A PRELIMINARY ANALYSIS OF VISUAL MOUTH SEGMENTS IN SWEDISH SIGN LANGUAGE

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ABSTRACT

In this article, we describe the form of a subset of mouth gestures in Swedish Sign Language, namely lexically determined, non-morphemic mouth gestures, here referred to as mouth components. We argue that mouth components can be analysed as sequentially ordered combinations of (a small set of) open and closed segments. We also propose a description of the mouth segments in terms of features. Finally, we test the hypothesis that mouth movements borrowed from Swedish are reconstructed according to the native pattern.

INTRODUCTION

Earlier studies of non-manual components in Swedish Sign Language have shown that they fulfill different linguistic functions, such as marking of sentence type (Bergman 1984), expression of negation (Bergman 1995) the mouth expressing adverbial meanings (Bergman 1985), and borrowed mouth actions (mouthings) marking noun phrases (Bergman & Wallin, in press). The present paper is a first attempt to describe the *form* of some of the mouth actions used in Swedish Sign Language. The study focuses on a subset of mouth gestures, viz. lexically determined, non-morphemic mouth gestures (cf. Vogt-Svendsen, this volume), thus excluding oral/facial adverbs. In the following, these mouth actions will be referred to as ”mouth components”.[1]

One aim of the present study is to suggest a systematic description of the form the mouth components based on *visual* contrasts. Such a description would enable us to create a transcription system specifically tailored for the representation of this subset of mouth actions (cf. e.g. Vogt-Svendsen 1981a, 1981b for a notation system for mouth movements in Norwegian Sign Language and Collville 1986 for British Sign Language). Another purpose of the study is to test the following hypothesis: when mouth movements are borrowed from Swedish into Swedish Sign Language, they are

[1] In Sweden, signs with native, lexically determined mouth movements are traditionally referred to as "genuine signs" or "signs with a fixed oral component". However, since "oral" often seems to be interpreted as pertaining to spoken language, rather than just to the mouth, we avoid the Swedish terminology in the present context, and use "mouth component" instead.

reconstructed according to the native pattern. In other words, the form of mouthings tend to develop in the direction of the lexically determined mouth actions in the recipient language.

DESCRIPTION OF MOUTH COMPONENT IN SWEDISH SIGN LANGUAGE

Data in the present study come primarily from three instructional videotapes (Swedish National Association of the Deaf, 1992) illustrating the meaning and use of ”signs with a fixed oral component”, i.e. mouth components, but also from other sources such as direct observation and introspection. At present we have more than 120 signs with such lexically determined mouth actions, most of which also have been checked with a native signer, who was shown only the manual component of a sign, and asked to sign the full form.

Basically, mouth components consist of a change from an open to a closed mouth or vice versa. These movements therefore could be described as sequences of closed and open segments, like e.g. some opening and closing hand internal movements of signs are described in terms of an initial and a final hand configuration. Furthermore, the mouth can be closed in different ways and an open mouth may take on different forms.

Traditionally, the search for distinctive elements involves the use of minimally contrasting pairs of words. However, the (non-morphemic) mouth components that we are interested in here do not carry any meaning of their own, so it is not quite clear what a minimally contrasting pair would look like. One possible example of a minimal pair would be the signs illustrated in figures (1) and (2) meaning ‘to the right’ and ‘furthest away’ respectively. Even though they are obviously both semantically and formationally related, they are clearly two separate lexical items, demonstrated e.g. by the fact that (1) can be reduplicated, which (2) can not.

As can be seen from the illustrations, the signs have the same manual characteristics, in other words, they constitute a minimally contrasting pair of signs, distinguished only by the mouth components: (1) has an opening movement and (2) has a closing movement, but they share one segment, viz. the closed part, where the lower lip is in contact with the upper teeth. However, the closed segment has different positions in the signs: initial in (1) and final in (2). The open segments are visually distinct and cannot be substituted for one another.

