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The Beginnings of Phonetic and Phonological Coding in the Signs of Ireland Digital Corpus: The Representation of Handshapes

Gudny Bjork Thorvaldsdottir
Institute of Technology Blanchardstown
thorvalg@tcd.ie

1. Introduction

This paper discusses some of the research that has been done on phonetics and phonology in signed languages. We will discuss aspects of a few phonological models in relation to two of the parameters that have been proposed for signed languages, hand configuration and local movement.

We will also discuss a range of issues with respect to expanding the annotation of the Signs of Ireland (SOI) corpus to incorporate phonetic and phonological coding. This forms part of ongoing PHD research work that explores the phonology-morphology interface in Irish Sign Language (ISL).

The SOI corpus includes data from Deaf ISL users across Ireland in digital form (See Leeson et al. 2006). It consists of over 40 narratives that have already been highly annotated using ELAN: it contains glossed lexical signs, classifier constructions and non-manual features. Classifier handshapes have also been annotated. It is my intention to identify the phonemes and the allophones of ISL using the corpus and it is thus necessary to incorporate a detailed annotation at the phonetic level.

I will outline here the factors influencing decisions regarding the coding and naming of handshapes at phonetic level. These include the question of whether already established naming conventions be maintained. Issues regarding handshape changes within signs will also be discussed.

2. Hand Configuration

Sign language researchers have established phonetic and phonological categories for signed languages, with Stokoe (1960) being the first to divide ASL signs into three main parameters, handshape, movement and location. Battison (1978) later added orientation. Researchers have since then remained true to these categories but not without dividing them even further. Below we will look at the handshape parameter.

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4 ELAN is a software programme developed by the Max Planck Institute, Nijmegan. ELAN (EUDICO Linguistic Annotator) is an annotation tool that allows for creating, visualizing, editing and searching annotations for both video and audio data. It is widely used for establishing and maintaining signed language corpora. (Source: ECHO Project - http://www.let.ru.nl/sign-lang/echo/index.html?http&httpwww.let.ru.nl/sign-lang/echo/data.html) (See also Leeson et al. 2006:1-2)

5 Classifier constructions (classifier predicates) are a class of verbs that consist of a movement morpheme and a classifier handshape morpheme. The handshape stands for the referent while the movement and location of the verb represents the movement and location of the referent. They are thus somewhat isomorphic with the real world (Valli and Lucas 1992, Sutton-Spence & Woll 1999).
The Hand Configuration category is made up of the shape of the hand and its orientation. Many different possibilities exist; various combinations of the four fingers and the thumb may be executed, the fingers and thumb can take on different positions by bending of different finger joints and they can be abducted (spread) or adducted (non-spread). If an internal movement occurs within a sign, this results in a hand configuration change such as a change of the position of the fingers and/or a change of orientation.

In the literature, handshapes were first seen as holistic units, bearing names like V-hand, L-hand etc. (Stokoe 1960). However, representing handshapes as whole phonological units does not account for the fact that handshape changes within signs are restricted. Researchers debate on if a sign with handshape change should be represented as having one or two handshapes. In later publications, handshapes were seen as having internal structure that was possible to break down (Mandel 1981; Sandler 1989).

Mandel (1981) divided handshapes into finger selection and finger configuration. The finger selection determines which fingers and how many are salient in a sign. One or more of the four fingers may be selected and more salient in a handshape and other fingers consequently not selected and thus, backgrounded. Unselected fingers are either all extended or all folded into the palm while the selected fingers are all extended and in the same position, which is specified by the finger configuration. Mandel (1981) formulated a Selected Finger constraint to describe properties of handshapes: only one group of fingers may be selected in a sign. Sandler (1989) later applied the selected finger constraint to per mono-morphemic sign. This means that in signs where a handshape change occurs, the number of selected fingers will remain the same while other properties of the handshape may change.

