs in *both* registers, even though the predicted forms for almost all signs occur only a little more frequently in the loud register than in the neutral register. Although there does seem to be a weak correlation between the loud register and the high relative frequency of combinations of location and orientation changes, these enhanced forms also occur for the neutral register.

Second, it is striking that so many other forms were found, mostly for the flexion/extension group. Apart from a few forms without movement, all these other forms have MCP movement, often in combination with orientation changes and sometimes location changes. The forms without movement typically had repeated minimal MCP movement, which was barely perceptible. Furthermore, there were three signs (GAY, KNOCK, SELECTION) which also had one token with only a change in location.

Third, one of the differences between the flexion/extension and rotation groups consists of the presence of variants with MCP movement: this frequently occurs for four of the flexion/extension signs, but only for one sign with rotation as the typical articulation of the orientation change. This one sign is LICK, which has an orientation change from dorsum facing forward to tips facing forward. Wrist movement is hard to distinguish from forearm rotation in most articulations; they jointly produce the change in orientation, and the amount of wrist extension and sidewards wrist flexion depends on the initial configuration of the whole articulator. Forearm rotation as the only movement can only lead to a change in orientation if the wrist is adducted all the way (and flexed), which is a relatively extreme position of the wrist. There is a general articulatory constraint that avoids extreme positions of any joint; this will be discussed further in the next chapter. A priori it seems to be easier to articulate the specified movement by wrist extension, and thus, LICK would have fitted better with the flexion/extension group. For both LICK and these other signs (OPEN, SLUICE, and WARM-WEATHER), MCP flexion or extension leads to the same perceptual effect as wrist flexion or extension: there is a change in both the location of the end of the articulator and in the orientation of the fingers. By orientation of the fingers I mean the rotational state in three dimensions of the selected finger(s), which like the orientation of any object in space has two degrees of freedom. The forms with MCP movement that were found as variants of forms with a change in orientation of the hand confirm the claim made by the model proposed in Chapter 3, namely that the orientation specification applies to the selected finger(s) and not to the flat part of the hand or the whole hand.

For some flexion/extension signs, however, there are no forms with MCP movement. KNOCK has a curved or hooked selected index finger, and probably this configuration inhibits MCP movement for physiological reasons. In SELECTION, MCP movement is inhibited by the aperture specification [closed], which requires constant contact between the index and thumb tips. For HOT-FOOD and GAY it is not clear why variants with MCP movement would not be possible, especially since they conform to another generalization about all the forms with MCP movement, namely that they have all fingers selected and extended.

Some signs show patterns that are not captured by the above generalizations. SELECTION has only one token out of 26 with only an orientation change (as in the reference form), but in the loud and not the neutral register. Most tokens (21 out of 26) have a combination of location and orientation changes. This contrasts with most of the other signs (of both the inflection and the rotation type), which have roughly equal occurrences of an orientation change and a combination of orientation and location changes. Hypothetically, it is the aperture specification (T hand, contact between index and thumb tips) that inhibits a degree of wrist extension and flexion large enough to constitute, on its own, the articulation of the repeated change in orientation. Wrist extension has an influence on the extensor tendons of the fingers (cf. Kapandji 1986, Mandel 1979), and during wrist movement it may therefore be especially complex to keep the different fingers in different positions (index MCP more flexed than MCP of the other fingers).

A further difference between the rotation and flexion/extension signs is that for the latter group alone, there are some signs with only location changes (GAY, KNOCK, SELECTION). The presence of these forms is strong evidence for the absence of an orientation change specification. Their low frequency (and their absence for the other signs) is not surprising: it requires special articulatory effort to keep the orientation of the hand constant while changing location. I suggest, then, that these signs have a location change in their phonological specification, and not a change in orientation. It then becomes less surprising that there are so few forms for SELECTION with only a change in orientation; the hypothesized physiological explanation is still necessary to account for the difference between SELECTION and GAY / KNOCK.

For SLUICE, there was no form at all with only an orientation change (the predicted standard form); all tokens had combinations of an orientation change with either MCP movement or a location change or both. For DECEASED, all tokens had a change in both orientation and location; no form was as the predicted neutral form (only a change in orientation). For HOT-FOOD and WARM-WEATHER there were no forms at all that combined a location change with another movement. The signs both have repeated movement of four selected extended fingers, and differ only in orientation. The same feature combination is found in SLUICE and OPEN (except for repetition, which is not found in the latter), but these do have frequent combinations of orientation and location changes. I propose that this reflects the difference in location: signs closer to the face (HOT-FOOD and WARM-WEATHER are made at mouth and neck height, respectively) have smaller movements than signs in neutral space (DECEASED, SLUICE and OPEN). This difference was first discussed by Siple (1978), who proposed a perceptual explanation for this constraint. Perceivers typically focus their eyes on the face of the signer, and in the periphery of the visual field (typically, everything outside the face) less details are perceived. Larger movements would thus be necessary to perceive and correctly recognize objects in the space in front of the chest than in front of the face.

Both HOT-FOOD / WARM-WEATHER and SLUICE / OPEN can have either an underlying orientation change specification or a location change specification. The present data leave open both possibilities, since so few forms of all signs have only a change in location (as was said above, this only occurred for GAY, KNOCK, and SELECTION). The presence of an orientation specification for SLUICE and OPEN might be warranted by their most obvious iconic origin: the signs consist of B-classifiers that represent the movement of doors in their hinges. For the signs HOT, WARM-WEATHER, EAT, GAY, KNOCK, and SELECTION there does not seem to be such a clear iconic motivation of the change in orientation. If we assume that these signs have only a change in location in their perceptual specification, then the fact that they are repeated suffices to predict their reduced articulations (wrist movement or MCP movement). I therefore propose that for HOT-FOOD, WARM-WEATHER, and EAT as well, the phonological specification consists of a change in location, even though, ironically enough, no forms were found in which the location of the whole hand changed. In these forms, I hypothesize, the location close to the face conspires with the repeated movement in preventing enhanced articulations with a change in location of the whole hand. This hypothesis will be further discussed in the next chapter, together with the other constraints and factors that I propose below.

The generalization across all these forms is a perceptual one: what changes is the location of the end of the articulator, in these signs the finger tips, while the location of the whole hand does not always change. For some signs (GAY, KNOCK, SELECTION) enhanced forms are found in which the change in location is realized by the whole hand; for other signs, which are always relatively reduced due to their location close to the face (HOT-FOOD, WARM-WEATHER, EAT), such enhanced forms were not found.

The orientation changes in SLUICE and OPEN prevent one from concluding that all orientation changes are due to forearm rotation and that all ‘orientation changes’ articulated by wrist movement are actually reduced changes in location. These signs always appear to always have a change in orientation (rotation about the ulnar-radial axis): even in enhanced forms they do not lose their rotation. This again encourages us to conceive of orientation and orientation changes as perceptual properties of a particular part of the articulator, typically the (selected) fingers, and not as the state or change in state of a particular joint.

			neutral				soft			
gloss	**S**	**I**	**o**	**o+l**	**l**	**other**	**o**	**o+l**	**l**	**other**
rotation										
DRESS	6	34		17				15		m+o+l 2
COME	6	34		14		m+o+l 3*	1	13		m+o+l 3
BULL	3	16		8				8		
MUCH	6	34		12		m+o+l 4		12		m+o+l 6
NEXT	6	34	1	15	1		1	13		m+o+l 3
flexion / extension										
BED-SHEET	5	29		14	1			12	2	
PUBLIC	6	32	3	11		m+o 1 m+o+l 2*	1	11		m+o 1 m+o+l 2*
OTHER-SIDE	6	33	1	12	1	m+o+l 3		10		m+o 1 m+o+l 5
PREVIOUS	6	30	2	9		m+o+l 4		6		m+o 1 m+o+l 8
WELCOME	4	24		8	1	m+o 1 m+o+l 2		4	1	m+o+l 7
Totals	–	300	7	120	4	m+o 2 m+o+l 18	3	104	3	m+o 3 m+o+l 36

Table 4.23

Results for hypothesis 1b: signs with both a location change and an orientation change in the neutral register form can lose the location change in a soft register

Abbreviations: number of subjects (S), number of items (I), location change (l), orientation change (o), MCP movement (m), no movement (no mov.), all variants realized by a single informant (*)

Figure 4.22

BULL, realized with a change in orientation only (and a finger configuration change)

Figure 4.23

MUCH, realized with a change in both orientation and location

Figure 4.24

WELCOME, realized with a change in location and orientation

If orientation changes tend to be articulated more frequently in combination with a location change in a loud register, then the opposite effect is predicted for a soft register: forms with a combination of location and orientation changes in the neutral register should appear in the soft form as orientation changes only.

The column totals in Table 4.23 above show that this prediction is not borne out. On the contrary, there were hardly any forms found with only a change in orientation, and if anything, these occurred more frequently in the neutral than in the soft register (3 out of 149, or 2% in the soft register vs. 7 out of 151 or 5% in the neutral register). This absence of the predicted register effect confirms the tendency observed above concerning the size differences of the different movement components: the experimental setup for the soft register condition did not produce the desired effect of reducing the movement size. There are no other differences in register apparent in Table 4.23 either: in both registers forms with only location changes occur, as well as forms which combine an orientation change and a location change with MCP movement.

Even more frequently than in the previous data set, we see that MCP movement is involved in the articulation. In contrast to tokens of the signs LICK and WARM-WEATHER above, MCP movement never occurs as the only movement in the present data set. Furthermore, it is found not only in the flexion/extension group, but also in the rotation group. The involvement in the rotation signs suggests that the MCP movement adds to the change in location (rather than a change in orientation), which apparently is part of the specification in these signs. The reason for this is that, in perceptual terms, forearm rotation always leads to a change in orientation of the fingers around a different axis (either longitudinal or palm-dorsum; see Figure 3.28) than the orientation change resulting from MCP movement (the radial-ulnar axis; see Figure 3.28). This is true irrespective of the positions of the wrist and MCP joints.[128] The MCP movement again enhances the path through space of the end of the articulator. Such MCP variants occur for all but two signs, namely BULL and BED-SHEET; both these signs have finger configuration specifications (flexion and aperture, respectively) that inhibit MCP movement.

Together with the observed scarcity (and for some signs even absence) of forms with a change in either orientation or location, the frequency of MCP movement imposes the conclusion that there is indeed a difference in perceptual specification between the data sets for hypotheses 1a and 1b: the former have a change in either orientation or location, the latter have both a change in both orientation and location.

The fact that there were so few forms with only an orientation change, in comparison with the first group of signs (hypothesis 1a), could in principle also be due to the fact that the targeted soft forms were not realized as reduced at all (which was already established above). However, given the frequent occurrence of orientation changes as the only movement in the neutral versions of the signs in the first group (hypothesis 1a), one would expect that such forms would occur as frequently for the neutral register for the present set of signs, which have a combined change in orientation and location in the reference form. The fact that

[128] An interesting exception to this generalization occurs in the articulatorily very complex 'waving' movement that is discussed below.

they do not corroborates the claim that there really is a difference in phonological specification between the two groups.

A few small remarks are in order. First, two different forms of WELCOME were found, differing in the coordination of the two hands. In the reference form, the sign was symmetrical, both hands moving towards the body, the hands rotating inwards. In many of the above forms, the hands performed an asymmetric, 'parallel' movement, both moving from one side of the signing space towards the center (Crasborn 1995, van der Hulst 1996). They seem to be different inflections; the object of the welcoming being the addressee vs. a third person located to the side of the signing space. The third person form has a much smaller orientation change; the movement of the end of the articulator (the finger tips) can be made large enough by moving the whole hand. The addressee form involves an extra rotation of the hand in the horizontal plane in order to enlarge the path. Performing the same path with the whole hand would imply starting the movement much further away from the body (about one hand's length), because the forearms or wrists will already touch the chest when the finger tips are still in the middle of the signing space. The difference in size of the orientation change is completely lost in the data above, since all size differences beyond absence vs. presence have been eliminated. The systematic differences in size of the orientation change between the different inflections suggest that the change in orientation in this sign is not lexically specified.

Second, for WELCOME and MUCH, an uncommon 'waving' motion of the fingers was found (most consistently for one subject, JH). This movement was already briefly mentioned in §4.4.3.4, where it was found in the articulation of the sign ALREADY. There, this asynchronic flexion and abduction/adduction of the MCP joints (starting with the pinkie, which moves most, and ending with the index, which moves least), was used to articulate the change in orientation. In WELCOME, the waved flexing motion of the fingers' MCP joints occurs in the second person form of all signers, and contributes to the realization of the location change. At the same time, the orientation of the fingers also changes, but again this is most likely an epiphenomenon of the location change.

In MUCH this finger movement did seem to contribute to the changes in both orientation and location. The change in orientation in the sign is typically from palm down to contralateral-up and articulated by forearm supination. It causes the index finger to be closer to the midline of the body than the pinkie finger at the beginning of the sign, while the reverse goes for the end of the sign. The same effect is realized by the waving movement of the fingers at the MCP joints (cf. the illustrations in Figure 4.12 above).

These 'waving' MCP movements were also found for some other signs, although they were not systematically transcribed from the outset. They will be discussed extensively in §5.4.4, where more relevant data will be incorporated in the discussion. Together, these data argue against the specification of the configuration of the whole hand and in favor of the proposal in Chapter 3 that considers the MCP joints in all signs to be part of the articulatory apparatus. This can be called upon to realize the perceptual specification for the configuration, orientation and location of the fingers.

One point that remains open for discussion is what the relationship is between orientation changes and arc-shaped movements. Almost all the signs in this group which were argued to have a combination of changes in location and orientation also have a specification for [arc] as movement shape. This issue will be discussed in the next chapter.

			neutral				soft			
gloss	**S**	**I**	**o**	**o+l**	**l**	**other**	**o**	**o+l**	**l**	**other**
TAX	0	0								
DEAD	6	32	7	9			3	12	1	
LOOK-AT-SOMEBODY	4	19	2	3		m+o 3	2	3	1	m+o 3 m+o+l 2
READY	2	10	1	4			1	4		
PEOPLE	6	33	10	5		m+o 2	13	3		
TIRED	4	9		5	1			2	2	
GRANT	4	21		5	5		1	5	5	
BETWEEN	2	11			3*	no mov. 3*			3*	no mov. 2*
SEE	6	31		13	1	m+o+l 1		15		m+o+l 1
Totals	–	166	20	44	10	no mov. 3 m+o 5 m+o+l 5	20	44	12	no mov. 2 m+o 3 m+o+l 3

Table 4.24

Results for hypothesis 1c: signs with a location change alone in the neutral register form can be realized with an orientation change alone in a soft register

Abbreviations: number of subjects (S), number of items (I), location change (l), orientation change (o), MCP movement (m), no movement (no mov.), all variants realized by a single informant (*)

Figure 4.25

DEAD, realized with a change in both orientation and location

Figure 4.26

LOOK-AT-SOMEBODY, realized with a change both in orientation and location

Figure 4.27

TIRED, realized with a change in location only

Figure 4.28

GRANT, realized with a change in both orientation and location

Figure 4.29

BETWEEN, realized with a change in location only

Figure 4.30

SEE, realized with a change in location only

For one gloss, TAX, all informants produced a sign different from the target; the signs PAY and MONEY occurred most frequently, together with the mouthing 'belasting' (tax).

Looking at the overall picture for the other signs, it turns out that the difference between the registers here is almost absent: near equal numbers of items are found in the two registers for all forms. Furthermore, it is remarkable that so few neutral forms were realized as predicted, with only a location change. For half of the signs (DEAD, LOOK-AT-SOMEBODY, READY, and PEOPLE) there was no form at all with only a change in location in the neutral register; one instance of this realization was found in the soft versions of DEAD and LOOK-AT-SOMEBODY. Most forms in both registers combined a change in orientation with a change in location, which is similar to what we saw for the previous two data sets for signs with an orientation change and a combination of changes in orientation and location, respectively.

Disregarding the difference in register, one can see that the predicted alternative realizations containing only a change in orientation were found mostly for DEAD, LOOK-AT-SOMEBODY, and PEOPLE, and in one and two items for GRANT and READY, respectively. For both DEAD and PEOPLE, the standard articulation includes a stable flexed state of the MCP joints while the PIP and DIP joints of all fingers as well as the wrist are extended. This flexion is necessary to realize the specified orientation of the hand, namely the finger tips pointing towards the neck in DEAD and towards the chest in PEOPLE. Rotation of the forearm in these cases causes the end of the articulator (in this case the finger tips) to move along the path that is traced by the whole hand in the reference form.

The other signs, then, had few or no orientation-only variants (READY, GRANT, BETWEEN, SEE). In READY, in which all fingers are extended and spread, the orientation of the hand and fingers is highly variable, and the different orientations lead to different possible articulations of the movement; in all cases the direction of movement is towards the ulnar side of the hand. The initial position of all forms that have the palm facing forwards and fingertips pointing upwards can be articulated either by flexing the elbow, thereby bringing the hands higher in neutral space, or alternatively by hyperextension of the wrist. In the latter case, the elbow has to be relatively more extended, and the sideways movement can be articulated by supinating the forearm. In the former case, where the wrist is extended, the movement has to be articulated by outward rotation of the shoulder joint.[129] Alternatively, the forms which at the start of the sign have the palms facing roughly contralaterally and fingers pointing forward will have more wrist hyperextension the closer they are to the center of the signing space and to the body, and the more the palms face forward. For all these forms with wrist hyperextension, forearm supination has the same effect as in the signs PEOPLE and DEAD: the fingertips trace the path which in the reference form is traced by the whole hand by movement of the elbow and/or shoulder joints.

A similar effect of forearm rotation is found in some but not all forms of GRANT. The difference between the different forms is tied to the variation in movement direction. In both variants of the signs there is downwards movement (towards the

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[129] Ulnar flexion of the wrist is also a possible articulation with a similar perceptual effect, but the amount of movement from extended to maximally ulnar flexion is rather limited (at most 30 degrees; cf. Luttgens et al. 1992).

weak B-hand, palm up). In the cases where the relative orientation is [tips], which in this case of the money hand refers to the thumb tip, there is only a change in location. In the cases in which the relative orientation is [ulnar] or [palm], the elbow and shoulder movement is accompanied by a change in forearm rotation leading to a change in orientation. GRANT can be inflected, so that the initial location of the movement is correlated with the subject of the verb and the final location with the object. It is most likely that the phonologically specified orientation value is [tips], and that the variants above that include forearm rotation are reduced versions of the same sign.

The sign TIRED also has 90 degree MCP flexion, but in this sign the relative orientation is [back], not [ulnar] or [radial]. For this perceptual specification, rotation of the forearm is not a good articulation, as it might be perceived as orientation [tips] while the contact of the ulnar side of the hand with the chest is not realized. Wrist extension (which would also lead to a change in orientation) does lead to a path outlined by all four fingers similar to the path of the whole hand in the reference articulation while at the same time realizing the contact between the ulnar side of the hand and the chest. However, the direction of the path in that case is as much sideways as downwards, and apparently this is not a good articulation.

For BETWEEN, only location changes were found for one signer, and for the other signer no movement was found at all. In the former case, the movement was a small repeated location change; in the latter case, the movement was a minimal repeated location change. Both were accompanied by a tense nonmanual expression (shoulders hunched, head forward). Here, too, tenseness of the movement may be involved in limiting the articulation to proximal joints (shoulder, elbow), inhibiting wrist flexion which would lead to the perception of a change in orientation.

For SEE, no variants were found with only a change in orientation, and there was only one location change that was so small that no accompanying change in orientation was perceivable. In only two of the 31 tokens was MCP movement involved. This sign does not have a small repeated movement, like LOOK-AT-SOMEBODY does, and there is no increased muscle tension such as one finds for small repeated movements as in BETWEEN. Unlike TIRED, however, there is a good distal articulatory candidate for SEE that would lead to the predicted perceptual category 'orientation change', namely wrist extension. This is used together with shoulder and elbow extension in all but one token. SEE resembles SAY, differing in location ([eyes] instead of [chin]) and finger selection ([two] instead of [one]). In the study of SAY in different sentential contexts (described in §4.2), only two signs were found out of 42 (5%) which had only a change in orientation (by wrist extension). Based on the comparison of SEE with LOOK-AT-SOMEBODY and BETWEEN, one generalization is that wrist flexion/extension can articulate a change in location on its own if the movement is repeated but not tense. Another generalization is that as in SAY the direction of movement in SEE is towards the signer and is thus typically perceived in the forward-backward dimension of the visual field. Especially since the articulators are at the same height as the eyes of the perceiver, the size of the movement may need to be relatively large to be perceived as a change in location, and this is preferably articulated as elbow extension (with or without accompanying wrist extension) rather than extreme wrist movement. Again, this may be due to a physiological constraint prohibiting extreme joint positions.

4.5.3.2 MCP movement vs. orientation and location changes

			neutral						loud					
gloss	**S**	**I**	**m**	**m+o**	**o**	**o+l**	**l**	**other**	**m**	**m+o**	**o**	**o+l**	**l**	**other**
DUCK	5	28	8	1				no mov. 5	9	3				no mov. 2
OBEDIENT	3	16	1	7						5				m+o+l 3
FLUFFY	2	11	1	1	2		1			5	1			
PLAY-TRUANT	3	16	8						7	1				
SADNESS	4	22	4			1	4	no mov. 1 m+l 1				4	4	no mov. 1 m+l 2
WARM-WEATHER	1	4	2							1			1	
Totals	–	97	24	9	2	1	5	no mov. 6 m+l 1	16	15	1	4	5	no mov. 3 m+l 2 m+l+o 3

Table 4.25

Results for hypothesis 2a: Signs with only MCP flexion or extension in their standard form can be realized as changes in orientation and/or location in a loud register

Abbreviations: number of subjects (S), number of items (I), location change (l), orientation change (o), MCP movement (m), no movement (no mov.), all variants realized by a single informant (*)

Figure 4.31

DUCK*, realized with MCP movement only*

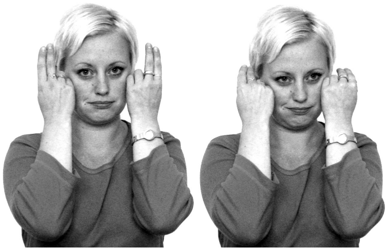

Figure 4.32

OBEDIENT, *realized with MCP movement only*

Figure 4.33

PLAY-TRUANT, *realized with MCP movement only*

Figure 4.34

WARM-WEATHER, *realized with a change in location only*

Looking at the column totals in Table 4.25, we see that in the loud register there are fewer forms with MCP movement as the only movement than in the neutral register; this is the only striking effect of the register. The predicted loud forms, which lack

MCP movement, occur as frequently in the neutral register as in the loud register. Altogether, the variants without any MCP movement (18 items) constitute a mere 19% of the total of 97 items, and more importantly, they only occur for three of the six signs (FLUFFY, SADNESS, WARM-WEATHER). The articulation of the three other signs (DUCK, OBEDIENT, PLAY-TRUANT) always included MCP movement. The clearest case confirming the hypothesis is SADNESS: in the neutral register there are both forms with only MCP movement and forms without MCP movement; in the loud forms there is never only MCP movement. For WARM-WEATHER there were only 4 items, but the same effect is found: only MCP movement in the neutral register, and one predicted and one non-predicted loud form. These two signs thus show an even stronger effect than was predicted: the prediction was that the forms without MCP movement can occur in the loud register, but not that the reference form would not occur at all.

Next to these three signs whose forms were as predicted, there were three signs for which none of the predicted forms were found at all: DUCK, OBEDIENT, and PLAY-TRUANT. However, all of these signs have forms in which MCP movement is combined with an orientation change and/or a location change.

PLAY-TRUANT has only one form that combines MCP movement with an orientation change. This may be due to the contact of the extended thumb tip with the cheek; moving the whole hand by wrist flexion would move the thumb across the cheek in an unpredictable manner, which the signer is likely to avoid. This inhibiting effect of contact would also apply to DUCK, which typically has contact between the radial side of the wrist and the hips or side of the body. DUCK was mostly articulated with MCP movement (the reference form), and no form with an orientation change (the predicted loud form) was found. Also, DUCK had most of the forms without movement. Almost all these signs had minimal MCP movement; one had a minimal orientation change. The effect of contact inhibiting larger movements was also found by Mauk (2000).

For OBEDIENT mostly forms combining MCP movement and orientation change were found (12 out of 16 items), and one form was realized as the predicted neutral form. Only for this sign were 3 loud versions found which combined MCP movement with changes in both location and orientation. If the perceptual specification of the sign were really a location change from front to back, then extension and flexion of the elbow would be a suitable loud articulation, but this is only used in combination with MCP and wrist movement, as another look at the transcriptions revealed. Unlike PLAY-TRUANT and DUCK, OBEDIENT does not have contact with the body nor does it have repeated movement, which would account for the fact that we only find reduced versions. I propose, then, that OBEDIENT has a change in orientation in its perceptual specification.

As in the group of signs selected for hypothesis 1a, the presence of forms with only a change in location is a strong argument for a change in location, and not orientation, in the perceptual specification for a sign. Both MCP movement and orientation changes can be perceived as either an orientation change or a location change or a combination of the two, but a change in location on its own does not imply any orientation change. For FLUFFY, SADNESS, and WARM-WEATHER, then, the proposed specification in Table 4.17 above turns out to be justified: they are indeed changes in location in their perceptual specification. Just as for OBEDIENT, a change in orientation seems just as plausible as a change in location for DUCK and PLAY-TRUANT, although the phonetic characteristic 'contact' could be used to predict the frequent occurrence of reduced articulations of changes in location. Again, as in OPEN and SLUICE, the likely iconic origin of DUCK (mimicking the location and movement of the duck's webbed feet when swimming) could be used to argue in favor of a change in orientation. For PLAY-TRUANT, however, any iconic origin is not obvious to me. Awaiting further evidence, I propose then that both DUCK and PLAY-TRUANT have a change in orientation.

			neutral						soft					
gloss	**S**	**I**	**m**	**m+o**	**o**	**o+l**	**l**	**other**	**m**	**m+o**	**o**	**o+ l**	**l**	**other**
AUGUST	4	22	9	1				m+l 1	10					no mov. 1
KEEP	4	21			3*	3*	5				3*	3	3	no mov. 1
CHILDREN	4	18		1	7		1				9			
WAIT	5	28				12	2					12	2	
Totals	-	89	9	2	10	15	8	m+l 1	10		12	15	5	no mov. 2

Table 4.26

Results for hypothesis 2b: Signs with a location change and relative orientation value [palm] can be realized by MCP flexion alone in a soft register

Abbreviations: number of subjects (S), number of items (I), location change (l), orientation change (o), MCP movement (m), no movement (no mov.), all variants realized by a single informant (*)

Figure 4.35

AUGUST*, realized with MCP movement only*

Figure 4.36

WAIT, realized with a change in location only

For this group of signs, too, we see hardly any differences between the neutral and the soft registers, while there are clear differences between the different signs. Most forms surprisingly do not consist of only a location change in the neutral register, although a few tokens of these forms did occur for every sign but AUGUST.