Figure 1: 'to the right'

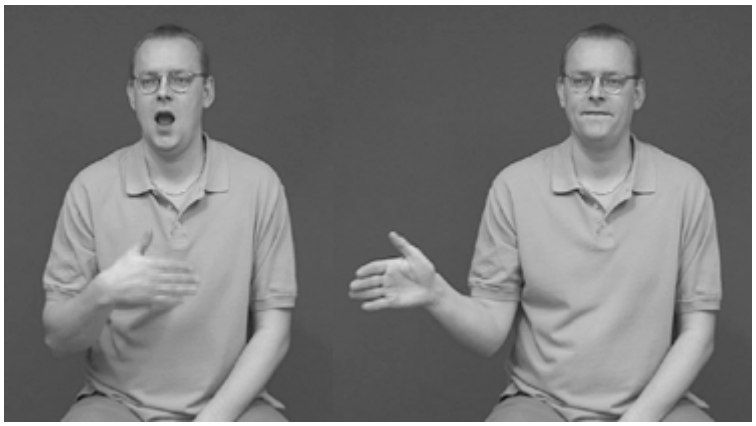

Figure 2: 'furthest away'

A similar pair of signs is shown in figures (3) and (4). Again, they are manually identical forms distinguished by bisegmental mouth components consisting of an opening and a closing movement respectively. The closed segment - lips in contact with each other - is the same, but is different from the closed segment in (1) and (2). The open segment of (4) is similar to that of (2), but contrasts with the open segments of (1) and (3).

Figure 3: 'I was lucky'

Figure 4: '(I) finally made it

The third example of a pair of "manual homophones" is the signs shown in figures (5) and (6). Here also the number of segments differ.

Figure 5: 'be at a loss what to do'

Figure 6: 'be at a loss what to say'

Comparing the mouth components of (2) and (6) we can see, that except for the initial closed segment in (6), they are identical: the open segments look the same and the final segment is the one with the lower lip in contact with the upper teeth. So these two signs are close to minimally contrasting mouth actions (- manually the signs are very different). Ideally, for an analysis of distinctive mouth segments we would prefer manual homophones with mouth components distinguished only by one segment in the same position, but we have not found any such pairs. Consequently, the form of the manual components of the signs has been ignored and we have used only minimally contrasting pairs of mouth components.

The signs were first categorized according to number of segments and within each group further sorted according to inital closed and open segments. An example of one such list of signs with contrasting mouth components is given in figures (7) - (10). As shown by the illustrations, all four signs have a mouth component with an initial closed bilabial segment, and they differ in the second segment. The second segments are all open, but visually different and can not be substituted for one another. E.g. the open segments in (8) and (9), which both have relatively rounded lips, represent two separate segment types and can not change places with one another.

Using the above described type of minimally contrasting sets of mouth components we arrived at a surprisingly small set of segments (listed in figure 11): three closed segments (I-III) and seven open segments (IV-X).

Seeing that some segments seemed to share the same feature, like e.g. protruding lips and rounded lips, we found it natural to continue the analysis beyond that of the segment and attempt to find a set of distinctive features that would capture the contrasts between segments. We ended up with eight features: **open, in, air, corner, forward, round, jaw,** and **tongue** (see figure 12).

The features are defined in terms of what acts. The feature **open** distinguishes between the two classes open and closed segments and pertains to the position of the lower lip. A segment in which the lower lip has contact with the upper lip or the upper teeth is marked **-open**, a segment in which the lower lip is not in contact is marked **+open**. Segment number I (see fig. 12) resembles a neutral, closed mouth, in that the lips are in contact with each other, but the lips are tense. The neutral, closed mouth, is not a segment. It is only when there is extra energy added to the closed mouth, that it participates in the language production. **In** also refers to a position of the lower lip, viz. whether the lower lip is inward and thus in contact with the upper teeth or not. The feature **air** refers to "active" air. If the mouth is **-open**, as in segment II, the result is puffed cheeks.

Figure 7: 'really(!)

