

Alignment of two languages: The spreading of mouthings in Sign Language of the Netherlands

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Abstract

Mouthings and mouth gestures are omnipresent in Sign Language of the Netherlands (NGT). Mouthings in NGT are mouth actions that have their origin in spoken Dutch, and are usually time aligned with the signs they co-occur with. Frequently, however, they spread over one or more adjacent signs, so that one mouthing co-occurs with multiple manual signs. We conducted a corpus study to explore how frequently this occurs in NGT and whether there is any sociolinguistic variation in the use of spreading. Further, we looked at the circumstances under which spreading occurs. Answers to these questions may give us insight into the prosodic structure of sign languages. We investigated a sample of the Corpus NGT containing 5929 mouthings by 46 participants. We found that spreading over an adjacent sign is independent of social factors. Further, mouthings that spread are longer than non-spreading mouthings, whether measured in syllables or in milliseconds. By using a relatively large amount of natural data, we succeeded in gaining more insight into the way mouth actions are utilised in sign languages.

Keywords

Sign Language of the Netherlands, NGT, mouthing, prosody, corpus linguistics, bimodalism

Introduction

Sign languages are the principal means of communication in deaf communities. However, since they grow up in a hearing world, virtually all deaf signers are functionally bilingual: they have sufficient command of both their signed language and the surrounding spoken language for at least

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daily communication (cf. Ann, 2001; Lucas & Valli, 1992). There are abundant examples of communities that mostly consist of bilingual speakers (Grosjean, 2010), including minority languages that only have bilingual speakers. Speakers of smaller languages are likely to also know a majority language (de Swaan, 2001). This is in fact what we see in deaf communities, where there is not a single situation in the world where sign language forms the dominant language; see Hiddinga and Crasborn (2011) for a discussion of the global situation of sign languages.

For the present generation of adult deaf signers in western countries, sign language is typically acquired informally from peers in school situations. Only a small minority of deaf people acquire their sign language from signing deaf parents, siblings, or deaf people in their extended family (Mitchell & Karchmer, 2004). Spoken language, by contrast, has typically been taught formally in school programmes to all generations alive today. Deaf education throughout the 20th century has seen a major focus on acquiring spoken language skills, which only in the last two decades has shown a slowly growing attention for sign language as a language of interaction between teachers and children, as a language of instruction, and as a subject language (Rietveld-van Wingerden & Tijsseling, 2010). Outside the western world, there is more variation in the impact of school settings on the acquisition of spoken language, with in certain cases no education for deaf children at all (Zeshan & de Vos, 2012). The most pronounced examples of these situations are ‘deaf villages’ such as those in Bali (de Vos, 2012) where nearly all deaf people are monolingual signers, while a significant part of the hearing population is fluent in both the spoken and the sign language of the village. Martha’s Vineyard (Groce, 1985) is a comparable case; see Nyst (2012) for an overview of such communities around the world.

There has recently been increasing attention for the resulting ‘bimodal bilingualism’, the combined knowledge of a spoken and a signed language, especially in the psycholinguistic literature (Emmorey, Borinstein, & Thompson, 2005; Emmorey, Luk, Pyers, & Bialystok, 2008; Hermans, Ormel, & Knoors, 2010). While we tend to think first of all of deaf people as bimodal bilingual, there are substantial numbers of hearing people that acquire a signed and a spoken language from birth: both hearing children of deaf adults (‘CODAs’) and hearing siblings of deaf children in signing families with hearing parents can be considered fully bimodal bilingual, as they have full exposure to both the signed and the spoken language from an early age. Studies on language production of CODAs have shown there to be code-mixing phenomena of the same type as observed in spoken languages (Emmorey et al., 2005).

As a result of the bilingual nature of western deaf communities, spoken language items found their way into signers’ communication. In spontaneous signing in Sign Language of the Netherlands (*Nederlandse Gebarentaal*, NGT), signs are usually accompanied by either mouthings or mouth gestures (e.g. Boyes Braem & Sutton-Spence, 2001; Crasborn, van der Kooij, Waters, Woll, & Mesch, 2008; Schermer, 1990; Vogt-Svendsen, 2001). Mouthings are silently articulated words, or parts of words, originally stemming from the surrounding spoken language. They are, presumably, lexically bound to the manual part of the sign, since they are in general temporally aligned and share the meaning with the manual sign (Bank, Crasborn, & van Hout, 2011; Sutton-Spence, 2007). Mouth gestures are all other linguistically relevant mouth movements that occur with signs. Among the various functions of mouth gestures are adverbial or adjectival functions (such as puffed cheeks with the NGT sign *HOUSE* to indicate the big size of that house), they can enact the manual sign (such as a chewing movement with the sign *CHEW*), they can be part of a facial expression (such as an open mouth in a surprised look), or they can add to the phonological well-formedness of the sign (such as the pursed lips with the sign for *BE-PRESENT*, cf. Vogt-Svendsen (2001) on Norwegian Sign Language, or Woll (2001) on British Sign Language (BSL)).¹