AUGUST resembles DUCK and PLAY-TRUANT in the previous data set, which also mainly had MCP only tokens in both registers. However, unlike these two other signs, AUGUST does not have contact. It only has small repeated movements (with no body contact), which for BETWEEN appeared to lead exclusively to proximal movements. I propose there is a difference in tension here, such that the fact that AUGUST is not specified for tense movement leads to mostly MCP variants, while the [tense] specification for BETWEEN causes it to be proximalized. The fact that there are no variants with a change in orientation makes it unlikely that the perceptual specification of the sign includes a change in orientation instead of location.

KEEP and WAIT did not have any reduced forms with MCP involvement. For both signs, this could be ascribed to their location, which is low in signing space and thereby also in the periphery of the visual field. The repetition of the signs already causes the movement to be relatively small, and further reduction would not impair perceptibility.

The secondary movement in CHILDREN (the primary movement, a sidewards path, was left out of consideration) was mostly articulated by wrist flexion, leading to a change in orientation. In one case elbow movement led to a location change, and in one case MCP movement accompanied the wrist flexion.

In conclusion, it appears that stronger reductions would be necessary to obtain fully distalized articulations; for three of these four signs the predicted reduced forms do not occur in either register. The difference in neutral articulations between the signs in this group and in the previous group is not only a matter of underlying perceptual specification (signs such as DUCK in the previous group were analyzed as changes in orientation rather than location), but determined by various other phonological characteristics of the specific signs, such as the actual location and specification for [tense] and [repetition]. This also explains why the realizations of AUGUST in this group look more like the signs in the first group.

			neutral						soft					
gloss	**S**	**I**	**m**	**m+o**	**o**	**o+l**	**l**	**other**	**m**	**m+o**	**o**	**o+l**	**l**	**other**
INTEND	5	28				3*	11					3*	11	
PROOF	5	26	2		2	8		no mov. 1		2	3	6	1	no mov. 1
GROW	3	16				7		m+o+l 1				5		m+o+l 3
OFTEN	3	14		1		5			1	1		5		no mov. 1
NEXT	6	34			1	13	1	m+o+l 2			1	10		m+o+l 6
DISGUSTING	0	0												
Totals	–	118	2	1	3	36	12	no mov. 1 m+o+l 3	1	3	4	29	12	no mov. 6 m+o+l 9

Table 4.27

Results for hypothesis 2c: Signs with a location change and relative orientation value [palm] can be realized by only MCP flexion in a soft register

Abbreviations: number of subjects (S), number of items (I), location change (l), orientation change (o), MCP movement (m), no movement (no mov.), all variants realized by a single informant (*)

Figure 4.37

PROOF*, realized with a change in orientation only*

Figure 4.38

GROW, *realized with a change in both orientation and location*

Figure 4.39

NEXT, *realized with a change in both orientation and location*

The gloss DISGUSTING led to a non-target sign for all signers (5 hand contacts chest with the palm, plus a specific facial expression). The other signs (which had relative orientation value [dorsum]) show the same pattern as the signs with value [palm] in the previous data set: there was very little variation between the registers, but a few fairly consistent differences between signs. The main difference with the previous set of signs is that there were three forms (two for PROOF in the neutral register, one for OFTEN in the soft register) that confirmed the prediction, in having only MCP movement. Unlike AUGUST, for which this seems to be the prototypical articulation, for OFTEN and PROOF these forms were exceptional, combinations of changes in location and orientation being the typical (most frequent) articulations.

INTEND is the only sign without any variants at all that include MCP movement. Location changes by themselves predominate (22 out of 28), and there are some combinations of location and orientation changes (6 out of 28). Here too, the feature [tense] seems to influence the articulation. In fact, INTEND is the clearest case of the effect of the feature [tense], since it is the only feature that distinguishes INTEND from SAY. As we saw at the beginning of the chapter, SAY can often be articulated by distal forms only (changes in orientation and MCP state). The data for SAY did include many context forms, however, where probably more extreme reductions occurred than in the neutral or soft register forms in isolation here.

For the other signs (PROOF, GROW, OFTEN and NEXT), then, MCP movement was found in combination with a change in orientation and/or location. Apart from the MCP only versions of PROOF and OFTEN mentioned above, the most striking difference between these signs is that only GROW has no reduction that leads to the loss of the change in location. OFTEN has a non-tense repeated movement, and this would explain why no forms were found with only a location change. GROW has a large non-repeated movement from low to high in the signing space, and articulating this change in location without an accompanying change in orientation would require extra compensatory effort of the wrist joint. The movement is not different phonologically from that in NEXT, where only one form was found with only a location change.

The differences in what seemed to be preferred articulations for the signs in the three different groups 2a-2b-2c have been discussed above for individual signs. However, we can also establish a more general pattern, which is apparent in Table 4.28. Here, the data for the different registers have been pooled. The shaded cells highlight the most frequent articulations for the different signs, and we see that AUGUST patterns with group 2a rather than 2b, for which it was originally selected, and INTEND patterns with group 2b instead of 2c.

		MCP movement		no MCP movement	
	gloss	MCP	MCP + orientation / location	location / orientation	no movement
2a	DUCK	28	1	–	10
	OBEDIENT	4	26	–	–
	TO-PLAY-TRUANT	23	7	–	–
	SADNESS	8	10	19	2
	WARM-WEATHER	2	2	2	–
2b	AUGUST	17	2	–	2
	TO-KEEP	–	–	27	2
	GAY	–	–	24	–
	CHILDREN	–	1	33	–
	TO–WAIT	–	–	38	–
	INTEND	–	–	39	–
2c	PROOF	2	6	28	2
	TO-GROW	–	5	15	–
	OFTEN	2	4	12	1
	NEXT	–	10	29	–

Table 4.28

Different preferred articulations for three groups of signs. Shaded cells highlight preferred realizations

For group 2c (PROOF, GROW, OFTEN, NEXT), we see that changes in orientation and/or location are most typical, sometimes accompanied by MCP movement. For group 2b (KEEP, GAY, CHILDREN, WAIT and INTEND) we find no combinations with MCP movement at all. For the signs in group 2a, a more mixed picture arises, but for all signs MCP movement is typically involved in the articulation. These different preferred forms call for an explanation, since there is no difference in the phonological specification of the kind of movement that accounts for them. All but two signs are changes in location; the exceptions are DUCK and OBEDIENT, which were argued to be changes in orientation, but the articulations of these two signs are not responsible for the different (shaded) preferred articulations for the different sets of signs.

The conclusion that is imposed by these differences in articulation of phonologically similar signs is that what is commonly conceived of as ‘the phonological specification’ is not articulatory in nature. At several points in the discussion of the data above suitable perceptual descriptions of the movement in these signs were already hinted at. In the next chapter, these descriptions will be further elaborated, and related to the articulatory shape of the signs.

The fact that there is a common (perceptual) denominator describing these signs does not relieve us from the task of explaining why the preferred articulations differ in the way they do. In the discussion of the data above, various perceptual properties were suggested to be responsible for the differences. The most obvious phonological feature referring to movement is the difference between changes in orientation and location, but other phonological features involved in determining the articulation of a change in location or orientation included the following:

(4.8) Perceptual features correlated with movement size

- tenseness
- repetition
- the actual location; this includes whether or not there is contact with a body location, which is not phonologically specified (cf. van der Kooij 1997)
- the movement direction, which can be derived from sequences of setting or orientation features
- the specific combination of relative orientation value and the setting change

The roles of these features will need to find a place in the phonetic implementation model. In the version of the model that will be discussed in Chapter 5, for example, it will be suggested that the influence of the actual location can be accounted for by a set of constraints on categorization (see page 280).

4.5.4 Conclusions

From the above presentation of the data we can conclude that surface realizations of the test signs where more variable than expected in two important respects. First, there were more different forms than predicted for almost all signs, in terms of the different categories that were distinguished. For the signs selected to investigate the difference between changes in orientation and location, we also found MCP movement to be an important component of many realizations. For the signs selected to investigate the difference between MCP movement and changes in location we found that there are also many variants with a change in orientation.

Second, variation in movement categories was found *within* each register as well, and thus does not only differ *between* the different registers that were elicited. There was thus no uniform or clear-cut effect of register difference between the neutral and the loud registers, in that some articulations are only found in neutral register while other forms occur only in loud register. The soft register condition did not lead to the expected reductions at all, due to methodological problems.

On the one hand, these results justify the starting point for the study, which was the prediction that different articulations exist for every sign, differing not only in the size of the movement at a given joint, but also in the (combination of) joints that are involved. On the other hand, the abundant variation within registers and the differences in phonological make-up between the test items show that it is very hard to pinpoint the source of the variation without taking into account further phonological differences in the selection of test signs.

For this reason the formulation of possible sources has been rather tentative. It *could* be that a certain form is or is not articulated by a certain movement type in the present data set because of factor X, but this must remain a hypothesis. There is no evidence in the present data for the systematic effect of factor X. The non-linguistic factor which was manipulated in this study, the distance between the signers, did not lead to extreme differences. In part this was due to the weak methodological setup, i.e. it turned out to be difficult to elicit register differences for forms in isolation. Several phonological factors which were not manipulated in the experiment seemed to play a role in determining possible articulations for many signs, but the experiment was not set up to provide evidence for such factors by controlling them.

The fact that the influence of the register difference was not as clear-cut as predicted may seem to be a very negative result. However, the fact that so many predicted and non-predicted alternative articulations were found is an important finding in itself. The main surprise in the findings lies in a larger role in the articulation for the MCP joints than expected. Both in the signs that were selected for hypothesis 2 (changes in location), and also in the signs selected for hypothesis 1 (changes in orientation), the MCP joints act together with the shoulder, elbow, forearm and wrist to articulate changes in either location or orientation or both.

Tables 4.29 – 4.34 again list the representations for all signs, this time including modifications suggested in the discussion above (repeated in the ‘changes’ column), and indicate which phonological factors were also suggested to be involved in allowing or disallowing certain realizations (‘factors’ column). In the next chapter, these factors will be discussed further. The column with translations of the glosses is omitted from the tables.

gloss	articu-lator	orienta-tion	loca-tion	set-ting	other	modifications	factors
			r o t a t i o n				
APPLE	all, curved, open	t, pdcc	mouth				
BLUE	all; L	[variable], lc	[neu]				
LICK	all	p, ruc	mouth		repeated		
NEW	1, closed; 1, open	[variable], lc	[neu]				
OR	all	p, lc	neu: horiz.				
LOCKED	1, curved, closed	t, lc	neu: frontal				
DECEASED	all	p, lc	neu: horiz.		2-h, alt., non-repeated		
FORTY	all, spread	[variable], lcc	[neu]				
SELF	thumb	t, pdc	chest				
			f l e x i o n / e x t e n s i o n				
EAT	1, curved, closed	p	mouth	away; close	repeated	change in location, not orientation	repetition and high location lead to reduced articulation
OPEN	all	u, ruc	neu: horiz.		2-h		
HOT-FOOD	all	r	mouth	high; low	repeated	change in location, not orientation	repetition and high location lead to reduced articulation
GAY	all	p	wh-dorsum	away; close	repeated	change in location, not orientation	
KNOCK	1, curved	d	neu: frontal	away; close	repeated	change in location, not orientation	finger configuration prohibits MCP movement
SELECTIO N	1, open; 1, closed	p	neu: frontal	close; away	2-h, alt., repeated	change in location, not orientation; frontal plane in neutral space	aperture prohibits large wrist movement
SLUICE	all	t, ruc	neu: sagittal		2-h, alt., repeated		
WARM-WEATHER	all	p	neck	away; close	repeated	change in location, not orientation	repetition and high location lead to reduced articulation

Table 4.29

Signs for hypothesis 1a (an orientation change only): revised representations

gloss	articu-lator	orien-tation	loca-tion	setting	other	modifica-tions	factors
r o t a t i o n							
DRESS	all	u, lcc	side	high; low	arc		
COME	1	b, rucc	neu: horiz.	away; close	arc		
BULL	all, open; all, closed	r, lc	temple	close; away	arc, 2-h.		curved/closed finger configuration prohibits MCP movement
MUCH	all	r, lc	neu: horiz.	close; away	arc		
NEXT	1	p, lc	neu: horiz.	close; away	arc		
f l e x i o n / e x t e n s i o n							
BED-SHEET	1, closed	p, ruc	neu: horiz.	away; close	arc, 2-h		aperture prohibits MCP movement
PUBLIC	all	d, ruc	neu: horiz.	close; away	arc, 2-h		
OTHER-SIDE	1	t, rucc	neu: horiz.	close; away	arc		
PREVIOUS	1	t, rucc	neu: horiz.	away; close	arc		
WELCOME	all	b	neu: horiz.	away; close	2-h	no change in orientation	movement direction in different inflections

Table 4.30

Signs for hypothesis 1b (both a location change and an orientation change): revised representations

gloss	articul ator	orien-tation	location	setting	other	modifica-tions	factors
TAX	1, curved, closed	t	wh-palm	close; away	repeated		
DEAD	all	t	neck	contra; ipsi			
LOOK-AT-SOMEBODY	2, spread	p	neu: hor iz.	high; low	repeated		
READY	all, spread	u	neu: fro ntal	ipsi; contra	2-h		with some orientations distalized versions are disfavored
PEOPLE	all	t	chest ipsi	high; low	repeated		
TIRED	all	b	chest	high; low	head tilted sidewards; face: tired		location and orientation prohibit change in orientation
GRANT	1, curved, closed	t	wh-palm	away; close	repeated		
BETWEEN	all	p	neu: sag ittal	contra; ipsi	repeated; tense	tense movement	tenseness prevents distal articulation of repeated location change
SEE	2, spread	d	eyes	close; away			

Table 4.31

Signs for hypothesis 1c (a location change only): revised representations

gloss	articu-lator	orienta-tion	loca-tion	setting	other	modifica-tions	factors
DUCK	all	p, rucc	hips		repeated, 2-h	change in orientation not location	contact prohibits enhanced realizations
OBEDIENT	2	u, rucc	temple		2-h	change in orientation not location	
FLUFFY	all, spread	t	mouth	high; low	repeated		
PLAY-TRUANT	all	r, rucc	cheek		repeated	change in orientation not location	contact prohibits enhanced realizations
SADNESS	1	t	cheek	high; low	repeated		
WARM-WEATHER	all	p	neu: frontal	away; close	repeated		

Table 4.32

Signs for hypothesis 2a (only MCP flexion or extension): revised representations

gloss	articu-lator	orienta-tion	location	setting	other	modifica-tions	factors
AUGUST	all	p	neu: frontal	away; close	2-h, repeated, mouthing: *augustus*		
KEEP	all	p	wh-palm	away; close	repeated		repetition and low location prohibit reductions
CHILDREN	all	p	neu: horiz.	high; low	repeated on ipsi-wards path		
WAIT	all	p	neu: horiz.	high; low	2-h, repeated		repetition and low location prohibit reductions

Table 4.33

Signs for hypothesis 2b (location change and palm pointing in the direction of movement): revised representations

gloss	articu-lator	orienta-tion	loca-tion	setting	other	modifica-tions	factors
INTEND	1	d	chin	close; away	tense		tenseness prohibits distal articulations
PROOF	all	d	wh-palm	away; close	repeated		
GROW	all	d	neu: horiz.	low; high			large location change (unrepeated and in neutral space) implies change in orientation
OFTEN	all	d	neu: horiz.	high; low	repeated		
NEXT	1	d	neu: horiz.	close; away	arc		
DISGUSTING	all, spread	d	neck	low; high	face: disgust		

Table 4.34

Signs for hypothesis 2c (location change and dorsum pointing in the direction of movement): revised representations

In a sense, then, the goal of the study was too ambitious: although full alternations between movement types would constitute the strongest kind of evidence for the nature of the underlying specification, they were hardly found at all. Apparently there is no need for recourse to such alternations: in many cases a sign can be enhanced or reduced by making the standard movement component larger or smaller, respectively.[130]

Whether this enhancement or reduction was indeed present was not evaluated for each individual item in the present study. The calculations for the average movement sizes in Tables 4.20 and 4.21 showed that the enhancements did occur but the reductions did not. The resulting movement size (defined for example as the distance traveled by the most distal end of the articulator) was not evaluated, let alone measured. This distance would have to be inferred from the combination of other transcribed properties, and this would not be an easy task. The size and duration of the movement of different parts of the articulator could be fruitfully measured in the way that Mauk (2000) did for some other properties of loud signing.

The failure to establish the size of the movements independently of the presence of movement in the different joints is the main deficit of the above study: it focused too much on the idea that location changes are inherently large and orientation changes and more so handshape changes are inherently small. The same assumption

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130 However, this conclusion assumes that the creation of the different registers in the lab setting was successful, and as was discussed above, there is good reason to doubt this assumption in the first place.

is implicit in the discussion of proximalization and distalization by Brentari (1998). Both approaches assume that the whole range of motion of a particular joint is used, and that the state of the rest of the articulator is constant. As was pointed out above, the optical-perceptual effect of a particular joint motion is dependent on the state of the rest of the articulator distal to it. Forearm rotation with extended wrist and finger joints has a much smaller perceptual effect than rotation while either the wrist or MCP joints are 90 degrees flexed. It still remains to be investigated which is the preferred way of making a movement smaller or larger, whether there are differences in this preference for different signers or different combinations of phonological properties, etcetera.

For some types of signs, the absence of categorical changes in movement component is precisely what we would expect: the fact that some orientation changes cannot be replaced by location changes but are frequently accompanied by them suggests that the specification for this sign only contains ‘orientation change’, while the location change is a predictable enhancement of these orientation changes. The question how these enhancements and reductions are predictable will be answered in the next chapter, which presents some details of the phonetic implementation model that was introduced for spoken languages in Chapter 2, and builds on the phonological model presented in Chapter 3.

4.6 Conclusions

Summarizing the results of the studies presented in this chapter, we can identify the following five points.

(4.9) Summary of the findings in Chapter 4

1. It was found that proximalized and distalized versions of ‘standard articulations’ of signs occur frequently in Sign Language of the Netherlands. In terms of traditional phonological categories, referring to properties of the whole hand, these alternations can be described as follows:
    - location changes can be reduced to changes in orientation and/or handshape
    - some orientation changes can be enhanced by replacing them with location changes; it is suggested that they are phonological location changes
    - some orientation changes can be enhanced by adding a change in location; these are suggested to be phonological orientation changes
    - handshape changes that consist of MCP movement can be enhanced by adding changes in orientation and/or location; these are either phonological location changes or orientation changes

2. As was predicted, proximalization (typically enhancement) and distalization (typically reduction) of movement were found in registers that differ depending on the distance between the signer and the perceiver. In addition, such alternations were also found frequently within each register. The use of transcriptions that only distinguished presence vs. absence of movement, rather than fine-grained quantitative distinctions, made it hard to identify a clear effect of register on movement size.
3. Proximalization and distalization play an important part in describing the typical citation form of a lexical item, in addition to characterizing atypical realizations (as described for example in Brentari & Poizner 1994 and Mirus, Rathmann & Meier 2001). That is, if we assume that the traditional categories of changes in location, orientation, and handshape are typically associated with movement at certain joints (respectively shoulder/elbow, forearm/wrist, and finger joints), then some signs are articulated in a ‘distalized’ or ‘proximalized’ way in their typical citation form. A clear example of this effect is found in signs with repeated MCP movement in their citation form, such as AUGUST. These signs have a change in location in their perceptual specification. It was hypothesized that various phonological features (such as repetition in the case of AUGUST) interact in the phonetic implementation of a sign, and that these interactions can lead to different articulations of signs with similar perceptual specifications for other aspects of the movement.
4. Distalization was found in different cycles of repeated movements: the first cycle tends to be much larger (and articulated by more proximal joints) than the second and subsequent cycles if any.
5. An interesting type of distalization which was not predicted occurred in the form of what I termed ‘finger waving’. This consisted of a complex movement of the fingers (at the MCP joint), which resembles the handshape change that is found in a few lexical items in SLN (such as BEAUTIFUL) as the standard articulation. In the data presented here, this waving was found to be used as the realization of both location changes (e.g. STREET) and orientation changes (e.g. ALREADY). More data on this subject will be presented in the next chapter.

It is important to emphasize that the studies presented here only looked at the presence or absence of movement in a certain joint, and not at the size of those movements or the size of the movement of a certain part of the articulator. This is relevant because proximalization does not necessarily lead to enlarged movement and distalization does not necessarily lead to reduced movement: their effect depends largely on how movement size is defined. It was proposed that for many signs, the size of the movement of the end of the articulator is relevant for the perception of signs, rather than the size of the movement of the hand as a whole. This movement size cannot be derived from the transcriptions made in the studies presented here, and should preferably be measured in future studies (cf. Mauk 2000).

Furthermore, the above studies focused on proximalization and distalization of the phonologically specified movement of signs. The terms proximalization and distalization can also be fruitfully used in describing the articulation of static aspects of the sign. This point will be further discussed in the next chapter, where I will argue that the same constraints are at work in both types of alternations.

The question that arises from the above conclusions is how the different variants come about, i.e. how can we insightfully describe how the different linguistic and nonlinguistic factors determine the articulation of signs, including the selection of the joints that are used in the movement? This question will be addressed in the next chapter.

5 Phonetic implementation in sign language

5.1 Introduction

In the study of different articulations of changes in orientation and location in Chapter 4, we found that for most signs, the joints that articulate a given movement differ from token to token. In traditional phonological terms, this variation can be seen as alternations between changes in location, orientation, and handshape. I aim to show in this chapter that whereas the combinations of joint actions involved in the different realizations of a sign vary, some aspect of the sign remains constant. I will characterize this constant aspect as the perceptual specification of the sign, while the joint actions are the articulatory implementation of this specification. The traditional distinction between (changes in) articulator, orientation, and location remains valid, but the definition of these categories is different in my proposal, and does not refer to the joints involved in articulating the movements.

In spoken language phonetics it is widely held that targets of sounds are defined in acoustic-perceptual rather than in articulatory terms. There are many examples that illustrate the appropriateness of perceptual targets. For example, the phoneme /r/ in Dutch can be realized by either apical ([r]) or dorsal ([ʀ]) articulations with highly similar acoustic consequences (see Ladefoged & Maddieson 1996 for general discussion). The vowel quality in so-called 'bite-block speech' closely approximates that of normal vowel articulations, even though the articulations differ considerably (Gay, Lindblom & Lubker 1981). The auditory impression of lip rounding can be realized either by actual lip-rounding, or alternatively by a downward pull of the larynx. Stressed vowels can be realized by different combinations of values for fundamental frequency, intensity and duration, which all have different articulations (Howell 1993). More examples are discussed in Ladefoged & Maddieson (1996) and Stevens & Blumstein (1981).

I first make explicit in §5.2 the difference between perceptual and articulatory representations and how they apply to the movement alternations found in the previous chapter. In §5.3, I show how different articulations can be generated by the implementation model outlined in Chapter 2. In §5.4, I discuss several other alternations, such as the waving movement of the fingers that was described in Chapter 4, and show that these too are instances of articulatory variation of perceptually invariant specifications.

5.2 Articulation vs. perception in the alternations in movement

To make clear the difference between articulatory and perceptual descriptions of the variation found in Chapter 4, let us consider the sign SAY once again. What remains constant in the different realizations of this sign is that the distal end of the articulator (the finger tip) moves forward from the chin. What varies between the different realizations is which joints change state, and as a result, the size of the movements of the different parts (including the end) of the articulator. In the dictionary form used in Chapter 4, we see that the phonological change in location is articulated by both elbow extension and wrist extension. The parts of the articulator that change location are the lower arm, the hand, and the index finger. In two of the realizations that were found in the corpus I used, there was only wrist extension. In those cases, the hand and finger but not the lower arm changed location. However, the different parts of the hand and finger change location to different degrees: the distal ends of these body parts move more than the proximal ends, because the bone is rotated about a joint.

I propose that this shared trait among all realizations, the forward movement of the finger tip, is the *perceptual* specification for the sign SAY. It is an abstract perceptual definition of what the specified articulator should do. This specified articulator in SAY is either ‘one finger’ or ‘index finger’, and the movement it performs is ‘away from the chin’. This specification crucially does not refer to movement at any particular joint: it was found in Chapter 4 that this change in location is not necessarily performed by the shoulder and elbow joints, but may also involve the wrist and MCP joints.

The different articulations of the perceptual target result in changing the location of parts of the articulator other than the finger to different degrees, and also result in changing the orientation of parts of the articulator.[131] Although these are all perceivable events, in the case of SAY, only a change in location is relevant. In this example, the changes in orientation are apparently considered unavoidable by-products of a change in location.

In the case of SAY, the impression might arise that there is a commonality at the articulatory level of the joints as well, since there is *extension* at all the different joints of the arm and hand. This in turn could be taken as evidence for an articulatory sonority hierarchy as proposed by Brentari (1998: Chapter 6), where the use of more proximal joints in a phonetic realization leads to higher sonority, and the use of more distal joints leads to lower sonority. The various studies in Chapter 4 indicate that in SLN there is no clear-cut distinction in the use of proximal vs. distal joints between different registers: both within and between registers proximal and distal joints are used, either by themselves or in combination. The distinction in trajectory size of the end of the articulator may well be seen as a distinction in sonority, but it is a perceptual rather than articulatory distinction (cf. Brentari’s perceptual definition of sonority, Brentari 1998: 27-28). The articulatory category ‘elbow flexion’ need not necessarily result in larger (more sonorous) movement of the end of the articulator than ‘wrist flexion’; this depends on the range of motion of the joints that is actually used.

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[131] Figures 4.4 and 4.5 in Chapter 4 illustrated the extent to which movement at different joints brings about a change in orientation of the fingers.

The case of SAY is misleadingly simple, because in this sign the configuration of the articulator is such that extension of the elbow, wrist or MCP joints all lead to the same perceptual result, namely movement of the end of the fingers in the same direction. The crucial aspect of this configuration is a supinated forearm. If the forearm were in a neutral position (midway between fully pronated and fully supinated), then wrist adduction would have a similar effect on the movement of the end of the articulator as elbow extension. If the forearm were in neutral position but the wrist fully flexed, then pronation would have an effect similar to elbow extension. The fact that the articulations that were found are all termed ‘extension’ is merely an accident.