We will discuss this in more detail below in relation to hand internal movement. Figure 2.1 below shows examples of selected fingers in combination with different position of the thumb.
As noted above, the finger configuration determines the position of the selected fingers and it is divided into three groups:

1) **Flexion**, at different finger joints:
   - MCP\(^7\) (base) joints are flexed: fingers bent
   - PIP/DIP\(^8\) (non base) joints are flexed: fingers clawed
   - All joints flexed: fingers curved

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\(^6\) Illustration copyright © Patrick Matthews (forthcoming), see also Matthews 2005.
\(^7\) Metacarpophalangeal joint (MCP)
\(^8\) Proximal interphalangeal joint (PIP), distal interphalangeal joint (DIP)
2) **Spreading**, 
   The adduction of the fingers: non-spread  
   The abduction of the fingers: spread  
   Fingers crossed  

3) **Aperture**,  
   The selected fingers do not touch the thumb: open  
   The selected fingers touch the thumb: closed  
   (Taken from Crasborn 2001 and van der Kooij 2002)

Below we see examples of Flexion at different finger joints in some ISL handshapes.

**Figure 2.2 a-c: Different finger joints in some ISL handshapes**

As noted above, dividing handshapes up further, can better account for handshape changes within signs. Seeing handshapes as whole phonological units predicts that any handshapes may occur in a sequence within one sign but handshape changes are restricted as claimed by the selected finger constraint, for example. We will discuss handshape changes in more detail below in relation to hand-internal movement, but first we will look at handshapes in ISL.
2.1 Handshapes in ISL
The discussion in this paper forms part of ongoing PHD research work that explores the phonology-morphology interface in ISL. The first part of the research is to identify the phonemes and the allophones of ISL, which entails establishing a list of phonetic features for the language. To date, no research has been done in this area apart from work describing phonetic handshapes in ISL. Thus far, there is no agreement on the phonetic alphabet inventory for ISL: Ó’Baoill and Matthews (2000) identified 66 handshapes while Matthews (2005) identified 78. The issue of allophonic variation has not yet been tackled for this language.

While currently we have a list of phonetic handshapes identified for ISL, we do not have any extended knowledge of their phonological status. Minimal pairs on the basis of handshapes have been identified but detailed phonological information does not exist. For example, we do not know which handshape sequences are allowed within signs in ISL and phonetic variation has never been identified although instances of these do occur as we see in figure 2.3a-b, which shows an example of variation in selected fingers articulated by the same signer within one narrative.

![Figure 2.3a: The sign BOY, articulated with four selected fingers.](image)

![Figure 2.3b: Variation of the sign BOY, articulated with one selected finger.](image)

It is my intention to identify the phonemes and the allophones of ISL using the Signs of Ireland (SOI) corpus and it is thus necessary to incorporate detailed annotation at the phonetic level. When attempting to transcribe or code phonetic features in a language with the aim of using the information in a phonological analysis, a problem arises as how to make the coding functional when doing different searches regarding phonology. Ideally then, one should know the phonology of the language and what kind of search will be necessary before attempting the phonetic coding. However, this is seldom the case.

This problem has been referred to as the database paradox by Crasborn et al. (2001) and Van der Kooij (2002). In order to beat this paradox, it is necessary to rely on research in other signed languages as well as preliminary observation of the language in question. The most extensive literature on sign language phonetics and phonology regards American Sign Language (ASL) and Sign Language of the Netherlands (NGT) and those will be consulted during the course of the research.

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9 Interestingly, the sign articulated before the variant of BOY is a two handed sign using a handshape with four selected fingers (the remnants of the sign can still be seen on the non-dominant hand), thus ruling out an instance of assimilation.
As noted above, the SOI corpus consists of over 40 narratives that have already been highly annotated: it contains glossed lexical signs, classifier constructions and non-manual features. Classifier handshapes have also been annotated. By adding phonetic annotations of handshapes in lexical signs, it will be possible to use the corpus to explore their phonological status in a systematic way. We will be able to detect, for example, what handshape changes occur within signs in ISL and explore occurrences of phonetic variation.