Figure 1. Selection of video frames illustrating the simultaneous signing of DOCTOR GO with the single mouthing 'dokter'.

Manual: DOCTOR _____ GO _____
 Mouth: d _____ o _____ (k)t _____ e _____ (r) _____
 Meaning: 'I go/went to the doctor'

Schermer (1985) said that 'the existence of a pure sign language, without the occurrence of any speech, among deaf adults, is more or less a theoretical construct' (p. 288). The exact linguistic status of mouthings, however, is a source of ongoing debate. Various contributions to Boyes Braem and Sutton-Spence (2001), such as Ebbinghaus and Heßmann (2001), Hohenberger and Happ (2001) and Keller (2001), illustrate the different viewpoints, ranging from mouthings as parts of multichannel signs to mouthings as a totally independent channel. Indeed, Vinson, Thompson, Skinner, Fox, and Vigliocco (2010) found different error patterns for hand and mouth in a word-translation task and a picture-naming task. This suggests that, on a lexico-semantic level, the manual components and mouthings have separate representations for lexical signs. Thus, the combination of signs with mouthings can be characterised as code-blending (Emmorey et al., 2005), the simultaneous articulation of manual signs and spoken words.

Schermer (1985) predicted 'that the role of speech in spontaneous [signing] will decrease in the future' (p. 286) as a result of the decreasing influence of the oral tradition in the schools for the deaf. While we do not know if Schermer's prediction has indeed come true, mouthings are still ubiquitous in NGT nowadays (Bank et al., 2011).

Importantly, mouth actions usually have roughly the same timing as the sign they occur with, and can thus be said to accompany manual signs. As previous research on highly frequent NGT signs has shown, these signs are not exclusively accompanied by either a mouth gesture or a mouthing (Bank et al., 2011). Signs vary in the way they co-occur with mouth actions, sometimes occurring with a mouth gesture, sometimes with a mouthing, and occasionally with no mouth action at all.

An interesting phenomenon is the loose character of the 'lexically boundedness' of mouthings. Bank et al. (2011) found that for most highly frequent signs there was at least one instance where a sign co-occurred with a mouthing related to the previous sign. In other words, the mouthing of the previous sign has spread over the next sign. In Figure 1, the signer says that she went to a doctor. The sign glossed as DOCTOR co-occurs with the onset of the mouthing *dokter* ('doctor'), and the following sign GO co-occurs with the rest of the mouthing *dokter*. There is no room for a mouth action to exclusively accompany the sign GO.

Spreading of mouthings has been described before by, among others, Boyes Braem (2001) for Swiss German Sign Language, Sutton-Spence (2007) for BSL, and Crasborn, van der Kooij et al. (2008), who describe spreading in NGT, BSL and Swedish Sign Language (SSL). For NGT (as well as for BSL and SSL), they found that the majority of spreading mouth actions spread rightward (progressively) over only one additional sign. Occasionally, mouth actions would spread over more than one sign, or spread leftward (regressively), but such cases were rare. Spreading mostly occurred over a pointing sign [PT, plural: PTS], a prosodically light element that often does not have an autonomous movement unit (Crasborn, van der Kooij et al., 2008, p. 62). This lack of inherent movement makes them easily absorbed by prosodically heavier signs (i.e. that have extensive specifications for location, movement and orientation), or in other words, they become clitics connected to the following or preceding sign. In her analysis of Israeli Sign Language (ISL), Sandler (1999) proposes the

existence of the prosodic word as a constituent of ISL. The spreading of mouthings over adjacent signs is one of the pieces of evidence she uses to support the claim that a lexical sign and the following pronoun should be regarded as one prosodic constituent. Boyes Braem (2001) found that early learners use spreadings ('stretched mouthings' in her words, p. 106ff) more frequently than late learners, and distinguishes three prosodic functions of spreadings: to bind constituents of noun phrases, to bind verbs with subjects and to bind larger prosodic units.