Such alternative realizations of path movements were found in signs such as DEAD (Figure 5.1). This sign has a change in setting from contralateral to ipsilateral combined with orientation value [tips] facing the major location neck (see footnote 68). The MCP and wrist joints together are 90 degrees flexed in all realizations (i.e. there is a 90 degree angle between the forearm and the fingers), so that the finger tips point towards the neck throughout the sign, and because of this configuration supination of the forearm leads to approximately the same movement of the finger tips as outward rotation of the shoulder. In fact, only one out of 32 tokens was performed without any forearm supination, most of them combining forearm and shoulder motion. About one third of the tokens were articulated with only forearm motion.

i. Initial state

ii. Final state

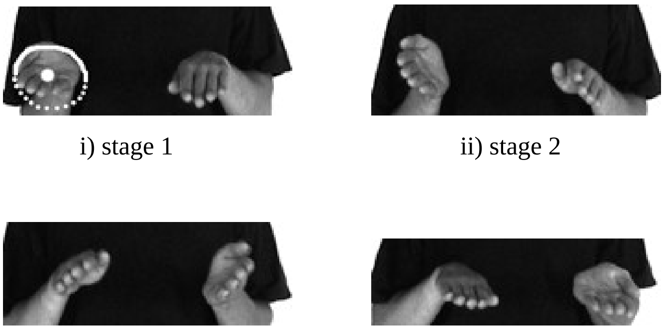
Figure 5.1

Initial and final state of DEAD *from two camera angles*

Here, again, there is no fixed joint action correlated to the change in location of the fingers (or finger tips): either shoulder or forearm or both can be used. The fact that the elbow, wrist and MCP joint are not involved (or only to a minor degree) is related to the configuration of the articulator necessary to realize the specific static feature values at hand (location [neck], orientation [tips]). These are differences in articulation, while the constant perceptual specification is the change in location of the end of the articulator from contralateral to ipsilateral. The different articulations lead to forms differing in size of the path of the fingers (or finger tips), while the direction of movement remains constant.

Something similar can be observed in the different realizations of orientation changes in the studies in Chapter 4. Orientation changes that are normally articulated only by forearm rotation (thus, without a change in location of the whole hand), such as NEW and SELF, were not enhanced in the loud register by making the forearm rotation more extreme. In many standard articulations these signs already use the whole range of motion available (about 160 degrees, cf. Luttgens et al. 1996). If the perceptual specification of these signs stated that the forearm rotation itself is the perceptual goal of the sign, then the only enhancement of this form could consist of ‘more forearm rotation’. Instead we find forms that appear to add a change in location of the whole hand, articulated by elbow and/or shoulder movement.

We can understand these alternations if we look at a perceptual description of the different forms. In the prototypical case of an orientation change, the hand rotates around its longitudinal axis, running from the wrist to the tips of the fully extended fingers. In these orientation changes some parts of the hand move through space just as the whole hand moves through space in prototypical location changes. This is illustrated in Figure 5.2 for the sign DECEASED.[132] The thumb and the pinkie sides of the hand move along an arc-shaped path through space, whereas in an idealized situation the center of the hand (roughly, the middle finger) does not change location at all.[133] The immobile center of the hand around which the hand rotates is indicted by the white dot. The path of the thumb side of the hand is indicated by the solid white line; the path of the pinkie side of the hand is indicated by the dotted white line.



i) stage 1 ii) stage 2

iii) stage 3 iv) stage 4

Figure 5.2

Four stages in DECEASED

Enlarging a sign such as in a loud register can then be realized by enlarging the path traced by a part of the hand in the normal version with only an orientation change; in traditional sign language terms, this comes down to adding an (arc-shaped) location change to the specified orientation change (hypothesis 1). If the hand has a flat shape (as e.g. the B-hand in DECEASED), and the hand rotates around its central longitudinal axis, both the pinkie and the thumb side might be chosen for enlargement, as can be seen in the illustration above. The additional criterion that is needed in order to choose which side of the hand to enhance is likely the visibility of the different sides of the hand. In the case above, the path traced by the thumb side is in view, while the pinkie side remains obscured throughout the rotation movement (for both signer and addressee).

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132 DECEASED was in fact one of the signs for which all the informants realized the form with a location change in the normal register. Although in the soft register versions of these signs the size of the location change was sometimes severely reduced, no signer uttered a soft form without any change in location.

133 In practice, given the irregular anatomy of the forearm, wrist, and hand bones, it is unlikely that there is any point in the hand that is completely immobile during the whole sign if the only movement is forearm rotation. This is even more true for changes in orientation that are articulated by wrist movement: in those cases, the axis of rotation is ideally the center of the wrist joint. This causes the most proximal part of the hand (bordering the wrist) to hardly move at all, whereas the most distal part of the hand (for example, the tip of the fingers in case the fingers are fully extended) moves a lot.

This enlargement of the path traced by one side of the hand in an orientation change is illustrated in Figure 5.3 and 5.4 for the sign NEW. In the normal register, most realizations of this sign only had a change in orientation (10 out of 14), whereas loud register forms more often had a change in both location and orientation (8 out of 14).

i) Initial state

ii) Final state

Figure 5.3

NEW, normal register, from two camera angles

i) Initial state

ii) Medial state

iii) Final state

Figure 5.4

NEW, loud register, from two camera angles

In addition to forearm supination, the articulation of this enhanced arc includes elbow extension followed by flexion, wrist flexion and wrist adduction.

The actual shape of the path that can be perceived in an orientation change depends both on the size of the rotation movement and on the configuration of the articulator. In the illustrations of DECEASED in Figure 5.2 the fingers are in a relatively compact configuration, and the rotation is almost 180 degrees. In the case of a sign like SELF, illustrated in Figure 5.5, the rotation is often limited to 120 degrees, and the thumb is fully extended. The resulting arc is less sharply curved than in DECEASED, and it could be perceived either as an arced movement (as in DECEASED), or as a straight movement forward or forward and upward.

i. Initial state

ii. Final state

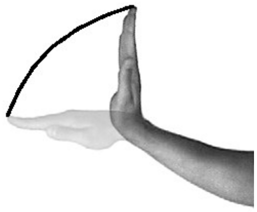
Figure 5.5

Less sharply curved arc in SELF, from two camera angles

Both in location changes and orientation changes we see variation in the articulation (the movements at the joints) as well as in the perceptual result of that articulation (the parts of the articulator that move and the paths they trace through space). The commonalities between the different realizations can best be understood by looking at perceptual aspects of the realizations. In §5.4 below I will discuss several other alternations that also manifest articulatory variability and perceptual similarity.

It is not the case that any use of additional joints will lead to an enhanced path of the end of the articulator, or that any location change would result in an enhanced change in orientation. Only if the actions of different joints are critically coordinated do enhancements such as those in Figure 5.4 occur. Conversely, reduced signs in which a change in location is lost so that only a change in orientation remains reduce the overall path parallel to the enhancement situation described above, but only if the location change and the orientation change together constitute one single location change in the first place. One can easily conceive of a combination of an orientation change and a location change whose path components move in opposite directions. This is illustrated in Figure 5.6. The initial state of the articulator is given in 5.6i. The photos in 5.6ii-iv illustrate three different final states of the articulator; the path of the fingertips through space is indicated by the black lines. In 5.6ii, there is only a change in orientation caused by extension of the wrist. In 5.6iii, wrist extension is accompanied by outward rotation at the shoulder joint. In this case, the change in location of the whole hand has the effect of enlarging the path of the fingertips in 5.6ii. The direction and shape of the path are approximately the same. In 5.6iv, wrist extension is accompanied by inward shoulder rotation, horizontal shoulder flexion, and elbow extension, and together these movements cause the fingertips to hardly change location at all.

i. Initial state of the articulator



ii. Final state after 90 deg wrist extension

iii. Enhancing path movement: final state after wrist extension plus 45 deg elbow flexion

iv. Opposing path movement: final state after wrist extension plus inward shoulder rotation, shoulder flexion, and elbow extension

Figure 5.6

Enhancing vs. opposing paths

In fact, it turns out that for all the neutral register citation forms with a combination of a change in location and orientation (those selected for hypothesis 1b in the study reported in §4.5), the orientation and location changes 'cooperate' to jointly realize one trajectory of one side of the selected fingers. As far as I have been able to establish, there are only very few SLN signs with non-repeated movement which have 'opposing movements', such as FIRST. However, in signs with a location change and a *repeated* change in orientation or handshape (so-called secondary movements), the movements do not generally collaborate to achieve one single perceptual effect. For example, in the sign FAR-AWAY, a repeated rotation of the index finger around its longitudinal axis is combined with a location change in the direction of the fingertip (Figure 5.7).

Figure 5.7

Non-enhancing combinations of movement in FAR-AWAY

The location change component in such signs cannot be seen as a predictable phonetic enhancement of the orientation change. This might already be inferred from the fact that only one movement component is repeated. Signs similar to FAR-AWAY include FESTIVAL and GENES.

Another perceptual effect of the coocurrence of arc-shaped movements and changes in orientation is that it looks as if the articulator is outlining or tracing a virtual round object. This is exploited in signs with an iconic origin such as MUCH and WORLD. In the first case a virtual 'heap of many things' is outlined, in the second case a virtual globe is outlined. In these and similar signs the palm side of the hand or fingers makes contact with the imaginary object. In signs such as these there seems to be good reason to assume that the perceptual specification actually contains an arced path – if not the virtual object itself. The orientation change in these movements is the optimal realization of the tracing of the curved surface with a constant side of the hand, or alternatively, the orientation change in lexicalized tracing movements can be considered the optimal phonetic realization of the relative orientation value on a curved path. As the direction of movement is constantly changing in arced or circular movement in order for the side of the hand that faces the end of the movement to remain constant, the orientation of the articulator has to change as well.

This finding that arced movements and orientation changes typically cooccur, together with the 'path enhancement' explanation proposed above for large orientation changes, calls into question whether the test signs for hypothesis 1b (Table 4.15, page 217) actually contain both a (arc-shaped) change in location and a change in orientation.[134] Does this specification redundantly include changes in both orientation and location, or does it only have a change in either orientation or location, the articulation of which in many cases leads to both a change in location

[134] Uyechi (1996) convincingly argues that many arc-shaped paths in surface forms come about as transitional movements between so-called 'double-contact signs'. This appears to be valid for SLN as well. These signs contact two different parts of a location in sequence, and a smooth transition between the end point of the first contacting movement and the beginning of the second contacting movement including the movement looks like an arc-shaped path. In these cases there is never an accompanying change in orientation.

and orientation? A claim to the effect that all these signs lexically only have a change in orientation would have to be accompanied by a discussion of why some orientation changes in the citation form do not get articulated with a movement of the whole hand (signs such as LOCKED and BLUE) whereas others do (signs such as DRESS and MUCH).

There seem to be two options, then, for representing signs with changes in both orientation and location in their surface form. If we focus on the iconic origin of some signs, where a curved path traces a virtual object related to the meaning of the sign, the signs would have a change in location with the manner feature [arc] in the lexicon. The production grammar then generates an orientation change as the optimal realization of the relative orientation and the arced change in location. For some of the signs that do not have such a clear iconic origin, the lexical specification would consist of a change in orientation, while their peripheral location in the visual field could be seen as the origin of the many enhanced versions with arced paths. Which of these two is the best option remains to be investigated, but either can be accounted for comprehensively in the implementation scheme outlined in the next section.

Finally, signs that do not have a markedly arc-shaped path, such as WELCOME, contain a location change in their lexical specification, which in some realizations is realized by changing the orientation.

In all cases the lexical specification takes the form of a perceptual description of a single abstract movement shape, and the combined movements found in the surface form are predictable enhancements of perceptual aspects of the signs – and not the articulatory aspects typically associated with the citation forms.

5.3 Accounting for the movement variation data

5.3.1 The different parts of the model

I will show in this section how the differences in movement size between different registers and between different phonological feature combinations (as summarized in §4.6) can be generated by the phonetic implementation model. For the variation between registers, I will explore two options below, and leave open which of these should be preferred. The first option will be a reranking of faithfulness constraints with respect to articulatory constraints; the second option will be the adoption of perceptual specifications of the different register themselves.

The outline of the implementation model is repeated in Figure 5.8, including not only the representations but also the other relevant components: the production grammar, the perception grammar, and the constraint sets that evaluate the articulatory output and the match between the perceptual specification and the perceptual output.

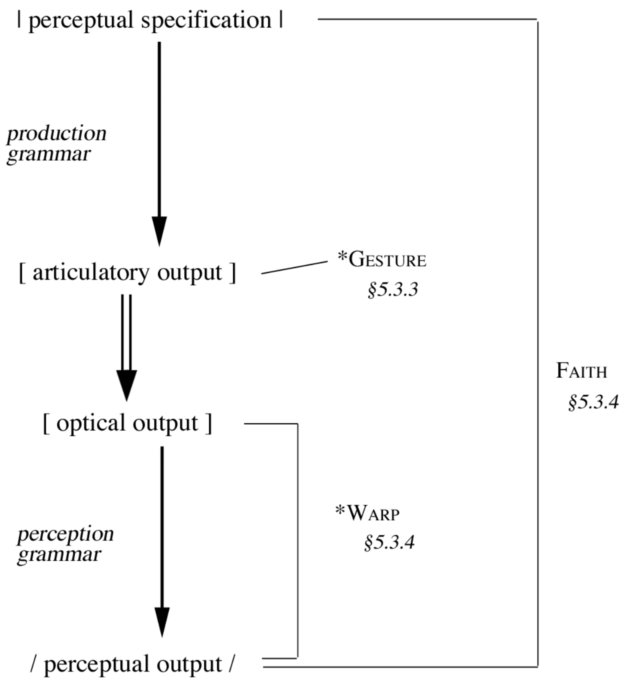


Figure 5.8

The implementation model

The perceptual specification for each sign consists of a set of feature values. The inventory of features and values was proposed in Chapter 3, while the (revised) representations for the test signs in Chapter 4 were presented in Tables 4.29 through 4.34 in §4.5.4.

The role of the production grammar in this model is to generate various articulatory scores for the perceptual specification at hand. This will be discussed in §5.3.2. The optical output is the automatic result of the articulatory output, yet is inherently extremely complex to describe, and is highly variable depending on low-level factors such as the angle from which it is perceived and the surrounding light level. The perception grammar creates a set of perceptual categories on the basis of this optical output – yet another extremely complex process. I will not be explicit about the working of either of these components, but simply assume that the perceptual output consists of categories similar to those in the perceptual specification, although they need not be identical to any of the values used in the lexicon of perceptual specifications. That is to say, I assume that the perceiver is able to perceive new signs with unfamiliar feature values.

One important simplification should be made explicit. Because of the focus in this thesis on the production side of the model, the perception that is discussed in this chapter refers to the perception by the signer of his own signing. In the variation studies in the previous chapter, on the other hand, the role of the perceiver has been a central one, as the goal was to elicit different articulations based on the signer's estimate of the perceiver's needs. At this point I will ignore this difference, acting as if the perceptual output is the same for signer and perceiver, and as if the constraints that evaluate the perceptual specification of the signer are the same as those of the perceiver. In the future the model should be expanded along the lines of Boersma (1998), so that the fact that the perceiver has no access to the perceptual specification of the signer (i.e. the process of lexical decision or recognition) can be accounted for. The differences in optical input between signer and perceiver or between different perceivers are enormous. Moreover, the signer also receives proprioceptive and tactile information about his own movements that is not available to the perceiver. The accompanying distinction between the producer and the perceiver is an important one in the model, and the simplification in this thesis is the result of a first attempt to apply this model to sign language.

This leaves two aspects of the model: the set of constraints on production, which will be discussed in §5.3.3, and the set of constraints on perception, which will be discussed in §5.3.4.

Note that no part of the model by itself is responsible for generating either of the two sets of sources of variation in movement size. These differences emerge from the evaluation of the representations by the constraints and from the interaction between different types of constraints (§5.3.5).

5.3.2 The production grammar

The task of the production grammar is to generate a (potentially unlimited) set of articulatory representations. I propose that these contain the state of each degree of freedom of each of the joints of the upper extremity, from the shoulder to the distal interphalangeal joints of the fingers (see Appendix A), as well as changes in these states over time.

This representation fully specifies all degrees of freedom of the joints, but does not in any way refer to the muscles that are activated to achieve the specified joint states. As was already remarked in Chapter 2, it is by no means clear what the level of movement is that the human motor system actually controls, if there is a single control parameter at all. This control parameter may well be perceptually driven to begin with, in that neither joint states nor muscle states are the ultimate control parameters. This is a hotly debated issue in research on motor control (Gottlieb 2000). The set of joint states over time serves as a convenient shorthand to describe the articulation of signs, on which articulatory constraints can act.

5.3.3 Articulatory constraints

I propose that there are two families of constraint sets, each representing different aspects of ease of articulation. Constraints referring to biomechanical cost are distinguished from constraints referring to physiological ease. To my knowledge, the former have rarely been discussed in the sign language literature (but see Poizner, Newkirk & Bellugi 1983, Wilcox 1992), while the latter have received quite a bit of attention (Mandel 1979, Woodward 1981, 1982, Ann 1993). Physiological constraints will not play a role in this chapter.

Biomechanical constraints militate against the expense of energy needed to move a part of the body. All of these constraints should be rooted in models of the effort involved in performing certain articulations, just as Boersma (1998) proposes in his articulation model for the speech articulators. As this is an impossible task to accomplish here, I rely on the general plausibility of the differences in biomechanical cost of movements at the different joints, being lowest at the interphalangeal joints of the fingers, and highest at the shoulder joint. Generally speaking, movement at a joint moves all of the segments of the body distal to it. For example, movement at the elbow joint changes the position of the mass of the forearm and hand, including the fingers, while movement at the shoulder in addition involves the cost of moving the mass of the upper arm.[135] This is expressed in the universal constraint ranking in (5.1).[136] A minute movement of the shoulder may well be less costly than a large movement of the wrist. Therefore, this ranking only applies to the comparison of movements of the same size. The constraints are defined in (5.1).

(5.1) *GESTURE constraints

*GESTURE(J, x): do not make a movement of x degrees at joint J

*GESTURE(shoulder, x) >>*GESTURE(elbow, x) >>*GESTURE(forearm, x) >>
*GESTURE(wrist, x) >> *GESTURE(MCP, x) >> *GESTURE(IP, x)

This fixed ranking assumes that all the parameters that can be specified for a gesture remain constant, such as size, duration, speed, and acceleration. The size of the gesture is what varies in the data in this thesis, and for the sake of ease I will

135 There are a many complexities that are ignored here. For example, the cost of abduction at the shoulder joint (assuming that the angular distance and the speed remain constant) depends on the position of the joints distal to it: it is cheaper when the elbow is fully flexed than when the elbow is fully extended. The interaction with forces of gravity and those generated by contacting parts of the body are also ignored. Moreover, energy is not consumed by bones or joints themselves, but rather by the muscles that move them. I assume that as a first approximation, the constraints proposed in (5.1) are coarse enough to be valid.

136 As in the rest of this thesis, what I refer to as the 'joints' of the arm and hand are not always single anatomical joints. For example, the functional unit 'forearm joint' that I refer to consists of the anatomical proximal and distal radioulnar joints, while the unit 'shoulder joint' is even more complex anatomically (Luttgens et al. 1992).

consider this size to refer to the change in location of the end of the articulator (typically, the finger tips). To move the tip of an extended index finger 5 centimeters is less costly when articulated by the index MCP joint, and more costly when articulated by the shoulder joint. Although the change in joint angle is smallest in the latter case, the mass that has to be moved is largest.

In addition, large movements at a joint are more costly than small movements at the same joint, again assuming duration, speed, and acceleration are constant. This is expressed in a set of universal constraint rankings, one for each degree of freedom of every joint, in which the numbers refer to the change in angle. For example, for the wrist joint the following two constraint sets are proposed.[137]

(5.2) *GESTURE constraint rankings

*GESTURE(wrist-abduction-α) >> *GESTURE(wrist-abduction-β)
where 50 > α > β > 0 degrees wrist abduction

*GESTURE(wrist-flexion-α) >> *GESTURE(wrist-flexion-β)
where 90 > α > β > 0 degrees wrist flexion

The constraints refer to the whole range of movement for each joint as given in Luttgens et al. (1992).

While in the above constraint set the size of the gesture varied, the speed of the gesture can also vary. Keeping all other variables constant, fast movements are more costly than slow movements, which is expressed in the following universal constraint ranking.[138]

(5.3) *GESTURE constraint rankings

*GESTURE(fast) >> *GESTURE(slow)

The main variables that are constant in this comparison are duration and size. This constraint ranking could therefore be taken as a way to favor non-repeated movements over repeated movements.[139] If the average duration of signs is roughly the same for repeated and non-repeated movements, the articulation of a repeated version of a sign has to have a higher speed than the same sign with a non-repeated movement of the same size and duration.

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[137] The names of these constraints are chosen at random, and are intended to refer to movement in both directions (not only flexion but also extension, not only abduction but also adduction).

[138] Many repeated movements are easier to perform in a fast than in a slow manner; this is a difference at the motor control level that is left out of consideration at this point. In the alternations found in Chapter 4, there is generally no difference in repetition between the various instances of a sign.

[139] Another way to express the difference in cost between repeated and non-repeated movements of the same size and duration would be to refer to the size of the change in joint angles summed up for each cycle of the movement.

Although constraints within each set are universally ranked, there is no fixed ranking among constraints of different sets. Following the proposal of Boersma (1998: 158), the articulatory cost of different movements is only compared on a local scale, that is, a set of constraints in which only a single parameter is varied. Thus, the grammar makes no universal prediction about the difference in cost between a long and slow flexion of the wrist and a brief and small movement of the elbow.

The second family of constraints refer to physiological ease of articulation. Several studies have aimed to correlate sign language phonotactics and physiological properties of the upper extremity, especially in relation to handshape (Woodward 1982, 1985, Ann 1993). These studies investigated the ease of putting various combinations of fingers in various positions (extended, curved, etc.). It is not the case that each finger has a separate muscle dedicated to extending, curving, abducting, etc., nor does the surrounding tissue have the same effect on all fingers. The thumb is most independent from the other fingers, and among those the index finger can most easily extend by itself (Kapandji 1986, Napier 1993). Complexity of articulation in sign language has been defined as the effort involved in coordinating different muscle actions (Ann 1993). A physiological constraint that has only been touched upon indirectly in the sign language literature is that extreme positions tend to be avoided. The ligaments around the joints and the muscles and their tendons do not easily allow extreme positions of the joints, or only at the expense of relatively large amounts of energy.

In a complete grammar, such physiological constraints all have to be incorporated, but they are not needed for the purposes of the analysis of the data in Chapter 4.

5.3.4 Constraints on perception

Faithfulness constraints evaluate the extent to which the perceptual output resembles the perceptual specification. As I already indicated above, this process is simplified in this thesis by ignoring the distinction between signer and addressee. While the signer ‘knows’ what the perceptual specification is, the task of the addressee is to determine which form in his lexicon best matches the perceptual output.

Before an aspect of the perceptual output can be compared to the perceptual specification, it must first be perceived. That is, the perception grammar has to categorize the continuous optical output into various perceptual categories. The constraints that evaluate the interpretation of the optical output by the perception grammar have the following general form.

(5.4) General formulation of the *WARP constraint

*WARP(X, Y): don’t categorize a movement of size X as a change in feature Y

At least two sets of constraints exist that militate against interpreting a rotation of the articulator of X degrees as change in orientation and against interpreting a movement of the end of the articulator of X centimeters as a change in setting. Within each set there is a fixed ranking, so that the larger the movement, the better it is to categorize it as a change in setting or orientation.[140] For example, the constraints referring to the phonological category 'longitudinal clockwise (LC) change in orientation' form the following universal scale, assuming that the maximum range of rotation is 160 degrees.

(5.5) Ranking of *WARP constraints

*WARP(α deg, LC) >> *WARP(β deg, LC)
where $0 < \alpha < \beta < 160$ *degrees rotation about the longitudinal axis*

I propose that some of these *WARP constraints can take into account the phonetic context, that is, other features of the sign. As we saw in Chapter 4, the size of a movement is determined by the location value, whether the movement is repeated or not, and whether the movement is tense or not. The set of constraints that are relevant here militate against the misinterpretation of movement size, depending on the context. The visible movement size to be interpreted concerns the trajectory of the end of the articulator. The constraints should thus express that a movement of the end of the articulator of 3 centimeters is more likely to be interpreted as a location change when it is perceived near the face than when it perceived near the waist, for example. The categorization of movement size is crucial for the correct interpretation of the phonological movement that is present in the specification of a sign, as we will see below. The implementation of this context-sensitivity is left for future research.

The categories that are constructed by the perception grammar are then compared to the perceptual specification. The general form of faithfulness constraints that compare the perceptual output with the perceptual specification is as follows.[141]

(5.6) General formulation of the *DELETE constraint

*DELETE(feature X: value Y): the value *Y* of feature *X* in the perceptual specification should be present in the perceptual output

Constraints exist for all features, such as the following.

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[140] Note that at this point there is no place in this model for the family of *CATEG constraints that Boersma (1998) proposes for the categorization of vowel height, for example, because the feature values for changes in orientation and changes in location do not differ on a single scale.

[141] The *DELETE constraints proposed here are similar to the MAX-IO constraints in McCarthy & Prince (1995); it is likely that we also need their counterpart DEP-IO that violate against the insertion of perceptual features.

(5.7) Instances of *DELETE constraints

*DELETE(location: head)
*DELETE(selected finger: one)
*DELETE(manner: arc)
*DELETE(manner: straight)
*DELETE(manner: tense)
*DELETE(setting change: high, low)
*DELETE(orientation change: longitudinal clockwise)

5.3.5 The interaction between constraints

In this section I will indicate how constraints in the sets outlined above interact to yield the different realizations of signs that we found in Chapter 4. If all faithfulness constraints are ranked below all articulatory constraints, the winning candidate shows no movement at all. This can be seen in Figure 5.9 for the sign SAY, where there is only one faithfulness constraint, referring to the one perceptual category that is present in these forms, viz. | setting: close, away |.[142] This example focuses on the specified movement of the sign only, and does not evaluate the realization of the location value, for example. In a full grammar *GESTURE constraints also evaluate the realization of the location, and in this fictitious case would prevent the raising of the finger tip to chin height. Only the representations and constraints referring to movement are shown in this and following tableaux. The actual candidates and constraints that evaluate them are a typical subset.