Figure 8: '(me) too'

Figure 9: 'I was lucky'

Figure 10: '(to) cause'

Figure 11: Visual mouth segments

		open	in	air	corner	forward	round	jaw	tongue
I		-	-	-					
II		-	-	+					
III		-	+	-					
IV		+			+	-	-	-	
V		+			-	+	-	-	
VI		+			-	+	+	-	
VII		+			-	-	-	-	
VIII		+			+			+	
IX		+		+					
X		+							+

Figure 12: Feature matrix for mouth segments

I		[-open]	/BILABIAL/
II		[-open +air]	/CHEEKS/
III		[+in]	/LABIODENTAL/
IV		[+corner]	/STRETCHED/
V		[+forward -round]	/FORWARD/
VI		[+forward +round]	/ROUND/
VII		[-forward -round]	/PURSED/
VIII		[+jaw]	/OPEN/
IX		[+open +air]	/AIRSTREAM/
X		[+tongue]	/TONGUE/

Figure 13: Mouth segments represented by photo, [feature bundles] *and* /LABELS/

/FORWARD$_{tongue}$/

/OPEN$_{tongue}$/

/FORWARD^{tongue}/

/OPEN^{tongue}/

Figure 14: Variants of the mouth segments /FORWARD/ *and* /OPEN/ *with raised and lowered protruding tongue*

The features **corner, forward** and **round** refer to activities of the lips. **Corner** is used for activity in the corners of the mouth, **forward** refers to lip protrusion and, and **round** to lip contraction. The feature **jaw** pertains to jaw opening, i.e. whether the jaw is markedly lowered or not. Note that in all open segments (when the lower lip is *not* in contact), the jaw is also normally lowered but, as it were, in an unmarked, relaxed way. **Tongue** indicates whether the tongue is protruding or not.

Comparing the three segments in the closed class we see that they are distinguished by being marked **+** for the features **in** and **air**. Thus the set of features needed to unambiguosly described the segments, can be reduced as shown in figure 13, in which we also introduce labels (written in small capitals within slashes) for the segments. The closed segments, I-III, are labeled /BILABIAL/, /CHEEKS/, and /LABIODENTAL/ respectively.

/CHEEKS/ is distinguished form /BILABIAL/ by the presence of **air** and the difference between /LABIODENTAL/ and /BILABIAL/ is the activity of the lower lip in the former, i.e. the feature **in**. Actually, /LABIODENTAL/ is unique among the segments in that it is the only asymmetrical segment, asymmetrical in the sense that the lips do not act as a unit.

The open segments are: /STRETCHED/, /FORWARD/, /ROUND/, /PURSED/, /OPEN/, /AIRSTREAM/, and /TONGUE/. Comparing them we see that e.g. /STRETCHED/ and /OPEN/ both have stretched lips, but differ in the feature **jaw.** The segment /AIRSTREAM/ contrasts with /CHEEKS/ in that the latter is closed, therefore not allowing the air to move out of the mouth, whereas the in former the air streams out making the lips part.

In /TONGUE/ the tongue is visible and protruding and the lips are not marked with any other feature. Tongue protrusion may also be used as reinforcement of the segments /FORWARD/ and /OPEN/, but for those segments the feature **tongue** is not distinctive. When the tongue is protruding, it may be raised and in contact with the upper teeth/lip or lowered in contact with the lower teeth/lip. This difference is represented by a superscript and a subscript respectively. Figure 14 illustrates the variants of /FORWARD/

and /OPEN/ with raised and lowered protruding tongue. Similarly, /FORWARD/ and /PURSED/ have variants with the feature **air**.

The set of labeled segments enables us to represent the mouth component of a sign in a simple way. Returning to the signs in figures 7 - 10, the mouth components can now be represented by combinations of segment labels:

Fig. 7) /BILABIAL, STRETCHED/
Fig. 8) /BILABIAL, FORWARD/
Fig. 9) /BILABIAL, ROUND/
Fig. 10) /BILABIAL, OPEN/

A quick glance at the representations shows the similar structure of the four mouth components: bisegmental components with an identical initial (closed) segment followed by different (open) segments.