The data described in Crasborn, van der Kooij et al. (2008) are based on a limited number of participants (two signers per language) signing stories to a camera. The current paper will build on their research. We will replicate the Crasborn, van der Kooij et al. (2008) study, with a much larger corpus of 46 participants (age range: 17–82), in an everyday language use setting. Further, to make full use of the size of our corpus, we will take region, gender, and age into account in our analysis. Whether any of these sociolinguistic variables has any effect on the way NGT is used has not been thoroughly studied to date. We know that there are some regional lexical differences between the Groningen and Amsterdam dialects of NGT, but it will be interesting to investigate if these signers also make different prosodic choices in their everyday signing. Further, with the wide age of signers range available to us in the corpus, we will be able to look at changes over age groups. If the prosodic structure of NGT has changed over the last few decades, we may expect this to turn up as differences between the age groups.

We will explore the following research questions. The first main question we will address is to what extent we find spreading of mouthings over neighbouring signs in conversational NGT. We will compare our results from a 46 signer corpus to the Crasborn, van der Kooij et al. (2008) study that was done with two signers. Given the size of our corpus, we will address two additional questions related to the background characteristics of the learners and spreading: first, are there any region-, age- or gender-specific differences in spreading behaviour? And second, do early learners show the same spreading patterns as late(r) learners?

The second main question relates to the timing of spreading. Is there a preference for mouthings to spread over prosodically light elements like clitics, or does it occur over heavier elements as well? A preference for light elements would indicate that spreading is not merely an articulatory coincidence, where multi-syllable mouthings push themselves over the sign boundary to spread over the next sign, but a prosodic strategy to create single prosodic words composed of content words and functional elements (Sandler, 1999).

We will use the Corpus NGT (Crasborn & Zwitserlood, 2008a; Crasborn, Zwitserlood, & Ros, 2008) and analyse natural language use to find the answers to these questions. The next section will provide more information on this corpus and on our methodology.

Methodology

The Corpus NGT

The Corpus NGT was recorded from 2006 to 2008, and contains data from all five regions in the Netherlands where deaf schools are located (Amsterdam, Groningen, Rotterdam, Voorburg and Sint-Michielsgestel). The corpus spans 72 hours of video of 92 signers, recorded in pairs. For the recording of the corpus, participants were selected on signing skill; all had followed secondary education and completed exams in spoken Dutch. All participants were prelingually deaf and started using NGT before the age of four. They were asked to perform tasks like retelling narratives based on cartoons, comic stories and signed fable stories, as well as engaging in (semi-)spontaneous conversation and discussion of topics regarding deafness and sign language issues (Crasborn & Zwitserlood, 2008a).

Table 1. Frequencies of mouth actions and mouthings, both in Sample 1 and Sample 2.

	Sample 1 frequency	Sample 2 frequency
Mouth actions	7979	4806
Mouthings	5929	3447

Over the last few years, gloss annotations for manual signs have been added to the video recordings for different kinds of projects, with an emphasis on the Amsterdam and Groningen regions. Consequently, for the Amsterdam and Groningen regions, more manual data is available for mouth annotations to be based upon.

As for the annotation of mouth actions, a firm first step was set by Van de Sande and Crasborn (2009) with the full annotation of 16 clips, again mostly (but not exclusively) by Amsterdam and Groningen signers. Bank et al. (2011) focused on the 20 most frequent lexical signs of the Amsterdam/Groningen part of the corpus, such as SCHOOL, DEAF and HEARING. Annotations were made throughout this part of the corpus for those frequent signs, including a few adjacent signs. While this was considered the best method for data collection for that study, it resulted in annotations being scattered throughout the Amsterdam/Groningen part of the corpus. Other small projects on the mouth, such as a study on homonyms, added more isolated annotations. For the current paper, to fill up some of the gaps between any scattered annotations, additional annotations of all occurring mouth actions were made between isolated annotations, in order to create longer continuous stretches of mouth annotations.

In all, there are 219 clips containing mouth annotations for the Amsterdam/Groningen part of the corpus, some fully annotated, others containing shorter stretches of annotations or even only a few isolated ones. Initially, we made two sets of data for this paper. Sample 1 contained all available mouth annotations from all 219 clips, both isolated mouthings and continuously annotated stretches. The proportion of mouth annotations for highly frequent signs and for homonyms was relatively high in this sample, for reasons explained above. In order to prevent possible strange outcomes, we therefore created Sample 2, a subset of the Sample 1. Sample 2 contained only the data from the 42 fully annotated clips, and was therefore a more balanced sample. In using Sample 2, any irregularities that may have been caused by annotation choices made in previous projects would be cancelled out. Table 1 gives the number of mouthings for both samples.