(5.8) SAY: no movement (wrong winner)

	| setting: close, away |	*GESTURE (elbow30)	*GESTURE (wrist30)	*GESTURE (wrist20)	*GESTURE (elbow20)	*GESTURE (elbow10)	*DELETE (setting: close, away)
	[elbow ext. 30] /setting: close, away/	*!					
	[elbow ext. 20] /setting: close, away/				*!		
	[elbow ext. 10, wrist ext. 20] /setting: close, away/			*!		*	
	[wrist ext. 30] /setting: close, away/		*!				
	[wrist ext. 20, MCP ext. 20] /setting: close, away/			*!			
☞	[no movement] /setting: none /						*

[142] Realizations of SAY without any lexical movement were found in almost 25% of the cases in the study in §4.2, but it was not quite clear what led to this loss of movement. Coarticulation effects that seemed to play a role in some cases could in principle also be formalized as the interaction of articulatory constraints acting on the transitional movement and faithfulness constraints evaluating the effect of context on the lexical specifications of signs. This is an interesting area for future research.

In the typical articulations of SAY, which have elbow extension either alone or in combination with wrist and or MCP extension, the *DELETE constraint demanding movement away from the body is undominated. The ranking of the various *GESTURE constraints determines the winning candidate. In Figure 5.10, these are ranked so that the candidate with 20 degrees of elbow extension wins.

(5.9) SAY: 20 degree elbow extension (different ranking, correct winner)

	| setting: close, away |	*DELETE (setting: close, away)	*GESTURE (elbow30)	*GESTURE (wrist30)	*GESTURE (wrist20)	*GESTURE (elbow20)	*GESTURE (elbow10)
	[elbow ext. 30] /setting: close, away/		*!				
☞	[elbow ext. 20] /setting: close, away/					*	
	[elbow ext. 10, wrist ext. 20] /setting: close, away/				*!		*
	[wrist ext. 30] /setting: close, away/			*!			
	[wrist ext. 20, MCP ext. 20] /setting: close, away/				*!		
	[no movement] /setting: none /	*!					

Aside from the candidate without movement, these two tableaux only evaluate candidates that contain a setting change as the perceptual category. This is the result of the perception grammar: the ranking of various *WARP constraints among each other has determined that all these joint actions are in fact location changes, and not changes in orientation.

The 'free' variation between different articulations that we found in the first study can be accounted for by not ranking a subset of constraints, in the same manner as Anttila (1997) and Boersma (1998) show for describing variation in spoken language. The interpretation of such free ranking among some constraints is that, when the grammar is used a random ordering of these constraints applies, and that the resulting variants are treated alike: they are either all ruled out by higher-ranked constraints, or they all win. Because of the many different possible rankings, detailed quantitative patterns of variation can be described.

For example, if in the above cases the constraints *GESTURE(wrist20) and *GESTURE(elbow20) were unranked with respect to each other, then two candidates would win. These would be interpreted as free variants. This is illustrated in the tableau in Figure 5.11, where the dotted line indicates that two constraints are not ranked with respect to each other.[143]

143 In fact, in this tableau the same two candidates would win if the two constraints that are not ranked with respect to each other were not present at all. The analysis would therefore only be valid if we can provide evidence that the constraints are really present in the language. This is clearly a topic for future research; the present discussion only serves to outline how a functional phonology analysis of the data would work.

(5.10) Free variation in SAY: two winning candidates

| setting: close, away |	*DELETE (setting: close, away)	*GESTURE (elbow30)	*GESTURE (wrist30)	*GESTURE (wrist20)	*GESTURE (elbow20)	*GESTURE (elbow10)
[elbow ext. 30] /setting: close, away/		*!				
☞ [elbow ext. 20] /setting: close, away/					*	
[elbow ext. 10, wrist ext. 20] /setting: close, away/				*		*!
[wrist ext. 30] /setting: close, away/			*!			
☞ [wrist ext. 20, MCP ext. 20] /setting: close, away/				*		
[no movement] /setting: none/	*!					

Both elbow extension and combined wrist and MCP extension are found as forms of SAY in this example. The presence of the constraint *GESTURE(elbow10) ensures that the form with 10 degrees elbow extension and 20 degrees wrist extension is ruled out.[144]

5.3.6 Two ways to generate register differences

The difference between registers can be accounted for in two ways. Following van Oostendorp (1997) and others, one way to generate different registers or styles in optimality theory models is to change the ranking of faithfulness constraints with respect to articulatory constraints. The higher the FAITH constraints are ranked with respect to the *GESTURE constraints, the larger the resulting movement will be. This is an intuitively attractive way of dealing with these facts, since it intuitively corresponds to what happens in different situations: the speaker or signer makes a (typically unconscious) estimate of how much articulatory reduction can take place before the addressee will fail to understand what was intended. Thus, it corresponds to Lindblom's (1990) notion of 'hyper and hypo speech'. However, Lindblom suggested a larger typology of "dynamically interacting determinants of intraspeaker phonetic variation" (1990: 418). Next to purely communicative constraints (making sure the listener receives enough information to recognize the words), social constraints may also impose boundaries on the amount of reduction that the speaker can afford. A listener may still be able to correctly identify words realized with extreme articulatory reductions, but the speaker may be considered impolite if he puts heavy demands on the listener.

[144] In a more realistic situation, there will also be a constraint against MCP movement, which would rule out the second winning candidate in this tableau.

Although such accounts are intuitively attractive, they ignore the fact that the listener is able to perceive and categorize the non-linguistic aspects in the signal as well. In the case of large signing above, the perceiver needs to assign a source to the larger movements with respect to the constant size of the signer's body, because they need not be the result of a register difference but could also be the result of a semantic difference expressed by a morphosyntactic process. Distinctions in movement size with accompanying differences in the manner of movement and facial expression can be used to express the contrast between 'come' and 'come all the way', for example. Actual confusion may not arise, as information in the phonological and semantic context will typically suffice to determine whether only a particular sign is enlarged (i.e. a phonological contrast) or rather the whole sentence (i.e. a contrast in register). The fact remains that there are multiple factors leading to differences in movement size. In order for semantic distinctions to be correctly perceived, the various other (phonological, extralinguistic) factors have to be disentangled all at the same time.

To account for the fact that perceivers can identify differences in registers, I hypothesize that, instead of proposing a reranking of constraints, the different kinds of variation discussed in Chapter 4 can also be modeled by introducing an additional perceptual specification. This further specification is not for the linguistic content (the lexical and prosodic specifications) but for what one might call the 'extralinguistic content' of the particular communicative situation. Stylistic and social factors not only influence choices in lexicon and morphosyntactic structures, but also influence the phonetic realization of words. Schematically, this can be displayed as in Figure 5.9. It remains to be seen whether the combination of the two perceptual specifications is really a separate stage, or whether the production grammar can directly interpret the two separate specifications.

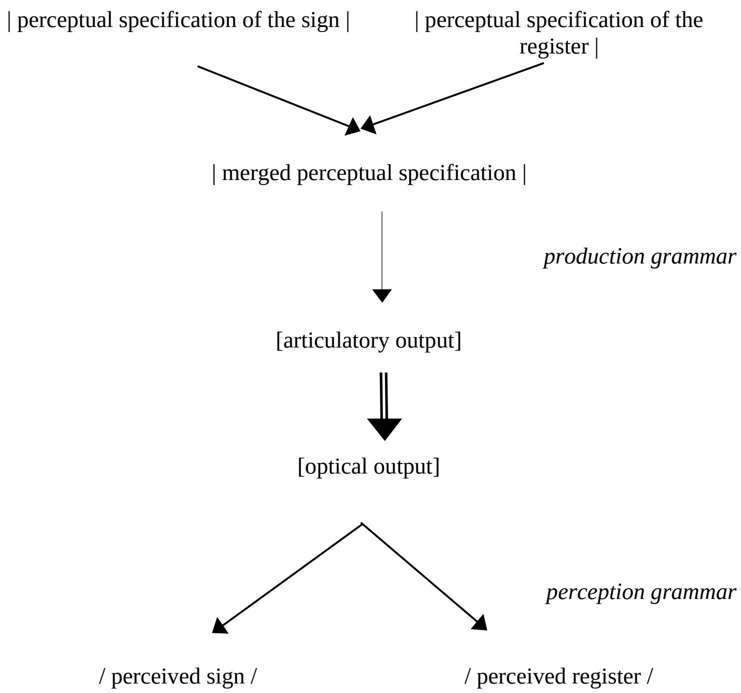


Figure 5.9

The incorporation of a perceptual specification for register

For example, when addressing a non-native speaker, the extra-linguistic perceptual specification might be something like ‘sign slowly!’. Signing to somebody at a distance would involve the perceptual specification ‘large movements’. In the case of SAY addressed to someone at a distance, we have the specifications, articulatory output, and perceptual outputs in Figure 5.10.

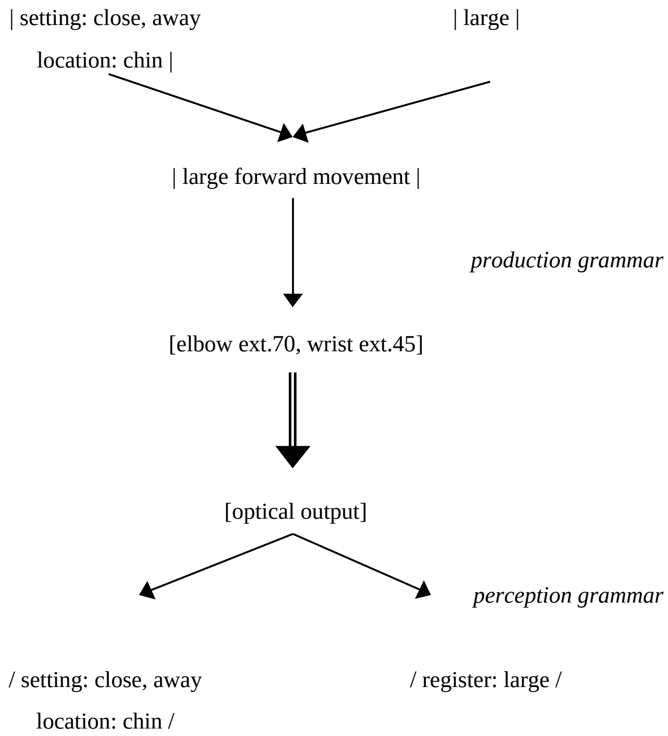


Figure 5.10

Perceptual specification and correct perceptual output of SAY *in a loud register*

The perception grammar will then generate several perceptual outputs on the basis of the large movement, some of which contain a large lexical movement, and some of which contain a regular lexical movement combined with a register specification such as 'large'. High-ranked *DELETE constraints referring to the register specification ensure that the register is correctly perceived.

Further research is needed to investigate this second option for describing register effects and to determine which of the two proposals better handles the observed effects. The second hypothesis does seem to be in line with the recent trend in phonological research to integrate the explanation for phonological and phonetic phenomena (Gussenhoven & Kager 2001) in incorporating paralinguistic signals in a linguistic analysis.

5.3.7 Concluding remarks

It will be clear that the constraints and their interactions that were proposed are only a first exploration of how the analysis that was proposed could be formalized, focusing on the variation within registers and leaving aside the various phonological determinants of movement size. Evaluating the OT formalization that was proposed, it is fair to say that the constraints and rankings are able to *describe* the observed data, but that they do not *explain* the data. To achieve explanatory adequacy, it will further have to be demonstrated that the rankings correctly predict the form of other signs. This is beyond the aims of this thesis.

The overall pattern of articulatory variability and perceptual constancies in the phonetic variation found in SLN are well established, though. The potential power of the Functional Phonology model is that it is able to provide an explanatory account of all kinds of phonetic variation in sign language by formalizing the functional drives of ease of articulation and ease of perception. In order to provide a detailed account of the different registers, we also need more quantitative data that enable us to go beyond stating the involvement of different joints, by quantifying e.g. how much each joint contributes to an overall movement of a given size.

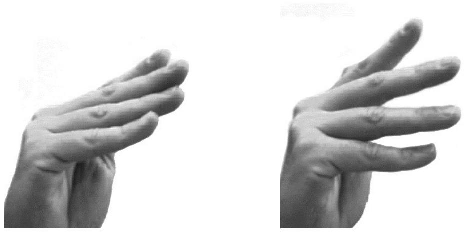
5.4 Articulation vs. perception in other alternations

5.4.1 Introduction

In addition to the variation in movement size, I have observed several other cases of phonetic variation that can best be analyzed by clearly distinguishing between the fixed perceptual target and the varying articulatory means used to attain that target. Some of these have already been mentioned in the previous chapters, such as the ‘waving’ movements of the fingers. I will discussed each case in turn in the next six sections. In each case, I will make explicit how the varying forms differ in their articulation, and which perceptual properties they share. Although none of these cases have yet been formalized in the model that was just presented, they all argue in favor of the central claim of this thesis, namely that the lexical representation of signs does not include references to specific joints or joint states, neither explicitly nor implicitly.

5.4.2 ‘Waving’ movements and variation in the articulation of [finger configuration: spread]

In Chapter 4, I found that in several realizations of signs such as ALREADY, MUCH, READY and WELCOME a peculiar ‘waving’ movement was found that has not been discussed in the literature. In these movements the fingers flex or extend at the MCP joint to different degrees, leading to a fan-like configuration. Typically, the pinkie MCP flexes most and the index MCP flexes least. The fan position sometimes occurs as the initial state of a movement (as in LICK and some realizations of OR), but most commonly as the final state of a movement (as in READY, ALREADY, FLUFFY, MUCH, WELCOME and most ‘waving’ realizations of OR). The resulting configuration is illustrated in Figure 5.11. Some informants realized all forms of a sign with this movement, which suggests that there is some personal preference involved in the use of these articulations. Altogether 80 forms with waving movement were transcribed in the last study in Chapter 4 (§4.5), occurring in all registers and for all six informants.[145]



i. Unspread ii. Spread

Figure 5.11

Fan position of the fingers

The movement occurs both as the realization of a change in orientation (as in OR and ALREADY) and a change in location (as in WELCOME). There is no sign among the set that was recorded where this movement appears to be a change in handshape. This is another piece of evidence against the phonological specification of the MCP joint state (see the discussion in §3.4.4). The question that needs to be answered for these realizations is how they should be interpreted: how do they contribute to the matching of the perceptual output to the perceptual specification?

In the signs with changes in orientation in their perceptual specification, such as OR, the waved position in the final state of the sign leads to the same orientation of the plane (horizontal or palm up in the case of OR) as in the standard realization. However, this plane does not consist of the whole hand, but of the fingers only, and the side of the fingers that is parallel to this horizontal plane is not precisely the palm side but the part of the fingers midway between the palm and the ulnar side of the fingers. This is illustrated in Figure 5.12. In 5.12i-ii a realization of OR is given where the whole hand rotates about its axis, and in 5.12iii-iv a realization of OR is given where only the plane constituted by the fingers rotates close to 180 degrees, while the rest of the hand only rotates for about 90 degrees.

[145] The transcription of these forms was only started after several instances were encountered during the regular transcription of the data. It is possible that many more forms actually occurred among the total of over 2,200 transcribed signs in the study presented in §4.5.

i. First realization, initial state

ii. First realization, final state

iii. Second realization, initial state

iv. Second realization, final state

Figure 5.12

Change in orientation in two realizations of OR, *from two camera angles*

The perceptual specification of this sign includes [selected fingers: 4], [location: horizontal plane], [orientation: palm], and [orientation change: longitudinal clockwise]. Disregarding the difference between the one-handed and two-handed realizations, there are two ways to look at the difference between the two forms above. One could either say that the perceptual output matches the perceptual specification perfectly: in both cases there is a change in orientation of the specified articulator, namely the four fingers. As the different characteristics of a sign are perceived by looking at the fingers and not at the hand or the arm, there is no difference whatsoever between the two forms that faithfulness constraints can refer to. Alternatively, one could say that in the first sign there are more *cues* to the perception of the change in orientation, as a larger part of the articulator performs the specified movement. In that case, the perception grammar would generate different perceptual outputs for the two forms that faithfulness constraints could evaluate. In informal terms, the first realization would be considered ‘more of an orientation change' while the second realization would be 'less of an orientation change'.

In all cases of this waving movement the articulation is rather complex compared to standard MCP flexion for multiple fingers: not all fingers bend or extend to the same degree.[146] Although the articulation is complex to describe in comparison with the more frequent 'winging' movement, with different angles for the different fingers, the fan *position* with the pinkie flexed most and the index flexed least does resemble a common relaxed or rest position of the hand. In this position, both the MCP and the IP joints of the fingers are flexed to different degrees: most for the pinkie, and least for the index (Kapandji 1986). In addition, the metacarpals (the bones that make up the flat part of the hand, between the wrist and the fingers) possess different degrees of mobility. The fifth metacarpal (proximal to the pinkie finger) can flex most, while the second metacarpal (proximal to the index finger) is almost immobile (Kapandji 1986). These anatomical properties of the hand contribute to the ease with which the fan position can be accomplished, and they also explain why the 'reversed' fan position, with the index flexed most and the pinkie flexed least, is not commonly found.

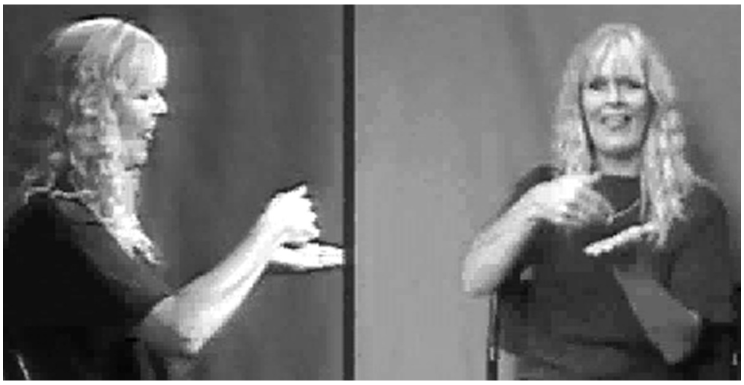
This articulation is as complex as it seems, then, in comparison with the 'winged' position (MCP joints flexed 90 degrees, IP joints extended). Moreover, if we look at the whole articulation of all the joints in these signs, including the one in 5.15iii-iv, these realizations can be considered another instance of distalized movement, and therefore are relatively cheap. In the case of OR as realized in 5.15iii-iv, the forearm rotates less while the wrist and MCP joints move more than in the form in 5.15i-ii (where there is no wrist or MCP movement). The articulatory means that are employed in these two realizations in terms of the joint movements are clearly different, while the perceptual effect is the same.

In summary, these waving movements also point to the relevance of distinguishing articulatory and perceptual specifications. What is stored in the lexicon is an abstract perceptual target that does not refer to the articulatory means that are employed to make it visible. What is important for successful recognition of the sign is that the perceptual result matches the perceptual specification of the sign in the lexicon, while the articulation may differ.

A fan configuration of different fingers was found in several other realizations of signs in the same study (§4.5). One informant used the fan configuration in most realizations of PROOF, and it also occurred in several realizations of APPLE, LICK, TIRED, OR, FORTY, and WELCOME. In all these cases, all four fingers are selected and the fan configuration was maintained throughout the whole sign (that is to say, there was no finger movement). It often appears that in these signs, too, the fan configuration serves to articulate the orientation specification using more distal joints than in the standard case. Examples of these configurations in the signs LICK

[146] In some cases there appears to be an asynchrony in the movement of the different fingers, the pinkie starting to move first and the index last. Possibly this perception of asynchrony is an artifact of the fact that the pinkie makes the largest movement.

and WELCOME are illustrated in Figure 5.13. In some cases it is not quite clear what the perceptual target of the fan configuration is.[147]



i. LICK, initial state

ii. LICK, final state

[147] These fan configurations seem to resemble what Brentari (1998) calls a "stacked" configuration, which "involves placing the fingers on top of one another, with the pinkie finger at the bottom – roughly speaking, in the position needed to grip a racket" (1998: 110). The feature [stacked] she proposes can occur in combination with [spread], as in $\text{SALAD}_{\text{ASL}}$ and in the K and P handshapes borrowed from the fingerspelling alphabet in ASL (and SLN as well), and without the feature [spread], as in FEW_{ASL}. The feature distinguishes between the K and V handshapes in ASL, although this distinction is claimed to be "allophonic, created by an operation that allows the palm of the hand to be oriented toward the midsagittal z-plane, in the absence of higher-ranking, conflicting constraints" (pp. 296-7). Earlier, Brentari stated that the occurrence of K in SEE_{ASL} is due to the feature [stacked] that is "supplied by a redundancy rule not discussed here" (page 110).

iii. WELCOME, initial state

iv. WELCOME, final state

Figure 5.13

Examples of fan configurations

Waving movements similar to the ones found in realizations of changes in orientation and location also occur in the SLN lexicon. Six signs were transcribed in SignPhon as having 'waving closing' movement (one of the values of the 'handshape change' field in the SignPhon database): STEAL, SHAME, INTERFERE-WITH, TENDER, ARISE, and DISLIKE. Waving opening movement occurred in three signs, ARTIFICIAL, COUNT and UNCOUNTABLE. These movements seem to be different from the non-lexical ones discussed above, however, in that they all concern movements from fully opened hands to fully closed hands (or vice versa), where the opened version has spread fingers, and the signs have all fingers selected.

I propose that these signs are characterized by a movement feature [waving].[148] An exception is formed by the sign WAVES, which had a repeated sequence of opening and closing waving movement accompanying a repeated arc-shaped location change. In this sign, the waving movement does appear to be the realization of the palm-side of the finger tracing the arc (whether this is represented as a change in orientation or not).[149]

While this waving movement only occurs with all fingers selected, a static version (the fan position) is found rather frequently in SignPhon for two selected fingers (without exception the default index and middle). Four signs are transcribed as having the K handshape, 22 signs have the handshape that was termed 'easy V' in the SignPhon database (in Dutch, *V-gemak*; see Appendix B), which differs from K only in not having the thumb tip contacting the middle finger (see Figure 5.14). The K handshape occurs in three signs that could be considered 'initialized' (their Dutch gloss and standard translation start with a K): CHALK (*kalk*), BE-RIGHT (*kloppen*), and ISSUE (*kwestie*). The fourth sign with a K handshape is PAIRS (*paren*).

The P handshape from the fingerspelling alphabet, which in SLN has the ring and pinkie fingers extended and parallel to the middle finger, only occurs in initialized signs. Both K and P for these initialized signs need a perceptual specification that refers to this thumb position and the difference in the amount of flexion between the index and the other finger(s), since these aspects cannot be predicted from other factors, and are consistently realized as thumb tip contact and a difference in the amount of MCP flexion of the index and middle.[150]

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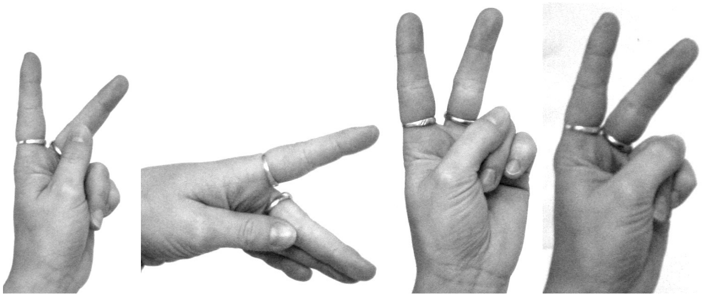
148 The resemblance of this waved movement to finger wiggling led Stack (1988) to propose that in fact the fully closing waved movement that is found in $\text{BEAUTIFUL}_{\text{ASL}}$ is the non-repeated version of wiggling movement. This allowed Stack to claim that for all secondary movements, there are repeated and non-repeated variants. Other than its use in reducing the number of features, I see no evidence in SLN that these movements are actually the same. Featural economy could also be attained by describing both wiggling and waving as [alternating] without being at the same time [repeated]. Some evidence that [alternating] and [wiggling] are manifestations of the same perceptual category is discussed below in §5.4.5.

149 The one sign in SignPhon that combined opening and closing waving movement (in sequence) is also WAVES. The opening and closing movements in this sign are not as large as in the other lexical signs, and rather resembles wiggling movements and the other variants discussed above. I propose that in this sign the waving is the realization of a change in orientation, which in turn could be the result of a repeated arced change in setting. The prediction is that WAVES can also be articulated without the finger movement. The fact that the arced movement and change in orientation are repeated could be responsible for the fact that the distalized finger movements regularly show up even in citation forms.

150 As was suggested in Chapter 3, this specification for P and K may be the feature value [adducted] that also appears in the 'money' handshape.



i. K ii. P iii. V iv. easy-V

Figure 5.14

Handshapes with spread selected fingers

In all the other cases of this ‘fan’ configuration of the index and middle fingers, I propose that this configuration is an articulation of the perceptual feature [spread]. Usually, [spread] is articulated by abduction at the MCP joint, as in the V handshape illustrated in 5.14iii. The articulation with flexion leads to almost the same perceptual result, the only difference being the ‘plane’ that the V-shape is parallel to. In the V handshape (the abduction variant with the MCP joints fully extended), the triangle that the spreading defines is parallel to the flat part of the hand. In the ‘easy V’ handshape (the flexion variant, in 5.14iv), this triangle is in a plane orthogonal to the flat part of the hand. As in the fan configurations above, the different states of the fingers can be interpreted as a difference in orientation. One of the reasons why we find this flexed articulation of spreading is that it is a way to distalize the articulation of some orientation relations. This can be seen in different realizations of the verb SEE. The orientation value for this sign is [dorsal], and in cases where the object location in space that the sign moves to is contralateral to the articulator, extreme supination of the forearm would be required to make the dorsal side of the articulator face the location. In the citation form of the verb, 1-SEE-2, the forearm is already about 90 degrees supinated, and further rotation of the triangle plane formed by the V is almost impossible without additional wrist flexion and adduction and rotation of the upper body. The same orientation of the triangle can be realized by relatively cheap MCP flexion replacing abduction as the articulation of [spread]. The trade-off in this articulation is that it is no longer exactly the dorsal side of the fingers that faces the location, but rather the ulnar side of the fingers. This may be the explanation for the fact that the citation form of SEE (1-SEE-2), features the articulatorily more expensive forearm supination in combination with MCP abduction.

Thus, instead of attributing this change in articulation to a rule that adds a feature like [stacked] or [fan], the different variants are considered to be predictable articulatory variants of the same perceptual specification [spread], which will both be categorized by the perception grammar as [spread]. The forms do differ in orientation.