The majority of the mouth components in our data are bisegmental, but there are also signs with one, three or four segments. (For a complete list of the mouth components in the present study, see Appendix.) Figures 15-16 illustrate signs with monosegmental oral components, and Figure 6 shows a sign with a trisegmental component. Mouth components with four segments are actually reduplications, i.e. they do not contain four different segment types, only two, and may therefore be described as reduplicated bisegmental forms.

Figure 15: 'get rid of'

Figure 16: 'I made it'

'ADAPTION TO NATIVE PATTERN' HYPOTHESIS

One reason for restricting the present study to lexically determined mouth gestures was that we wanted to test the hypothesis that mouth movements borrowed from Swedish are reconstructed to fit into the native pattern. The basic assumption is that the number of phonemes of a lipread word is reduced, resulting in a mouth action with at most three segments, and furthermore, that only phonemes sharing visual characteristics with the native mouth segments will be chosen.

Data for this part of the study also come from the short narratives illustrating the use of the signs with mouth components. In addition, we have used our own lexical database, which is a digitized version of the printed dictionary (*Svenskt teckenspråkslexikon*, 1997). supplemented with videoclips illustrating signs in isolation and in signed utterances. Preliminary observations support the hypothesis. There is a strong tendency to reduce a word into two segments as shown by the following examples with mouth actions identical to those shown in figures 7 - 10:

(1)
/BILABIAL, STRETCHED/
bi *llig* ('cheap'), ***b*** *r* ***i*** *st* ('lack')

(2)
/BILABIAL, FORWARD/
b *et* ***y*** *da* ('to mean')
o ***mö*** *jlig* ('impossible') (see Fig. 17)

(3)
/BILABIAL, ROUND/

må *ste* (‘have to’), ***p*** *r* ***o*** *va* (‘try’)

(4)
/BILABIAL, OPEN/
pa *rkera* (‘to park’), ***ba*** *cke* (‘hill’)

For many of the words it is the first syllable that has given raise to the mouth component, but other choices are possible, as can be seen from *betyda* (‘to mean’) and *omöjlig* (‘impossible’) where the inital and fourth segments and the second and third segments are chosen respectively. Below a few examples of monosegmental and trisegmental borrowed mouth actions are given:

(5)
/FORWARD/
T ***y*** *skland* (‘Germany’), *l* ***y*** *cklig* (‘happy’)
st ***y*** *relse* (‘board’) (see Fig.18)

(6)
/OPEN/
h ***ä*** *rlig* (‘wonderful’)

(7)
/BILABIAL, ROUND, BILABIAL/
b *r* ***å*** *tto****m*** (‘in a hurry’)

(8)
/BILABIAL, STRETCHED, BILABIAL/
me *dle* ***m*** (‘member’) (see Fig. 19)

(9)
/STRETCHED, BILABIAL, STRETCHED/
s ***eme*** *ster* (‘vacation’)

It seems that rather than choosing just the first segements of the word, visually salient segments are favoured. Further studies will reveal whether it is possible to predict the form of the borrowed, reconstructed element.

At a later stage we would like to extend the analysis to oral/facial adverbs and see how, if at all, they fit into the model presented here. One may hypothesize that those adverbs that consist of mouth actions only should be either combinations of segments already used in non-morphemic mouth components, or if not, they should be describable with the set of features that we have proposed. E.g. the non-manual adverb meaning ‘small’ is a monosegmental form /PURSED/ and the one meaning ‘intense’, ‘with effort’ has the form /STRETCHED/. However, the oral adverb meaning ‘normally’, ‘with ease’ when used with dynamic verbs does not use any of the segments in our set. It is a closed mouth with protruding lips so a possible description would be **-open, +forward**. - Non-manual adverbs produced by other facial activities as well, are probably best represented by the Facial Action Coding System (Ekman & Friesen, 1978).