The differences between Sample 1 and Sample 2, however, turned out to be marginal. There were no significant differences in spreading between Sample 1 and 2, either for progressive or for regressive spreading. Calculations on scope and on spreading over PTS (see sections ‘Scope of spreading’ and ‘Spreading over pointing signs’) on any of the sociolinguistic variables that we explored did not reveal any significant differences either. We therefore concluded that it is safe to only use Sample 1 for the current study and benefit from the larger numbers in that sample.

Participants

The signers from the Amsterdam and Groningen regions account for over half of the entire corpus (50 signers out of a total of 92). As explained above, the largest number of manual glosses is available for this group. Therefore, for the current study we concentrated on this subset of the Corpus NGT. With these 50 signers, we have 219 short video clips fully annotated for manual signs and (partly) annotated for mouth actions. It turned out that for four signers there were no annotated mouth actions, leaving us with 46 participants.

Table 2. Breakdown into age groups and gender (M=male, F=female) and number of participants with deaf parent(s), for all participants and for the subset of native signers.

Age range	All participants (M/F)	Native signers (M/F)
Younger (range 17–30, mean 23)	13 (7/6)	3 (1/2)
Middle (range 31–60, mean 43)	21 (7/14)	7 (5/2)
Older (range 61–82, mean 69)	12 (6/6)	3 (1/2)
All (range 17–82, mean 44)	46 (20/26)	13 (7/6)

When reporting on effects of language learning, usually the Age of Acquisition (AoA) is reported. In the present case, the AoA was self-reported by the signers by means of a questionnaire that the participants had to fill out when the video recordings of the Corpus NGT were made. Since fluent sign language acquisition is dependent on many factors, we felt that AoA, being self-reported, would not truly reflect a signer's sign language skills. Therefore, following Lucas, Bayley, and Valli (2001), we chose a division that was based upon the hearing status of the signer's parents. This serves as a good rough marker for AoA: if at least one of the parents was deaf, the participant would have sign language input from birth, from an experienced (not necessarily native) signer, and could hence be considered a true L1-learner. Thirteen out of 46 signers (28%) had at least one deaf parent: 12 had two deaf parents, one had a deaf mother and a hearing father. In this paper, we will refer to these signers as native signers, vs. non-native signers who were born from two hearing parents. The signers we here consider as non-natives learned NGT from their peers and teachers at deaf schools, starting from four years and one month of age, on average.

Table 2 provides a breakdown into gender and three age ranges, for all participants vs. the subset of native signers.

Data

Annotating the Corpus NGT is an ongoing process, for all aspects of the sign stream. We used the ELAN annotation software (Wittenburg, Brugman, Russel, Klassmann, & Sloetjes, 2006) to annotate the mouth actions. Signs had been annotated following the guidelines in Crasborn and Zwitserlood (2008b), and the mouth annotation guidelines were adapted from those: signs and mouthings start on the first video frame where the hands or mouth start moving towards the target articulation, and they end on the frame before the movement towards the next target articulation (or neutral position) begins. In case the end of a mouthing had the same form as the start of the following mouth action (or neutral state, such as /m/ followed by closed lips), the mouthing would end on the frame where that following articulation (or neutral position) is started. Mouth annotations were made on four tiers for each signer, as explained in Table 3.

A mouthing was understood to spread over a neighbouring sign if it continued to be present for at least 50% of that neighbouring sign's duration. The sign that is the source of the mouthing is the sign that has the closest semantic relation with that mouthing (usually a standard mouthing, see Bank et al., 2011). If the source sign was two-handed and both the non-dominant hand and the mouthing spread over a one-handed target sign, this would still be considered spreading of the mouth action, although the spreading of the non-dominant hand may phonetically be more prominent. When calculating the length of the source sign (see section titled 'Length of signs') in such cases, the length of the annotation of the dominant hand was taken.

Table 3. Tier description for annotation of mouth actions in the Corpus NGT. Child tiers inherit temporal alignment from the main tier.