This flexion as a means to articulate a certain (change in) orientation in combination with spreading of the fingers seems to be at work in some of the SignPhon forms, such as HONEST, MODIFY, and TWENTY, while in others it is not quite clear what the cause of the flexed variant is. Depending on the angle the hand is seen from, the flexed or abducted variant will be easier to see. If the palm of the hand faces the perceiver, the abduction variant will be easier to see, while the flexion variant will be easier to see if the ulnar or radial side of the hand faces the perceiver.

The use of the different forms seems to be in part a matter of personal preference as well. As the SignPhon data consisted of transcriptions of only one phonetic token for each sign, they cannot provide evidence for this hypothesis. However, impressions from the pilot studies in Chapter 4 indicated that one informant used the K handshape in many forms of SEE, including the citation form. I have since observed that there is much variation between signers in their realization of the citation form: there are several signers that regularly use the flexed variant of V in the form 1-SEE-2 (though with a different thumb position than in the K handshape).[151]

Finally, note that since the two forms compared above are perceptually almost identical, there is no sense in which the abduction (V) variant is 'default' or 'standard'. Moreover, it should be emphasized that although I have consistently referred to two distinct variants above, in fact an endless number of distinct forms is predicted to occur, including those that combine flexion and abduction. I consider this large number of possible realizations to be further evidence against a rule that generates only one allophonic variant (that differs in the presence of a feature [stacked]).

5.4.3 Different realizations of [SF: 1] with [aperture: open]

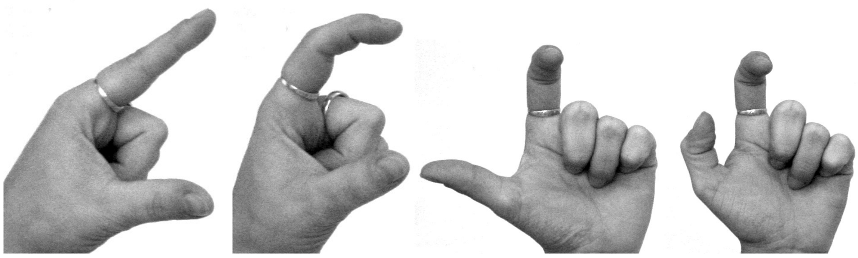
Different realizations can be found in SLN of the feature combination [SF: 1], [aperture: open], and [configuration: curved]. This is commonly referred to as the 'baby C' handshape (Figure 5.15ii), differing from the C handshape in having [SF: 1] instead of [SF: all]. In the case of the baby-C handshape, the feature

[151] I hypothesize that phonetic distinctions such as these could constitute the sign language corollary of 'personal accent' or 'voice quality'. To my knowledge, systematic inter-signer distinctions in phonetic realizations have not been investigated at all. Another property of the signer that can be seen as the sign language equivalent of voice quality is hand dominance. Right-handed signers use their right hand more in signing, while left-handed signers use their left hand more. Although this distinction in what the 'strong' or 'dominant' hand is in the realization of signs has been acknowledged in the literature on two-handed signs (e.g. van der Hulst 1996), the differences between left-handed and right-handed signers have not been put in a broader context of signer-bound phonetic characteristics. The only discussion of phonetic regularities that differ from sign language to sign language that I found in the literature concerns the difference in realization of the A handshape in ASL and Chinese Sign Language, discussed in Klima & Bellugi (1979).

[configuration: curved] is present, which is absent in the 'baby-open-beak' (Figure 5.15i).[152]

Some of the variants of the baby-C resembles what the KOMVA notation system calls 'X-2-zero' handshape (Figure 5.15iii), in which the index finger is clawed and the thumb is extended and non-opposed (NSDSK 1988). In most instances I have seen, however, the IP joints of the index are not flexed as much as in this X-2-zero handshape, and the thumb is not extended as far. The shared trait in the different variants is that there is an space between the distal phalanx of the thumb and that of the index finger, the two being about 5 centimeters apart. This is a somewhat cryptic description of what is commonly termed 'aperture', a relationship between the thumb and the finger(s). In the standard form of the baby-C handshape, the thumb is opposed, and this is often included in descriptions of the meaning of aperture. In many alternative realizations, the thumb is not opposed (flexed and abducted at the CMC joint of the thumb, and flexed at the MCP joint) but extended to different degrees.

Several variants of the feature combination [aperture: open] and [SF: 1] are illustrated in Figure 5.15.



i. baby-open-beak ii. baby-C iii. X-2-zero iv. other variant

Figure 5.15

Different forms of [aperture: open] and [SF: 1]

The claim that the rightmost three handshapes are in fact realizations of the same lexical specifications is partly based on the occurrence of different variants of the baby-C classifier. This classifier is found in lexical signs such as PERSON and TURKEY. The latter sign can be localized in space, and the different locations and orientations sometimes enforce the use of forms other than the baby-C handshape.

Once again, these context effects are the result of the differences in the specified orientation of the different variants. The line between the tips of the index finger and

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152 For the latter form I have not seen clearly divergent forms in many signs. This is probably due to the fact that this handshape occurs mostly, if not exclusively, in opening and closing hand-internal movements (changes in aperture from [open] to [closed] or vice versa). If the index finger is extended, contact between the tip of the thumb and the tip of the index finger is almost impossible in any but the standard configuration, in which the thumb is opposed. Alternative realizations of this form would therefore automatically include curving of the index finger. Such a realization is often seen for THIRSTY.

thumb is oriented differently in the two forms, and this can be exploited. For example, in a sign like THIRSTY, in order for the finger tips to be on two sides of the cheek (implying the line between the tips of index and thumb is approximately horizontal), extreme supination and wrist flexion would be needed if the index is extended at the IP joints and the thumb is opposed. If the index is curved and the thumb extended, however, forearm and wrist can remain in a neutral position. For signs like THIRSTY that lack a perceptual specification [configuration: curved], this realization is at the expense of a lack in faithfulness, but apparently the articulatory costs that are saved outweigh this mismatch.

In several citation forms of signs in the SLN dictionary GLOS (GLOS 1999) the occurrence of the different forms (baby-C and X-2-zero) in citation forms of different signs is predictable on the basis of this trade-off between the realization of the orientation specification at a given location and the articulatory effort involved in articulating the aperture relation. This is illustrated in Figure 5.19 for the two signs CUSTOMS and TURKEY.

i. CUSTOMS ii. TURKEY

Figure 5.16

Articulations of aperture in different citation forms

In CUSTOMS, the finger tip and side of the thumb contact the chest during a movement from contralateral-high to ipsilateral-low. The orientation specification for this sign is [ulnar]. If both the fingertips were to contact the chest, so that also the ulnar side of the thumb faces the end location and the handshape would be the baby-C, the wrist would have to flex and adduct. Moreover, the whole arm would need to be higher in space to realize the same initial location (this could be articulated by more shoulder and elbow extension). The articulation as in Figure 5.16i does not need any of these additional movements.[153] Signs similar to CUSTOMS include FANTASY and PIPE.

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[153] The movements in this context refer to the transitional or coarticulatory movement to attain the initial articulator configuration in the sign, rather than the lexical movement. Such movements have not been discussed above, but I hypothesize that such movements are evaluated by the same *GESTURE constraints. That is, the realizations that the grammar evaluates include transitional movements between signs, and in the case of citation forms, it includes the movements from rest position and maybe also back

In TURKEY, the radial side of the hand faces the forehead (specification [orientation: radial] and [location: forehead]), and the use of the baby-C configuration in this case is the simplest one. Using the thumb-extension variant for this location-orientation combination would require further pronation of the forearm. Signs similar to TURKEY include DRUG-STORE and DRINK.

Again, there is a single perceptual target for these forms (aperture: open) that can be articulated in different ways (roughly, extension vs. opposition of the thumb). The variant that is used is at least in part determined by the phonetic context, but for this case too, it should not be excluded in advance that there are other factors such as personal accent that also play a role in the realization of [aperture: open].

5.4.4 Similarities between manual and non-manual articulators

Several cases are reported in the literature where non-manual articulators, in particular the jaw, lips, and tongue, are used to realize features expressed normally by the manual articulators. Because of the clear difference in the articulatory structures involved, these alternations too are good evidence for the claim that lexical phonological features are perceptual in nature.

Woll (to appear, see also Woll & Sieratzki 1998) discusses mouth gestures in British Sign Language that are not derived from spoken words in English, but rather “mirror or echo the manual movement in these signs” (Woll to appear: 5). Allowing some abstraction, these shared features are phonetic properties ‘movement to contact’ and ‘movement away from a contacted location’. Thus, lip contact followed by jaw opening is found in combination with opening handshape changes and separating movements of the two hands (an example of the latter she cites is $\text{SUCCEED}_{\text{BSL}}$). An open mouth followed by jaw raising and lip contact is found in combination with closing handshape changes and movement to contact of the two hands (an example in which both the hand movements are found is TRUE_{BSL}).

In the BSL cases discussed by Woll the data concern lexical combinations, and she suggests that these pairings of a hand gesture with a resembling mouth gesture can be explained in part by the tendency of the motor control system to produce related movements of different body parts. This is a plausible explanation, but the similarities in these cases (contact vs. no contact) are also of a perceptual nature, expressed by different articulators.[154]

Brentari (1998) mentions similar cases of opening of the jaw corresponding with a movement of the two hands away from each other (as in $\text{JAW-DROP}_{\text{ASL}}$). She also notes that “*tongue wagging* can be substituted for *wiggling* as an allomorph in certain derived forms” (1998: 167). Tongue wagging is a repeated left-right

to rest position. An explanatory analysis of the initial configuration of the articulator thus also evaluates movements towards that configuration, and not only the configuration itself.

154 Anecdotally, these similarities can also be witnessed in BSL outside lexical items, as appears from Sutton-Spence’s (2000) discussion of BSL poetry. In a poem by Dorothy Miles, a bird, a dog, and a human all yawn at the same time. The yawning of the animals is expressed by an opening aperture relation between the thumb and fingers, while the human’s yawning is expressed by the lowering of the signer’s jaw.

movement of the tongue tip. In ASL tongue wagging and wiggling finger movement are also found in bound morphemes, then. In verbs, wiggling finger movement and tongue wagging are found as allomorphs of the realization of the protractive aspect marker, while in adjectives and adverbs both tongue wagging and finger wiggling have an intensive meaning (Brentari 1998). The similarity here is an abstract perceptual feature like 'repetition', while the articulators and articulatory actions with which this feature is expressed are different. Another form of similarity between manual and non-manual features Brentari discusses consists of a backward movement of the body accompanying an enhanced form of PERPLEXED$_{ASL}$ with backward movement of the whole hand. (In the citation form the sign has a backward movement of the finger tip only (a part of the perceptual category aperture opening realized with that specific combination of location and orientation values, viz. [forehead] and [root]). Other resemblances between manual and non-manual aspects are found in enhanced versions of STUNNED$_{ASL}$ (the vertical separating movement of the two hands is mirrored by the opening of the mouth) and VANISH$_{ASL}$ (the flexion of the fingers into a fist is mirrored by the retraction of the tongue and closure of the lips).

I agree with Brentari's claim that "this type of assimilation from the manual to the nonmanual branch is another form of phonetic enhancement" (1998: 173). Using the terminology adopted here, we are able to further specify that these enhancements are based on perceptual similarities, and not on articulatory similarities in terms of the joints or even body parts involved to realize the different movement components.

5.4.5 One-handed and two-handed versions of signs

Several anecdotal reports exist of alternations between one-handed and two-handed versions of signs, which also point to the abstract perceptual nature of the lexical specification of signs. Some of these alternations concern lexicalized classifier forms, and this makes the 'phonetic' nature of the alternation somewhat uncertain: it may be that the different lexical forms express semantic distinctions that my informants were not aware of or that the data source did not mention.

One-handed and two-handed versions exist of the signs SAME and SMALL. In the two-handed version, the two hands approach each other (contacting each other in SAME, not in SMALL), with relative orientation values palm (SMALL) and radial (SAME). In the one-handed versions, two fingers approach each other. In SMALL, the extended thumb and index start with [aperture: open] and end with [aperture: half open]. In SAME, the index and middle fingers move from spread to unspread. Informants suggested that these variants are used in cases where only one hand is available for signing, implying that they are not used to make semantic distinctions when both hands are available. In both these signs, the perceptual categories 'approaching' and 'contacting' are realized by different articulators in different contexts. It appears that the context imposes strong articulatory constraints that make impossible the use of the other extremity as the second articulator.

In a dictionary of Thai Sign Language (Suwanarat et al. 1990), a similar case can be found, where the difference between the form $\text{CRY}_{\text{ThaiSL}}$ and the enhanced form $\text{CRY-EMPHATIC}_{\text{ThaiSL}}$ is realized by the difference between one-handed and two-handed movements. The shared perceptual feature [SF: 2] is articulated in one case by the index and the middle finger of one hand, and in the other case by the index fingers of the two hands. In both cases the finger tips point to the eyes, the fingers being horizontal, and they move downward.

In the SLN lexicon, there are several classifier-like constructions to refer to properties of animals, such as their mouths and legs. The sign referring to a small animal like a chicken uses an aperture change, while the sign referring to a large animal like a crocodile uses palm-to-palm contact of the two hands. Similarly, there are different classifier constructions that can be used to refer to walking of humans and elephants. The downward-pointing index and middle finger can be used with wiggling movement of the fingers, or alternating movement of the two hands (with extended index, or with all fingers spread and curved) can be used as a representation of the two legs. The fact that there are two 'legs' that move in an asynchronous manner is a perceptual feature that the different forms referring to locomotion share. These shared aspects are articulated in different ways, using different articulators in different configurations. In these cases it is clear that there are also semantic differences that are conveyed by the distinction, or in other words, that there are different perceptual categories in the lexicon.

To test the lexicalized status of such classifier forms, a pilot study was carried out to test the extent to which the iconic properties of these forms influence the articulation (Crasborn 1999). The hypothesis was that the shared perceptual categories could surface not only in their standard form (small wings in the one-handed small movement sign FLY, large wings in the two-handed large movement sign EAGLE), but also in alternative forms depending on the context ('huge fly' vs. 'tiny eagle'). The results suggested that the classifier constructions in these lexical items are indeed lexicalized: in only one case out of 17 did the signer adapt the articulators to match the changed context (SMALL-EAGLE was realized as a one-handed sign, resembling the lexical item FLY).

In conclusion, then, it seems to be the case that perceptual commonalities among different articulations exist in the classifier system as well, but the hypothesis remains that these different articulations are grammaticalized and need metalinguistic analysis to be used creatively.

5.4.6 Alternative articulations of [selected fingers: 1]

In SLN, variation is sometimes found between signs with extended thumb and extended index finger. Two variants exist of the sign ELEVEN, one with extended index finger and one with extended thumb. Both contain a change in orientation. The same variation is found in forms for TOMORROW and YESTERDAY. It is not clear to what extent these two signs are lexically different forms used in different regions (i.e. dialectal differences). Somewhat more systematically, the extended thumb is sometimes used as the pronominal INDEX,which normally is realized with an extended index finger. One informant uses this regularly to point to ipsilateral locations in space. Using the index to point to ipsilateral locations either requires extreme hyperextension of wrist and MCP joints, or outward rotation of the shoulder joint and flexion of the elbow. Supination of the forearm in combination with an extended thumb would be a less costly articulation.

Provided these somewhat anecdotal pieces of data are confirmed by future studies, this alternation also points to the perceptual nature of underlying forms. Completely different articulations of the perceptual specification [selected fingers: 1] and [orientation: tip] are found in different contexts, where just as in the case of different realizations of [spread] the actual form that is found is determined by the phonetic context. In the case of the indexes, the context is the location in space with respect to which the orientation value is interpreted.

5.4.7 Wiggling and twisting movements

It has been observed that wiggling movements of the fingers and twisting movement of the forearm alternate or can be combined in the realization of some signs, such as VARIOUS in SLN (Els van der Kooij and Chris Miller, personal communication). Wiggling movement consists of small repeated asynchronous flexion and extension at the MCP joints of the different fingers. Twisting movement is a repeated rotation along the longitudinal axis of the articulator, typically articulated by forearm rotation with the wrist in extended position. Flexion of the fingers and rotation of the forearm are completely different articulations, but in the alternations observed they have a similar perceptual effect, due to the extended and spread configuration of the fingers: the finger tips move up and down in an alternating manner.

5.5 Conclusions

In this chapter I showed how the alternations between movement categories observed in Chapter 4 can be understood if we make a clear distinction between the perceptual and the articulatory description of a sign form. Although it is true that the sign language articulators themselves can be perceived, I have argued that this does not automatically lead to the conclusion that there is no distinction between the perception and articulation of signs. Put differently, not every aspect of the articulation of a sign is perceived as linguistically relevant. The many visible aspects are abstracted away from, i.e. categorized, by the perception grammar, and the resulting categories are by definition perceptual ones. The variation data presented in Chapter 4 were used to show that these categories do not consist of joint states (or the resulting positions of segments of the upper extremity such as the forearm or hand). Moreover, it turned out that enhancing the articulation of a sign does not simply consist of adding movement at a more proximal joint or shifting the movement to a different joint. Similarly, reducing the articulation of a sign does not necessarily or only involve adding movement at a more distal joint.

Rather, ‘change in location’ and ‘change in orientation’ are abstract perceptual categories, which can be articulated by both proximal and distal joints. Enhancements and reductions of these movements are based on the observation that rotating an object involves a change in location of parts of that object. Every change in orientation carries the seeds of a change in location, and this can both explain why changes in orientation can be realized by adding a path movement of the whole hand and why changes in location can be reduced to changes in orientation.

The traditional split between path movements and local or secondary movements (e.g. Corina & Sandler 1993) remains valid, then, but these categories do not directly refer to distinctions in the use of proximal vs. distal joints.

Similarly, the data on the different realizations in static aspects of the sign such as the various configurations of the fingers and thumb used to articulate particular orientation-location combinations further demonstrate the flexibility of the whole articulator, including the fingers, in realizing perceptual targets. Distalization, or the use of relatively distal joints compared to some standard articulation, was thus shown to not only occur in reduced articulations, but also in normal register articulations of many forms.

The model that was proposed to formally describe the variation in movement size is a first attempt to account for these data. Despite the exploratory nature of the model as it was spelled out here, it constitutes a first attempt to deal with *all* the variation that can be found in the realization of a sign and not just a selected subset of ‘allophonic’ variation. The explanatory nature of the model, achieved by directly incorporating non-linguistic constraints on articulation and perception, as well as its achievements in dealing with a wide variety of facts from spoken languages (Boersma 1998) make it a good candidate for further exploration of both ‘phonological’ and ‘phonetic’ patterns in sign languages.

6 Summary and conclusions

6.1 Summary

In this thesis I have documented and analyzed several aspects of phonetic variation in Sign Language of the Netherlands (SLN). The study aimed to answer three questions, repeated in (6.1).

(6.1) Research questions (repeated from Chapter 1, page 27).

1. Does phonetic variation in the realization of handshape changes, orientation changes or location changes cross the boundaries of the parameters handshape, orientation, and location in Sign Language of the Netherlands? For example, can a handshape change be realized as a location change?
2. If the answer to the first question is positive, is the distinction between changes in location and changes in handshape and orientation still valid?
3. How can the grammar, including a phonetic implementation component, generate the different variants that are found?

This section summarizes the findings of the different chapters, in order to establish to what extent we have been able to find answers to the above questions. §6.2 and §6.3 discuss respectively the linguistic and practical implications of the findings. §6.4 presents some of the further questions that future research might find an answer to.

Chapter 2 presented an overview of what is known about phonetic variation in sign languages, based on a typology of variation that emerges from work on spoken languages. Linguistic factors (prosodic structure and simultaneous phonological context) are distinguished from non-linguistic factors. These non-linguistic factors can be subdivided into those that pertain to the signer, to the addressee, and the situation (which includes the relation between the signer and the addressee). Studies on ASL have addressed all these different factors, but few systematic studies exist of phonetic variation. Several studies discussed phonetic differences in movement size, which is not lexically distinctive in either ASL or SLN. These studies raise the question to what extent such size distinctions can make use of or cross phonological category boundaries between handshape changes (small), location changes (large) and orientation changes (in between). A number of recent studies on 'proximalized' and 'distalized' movements in ASL demonstrated that there is indeed quite a bit of variation in the use of the different joints of the arm and hand in the realization of movement.

In the second part of the chapter, different theoretical views on the relation between phonological representation and phonetic variation were discussed. Because of its explicitness and broad scope, I proposed to use the Functional Phonology model developed by Boersma (1998) to analyze the variation studied in later chapters. The central claim of this model is that there is a clear distinction between perceptual representations and articulatory representations. Both of these play a role in analyzing phonetic and phonological patterns, but the phonological information stored in the lexicon consists only of perceptual categories. The distinctions between a spoken language and a sign language version of the model and the accompanying differences in terminology were discussed.

In Chapter 3 I proposed a set of phonological features used in SLN, without focusing on the organization of these features in a hierarchical structure. Rather, the aim was to look critically at the definition of some of those features, specifically handshape and orientation features. The core of the analyses is based on joint work with Els van der Kooij (see van der Kooij in prep.).

The central distinction in the description of handshapes introduced by Mandel (1981) is between finger selection and finger configuration. Only for a subset of *selected* fingers can a *configuration* be specified. This configuration can be one of four or five values, such as extended or clawed. Although not all phonological models incorporate a distinction between 'base joints' (the MCP joint for each finger) and 'non-base joints' (the PIP and DIP joints for each finger) to describe configuration, all models claim that in various sign languages an 'extended' configuration (all joints extended) is different from a 'hooked' configuration (MCP flexed 90 degrees, PIP and DIP extended). In other words, MCP state appears to be a phonological parameter in sign languages.

On the basis of observations of variation in MCP state in multiple realizations of signs and using further phonotactic data from SLN, I argued that MCP state is not distinctive in the SLN lexicon. The distinction between curved and clawed configurations, which is sometimes distinguished by a feature for MCP state (Brentari et al. 1996), is proposed to be the result of a change in tenseness that is also manifest in other aspects of the sign such as movement speed. The distinction between bent and extended configurations can result from two different aspects of the phonological specification. Firstly, aperture relations between the thumb and the fingers are near to impossible to articulate without some degree of MCP flexion. If no finger configuration is specified, the result will 'automatically' be a bent configuration. This automaticity implies a separate predictable phonetic implementation component in the grammar, which generates articulatory gestures on the basis of a phonological specification. The degree of bending will depend on the nature of the aperture specification, namely [aperture: open] vs. [aperture: closed]. In the former case there is no contact between the fingers and the thumb; in the latter there is.

Secondly, the state of the MCP joint may be influenced by the orientation of the hand. Depending on the location of the sign, a given orientation sometimes appears to be most easily articulated by flexing the MCP joints. This in turn implies that it is the orientation of the *fingers* that is phonologically relevant in these cases, and not the orientation of the *hand*.

Closer inspection of this orientation parameter suggested that the palm of the hand (or the finger tips) is in no way privileged. Most traditional analyses of the orientation of the hand described this parameter in terms of the direction in space in which the palm of the hand is pointing, and sometimes in addition the direction in which the fingers point. Although this combination of two values can fully describe all possible orientations of the three-dimensional object that the hand is, these descriptions do not capture what appears to remain constant across different realizations of the same sign. This constant aspect is proposed to be the side of the specified articulator that points to the end location of the sign. In case there is a setting change in the sign, the location is the end setting; in case there is no setting change, the target location coincides with the specified major location. The side of the specified articulator can be any of the six available sides, not only palm or finger tip: i.e. palm, dorsum, ulnar side, radial side, tips or root. The actual rotation in space of the whole hand (or of the fingers alone) may vary from one realization of a sign to the next, depending on changes in body posture and accuracy. In the prototypical case, the second degree of freedom in rotation of the articulator is not specified phonologically but rather is the result of the simplest articulation of the other parameters of the sign. In some signs, however, this second degree of freedom appears to be either unpredictable or even phonologically contrastive. In these cases, next to a side of the hand that points towards the end location, a side of the hand needs to be specified that contacts the major location. All these cases of 'location' can refer to either a physical body location, or to a virtual location in the space in front of the signer. The default location in space is proposed to be a horizontal plane at stomach height. Finally, the orientation value that is specified refers to a side of the specified articulator, which is typically the fingers rather than the whole hand.

A third factor influencing MCP state is related to movements at this joint. If the only movement in the hand is at the MCP joints (always with extended fingers), this is proposed to be the reduced realization of a change in location. Seemingly random alternations were observed between movements of the whole hand and movements of the MCP joint for signs like AUGUST, and no minimal pairs or near minimal pairs were found that contrasted in this respect.

The answer to **research question 1** appears to be positive, then: changes in location can indeed be realized by finger joints. Traditionally, changes in location are considered to apply to the location of the whole hand, just as the orientation and shape are specified for the *hand*, rather than for the fingers.

These observations on MCP movement leave open to what extent there are also alternations in movement components that involve the orientation parameter (**research question 1**). In Chapter 4, I addressed these questions with a series of studies on variation in movement in SLN. Starting from the observations in Chapter 3 on the role of the MCP joints in realizing orientation targets and changes in location, I looked in increasingly controlled qualitative studies at the articulation of movement in a large group of signs.

Exploratory studies showed that in general there are many different realizations of both static and dynamic aspects of the same sign realized by the same signer in different sentence contexts, and specifically, that not only MCP movement but also wrist movement (changing the orientation of the hand in space) can surface as the realization of a change in location. To prevent coarticulatory effects, further studies focused on signs in isolation, using different extra-linguistic contexts to elicit variation. In the overview of phonetic variation in Chapter 2 it was shown that in no sign language studied so far is movement size by itself lexically distinctive. Observed differences in movement size have been found to arise in part from differences in register, 'shouted' registers using larger movements and 'whispered' registers using smaller movements. In a pilot study it appeared that these differences leads not only to differences in movement size, but also to differences in location and orientation of the body and the signing space. This signing space is usually in front of the signer and extends from the waist to just above the head, and about a forearm's length forward from the upper body. In the 'shouted' register the signing space was not only enlarged but also raised, while in the 'whispered' register the signing space was not only reduced but also lowered and oriented a bit sidewards. In addition to distance, 'formality' appeared to differ between the different registers in this study as well.

Aiming to reduce the changes in movement to size only, data were elicited by manipulating the distance between the signers. Small signs were expected when the signer and addressee are sitting knee to knee, while large signs were expected when the signer and addressee are sitting at 30 meters distance. A neutral distance of 3 meters was also recorded. In this final study, MCP movements that occurred in citation forms were predicted to be realized larger as changes in location of the whole hand, while location changes in citation forms were predicted to be realized smaller as MCP movement. Similarly, signs with an orientation change in their citation form were expected to be realized as enlarged with additional changes in location, while signs with changes in location (or combined changes in location and orientation) were predicted to be realized as reduced as changes in orientation only. For the purpose of this study, changes in orientation and location were defined as changes in orientation and location of the whole hand.