Another logical continuation of this study is to test of the preliminary results presented here in study of mouth movements in relation to those of the hands. As has

been pointed out by others (e.g. Vogt-Svendsen and Woll, this volume), the movements of the hands and mouth seem to be synchronized, so using a segmental representation of mouth components should facilitate a closer investigation of the manual - oral interaction.

*Figure 17: o **mö** jlig ('impossible')*

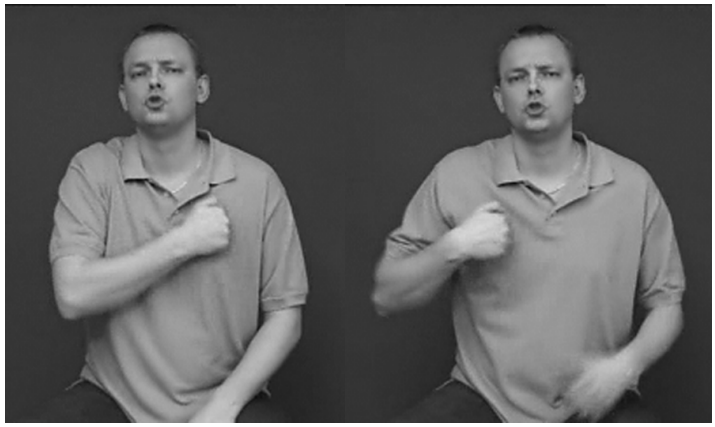

*Figure 18: st **y** relse ('board')*

*Figure19: **me** dle **m** ('member')*

CONCLUSION

In conclusion, we have shown that it is possible to describe mouthl components with a restricted number of segments. Thus, the mouth components of the symbols in Swedish Sign Language are characterized by a hierarchical structure similar to that found in manual components of signs and in the words of spoken languages. Our present data consist of 120 lexemes with mouth components, but since the same mouth component may be used in more than one lexeme, the total number of components is less: 32 components (listed in Appendix), plus tongue and air variants. The mouth components consist of combinations of 10 different segment types, and they in turn can be described with a smaller set of distinctive features. We have also demonstrated how borrowed mouth movements seem to be reconstructed according to the pattern of the native, mouth components.

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APPENDIX
OVERVIEW OF MOUTH COMPONENTS

Monosegmental Mouth Components

-open

/BILABIAL/
/CHEEKS/

+open

/STRETCHED/
/FORWARD/ (Fig. 16)
/ROUND/
/PURSED/ (Fig. 15)
/OPEN/

Bisegmental Mouth Components

-open, +open

/BILABIAL, STRETCHED/ (Fig. 7)
/BILABIAL, FORWARD/ (Fig. 8)
/BILABIAL, ROUND/ (Fig. 3)
/BILABIAL, OPEN/ (Fig. 10)
/BILABIAL, AIRSTREAM/
/BILABIAL, TONGUE/
/LABIODENTAL, ROUND/
/LABIODENTAL, FORWARD/
/LABIODENTAL, OPEN/
/LABIODENTAL, TONGUE/

+open, -open

/FORWARD, BILABIAL/
/FORWARD, LABIODENTAL/
/OPEN, CHEEKS/
/OPEN, LABIODENTAL/ (Fig. 2)
/OPEN, BILABIAL/ (Fig. 4)

+open, +open

/STRETCHED, PURSED/

+open, +open

/STRETCHED, PURSED/
/ STRETCHED, OPEN /
/OPEN, STRETCHED/
/OPEN, PURSED/
/OPEN, TONGUE/ (Fig. 5)

Trisegmental Mouth Components

-open, +open, -open

/BILABIAL, ROUND, LABIODENTAL/
/BILABIAL, OPEN, LABIODENTAL/ (Fig. 6)

+open, -open, +open

/OPEN, CHEEKS, AIRSTREAM/

Reduplicated Bisegmental Mouth Components

open, +open, -open, +open (Fig. 1)

/BILABIAL, STRETCHED, BILABIAL, STRETCHED/

+open, +open, +open, +open

/OPEN, STRETCHED, OPEN, STRETCHED/