Tier name	Description
Mouth (<i>main tier</i>)	Main annotation tier for mouth actions. In case of mouthings, the observed (interpreted) Dutch word that is mouthed is inserted here, including any inflection and/or temporal reduction.
MouthType (<i>child of Mouth</i>)	Tier for the classification of the mouth action as mouthing (M) or mouth gesture (A for adverbial/adjective, E for empty, 4 for mouth-for-mouth, W for whole face, see Crasborn, van der Kooij et al., 2008).
MouthLemma (<i>child of Mouth</i>)	Tier for the dictionary version of a mouthing, i.e. the unreduced, uninflected perceived intended meaning.
MouthSpreading (<i>child of Mouth</i>)	Tier for the marking of spreading phenomena. Annotations list the signs co-occurring with the mouthing and the direction of spreading.

Annotations on the MouthSpreading tier were made in the form of [originating sign >> next sign] or [previous sign << originating sign] to indicate progressive vs. regressive spreading, respectively. In cases where spreading would occur over more than one sign, the annotation would be extended with [... >> next sign] (or, in case of regressive spreading, [previous sign << ...]).

After initial analysis of the data, we wanted to know if there would be any differences between spreading occurring over PTS and spreading over non-pointing signs, because of the prosodic lightness of PTS (Crasborn, van der Kooij, & Ros, 2012; Sandler, 1999). This analysis showed that roughly a third of all PTS occurred with their own mouthing, not spreading from another sign. Since PTS in pronominal or demonstrative use only occasionally occur with their own mouthings (because their referents are usually present or become clear from the context (Sutton-Spence & Day, 2001)), we looked up all of these occurrences to see which mouthings were used with these PTS. It turned out that 28% of the tokens were false positives: PTS that seemed to occur with their own mouthing, but that were in fact overlapping with one or two frames of a mouth action from an adjacent sign. They were not annotated as 'spreading' because the overlaps were too short for that (i.e. less than 50% of the PT's duration).

Finally, one of the things we wanted to know was if there is something in the mouthings that makes them spread. Are they longer than other mouthings? Or are the signs they occur with very short? Unfortunately, we do not have phonetic information of the signs (like path of movement, length of hold or sign-internal repetition). But we did transcribe mouthings as how they were pronounced, so we know how many syllables there are in a mouthing. We did this quick and dirty, and defined a syllable as any vowel or string of vowels that is preceded or followed by either a word boundary or a consonant. The section 'Length of spreadings' will present the results for the length of mouthings. The section 'Length of signs' will present the results on the length of the signs that are the source of the mouthings that spread over the next or previous sign.

Results on direction and scope

At the time of data selection for the current study (i.e. after additional annotation work), there were 7979 mouth actions in our sample, including 5929 mouthings (74.3%). Of all these mouthings, 810 (13.7%) spread over one or more neighbouring signs. This percentage on spreading is based on the total number of spreadings in comparison to the total number of mouthings, not taking into account that some signers may contribute more to the average than others. The average of all individual

Table 4. Number of annotations for mouth actions, mouthings and spreading: overall, per gender, per region, per age group, per having deaf parents or not, and per register.

	Mouth actions	Mouthings	Spreadings
Total number	7979	5929	810
Male / female	3887 / 4092	2735 / 3194	342 / 468
Amsterdam / Groningen	2909 / 5070	2182 / 3747	331 / 479
Younger / middle / older	1983 / 3125 / 2871	1462 / 2214 / 2253	194 / 324 / 292
Native / non-native	2774 / 5205	2063 / 3866	289 / 521
Conversational / narrative	6552 / 1427	5223 / 706	711 / 99

Table 5. Frequencies and percentages for direction of spreading. Percentages on the right side are relative to spreading.

	Frequency	Percentage	
Mouthings	5929	100%	
Spreadings	810	13.7%	100%
Progressive spreading	762		94.1%
Regressive spreading	42		5.2%
Outward spreading	6		0.7%

ratios (mouthings compared to spreading) is 13.8%, ranging from 0% to 22.7%. We will report below on possible influences of region, age, gender or nativeness.

There are a few more annotations for female signers than for male signers, reflecting the larger number of females in the sample. The same applies to signers from the Groningen area compared to the Amsterdam area. Table 4 summarises the results, and also reports on the numbers of annotations per gender and nativeness. Further, frequencies for register (conversational or narrative) are given as well, although we did not investigate this further. Please note that the number of mouthings is a subset of the number of mouth actions, and that the number of spreadings is in turn a subset of the number of mouthings, as explained above.