Data elicited from six different signers of 50 different signs revealed a very complex picture. Although the predicted forms were indeed found in the predicted register, many other forms were also found for many signs, combining orientation changes and MCP movement, for example, in the realization of a location change. Another clear result was the large variability within each register. Although the relatively fuzzy distinctions between forms found in reduced vs. enhanced registers could be taken to imply that the experimental setup did not lead to the expected distinction, it is clear that the intra-register variation does reflect the variation found in spontaneous signing. These results are especially significant given the fact that all signs that were used were citation forms. Apparently this did not lead the signers to realize one standard articulation for the sign no matter what the context was. The conclusion is that there is no standard articulation corresponding to a phonological feature in the first place, and that only deviations of this standard need to be explained. The phonological specifications stored in the lexicon are proposed to be perceptual targets, and the joints with which these are articulated may vary from one instance to the next. In traditional terminology, location changes can be realized as orientation and handshape changes (using relatively distal joints such as the forearm, wrist, and MCP joints). Conversely, orientation changes may be realized in part by proximal joints such as the shoulder and elbow, leading to a change in location of the whole hand. The abundance of both proximal and distal articulations for each type of movement within each register suggest that changing register is not simply a matter of proximalizing the articulation to attain enhanced forms and distalizing the articulation to attain reduced forms. Apparently the change in movement size is a perceptual rather than an articulatory category, just as the lexical specifications of the signs are proposed to be stated in perceptual categories without reference to the joints of the upper extremity. Although movement size was not quantified in this study, it is hypothesized that size is to a large extent perceived by looking at the size of the path that the *distal end of the articulator* traces through space.

The phonological distinction between orientation changes and location changes nevertheless remains valid: some signs such as DEAD can lose the orientation change present in the standard articulation, whereas others such as DECEASED cannot. Only the latter group is characterized by a lexical change in orientation. Similarly, changes in handshape that affect the curving of the fingers do indeed constitute a separate phonological category that may be combined with changes in location or orientation. It is only the 'winging' movement of extended fingers at the MCP joint that is argued to be an instance of a change in location or orientation. In conclusion, the answer to **research question 2** is that variation in the realization of movement that was found in SLN does not invalidate the phonological distinctions between the different phonological types of movement.

In addition to extra-linguistic factors determining movement size, it was found that the joints that are used to realize a particular movement and the resulting movement size are also determined by the values for other phonological features. It was hypothesized that a setting change will be smaller if it is repeated than if it is not, and moreover the size of the setting change will adapt to the size of the physical location (leading to small movements on the cheek vs. large movements on the chest, for example).

In Chapter 5 the distinction between articulatory and perceptual descriptions of different movements was discussed. In all the prototypical cases of the variation between location changes, orientation changes, and handshape changes, the wide disparity in articulatory actions that is found between different realizations was argued to be balanced by a common perceptual property in these articulations. This shared perceptual feature is the path through space that the end of the articulator traces. In a change in orientation, the finger tips or the sides of the hand move through space, and thus, change location. This change in location takes place regardless of whether the phonologically specified movement (a change in orientation) is considered to apply to the hand as a whole or only to the fingers. This change in location can be used to *enhance* the realization of a change in orientation by changing the location of a larger part of the articulator, such as the whole hand or the hand and the forearm, in a similar way. The outcome can then resemble a combined change in orientation and location, but in fact the only perceptual category involved is either a change in orientation or a change in location. The ability of the perceiver to decide which of the two is actually appropriate depends on his ability to recognize the multiple factors that lead to differences in movement size.

The converse happens in *reduction* of phonological changes in location: these can be reduced so that a smaller part of the articulator changes location. The result sometimes resembles a change in orientation of the whole hand (or of the fingers). Potentially, this type of enhancement can also apply to finger configuration changes. These were not taken into account in the studies in Chapter 4, but merit further investigation.

A model of phonetic implementation was proposed that can describe the variation observed, by making use of low-level phonetic constraints on perception and production. In this model, a first attempt at a sign language version of the Functional Phonology model developed by Boersma (1998), all variation is treated in a uniform way, making no distinction between 'allophonic variation' generated at one level of the grammar and 'phonetic variation' generated at another level. Although the details of the analysis within this model are still to be worked out, the present version makes explicit what the different parts of the implementation model (and potentially, a whole phonological grammar model) are, incorporating in its core the distinction between articulatory and perceptual representations. Both aspects of signs are important and need to be described, but the lexicon only stores perceptual representations. In conclusion, the answer to **research question 3** is that in order to generate the observed variation, a phonetic implementation model crucially needs a lexicon filled with perceptual definitions of the different aspects of a sign's form.

Because of the visibility of the articulators in sign language, it is not a priori impossible that joint states *themselves* are perceptual categories stored in the lexicon. However, the variation data described in this thesis and the set of feature values that was proposed to describe all lexical items in SLN demonstrate that at present there are no articulatory features that have actually become perceptual categories in the lexicon.

The overall conclusion of the study, then, is that the unit 'hand' plays a less central role in the composition of signs than has been assumed since Stokoe's first phonological analyses in 1960. The size of the linguistically relevant articulator can vary from sign to sign, but it typically equals the *fingers* rather than the *hand*, and its shape, location and movement are best described in perceptual terms that do not refer to the joints of the arm and hand.

6.2 Linguistic implications

The implication of the large role played by a phonetic implementation model in the generation of surface forms is that it is not obvious in advance whether a certain movement (say, forearm supination) should be considered to be a change in orientation or location. This has been implicit in much of the literature on ASL, where often the phonological representation of a sign is proposed to include a change in location and not orientation, even if a change in orientation of the whole hand is manifest in the citation form. The assumption seems to have been that a movement has to be large enough to qualify as a phonological movement. The analysis of the SLN data described in this thesis has shown that movement size cannot be the only criterion. For example, forearm rotation (and its perceptual result, a change in orientation of the whole hand without the whole hand or the wrist moving through space) can be the realization of a change in *location* rather than *orientation*, given the proper linguistic and extralinguistic context. Examples of the linguistic context include the phonological features [location: head] and [movement: repeated], both of which favor a relatively small size of the movement. An example of the extralinguistic context that may lead to a relatively small movement is a nearby location of the addressee.

It is important to point out that the data and analysis presented in this thesis do not invalidate the distinction between path movements (location changes) vs. local movements (changes in articulator configuration or orientation). Sandler (1993) stated that the movement parameter in sign language phonology comprises “either (a) movements of the fingers or palm at a single location or (b) movement of the whole hand along a path from one location to another” (p. 243). The conclusion that the present arrives at is that it is not the path *of the whole hand*, but rather the path of the *articulator* (which may vary in size between and within signs), that is interpreted as a change in location. To be even more precise, it is typically the distal end of the articulator, whatever its size, that determines the interpretation of the size of the location change. It has been implicit in previous studies that in signs with a location at the body, the path is where the hand makes contact. Thus, in DEAF, the path is from high to low *on the cheek*. Put this way, it may appear obvious to any signer or sign linguist that it is not always the whole hand that is interpreted as the articulator. However, it has not been made explicit so far that it most signs it is a smaller part of the articulator than the whole hand that is the perceptual target that is specified in the lexicon.

These multiple different realizations of every sign make it important to describe data in detail, and to describe more explicitly why certain movements have been categorized as either changes in location or orientation. To mention only the intuition of a signer or researcher is insufficient: it should be possible to spell out in detail the abstraction from phonetic surface form to abstract phonological representation, and the context that led to the specific realization at hand. This can be considered the reverse of the phonetic implementation process.

From a wider perspective, these results emphasize that for sign language as for spoken language, phonetic and phonological phenomena cannot be studied separately (cf. the 'laboratory phonology' paradigm for spoken languages, see Pierrehumbert et al. 2000 and Gussenhoven & Kager 2001 for general discussion of the paradigm).

Another implication from the present research is that probably signs in sign languages cannot, as Stokoe, the pioneer of sign language phonology, hypothesized in recent years, "be described in terms of muscular gestures" (Armstrong, Stokoe & Wilcox 1995: 11; see also Jacobowitz & Stokoe 1988, Stokoe 1991).[155] To be sure, the articulation of signs needs to be described in a full model of sign communication, but muscular gestures or even abstractions such as joint movements are not the components that signs are made of. Rather, the data in the chapters above on the variation in the articulation of both movements and static aspects of signs argue for perceptual categories as the components of the form of signs that are stored in the mental lexicon. In earlier chapters, it was emphasized that there is no a priori reason why joint states (or changes in those states) themselves cannot be perceptual categories, as they are visible just as much as movements of parts of the articulator. In SLN, such articulatory categories appear not to be used in the lexicon. I hypothesize that there is good reason for this state of affairs: by not pre-specifying parts of the state of the articulator, the whole articulator is available to flexibly realize various different combinations of perceptual targets in various different linguistic and non-linguistic contexts. Specifically, it was shown in Chapter 3 how the absence of a specification of the state of the MCP joints in the description of the traditional category 'handshape' allows for relatively cheap articulations of different orientation and location combinations. The underlying functional motivation for this division of labor between perceptual and articulatory categories leads us to hypothesize that the absence of reference to joints in the phonological representation of signs also holds for sign languages other than SLN.

6.3 Practical implications

The linguistic research presented in this thesis has direct implications for the creation of sign language materials such as dictionaries and course books. The general trend of these implications is that it would be good to focus less on the hand as a unit, while paying more attention to different realizations of signs.

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[155] At best, the distant perceptual targets of articulatory gestures play a role in the phonology. I chose to term these 'perceptual specifications' in analogy to Boersma's (1998) model for speech, but admittedly they are perceptual specifications of what (a variable part of) the articulator should do. The variability in the size and movements of the articulator leads me to see these abstractions as perceptual categories and not articulatory ones. The case studies of phonetic variation in §5.4 provide the most compelling evidence for the claim that the target of language production are perceptual in nature. As was mentioned at the outset of Chapter 5, this is commonly agreed upon in spoken language phonetics.

Many sign language dictionaries use handshape as the prime ordering unit.[156] In recent multimedia versions of some dictionaries the handshape is one of the search parameters that can be used to look up signs. Since I argued handshape to be a misleading concept, at the very least it is important to warn the user about possible variations between handshapes that they see in real life, and ones that they (try to) find in the dictionary. In practice, this could take the form of implementing fuzzy search capacities that neglect differences in finger flexion, or of ordering signs by sub-categories of the articulator representation such as finger selection and finger configuration. However, dictionary makers could also consider abandoning the concept handshape altogether, focusing only on the number of selected fingers.

On a related note, the description of orientation as the absolute orientation of the hand in space can lead to confusion for users of dictionaries and teaching materials as well, as in context forms users will encounter variation in the exact palm and finger orientation. Instead of the orientation of the whole hand in space, the side of the fingers that is oriented towards the location will typically be more informative and is predicted to lead to more successful searches in dictionaries.

The absolute palm and finger orientations described in dictionaries is likely a reflection of the notation systems used in the collection and transcription of data. Notation systems such as KOMVA (NSDSK 1988) and HamNoSys (Prillwitz et al. 1989) transcribe orientation by looking at the orientation of the palm of the hand and the 'extended finger' orientation, that is, the direction in which the fingers point *if they were extended*. These notations can be extremely useful in the narrow phonetic transcription of signs, but they often fail to capture the phonological specification of the sign, which specifies the relative orientation of the specified articulator, typically the fingers. For use as a mnemonic aid in dictionaries and teaching sign language, notation systems would do better not to focus on the hand orientation in space, but rather on the finger orientation with respect to the location of the sign. Similarly, it may lead to confusion for users to incorporate drawings of and symbols for the shape of the whole hand: focusing only on the (selected) fingers and their shape corresponds more closely to the phonological representation of signs. In some dictionaries, B and B-bent are presented as variants of each other (either explicitly, as in Hedberg 1997 for Swedish Sign Language, or implicitly, as in Radutzky 1992 for Italian Sign Language), while in others they are grouped in different sections of the book (Kennedy 1997 for New Zealand Sign Language).

Finally, the abundant variation in the realization of signs documented here makes clear the necessity for dictionary makers to make users aware of the existence of such variation. The inclusion of one specific surface form in dictionaries by use of photographs, drawings, or movies, may give users the false impression that there is only one 'correct' pronunciation for each sign. This situation does not arise in the prototypical spoken language dictionaries because the use of a written form of a word does not inform the user about many of the details of the pronunciation.

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[156] See for example Suwanarat et al. 1990 for Thai Sign Language, Hedberg 1997 for Swedish Sign Language, Malm 1998 for Finnish Sign Language, Kennedy 1997 for New Zealand Sign Language, and Radutzky 1992 for Italian Sign Language.

Although ‘spelling pronunciations’ point to the existence of misled users of spoken language dictionaries as well, I hypothesize that the chances of misconceptions about signs are much larger. It will not be easy to teach the details of sign language articulation explicitly, disregarding for the moment the lack of knowledge in this area to begin with, pointing out to users that a sign may be articulated in many different ways might make them more sensitive to phonetic variation and prevent overly precise interpretations of the forms presented in dictionaries.[157]

6.4 Further research

The present work raised many questions that future research could address. As the central conclusion of the present investigation is that the specified articulator is typically the fingers rather than the whole hand, the question arises how many signs there are in which the articulator is not formed by the selected fingers (together with the thumb in case of aperture specifications). It was suggested that occasionally the finger tip alone is the articulator, as in some indexical signs, and occasionally the whole underarm together with hand and fingers is the articulator, as in signs like TREE. How frequent are such non-finger articulators in SLN? Are there signs in SLN in which the articulator is the whole hand after all?

The findings and conclusions presented here concern SLN. It remains to be seen whether the same variation in handshape, orientation and movement will be found in other sign languages. The functional phonetic motivation for excluding articulatory actions as perceptual categories, namely the resulting flexibility of the articulator in the realization of phonological specifications, leads us to predict that indeed the same variation will be found for other sign languages as well. Future research could test this prediction.

More quantitative experimental studies (in the spirit of Mauk 2000) are needed to establish how much variation in articulatory and perceptual categories actually occurs between different contexts (and possibly between different sign languages). Although the present study gives an impression of how much variation in the realization of movement exists in terms of traditional categories, these do not make clear how much variation there is in terms of the movement of the end of the articulator, nor how frequently different combinations of joints (including proximalized and distalized articulations) are employed in the articulation of different types of movement.

Such detailed information will be needed to be able to explicitly use the knowledge of different articulation in teaching sign language as a foreign language

[157] Although existing writing systems for sign language are not commonly used among Deaf people, at least one dictionary of ASL (Stokoe, Casterline & Croneberg 1965) used only transcriptions of signs instead of illustrations. The use of illustrations has undoubtedly made sign language dictionaries more accessible and more attractive to use. To my knowledge, the complication that an illustration necessarily represents too much detail has not been discussed in the literature. The problem increases with the inclusion of movies instead of drawings or photos, as details of the realization of the movement that still pictures abstract away from are necessarily included in movies.

(see also Lupton & Zelaznik 1990, Mirus et al. 2001). The teaching of the details of sign articulations is closely related to the existence of personal ‘accents’ in sign language. As I mentioned in the overview of the literature in Chapter 2, I know of no studies investigating such idiolectal phonetic differences. Although the present study found very few clear distinctions between subjects, notably the waved articulations specifically used by one informant, it is still possible that phonetic properties such as the use of small vs. large movements and different articulations of small and large movements characterize the signing of individual signers. This is a major field for future investigation.

Variation in the state of the IP joints was not investigated in this thesis, yet merits further attention. It is predicted that although the state of the IP joints is typically needed to realize finger configuration values (straight vs. curved), in cases where there is no sharply contrastive role for such a value, articulatory ease may override the perceptual specification for finger configuration.[158]

The articulation of many perceptual categories was not studied here. Specifically, preliminary data discussed in Chapter 5 suggest large variability in the realization of spreading. The occurrence of MCP flexion as a variant of MCP abduction that was found in the realization of finger spreading in SLN seemed to function in part as articulations of orientation specifications that would otherwise be expensive to articulate. This hypothesis needs to be further explored, together with the related phenomenon of ‘waving’ movements.

A large field of research that this thesis has not addressed at all concerns the phonological structure above the word level. Recent research on prosodic structure of ASL and Israeli Sign Language lead us to expect that in SLN, too, sequential combinations of signs are organized in prosodic groups. A novel hypothesis that can be derived from the present investigation is that different articulations of a sign (as the expression of a perceptual target such as movement size, speed, or repetition) can be found as the phonetic correlates of prosodic boundaries.

In Chapter 5 it was suggested that the actual location of a sign may be an important determinant of movement size, with reference to Siple’s (1978) article on the salience of movement at different locations. Studies on the perception of signing are needed to confirm Siple’s claims on the salience of movement at different locations. Siple claimed that the fact that more detail can be perceived in the center of the visual field than in the periphery can explain why in ASL more distinctions in location are found near the face than anywhere else. This explanation assumes that the eyes are constantly fixated on the face, but there has been no study of eye

[158] A specific case at hand is the realization of the V classifier for verbs for human locomotion, which occurs in many sign languages. In the prototypical form of this classifier in SLN, the spread extended index and middle finger point downwards. Movement may consist of an dorsumward change in location combined with finger wiggling, or consist of an dorsumward change in location combined with a repeated up-down movement. In SLN, the latter form is often realized with flexed IP joints, so that the finger tips still point downward while less flexion of the more proximal wrist and MCP joints is required. The same alternation appears to occur in Danish Sign Language (Elisabeth Engberg-Pedersen, personal communication). It is possible that the two forms constitute a lexical difference, the present study raises the question to what extent the form with flexed IP joints is not merely a phonetically reduced form of the V handshape.

movement in sign language perception yet. Work on perception of gesture (Gullberg & Holmqvist 1999) suggests that signers might show brief saccadic eye movements to other locations than the chin, which might invalidate Siple's claims that were adopted here.

Several aspects of the Functional Phonology model that call for attention have been mentioned in the previous chapter. The interaction between different phonological factors leading to differences in movement size have not yet been formalized. The formulation of both the articulatory and the perceptual constraints specific to sign language needs to be studied, as well as the distinction between the signer's grammar and the perceiver's grammar that was ignored here.

The way the model deals with the abundant exceptions found in SLN (van der Kooij in prep.) also needs to be investigated. More generally, the question arises how the model deals with frequency differences among feature values, of which exceptions such as loan words are only one instance. The lack of structure in the feature set proposed in Chapter 3 (such as binary branching and headedness, cf. van der Hulst 1993 and later) was influenced in part by the absence of a role for such structure in the Functional Phonology model, yet it is not clear at this point how the model deals with such frequency differences. The sensitivity of language users to subtle frequency differences of both lexical items and phonological categories has been demonstrated in recent research (Pierrehumbert 2000, Bybee & Hopper in press), and should be expressed in the model as well.

Appendix A: Anatomical and physiological terminology

The first two figures illustrate the names of bones and joints in the upper extremity; the second series of pictures illustrates the names of the movements at these joints combined with the range of motion and the reference position with respect to which joint states are measured.[159]

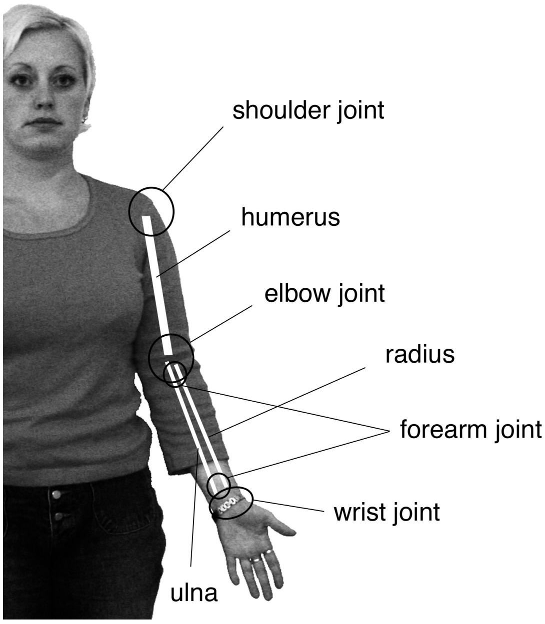


Figure A.1

Names of bones (white lines) and joints (encircled) of the arm

159 The information on the range of motion used in this appendix stems from Luttgens, Deutsch & Hamilton (1992). See the same source for further terminology, especially concerning the structure of and movements at the shoulder joint.

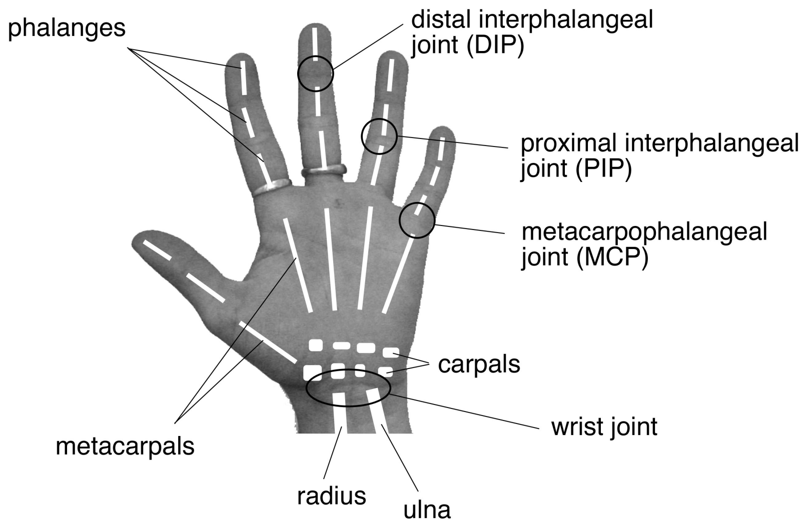


Figure A.2

Names of bones (white lines) and joints (encircled) of the hand

Movement terms are based on the ‘anatomical standing position’ (Figure A.3), in which the arms are beside the body (elbow, wrist, and fingers extended), and the forearm is fully supinated. Movement towards the midline of the body is called adduction, movement away from the midline of the body is called abduction (except for movement at the MCP joints; see below). Forward movement is flexion, the reverse movement is called extension. Extension movement which goes further than the fully extended position of the anatomical standing position is called hyperextension. Rotation at the shoulder can be inward or outward, rotation of the forearm is either supination or pronation.

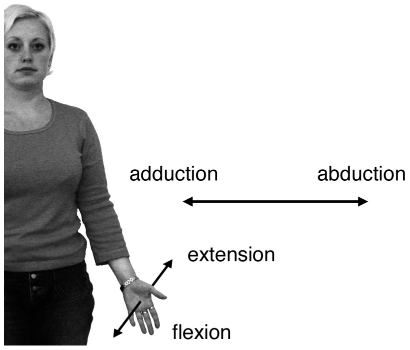


Figure A.3

Anatomical reference position, with general movement terms

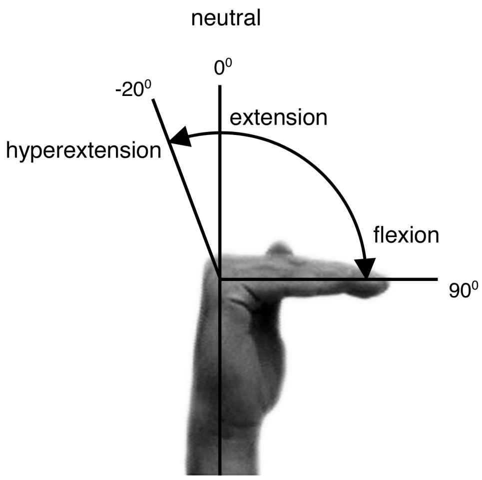


Figure A.4

Movement at the MCP joint

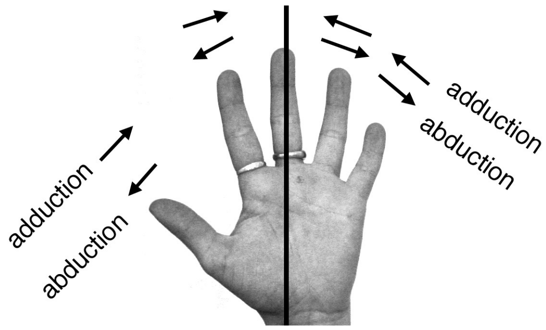


Figure A.5

Movement at the MCP joints

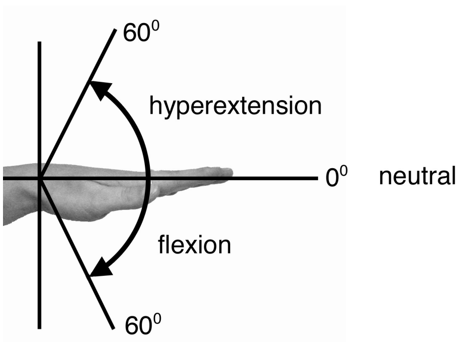


Figure A.6

Movement at the wrist joint

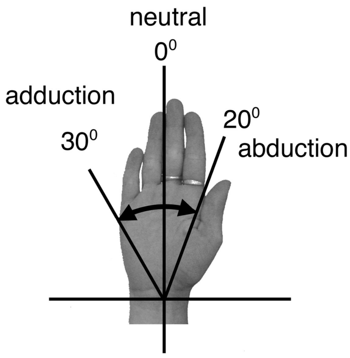


Figure A.7

Movement at the wrist joint

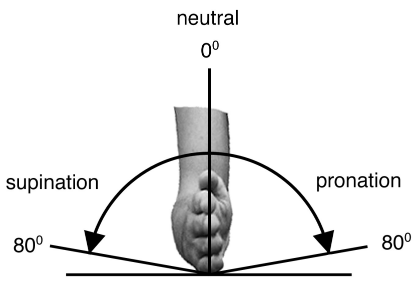


Figure A.8

Movement at the forearm joint

Appendix B: The SignPhon database

B.1 Introduction

This appendix describes the SignPhon database project. Parts of this appendix have also appeared in the SignPhon manual (Crasborn et al. 1998) and in a recent article (Crasborn et al. to appear); it also appears in van der Kooij (in prep.).

We start out by describing the goals and history of the project (B.2-3). The structure of the database and the information that can be stored in it is discussed in sections B.4-5; a more elaborate discussion of all the database fields can be found in the manual. Both the software and the manual are freely available from the SignPhon website (http://www.leidenuniv.nl/hil/sign-lang/signphon2.html). §B.6 describes the (selection of) data that were transcribed for the purposes of this thesis. Finally, §B.7 discusses our experiences in using the database for phonological research, including several drawbacks of the project and areas for future improvement.