For annotation purposes, challenges arise in terms of how handshapes are recorded: for example, of the 66 handshapes identified in O’Baoill and Matthews (2000), 28 are established as occurring as classifier handshapes also. These are annotated following ECHO project annotation norms (Nonhebel et al. 2004) where possible, with additional handshapes drawn from a list of 48 classifier handshapes described for BSL in Brennan (1992) using names like CL-B, CL-ISL-K etc. within the framework of the SOI corpus. For this research, decisions have to be made regarding naming and coding handshapes at the phonetic level. These include the question of whether already established naming conventions be maintained when annotating lexical signs. Moving away from established protocols will result in inconsistencies within the annotations in the corpus. However, for the purposes of phonetic research a more elaborate coding might be necessary.

There is some inconsistency in the literature when it comes to handshape names. Researchers usually use names that refer to the alphabet in the sign language being discussed. Although some of these names are compatible between many signed languages, such as B (a flat hand) and A (a fist-handshape), we do find different naming conventions as well (e.g. W in NGT uses thumb, index and middle finger which is represented as 3 in ASL).

For transcription purposes, we have decided to incorporate the coding used in the SignPhon database.\textsuperscript{10} These are coordinates into the table of handshapes in HamNoSys (see Prillwitz et al. 1989)\textsuperscript{11}, where the handshapes are organised according to articulatory properties and each handshape is given a code consisting of a letter and a number (A1, A2, B1, B2 etc., see van der Kooij 2002: 297-9).

Figure 2.5 below shows how a few ISL handshapes have been organised and given codes, corresponding to the system used in SignPhon. It would be very time consuming to have to describe a handshape in its full articulatory terms every time it occurs in the corpus. Thus, the use of codes will save some time when transcribing and is also useful if we later decide to use SignPhon to create a database for lexical signs in ISL. Also, deciding on names for all ISL handshapes is a time consuming process and redundant at this stage since we expect our current list of handshapes to change as the research proceeds. Some changes have already been made to our current list of handshapes as we see in figure 2.6 below.

\textsuperscript{10} This is a database created to research the phonetics and phonology of NGT and includes lexical signs only (See Crasborn 2001; Crasborn et al. 2001; van der Kooij 2002 ).

\textsuperscript{11} Thanks to Thomas Hanke for pointing this out to me.
Figure 2.5: Part of the table of handshapes with codes corresponding to HamNoSys table of handshapes (Prillwitz et al. 1989) (see also Van der Kooij 2002).

The empty boxes mean that a handshape that belongs in that box does not exist (or has not been identified so far) in ISL. New handshapes that we expect to be identified in the process of the annotations will be added in.

Figure 2.6: handshape not noted before in ISL (but used in signs like BOY).\(^\text{12}\)

Thus, the naming conventions for classifier handshapes in the corpus have not been maintained for lexical signs. In order to facilitate search between handshapes in lexical signs and classifier constructions, information on the names of classifier handshapes is included in the notes tier already established within the SOI annotations. A subdatabase for handshapes, drawing on SignPhon, will be created where the exact articulation of the handshape and semantic information is included. This is still work in progress and will not be discussed further here. In the next section, we move on to talk about aspects of the movement parameter.

3. Movement

A large part of the sign language literature in phonology concerns the movement feature and the term *movement* has been used in different ways. Generally, movement features in lexical signs have been categorized as *path* movements, i.e. the movement of hands and arms in space that results in a change of place of articulation, and *internal*

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\(^{12}\) The handshape figure is from HamNoSys (Prillwitz et al. 1989)
or *local* movement, which consist of either a handshape change or an orientation change and these have been further categorized into hooking, flattening, releasing, wiggling, rubbing, twisting, nodding and circling to name a few. (See for example Liddell 1990; van der Hulst 1993). Local movements can occur on their own or in combination with path movements. The discussion here will be restricted to handshape change only. The different movement types are illustrated in figure 3.1.