The SignPhon project has been financially supported by two grants from the Dutch Organization of Scientific Research (NWO), project numbers 300-75-009 and 300-98-031. We also received a grant for equipment from the Gratama Foundation. Finally, the Faculty of Arts of the Leiden University gave us financial support for both equipment and research assistants. The help of all of these institutions is gratefully acknowledged.

We wish to thank Marja Blees, Corine den Besten, Henk Havik, Alinda Höfer, Karin Kok and Annie Ravensbergen for collecting, digitizing and coding of data, and Rob Goedemans and Jos Pacilly for technical assistance. In designing the structure of the database we have discussed various linguistic issues with Diane Brentari and Wendy Sandler. With support from NWO, in 1996 we organized a workshop in which we discussed the structure of SignPhon with a number of sign language researchers. We wish to thank Jean Ann, Diane Brentari, Thomas Hanke, Bob Johnson, Scott Liddell, Chris Miller, Elena Radutzky, Wendy Sandler, Leena Savolainen, Trude Schermer and Ronnie Wilbur for their useful comments and criticism during this workshop.

B.2 Goals

An analysis of the phonology of a language starts at the lowest level: the level of morphemes. We must establish what the set of distinctive units is from which morphemes are constructed. This is a purpose in its own right, leading to the description of lexical forms, but it is also a necessary step before we can investigate the phonology at higher levels, i.e. at the level of complex words and phrases. An investigation into the phonological structure of any language requires insight into the array of phonetic properties and into the role that these properties play in distinguishing the morphemes of the language. Phonological research generally uses three kinds of data sources:

1. dictionaries
2. native user judgments
3. transcriptions of videotaped materials

Dictionaries generally provide illustrations of one prototypical token of each sign. Sometimes, they also offer a transcription of that one token, and information about regional or phonetic variation. Since most SLN dictionaries that have been made so far list the core lexicon of the sign language, consisting of highly frequent items, they provide useful data on the frequency of phonetic characteristics as well. This information is typically hard to access, since even on CD-ROMs, search facilities tend to be limited and are not always linked to an elaborate transcription (e.g. GLOS 1999).

Native signer judgments can be used to confirm the realization of a sign found in a dictionary, to distinguish between prototypical and odd realizations of signs, to test the phonological status of non-existing signs, etc.

In collecting new material on videotape, some kind of transcription is necessary to categorize what is found. When we started working on the phonological structure of SLN, we felt that detailed insight in the phonetic and phonological characteristics of the language was not sufficiently available and also was not easy to obtain by inspecting the data that had been published in a number of small dictionaries. We therefore decided to build a database, called 'SignPhon'.

The primary goal of SignPhon is to be a tool for research into the phonetic and phonological structure of sign languages. It is designed to store information about the phonetic and phonological structure of isolated signs. It does not easily allow for transcription of sentences in the way that the SignStream software does (see MacLaughlin, Neidle & Lee 1996, Neidle & MacLaughlin 1998). The information on the phonetic-phonological description of signs is divided over 65 fields. In addition, elementary semantic and morphological information as well as information on the signer and the source of the transcription can be stored in altogether 69 fields. By storing detailed information about a relatively large collection of signs, we enable ourselves (among other things) to establish the inventory of phonetic properties, to decide which of these are distinctive, and to make generalizations on combinations of these properties.

B.3 Design history

We were aware of the fact that probably we would not be the first to undertake such a project. After consulting several colleagues we learned that although there are (or have been) quite a number of database projects, most of these have a more general lexicographic goal, implying that the phonological and/or phonetic encoding is usually rather limited.

We therefore decided to start from scratch, relying as much as possible on insights into the structure of signs that are available in the theoretical literature on phonetic and phonological features and in encoding systems. The latter mainly consisted of notation systems, such as KOMVA (NSDSK 1988, which is based on Stokoe notation; Stokoe 1960) and HamNoSys (Prillwitz et al. 1989). We started designing a database structure in which every record specifies information on signs in isolation.

The coding system (which is briefly outlined in §B.5) allows us to encode relatively well-known properties of signs, such as movement shape and major location. However, we deliberately chose to also encode finer phonetic detail from various perspectives, using both familiar and new terminology. The goal of including more detailed and redundant information than most notation systems was to facilitate its use by researchers from various theoretical persuasions, as well as by more practically oriented linguists. Among other things, this implies that no systematic choice has been made for either a perceptually or an articulatorily based encoding: some properties are easier to encode perceptually, others are more tractable when we consider the production side. In many cases, both perspectives were included.

During the second half of 1995 we designed the record structure which was implemented by Onno Crasborn and Rob Goedemans in early 1996, using the software package ‘4D First’. After that, we started entering the first 250 signs into the database. We expected that our first experience with storing data would lead to modification of the record structure and to fine-tuning the values necessary for each field.

At the sixth conference on Theoretical Issues in Sign Language Research (TISLR6) in Montreal in 1996, we organized a special meeting with the aim of improving the current state of the database. Various specialists on databases and/or the phonology of sign languages were present at this meeting. Specific questions addressed concerned the content of the database (what are the signs that we should best transcribe?) and the way temporal sequencing in signs could be stored.

We then designed a second version of SignPhon, which was implemented by Onno Crasborn in 1998 using the ‘4th Dimension’ software. Version 2 of SignPhon has been set up as a relational database (a set of connected databases; this is illustrated in Figure B.1), whereas version 1. was a single (‘flat’) database. As for the content, version 2 differs from version 1 with respect to several fields and their codes. In addition, version 2 allows us to encode various stages in time of a sign separately, thus better capturing the dynamic nature of signs. The choice of the number of stages is independent from a phonological analysis in terms of holds and movements, for example (Liddell & Johnson 1984).

SignPhon has not been designed as a language-specific system. Parts of the database have been used in the PhD-project of Lodenir Karnopp, who did a study of the phonological acquisition of LIBRAS (Brazilian Sign Language; Karnopp 1999). Victoria Nyst used parts of the database for a first analysis of Uganda Sign Language handshapes (Nyst 1999). The database is presently used for a phonological analysis of Flemish Belgian Sign Language. In principle SignPhon can be used for any sign language. Expanding the database with data from other sign languages would make it a highly powerful tool for crosslinguistic investigations. Using a uniform computerized coding system will make it possible to easily compare data from various languages and exchange data with other researchers.

SignPhon differs from transcription systems like HamNoSys not only in including non-phonetic information (about the morphology, semantics, and background of the signer), but also in being more detailed and more redundant. Orientation of the articulator, for example, is encoded in great detail (both 'absolute' and 'relative', Crasborn & van der Kooij 1997) and in addition to specifications of point of contact. There is also redundancy in the aim to encode both perceptual and articulatory categories. Another difference with transcription systems is that SignPhon allows the user to add categories (or rather values in the fields) without interference of the designer of the database, and without the need to design new notation symbols. Most fields accept any (combination of) alphanumeric character(s), and in our experience this has been especially useful in for instance adding handshape distinctions that we did not foresee.

B.4 Structure of the database

The first version of the database had a so-called 'flat structure'. The program contained a number of fields (columns), which concerned different descriptive categories (gloss, translation, handshape, movement, etc.). Each sign formed one record (row) with values for all of the fields. This design was very inflexible: it was not easy to describe multiple segments in the sign (e.g. an initial and a final orientation in an orientation change), or to encode that one sign occurred on multiple videotapes, etc.

The new structure was designed with the goal of being more flexible. Especially in the area of the phonetic description in multiple stages in time, we wanted to be able not just to describe very simple signs, or to make gross abstractions enforced by the program. Below we present the new structure of SignPhon in the form of a diagram. It is a relational database design: the information is distributed in different subdatabases, and there need not be a one-to-one correspondence between them. Arrows in the diagram point from 'one' to 'many': one language has many signs, one sign has multiple sequential stages of phonetic description, one handshape can occur in multiple stages of phonetic description, etc. The 'articulation' and 'compound parts' parts of the structure have not yet been fully implemented at this time (version 2.22 of the software).

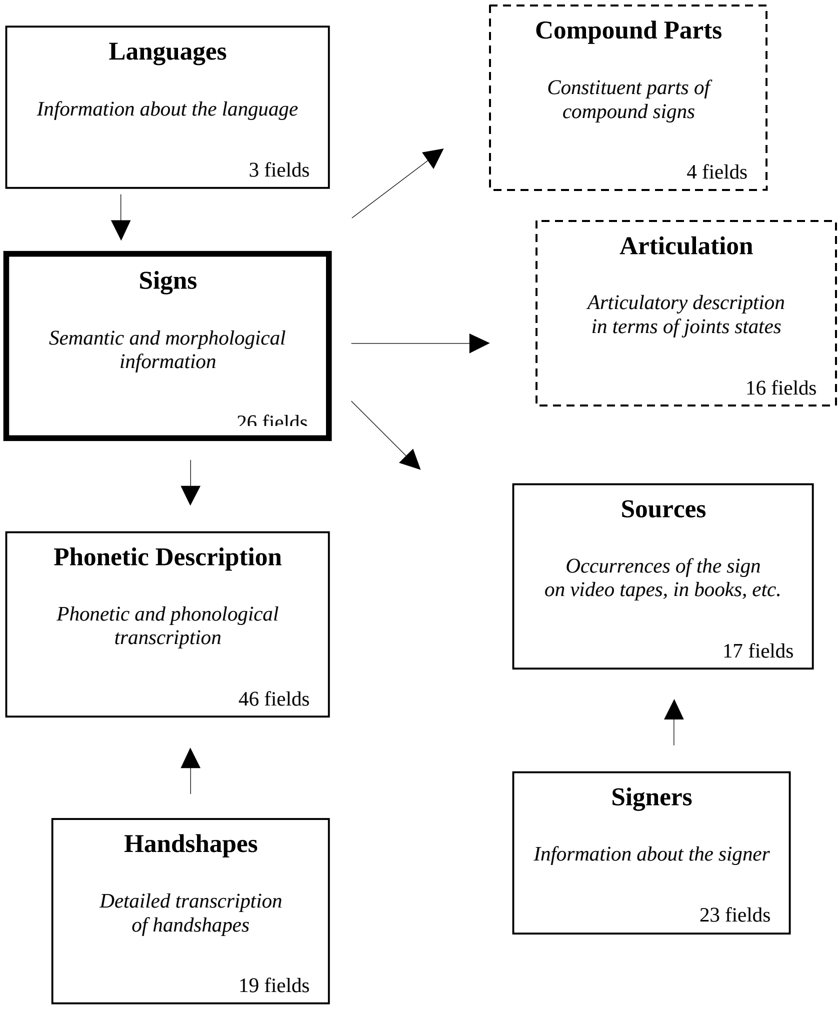


Figure B.1

Macro structure of SignPhon

In the description of the record structure below it will become clear that not all fields need to be filled for all signs. In addition, some fields are filled only once for all signs, like the fields in the handshape subdatabase. Generally it takes about 20 minutes to encode one sign. The present number of encoded SLN signs is a little over 3,000 (September 2001).

The central unit for usage is the *Signs* subdatabase. Most frequently, the database will be used to answer questions like ‘how many signs are there which have property X?’.

One sign can be found in multiple places (on different video tapes, in different pictures and drawings in books, etc.). Each occurrence can be registered in the *Sources* subdatabase. Each signer that is identified in the source of a sign is characterized in the *Signers* subdatabase. The language in which the sign occurs can be specified in the *Language* subdatabase.

One sign can be described in multiple phases, i.e. stages in time. We call these stages of *Phonetic Description*. In SignPhon, as many stages are used as is necessary to completely describe the sign. This is independent of the phonological analysis of the sign: a stage of phonetic description does not correspond to a hold segment in the model of Liddell & Johnson (e.g. 1986, 1989) or to an X slot in the Leiden model (e.g. van der Hulst 1993, 1995b). Thus, SignPhon transcription is similar to IPA transcription of speech sounds: it will take some effort to use the system independently of and unbiased by one’s own phonological analysis. More importantly, conventions and agreement will have to be established by intensive use of the system. (Even so, as in spoken language transcription, it is unlikely that perfect agreement between transcribers can ever be achieved, despite explicit guidelines and intensive training; cf. Vieregge 1985.)

Handshapes are described in detail in a separate part of the database, as it would be very inconvenient to have to describe for each sign with a B-hand in terms of its selected fingers and their exact position.

Future developments include the addition of the *Articulation* part, allowing transcription of each degree of freedom of each joint in the arm. The articulation of handshapes, i.e. the state of the joints of the fingers, can already been transcribed in the handshapes section. Further, to enter information on different parts of compounds, a separate subdatabase *Compound Parts* will be created.

B.5 Description of the fields

In this section, all the fields are listed from the most important subdatabases. The compound parts and articulation databases have not yet been fully implemented; the languages subdatabase only contains a few fields such as the number of signers, and is only useful if several languages are transcribed in the same data file. Below the most important fields of the operational subdatabases are listed with a few brief comments, in order to provide an idea of the amount of detail that is stored for each sign. As was remarked above, not all fields are relevant to all signs.

B.5.1 General fields

The fields mentioned here do not constitute a separate subdatabase in the diagram. They surface in most subdatabases and contain administrative information, keeping track of who entered what and when. Every subdatabase also contains a REMARKS field, where the user can store an unlimited number of comments.

ENTRY DATE	MODIFIER NAME
ENTERER NAME	REMARKS
LAST MODIFICATION DATE	

B.5.2 Signs

This subdatabase stores elementary semantic and morphological information.

GLOSS	MOTIVATEDNESS
LANGUAGE	MORPHOLOGY,
NUMBER	WORD TYPE
NUMBER OF STAGES	BORROWING
DUTCH TRANSLATION	NUMBER OF PARTS
ENGLISH TRANSLATION	SEQUENTIAL COMPOUND
SEMANTIC FIELD	COMPOUND PART[1-5]

B.5.3 Phonetic description

The phonetic description subdatabase is the most important database, because here we encode in great detail the shape of the signs, divided over 46 fields. Most field names speak for themselves (if one is familiar with analyzing the formational structure of signs). Some fields with administrative information have been left out of the list below.

ARTICULATOR NUMBER	PLANE
RELATION STATIC	LOCATION STRONG
RELATION DYNAMIC	LOCATION WEAK
ALTERNATING	LOCATION SYMMETRY
HANDSHAPE STRONG	CONTACT MOMENT
HANDSHAPE WEAK	CONTACT PLACE
HANDSHAPE CHANGE	MONO/BI DIRECTIONAL
PALM ORIENTATION STRONG	PATH ON PATH
PALM ORIENTATION WEAK	PATH SHAPE
FINGER ORIENTATION STRONG	MOVEMENT DIRECTION
FINGER ORIENTATION WEAK	MOVEMENT DIRECTION WEAK
ORIENTATION CHANGE	SEQUENTIALITY
LEADING EDGE	REPETITION
LOCATION TYPE	SPEED

INTENSITY	FACIAL MOVEMENT
SIZE	ORAL COMPONENT
SIGNING SPACE	POSTURE HEAD
FACIAL EXPRESSIONS	POSTURE BODY

B.5.4 Handshapes

This subdatabase allows the transcription of all the attested handshapes. The handshapes that are used in every individual sign are encoded in the phonetic description of that sign in terms of a code (HANDSHAPE CODE) which refers to this handshape database. The abbreviations MCP, IP, PIP, and DIP refer to the different joints in the fingers and thumb (see Appendix B); these fields include an articulatory description of each handshape. The articulatory information for the rest of the articulator can be made in the articulation subdatabase.

PICTURE	INDEX PIP
HANDSHAPE CODE	INDEX DIP
NAME	MIDDLE MCP
OTHER NAMES	MIDDLE PIP
CLASSIFIER	MIDDLE DIP
CLASSIFIER MEANING	RING MCP
HANDSHAPE REMARKS	RING PIP
HAND ALPHABET	RING DIP
SELECTED FINGERS	PINKY MCP
SHAPE SELECTED FINGERS	PINKY PIP
SHAPE UNSELECTED FINGERS	PINKY DIP
SPREADING SELECTED FINGERS	THUMB MCP
SPREADING UNSELECTED	THUMB IP
FINGERS	CONTACT PART
CROSSING	POINT OF CONTACT
THUMB	TENSE
INDEX MCP	

B.5.5 Sources

One can distinguish between signs from different sources, although currently for our own research most of them are recorded especially for the SignPhon project. Other sources might be dictionary CD-ROMs, for example.

SOURCE	REGISTER
SIGNER	CONTEXT
DIALECT	COLLECTION
SWITCH	

B.5.6 Signers

In the Signers subdatabase, we keep track of as much information about the informants as might be relevant.

SIGNER CODE	CHILDREN
FIRST NAME	PARTNER
SURNAME	FRIENDS
SEX	FIRST LANGUAGE
HANDEDNESS	SECOND LANGUAGE
BIRTH YEAR	AGE OF ACQUISITION
HEARING	SCHOOL
GRANDPARENTS	REGION
PARENTS	CURRENT RESIDENCE
SIBLINGS	

A detailed description of the database structure and of the implementation can be found in the SignPhon Manual which is available on the SignPhon web site (http: //www.leidenuniv.nl/hil/sign-lang/signphon2.html).

B.6 Data collection

The signs stored in the SignPhon database that were used in this study are all signs in isolation (citation forms). A citation form is the answer to the question: 'what is the sign for X?', where 'X' was a written Dutch word. The citation form yields a particular prosodic context that may not (often) be found in current signing. As Sandler (1999) pointed out, "words are often pronounced differently in connected speech than they are in isolation" (cf. Kaisse 1985). However, looking at signs in isolation is a necessary start for a phonological analysis of lexical signs.

The procedure we followed in the recording of the data stored in SignPhon was to offer a written Dutch word to the consultant, who first signed the sign in isolation and then made up a ghost story, situation or sentence containing that sign. Sometimes the informant did not know of a good sign translation for the written word that was offered; in that case the word was skipped.

These signs in isolation and the sentences or stories following them were recorded on videotape. Both the signs in isolation and the sentences have been stored as digitized QuickTime files, but only the former were encoded in the database.[160] The video files were point of departure for the encoding of the signs in

[160] The video files have not been integrated in the SignPhon structure as yet. At this point, the video fragments have to be played back by another application such as QuickTime Player. In the future SignPhon could be linked to a database of digitized video fragments so that for each occurrence in SignPhon (a 'source', see below), the actual realization of the sign can be consulted.

the database. This encoding appeared extremely time consuming. An experienced transcriber need about 20 minutes to fully describe a single sign. For over two years we benefited from the help of a hearing research assistant who was also involved in the development of the database. Later, two Deaf research assistants pursued the transcription work for several months.

The criteria for the set of Dutch words that we used as elicitation material were threefold. Firstly, the set of words should include the set of most frequent (type and/or token) lexemes of SLN. Secondly, no phonological or phonetic criteria could be employed, as one of the goals of the database and of the research project was to look at relative frequency of formal elements. Finally, the words had to originate from different semantic fields, as we acknowledged the fact that in sign languages more than in spoken languages formal elements can be associated to specific semantic fields.

These criteria materialized as follows. Since there was no information on the set of most frequent signs of SLN, and no corpus of (coded) current signing is available to make frequency counts, we started with the signs of one dictionary (KOMVA 1989). We also tried to find out what the criteria were for storing signs in some other dictionaries (e.g. of BSL and ASL), and we realized that translating these dictionaries to Dutch would involve many culture-specific terms. As we did have easy access to frequency counts of words in written Dutch texts, we decided to use the 30,000 most frequent term of this corpus, the CELEX database (Baayen et al. 1995).

We added some items to this list that appear to be specifically frequent in Deaf culture, such as 'TTY' (*teksttelefoon*). We also removed many items from the list, such as grammatical items that do not exist in SLN, because of the difference in grammatical structure. A complete list is given in (1).

(1) Items that were removed from the list of most-frequent Dutch words

- Words that were already stored in SignPhon
- Words referring to sounds, such as *knisperen* and *tsjilpen*
- Archaic or difficult coordination words such as *noch... noch*, *aldus*, *namelijk*
- Local and temporal items starting with *er*, such as *ervoor* , *erna*, *erbij*
- 'Difficult' or specialist terms, such as *anemie*
- Names, except for country names and city names
- Counting words
- Inflected verbs
- Inflected adjectives
- Diminutives
- Parts of expressions such as: *(ter) sprake*, *(ons) inziens*, *(als het) ware*
- Plurals of count nouns
- Interjections, such as *trouwens*, *he*, *toch*
- Words ending in -*heid* such as: *oneindigheid*

B.7 Drawbacks and improvements

In the course of the PhD projects of Els van der Kooij (in prep.) and Onno Crasborn (this thesis), the main types of queries concerned frequency distributions of formal elements (for instance; handshapes, points of contact, location types), and of combinations of elements (for instance: all handshapes in neutral space or on the head). The database also turned out to be useful in collecting data for specific investigations. For instance, it can be used to answer the question what proportion of signs are made near the temple that are not in the semantic field of ‘mental state or activity’.

A major drawback of the database was its content in relation to the goal and the type of research that we performed with it. All signs that were stored in immense phonetic detail were based on a single phonetic instance articulated by a single signer. Ideally, to carry out phonological analyses, one would want to compare different instances of the same sign, signed by various signers in various contexts. In principle this can be done in SignPhon, even though the need would arise for more sophisticated search facilities than presently implemented: comparing the content of the fields for different signs is a laborious task in the present implementation. The encoding of signs would also benefit from such search facilities. In the current encoding procedure the encoder had no easy way to check if the sign at hand was already encoded. The database currently warns the encoder if a sign is already present with the same gloss; but as this gloss is just a label for the sign, it might also be the case that the phonetic form itself is already present, but with a different gloss label. At this point it is not possible to automatically compare different records in the database. In the ideal case, one should be able to select a sign and search for similar signs, where the comparison criteria could be chosen from a set of predefined characteristics or composed by the user. Currently one has to do this by searching for a combination of criteria that is featured in the sign that one wants to compare.

To determine the nature and precise content of phonological features the comparison of several instances of a sign is desirable. Given our experience that it takes about 20 minutes to transcribe one sign, it is obvious that building such a corpus of transcriptions in SignPhon would require the investment of a great deal of time and money. Further, when hypotheses about details of a sign’s form become specific and detailed enough to do quantitative research, using transcriptions may not be the best methodology. Actual measurements of the articulation of many different tokens then becomes a better strategy.

A more fundamental problem also becomes apparent during the design of a notation system or a database like SignPhon, which one could refer to as ‘the database paradox’. In order to design the system, and decide on the categories that can be distinguished by the user, one should already have the results of the research that the transcription system is designed for. Every transcription is an act of analysis – and this holds a fortiori for the design of a transcription system. SignPhon is used (among other purposes) to determine the distinctivity vs. predictability of phonetic features in a sign language. However, one can never know in advance what these properties are, and how many values along a certain scale might be ‘used’ in the language. We tried to address this paradox by including most of the distinctions that we found in the literature on ASL and other sign languages, and by not striving towards the elimination of all redundancy. To reduce the time needed to transcribe items, it was also necessary to limit the number of distinctions that can be made in each field. The database is designed so that in most fields, the user can add values that appear to occur in the language that is being transcribed.

Appendix C: KOMVA notation symbols

This appendix presents an overview of the most important distinctions made in the KOMVA notation system (NSDSK 1988; illustrations reproduced by permission).

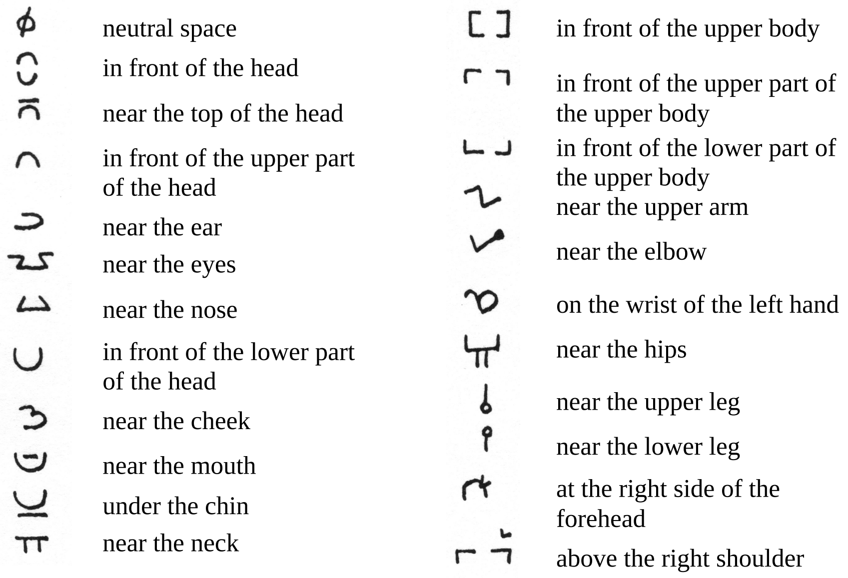


Figure C.1

Symbols for location

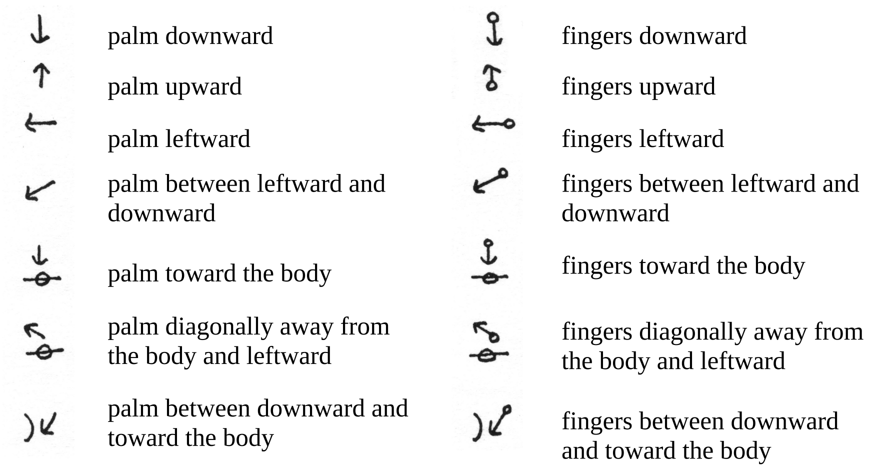


Figure C.2

Symbols for orientation

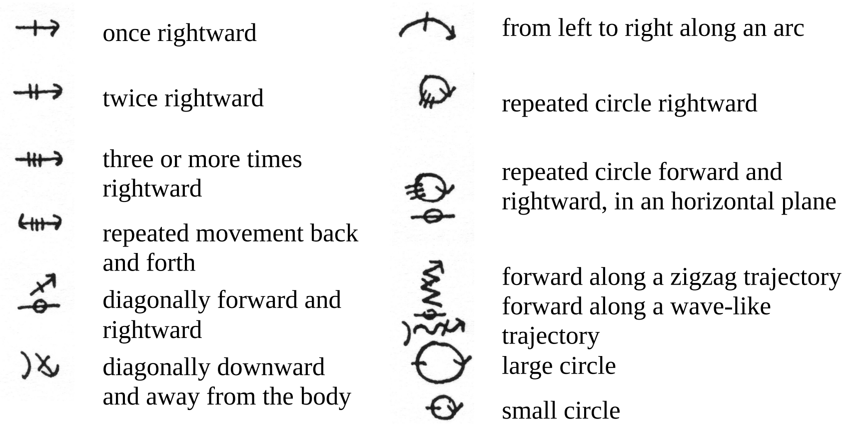


Figure C.3

Arrow symbols for movement

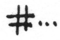
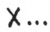
	nodding movement at the wrist
	nodding movement at the MCP joints
	nodding movement at the PIP/DIP joints
	rapid wiggling movement of the fingers
	nail of the thumb forcefully rubs along finger, ends extended
	hand contacts the other hand or the body
	rotating movement at the forearm
	rapid wiggling movement of the index and middle finger
	thumb rubs the finger tips
	hand opens
	hand closes
	alternating
	hand closes repeatedly
	repeated contact

Figure C.4

Further symbols for movement

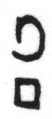
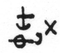
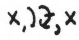
	downward while the hand contacts the location
	nodding movement at the wrist while the hand opens
	towards the body, ending in contact
	contact, then downward, then contact

Figure C.5

Combinations of movements

g	large
k	small
s	quick
l	slow
f	forcefully
t	tense
h	hold; suddenly stopping, after which the hand remains at the same location for a while

Figure C.6

Symbols for manner of movement

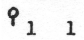
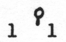
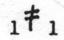
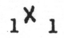
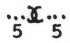
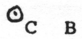
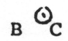
	left hand lower than right hand
	right hand lower than left hand
	close together
	left hand closer to the body
	right hand closer to the body
	hands are crossed
	hands contact each other
	hands grasp each other
	left hand encloses right hand
	right hand encloses left hand

Figure C.7

Symbols for the spatial relation between the two hands

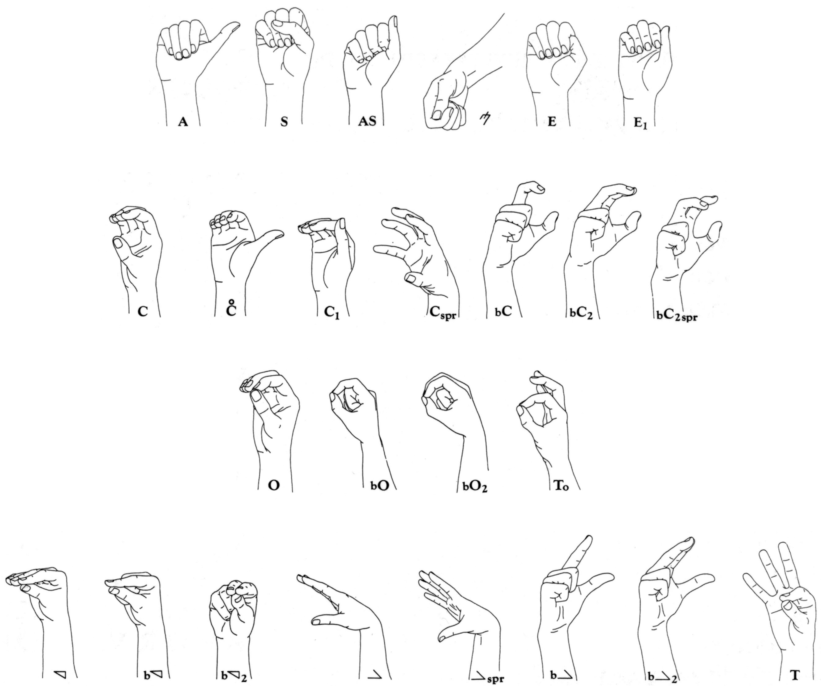


Figure C.8

Symbols for handshapes

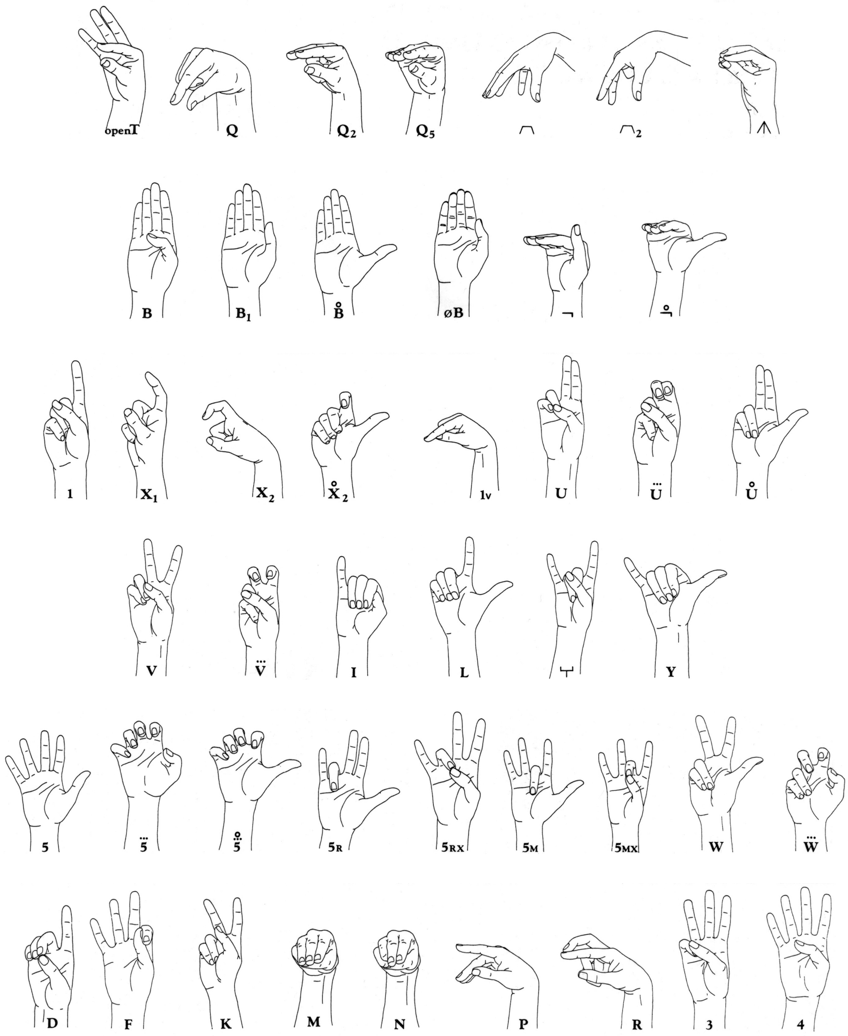


Figure C.8 (cont.)

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Index of glosses

Illustrations are provided on pages given in bold face. Glosses refer to SLN signs, unless a subscript indicates another sign language. The following abbreviations are used: American Sign Language (ASL), British Sign Language (BSL), Italian Sign Language (LIS), Quebec Sign Language (LSQ) and Thai Sign Language (Thai SL).

D

E

F

Samenvatting

Fonetische implementatie van fonologische categorieën in Nederlandse Gebarentaal

De illustratie op de kaft van dit boek sluit nauw aan bij de onderzoeksvraag die het uitgangspunt vormde voor het proefschrift. We weten allemaal dat de vingers, hand, onderarm, en bovenarm aan elkaar vast zitten. Maar kunnen we op grond daarvan ook voorspellen welke gebaren wèl en welke nìet vaak voorkomen in Nederlandse Gebarentaal?

De intuïtie van de meeste mensen zal zijn dat 'makkelijke' gebaren vaker voorkomen dan 'moeilijke'. Vergelijk bijvoorbeeld de vormen die hieronder zijn afgebeeld. Het gebaar links, waarin de wijsvinger vanaf de kin naar voren beweegt, bestaat echt in Nederlandse Gebarentaal (NGT) en betekent ZEGGEN. Alle armgewrichten staan in een neutrale stand, alleen is de elleboog sterk gebogen om te zorgen dat de vinger contact kan maken met de kin. Het rechtergebaar komt niet voor in NGT. Dat lijkt voor de hand te liggen: er is immers een extreme draaiing van de onderarm voor nodig om met de pinkkant van de wijsvinger de kin aan te raken.

Het gebaar ZEGGEN

Een niet-bestaand gebaar

In taalkundige analyses van gebarentalen, waaronder NGT, wordt merkwaardig genoeg weinig rekening gehouden met wat moeilijk is en wat makkelijk is voor het menselijk lichaam. In beschrijvingen van gebaren wordt de hand impliciet of expliciet als een losstaand blokje gezien, dat niet vastzit aan de arm. Dit 'blokje hand' heeft verschillende eigenschappen, zgn. 'parameters', die voor elk gebaar gespecificeerd kunnen worden. De hand heeft een bepaalde vorm (‘handvorm’), een bepaalde draaiing in de ruimte (‘oriëntatie van de palm en vingers’), en een bepaalde plek in de ruimte (‘plaats’). De ‘beweging’ in een gebaar kan beschreven worden als een verandering van één of meerdere van deze drie eigenschappen. Tot slot speelt in veel gebaren de gezichtsuitdrukking en lichaamshouding een belangrijke rol. In dit onderzoek lag de nadruk op de handbewegingen. De twee bovenstaande gebaren kunnen dan als volgt beschreven worden.

	Beschrijving van ZEGGEN	Beschrijving van het niet-bestaande gebaar
Handvorm	1-hand (gestrekte wijsvinger)	B-hand (4 gestrekte vingers)
Oriëntatie	vingers omhoog, palm naar *links*	vingers omhoog, palm naar *rechts*
Plaats	kin	kin
Beweging	beweging naar voren	aantikken van de plaats

Een beschrijving van twee gebaren

Het belangrijkste verschil tussen deze twee gebaren is de oriëntatie van de palm. Door de verschillende parameters voor elk gebaar op deze manier te specificeren, kunnen we al iets preciezer zeggen welke gebaren wel en welke niet bestaan. Er bestaan bijvoorbeeld wel gebaren waarbij de plaats van de hand bij de kin is (zoals ZEGGEN, STEL-DAT, en VAKANTIE), maar geen gebaren waarbij de hand de knieholte aanraakt (wellicht met uitzondering van het gebaar KNIEHOLTE). Eén mogelijke verklaring voor het feit dat de plaats ‘knieholte’ niet voorkomt, is dat de gewrichten van de arm en hand daarvoor té grote bewegingen moeten maken. Om duidelijk te maken waarom het rechtergebaar niet voorkomt, zouden we iets kunnen zeggen als ‘de palmoriëntatie *naar rechts* komt niet voor als de plaats *kin* is en als de vingeroriëntatie *naar boven* is’. Meer in het algemeen zouden we kunnen voorspellen welke gebaren wel en niet voorkomen: er bestaan geen gebaren waarvan de gecombineerde eigenschappen van de hand té ingewikkelde gewrichtsstanden vergen.

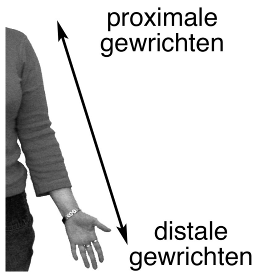
Het is erg moeilijk om vast te stellen wat precies ‘te ingewikkelde gewrichtsstanden’ in gebaren zijn. Een eerste stap was om een beeld te vormen van welke gewrichtsstanden wel en welke niet voorkomen in NGT. Een probleem hierbij was dat al snel bleek dat de standen van de hand- en armgewrichten niet precies hetzelfde zijn bij iedere ‘uitspraak’ van een gebaar. In ZEGGEN, bijvoorbeeld, kan de stand van de pols de ene keer wat meer gestrekt zijn dan de andere. Ook viel het op dat er veel variatie is in de uitspraak van beweging: bewegingen als in het gebaar ZEGGEN, die de ene keer meer met de elleboog gemaakt worden (waardoor de *plaats* van de hand verandert, zoals in het bovenstaande plaatje), worden de andere keer met de pols gemaakt (waardoor de *oriëntatie* van de hand verandert, zoals in het onderstaande plaatje).

Een uitspraak van het gebaar ZEGGEN*, waarbij de beweging vooral door de pols wordt gemaakt. De plaats van de hand verandert nauwelijks, terwijl vooral de oriëntatie van palm en vingers verandert*

Een analyse van de verschillende onderdelen van de vorm van een gebaar behoort tot het vakgebied van de 'fonologie'; de 'fonetiek' houdt zich bezig met de verschillende uitspraken van die onderdelen. Uiteindelijk heeft het onderzoek zich toegespitst op de variatie in de uitspraak van gebaren, en op de vraag wat dit ons kan leren over de verschillende fonologische parameters. In **Hoofdstuk 1** worden de volgende drie onderzoeksvragen geformuleerd.

1. Kan fonetische variatie in NGT de grenzen overschrijden van de eigenschappen van 'het blokje hand'? Dat wil zeggen, kan een verandering van plaats worden uitgesproken als een verandering in handvorm of oriëntatie, en andersom?
2. Als het antwoord op de eerste vraag bevestigend is, heeft het dan nog wel zin om een onderscheid te maken tussen veranderingen van handvorm, oriëntatie, en plaats?
3. Hoe kunnen we de vorm van de verschillende uitspraken voorspellen?

In **Hoofdstuk 2** wordt een overzicht gegeven van bestaand onderzoek naar variatie in gebarentalen, dat vooral op Amerikaanse Gebarentaal is gebaseerd. Uit dit overzicht blijkt in de eerste plaats dat fonetische ('uitspraak') variatie op precies dezelfde manieren voorkomt als in gesproken talen: er zijn regionale verschillen, verschillen tussen ethnische groepen, stijlverschillen, enzovoorts. In het algemeen zijn de onderzoeken naar fonetische variatie zeer beperkt van opzet geweest, en weinig onderzoekers hebben zich bezig gehouden met variatie in de uitspraak van de verschillende soorten bewegingen. Wel is er recentelijk voor Amerikaanse Gebarentaal vastgesteld dat er bij Parkinson-patiënten meer 'distale', en bij kleine kinderen meer 'proximale' uitspraken van bewegingen voorkomen. Proximale bewegingen worden gemaakt in gewrichten die relatief dicht bij het bovenlichaam zitten (de schouder en elleboog) – zoals in veranderingen van plaats. Distale bewegingen worden gemaakt in gewrichten die relatief dicht bij de vingertoppen zitten (bv. de vingergewrichten) – zoals in handvormveranderingen. Bij gezonde volwassene gebaarders is dit soort variatie tot nu toe slechts incidenteel vastgesteld.



Distale vs. proximale gewrichten

In het tweede deel van het hoofdstuk wordt beschreven hoe in de taalkundige literatuur tegen fonetische variatie is aangekeken. De afgelopen jaren is de aandacht hiervoor toegenomen, samen met het inzicht dat de abstracte (fonologische) vorm van een woord of gebaar niet los bestudeerd kan worden van de verschillende uitspraken van die vorm. Het verst hierin gaat de Amsterdamse fonoloog Paul Boersma, met zijn 'Functionele Fonologie' model. Hierin worden de verschillende stappen van het productie- en perceptieproces duidelijk onderscheiden, waardoor het mogelijk is om beperkingen aan de articulatie, wat die ook moge zijn, een belangrijke rol te geven bij het beschrijven van de vorm van woorden. Doordat het model zo duidelijk is over de verschillende aspecten van spreken en luisteren, is het relatief makkelijk aan te passen voor het *gebaren* en het *zien* van gebarentaal (Hoofdstuk 5).

In **Hoofdstuk 3** worden de mogelijke waardes voor de parameters van een gebaar beschreven (zgn. 'fonologische kenmerken'; de parameters zijn *handvorm*, *oriëntatie*, *plaats*, en *beweging*). In het bijzonder worden twee voorstellen gedaan, gebaseerd op onderzoek samen met Els van der Kooij. Het eerste voorstel betreft de oriëntatieparameter, en houdt in dat er beter geen 'absolute' richting in de ruimte kan worden beschreven, zoals in het KOMVA-notatiesysteem gebeurt. Hoewel dit een handige manier van beschrijven is, raakt het niet de kern van het gebaar. Die kern is volgens ons dat een bepaalde kant van de vingers naar de plaats gericht is (of naar de eindplaats, als er een verandering van plaats in het gebaar is). We noemen dit 'relatieve' oriëntatie. Hier zitten twee belangrijke voordelen aan. In de eerste plaats hebben de palm-kant en vingertop-kant van de hand geen speciale status meer. In het gebaar OOK bijvoorbeeld wijst de duim-kant van de hand naar de eindplaats (op de borst). Dit geeft op een meer natuurlijke manier weer wat er in dit gebaar gebeurt; de precieze richting van de palm en vingers is eigenlijk maar 'toeval' in dit gebaar.

Het gebaar OOK*: de duimkant van de hand tikt de plaats (borst) aan*

Het tweede, en belangrijkste, voordeel van relatieve oriëntatie is dat er maar één kant van de hand hoeft te worden beschreven, in plaats van twee. De richting waarin de andere vijf zijden van de hand wijzen is voorspelbaar op basis van de specifieke combinatie van plaats en oriëntatie. In het geval van OOK wijzen de vingers schuin omhoog en naar rechts, en de palm schuin naar beneden, omdat daarvoor de pols of vingers niet hoeven te buigen.

Het tweede voorstel betreft de parameter handvorm. De stelling wordt verdedigd dat er geen fonologisch onderscheid is tussen de 'B-hand' en de 'hoek-hand'.

B-hand

Hoek-hand

Voor beide handvormen geldt dat de stand van het MCP-gewricht bepaald wordt door de fonologische en fonetische context: afhankelijk van de oriëntatie en plaats-specificatie zal de ene keer de B-hand voorkomen en de andere keer de hoek-hand. Bovendien kan elke stand tussen B en hoek in ook voorkomen. Meer in het algemeen is het voorstel om geen fonologische rol toe te kennen aan het MCP-gewricht, waarmee de vingers vastzitten aan de hand: ook in andere handvormen is de stand van dit gewricht voorspelbaar.

Een probleemcategorie wordt gevormd door gebaren als AUGUSTUS, waarin de enige beweging juist in dat MCP-gewricht plaatsvindt. De hypothese is dat er in dit soort gebaren niet sprake is van een verandering in handvorm, maar eigenlijk van een verandering in plaats of oriëntatie die wat kleiner wordt uitgesproken dan een verandering van plaats als in het gebaar ZEGGEN. De voorspelling is dan ook dat als dit gebaar groter uit wordt gesproken dan normaal, er ook beweging zal zijn in het polsgewricht (‘verandering van oriëntatie’) en/of het ellebooggewricht (‘verandering van plaats’).

Deze hypothese wordt getest in **Hoofdstuk 4**. Een aantal onderzoeken wordt beschreven waarin gekeken werd naar de precieze uitspraak van de beweging in gebaren. In het meest uitgebreide onderzoek werden twee gebaarders eerst heel dicht bij elkaar gezet (om ‘fluisteren’ uit te lokken, ofwel kleine bewegingen), en dan heel ver van elkaar af (‘schreeuwen’ ofwel grote bewegingen). De resultaten wijzen erop dat onderzoeksvraag 1 met ‘ja’ kan worden beantwoord. Sommige veranderingen van handvorm zoals in AUGUSTUS kunnen ook met de hele hand gemaakt worden. Hetzelfde geldt voor sommige veranderingen van oriëntatie, zoals in OPEN: als deze groot gemaakt worden, wordt er een verandering van plaats toegevoegd aan de verandering van oriëntatie. Omgekeerd kunnen sommige veranderingen van plaats zo klein gemaakt worden dat ze lijken op veranderingen in de oriëntatie of handvorm.

In **Hoofdstuk 5** wordt beargumenteerd dat het antwoord op onderzoeksvraag 2 ‘ja’ is: er is weliswaar variatie in welke gewrichten de beweging in een gebaar uitvoeren, maar dit zijn geen veranderingen in fonologische categorieën. Het blijft zinvol om een onderscheid te maken tussen gebaren met een verandering in vingerstand, oriëntatie, en plaats. De fonologische beschrijving van een gebaar (zoals die van ZEGGEN aan het begin van deze samenvatting) bestaat uit abstracte perceptuele eigenschappen, waarin geen plaats is voor de gewrichten van de arm en hand. In het gebaar ZEGGEN, bijvoorbeeld, luidt de perceptuele beschrijving ‘beweeg de gestrekte wijsvinger vanaf de kin naar voren’. Om dit perceptuele doel te bereiken kan ofwel de elleboog gestrekt worden, ofwel de pols (of beide). Hoewel in het geval van polsbeweging de *absolute* oriëntatie verandert, blijft de rug van de hand – de *relatieve* oriëntatie – in de richting van het eindpunt van de beweging wijzen.

Iets vergelijkbaars is te zien in het gebaar DOOD. In de normale uitspraak beweegt de hand van links naar rechts langs de nek, en blijft de oriëntatie constant. In een ‘kleine’ uitspraak kan de beweging door alleen een draaiing van de voorarm worden uitgesproken. Hierdoor veranderen de vingertoppen nog steeds op dezelfde manier van plaats: van links naar rechts. Hoewel de palmoriëntatie van de hele hand nu verandert, is het niet zo dat de fonologische beweging in deze uitspraak van het gebaar ineens veranderd is van een plaatsverandering in een oriëntatieverandering.

Een kleine uitspraak van het gebaar DOOD

De omgekeerde verandering in uitspraak komt voor in een gebaar als OVERLEDEN: in een kleine uitspraak heeft dit gebaar alleen een verandering van oriëntatie; in een grote uitspraak word hier een boogvormige verandering van plaats aan toegevoegd. Ook dit is geen fonologisch proces: het is een voorspelbare grote uitspraak van een draai van de hand om zijn as. Tijdens deze draai wordt al een klein boogje beschreven door de duimkant van de hand; de grote uitspraak benadrukt dat boogje door de hele hand op die manier te laten bewegen.

Het gebaar OVERLEDEN

Vervolgens wordt in Hoofdstuk 5 een korte schets gepresenteerd van het Functionele Fonologie model, en hoe dit de gevonden variatie zou kunnen beschrijven en verklaren (onderzoeksvraag 3). Het belangrijkste aspect van dit model is het duidelijke onderscheid tussen perceptuele categorieën (die in ons mentale woordenboek liggen opgeslagen) en articulatorische categorieën (die door het productiesysteem bij iedere uitspraak weer anders kunnen zijn, afhankelijk van de situatie). In dit model kunnen enkele concrete articulatievoorkeuren worden ingebouwd, ook al is er voor de precieze formulering van deze voorkeuren nog veel onderzoek nodig. Zo luidt één voorkeur 'gebruik liever distale (kleine) dan proximale (grote) gewrichten', en een andere voorkeur 'maak bewegingen in een gewricht liever klein dan groot'. Als de persoon tegen wie gebaard wordt dichtbij zit, kunnen deze articulatievoorkeuren worden toegepast zonder het risico dat men niet begrepen wordt: de beweging kan dan kleiner worden dan normaal.

Tot slot worden nog enkele andere gevallen van fonetische variatie besproken, zoals het verschil tussen de baby-C-hand en de X2-nul-hand, die verschillen in de positie van de duim en de mate van buiging van de wijsvinger. Ook voor deze vormen geldt dat ze articulatorische varianten zijn van een constant perceptueel doel. Dit doel bestaat uit een gekromde wijsvinger, en een kleine afstand tussen de top van de wijsvinger en de top van de duim (‘aperture’ genoemd).

Baby-C-hand:
duim tegenover de palm

X2-nul-hand:
duim naast de hand

In **Hoofdstuk 6** wordt de belangrijkste conclusie van het onderzoek samengevat, namelijk dat gewrichtsstanden geen rol spelen in de lexicale (fonologische) beschrijving van gebaren. Gebaren hebben een articulator, een oriëntatie, een plaats, en een beweging, maar deze vier eigenschappen hebben niet per se betrekking op de hand als geheel (het ‘blokje hand’). In de meeste gebaren vormen de vingers de articulator; in sommige gebaren kan de articulator bestaan uit alleen de vingertop(pen) of uit de hele hand. Bij geen van de vier parameters hoeft verwezen te worden naar gewrichtsstanden.

De articulator is flexibeler dan we voorheen dachten, omdat niet de hele hand, maar meestal alleen de vingers een bepaalde stand of plaats proberen te bereiken. Er zijn nog steeds beperkingen aan de mogelijke vorm van gebaren omdat de vingers vastzitten aan het bovenlichaam, zoals de heer op de kaft duidelijk maakt. Maar die beperkingen aan de articulatie worden deels omzeild doordat de vingers, en niet de hele hand, de verschillende parameters van het gebaar kunnen uitspreken.

Naast het belang van dit onderzoek voor onze taalkundige kennis over gebarentalen, zijn er ook duidelijke praktische aanbevelingen uit af te leiden. In woordenboeken en lesmateriaal kunnen mensen erop attent gemaakt worden dat er naast regionale variatie in NGT ook uitspraakvariatie is. Bovendien zou overwogen kunnen worden om in dit soort materiaal minder nadruk te leggen op de ‘hand’ als centrale eenheid in gebaren. Dat kan bijvoorbeeld door expliciet varianten naast elkaar te zetten, bijvoorbeeld door de handvormen ‘B’ en ‘hoek’ als twee extremen op een continuüm af te beelden. Een andere mogelijkheid is om bij dit soort vormen de symbolen waarin de hand als geheel wordt afgebeeld te wijzigen in symbolen waarin alleen de vingers te zien zijn.

Curriculum vitae

Onno Crasborn (Waddinxveen, 1972) completed his high school education in 1990. In the same year, he started studying French Language and Literature at the University of Nijmegen (*propedeuse* diploma 1992). In 1995, he received his MA degree in General Linguistics (*cum laude*) from the same university. From 1995 to 2000, he was employed as a PhD student in the Holland Institute of generative Linguistics (HIL) at Leiden University, carrying out the research that is reported on in this dissertation. He is currently enrolled in the Dutch sign language interpreter program. In November 2001 he started work on a postdoc project at the University of Nijmegen, investigating phonetic and phonological aspects of the prosodic structure of Sign Language of the Netherlands.