![Movement types](image)

**Figure 3.1: Movement types**

### 3.1 Handshape Change

Stokoe (1960) analyzed signs as having three major compositional features, handshape, location and movement, and these were seen as occurring simultaneously within a sign. Later, the importance of acknowledging the sequential organization of signs became evident in order to account for different initial and final position of the hand in the production of a sign. Liddell and Johnson (The Movement Hold model 1989), and Sandler (The Hand Tier model 1989) and Perlmutter (The Moraic model 1992) all argued for sequentiality in signs. The three models all represent signs as being combinations of static elements (i.e. holds, locations or positions) and dynamic elements (i.e. movements). Below, we will discuss the Movement Hold model in relation to handshape change within signs.

The Movement Hold model (Liddell and Johnson 1989) includes two types of skeletal units, movements (M) and holds (H) and each of these units has a bundle of articulatory features associated with it (figure 3.2). In the articulatory bundles, features such as hand configuration, place, contact and non-manual features can be specified. When the hands move during a sign, this is associated with the M segment and when they are held stationary, they belong to the H segment. Signs are thus seen as sequences of the skeletal units. This model is based on autosegmental phonology (Goldsmith 1976), there is a temporal relationship between phonological elements.

![Movement-Hold Model](image)

**Figure 3.2: The Movement-Hold Model (Liddell and Johnson 1989)**

In the MH-Model (Liddell & Johnson 1989), handshapes are represented in a sequence, i.e. in a separate segment cells with movement in between. The handshape is represented twice, for initial and final state regardless if handshape change occurs or not. The claim here is that in signs that include handshape change, the initial and final
handshape must be specified separately because the change is not predictable. In the ASL sign UNDERSTAND, for example, the initial handshape is an S-handshape (closed fist), which then opens into an INDEX-handshape instead of a predictable 5-handshape.

Thus, this model predicts that any sequence of handshape is allowed but other researchers claim that changes in handshapes are restricted and the relationship between the first and the second configuration are predictable in many signs (Sandler 1989; van der Kooij 2002). The Selected Finger constraint is one argument for this. As we have noted in the previous section, there can only be one set of selected fingers in a monomorphemic sign (Sandler 1989). Hence, Liddell & Johnson’s example of the sign UNDERSTAND, above seems to breach this constraint, as the initial handshape has no selected fingers while the final handshape has one selected finger. Liddell (1990) claims that the final handshape in such signs is not predictable based on the fact that ASL signs with an initial S-handshape open into several different handshapes; UNDERSTAND opens into an INDEX-handshape, THROW opens into an ASL h-handshape (only INDEX finger and middle finger selected) and GAMBLE opens into a 5-handshape. However, Sandler (1989) and van der Kooij (2001) claim that in such signs, the fingers are selected underlingly. In signs where a closed fist handshape opens into an H-handshape, the two fingers are assumed to be underlingly selected. According to this view then, handshape changes are predictable.

Van der Kooij (2002) refers to static handshapes when they remain the same throughout signs and dynamic handshapes when they change within signs. She finds that aperture change is the most common type of hand-internal movement in NGT and some handshapes only occur when there is a change in aperture and, thus, are dynamic handshapes. Thus, she represents signs with a handshape change as having one handshape as opposed to two, like in the Movement Hold model. The second restriction on hand-internal movement, apart from selected fingers, concerns aperture change. Van der Kooij (2002) claims for NGT that there are constraints on which handshape sequences may occur in a sign with handshape change based on the joints that are involved. She proposes the following generalization:

1. There is one joint selection per mono-morphemic sign (Van der Kooij 2002: 64)

This captures the generalization that finger configuration does not change within a sign in signs involving aperture changes in NGT as we see in figure 3.3 below (this has also been reported for ASL, see Uyechi 1996):

![Figure 3.3: A closed handshape](a) ![Figure 3.3: A closed handshape](b)
A closed handshape that involves bending of the base joints only (a) does not open to a handshape with the non-base joints curved (b), i.e. a flat shape does not become a round shape and vice versa (adapted from van der Kooij 2002: 64).

3.2 Handshape Changes in ISL
Information on hand-internal movements in ISL is very limited. Although we might assume that there are restrictions on handshape changes within signs in ISL as reported for other signed languages, this has never been formally researched in the language as far as I know. Thus, we still do not have evidence regarding the constraints on handshape change that where discussed above for selected fingers and joint selection. Hand-internal movements that are found in other signed languages also exist in ISL as we see in figure 3.4, which shows a part of an inventory of hand-internal movements based on van der Kooij (2002)\textsuperscript{13}. According to van der Kooij (ibid.) these movements may occur both on a path movement and without a path movement. We will initially assume that this is the case in ISL as well, although further research will have to confirm this.

<table>
<thead>
<tr>
<th>Hand-internal movement</th>
<th>Description</th>
<th>Example, ISL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening/Releasing</td>
<td>The hand changes from a closed to an open position. (closed: in a fist or the thumb touching or restraining the fingers)</td>
<td><img src="image1" alt="BEAUTIFUL" /></td>
</tr>
<tr>
<td>Closing</td>
<td>The hand changes from an open position to a closed one.</td>
<td><img src="image2" alt="SLEEP" /></td>
</tr>
<tr>
<td>Rubbing</td>
<td>Thumb rubs one or more of the finger pads or sides of the selected fingers.</td>
<td><img src="image3" alt="SOON" /></td>
</tr>
<tr>
<td>Hooking/Clawing</td>
<td>The selected fingers flex at the base joint only and there is no opposition relation with the thumb.</td>
<td><img src="image4" alt="TOPIC" /></td>
</tr>
</tbody>
</table>

Figure 3.4: ISL signs that include hand-internal movements
(Text adopted from Van der Kooij 2002: 61)

\textsuperscript{13} Note that van der Kooij’s inventory is based on Liddell (1984), Wilbur (1993) and Stack (1988).
We see here that the signs that include a closing or opening movements, SLEEP and BEAUTIFUL, follow the selected finger constraint discussed in the previous section. The number of selected fingers remains the same so the handshape might be interpreted as one (dynamic) handshape as opposed to two different handshapes. The joint selection constraint is adhered to in these signs as well. The flat open handshape in SLEEP becomes a closed flat handshape and the round curved closed handshape in BEAUTIFUL opens into an extended 5-handshape, and not flat open handshape, which would break the constraint. To conclude, the above examples could be seen as preliminary evidence that the selected finger constraint and the joint selection constraint apply to ISL as well as NGT, but this can be confirmed by further research within the SOI corpus.

4. Summary

We have now discussed some of the literature on phonetics and phonology in signed languages, focusing in particular on handshapes and handshape changes that occur within signs. This was discussed with respect to expanding the annotation of the SOI corpus to incorporate phonetic and phonological coding with the aim to identify the phonemes and the allophones of ISL.

It has been noted by other researchers in this field that preferably one should know the phonology of a language before annotating corpus data in order to facilitate searches regarding phonology. Since this is not the case here, we rely on research that has been done on other signed languages and make assumptions about ISL based on that and preliminary observation.

We outlined decisions regarding the coding of ISL handshapes at phonetic level, reporting that the coding system from SignPhon will be incorporated into our corpus. By adding phonetic annotations of handshapes in lexical signs, it will be possible to use the corpus to explore their phonological status and phonetic variation, but currently all that has been established in the language is a list of phonetic handshapes.

In discussing handshape changes within signs we find that knowledge of this is very limited in ISL, although preliminary evidence suggests that handshape changes within signs adhere to two constraints: the selected finger constraint and joint selection constraint. Further research within the SOI corpus will be able to establish this.

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