Direction of spreading

Our sample contains 810 spreading mouthings. The majority of these mouthings (762, 94.1%) spread rightwards (progressive), while only a small number spread leftwards (regressive) (42, 5.2%). The remaining six mouthings (0.7%) spread from one of the middle ones of multiple signs. Although the 42 leftward spreadings take up only 5.2% of all spreadings, it is by no means an idiosyncratic process: 24 of the 46 signers do it sometimes. Table 5 summarises the spreading behaviour of all subjects.

We performed a mixed model analysis on the sample data (random intercept model, with signers as a random effect) with a logit link function on the frequency of occurrence of spreadings and on the direction of these spreadings (SPSS 19, mixed models). We investigated whether age (in three age groups), region (Amsterdam, Groningen), gender and being a native signer (i.e. having at least one deaf parent, see section ‘Participants’) had an effect on the frequency of occurrence, but none of these variables had a significant impact. Variation in frequency of regressive spreading seems to be bound primarily by individual differences. The number of regressive

Table 6. Frequencies and percentages for spreading over multiple signs.

	Frequency	Percentage
Mouthings	5929	
Spreadings	810	100%
Spreading over 1 adjacent sign	761	94.0%
Spreading over 2 adjacent signs	45	5.6%
Spreading over 3/4/5 adjacent signs	4	0.5%

Table 7. Frequencies and percentages for spreading over PTs. Percentages on the right side are relative to spreading over any PT.

	Frequency	Percentage	
Mouthings	5929		
Spreadings	810	100%	
Spreading over any PT	472	58.3%	100%
Progressive spreading over 1 sign that is a PT	403		85.4%
Regressive spreading over 1 sign that is a PT	32		6.8%
Spreading over multiple signs, including any PTs	37		7.8%

PT: pointing sign.

spreadings is moderately correlated to the number of spreadings at the signer level ($r = .481$, $N = 46$, $p = .001$). This may indicate that other factors play a role, but it seems safer to conclude that regressive spreadings are not only rather infrequent, but that the variation in frequency is largely a signer-bound phenomenon.

Scope of spreading

Most often, mouthings spread over only the immediately adjacent sign. This happened in 761 cases (94.0% of all spreadings). But just as Crasborn, van der Kooij et al. (2008) found, there is also spreading over more than one adjacent sign, although this does not happen frequently. There are 45 occurrences (5.6%) of mouthings spreading over two signs, the pooled number of spreadings over three, four or five signs is four (0.5%). Once again, spreading over more than one sign is not idiosyncratic: it is done by 23 signers. Table 6 summarises the results.

The number of multi-sign spreadings is highly correlated to the number of spreadings at the signer level ($r = .842$, $N = 46$, $p = .000$). More spreadings means more multi-sign spreadings, which applies to all signers. Given this strong relation, it is evident that no effects were found for age, region, gender or being a native signer on the occurrence of multiple-sign spreadings (mixed models analysis).

Spreading over pointing signs

The majority of spreading mouthings occur over PTs. These are typically pronouns, but can have various functions such as possessive, demonstrative or locative. Of all mouthings that spread, 472 (58.3%) do so over a PT. Table 7 summarises the results.

The number of spreadings over any PT is very highly correlated to the number of spreadings at the signer level ($r = .932$, $N = 46$, $p = .000$). More spreadings means more spreadings over PTS, which applies to all signers. Given this strong relation, it is evident that no effects were found for age, region, gender or being a native signer on the occurrence of spreadings over PTS (mixed models analysis).

Regressive spreading at the sign level

Now that we have determined the basic spreading behaviour of mouthings, we will take a short closer look at regressive spreading. We examined the 42 left-spreading mouthings in our sample, to see if there is anything they have in common. We found no distinctive pattern in regressive spreading. Source signs include verbs, nouns, adverbs and adjectives, as well as ordinals and interjections. Out of these 42 mouthings, 33 (79%) spread over a PT (including *THERE*). Regressive spreading appears to occur mainly over PTS, but there are a few other cases that have to be accounted for. Lacking evidence for a more specific explanation, we keep open the possibility that leftward spreadings are merely errors in production planning.

Results on the relative length of spreadings

Now that we have established that age, gender, region or having a deaf parent are not factors that can help us in understanding the spreading behaviour of mouthings, we want to test one specific hypothesis on the reason for spreading, namely that the length of the manual or mouthed units is somehow involved. First we will report on the length of the mouth part, both in milliseconds and in number of syllables (section 'Length of spreadings'), then we investigate the length of the sign part (section 'Length of signs').

Length of spreadings

The average length of a mouthing that does not spread over an adjacent sign is 462 ms, and contains 1.36 syllables (both milliseconds and syllables are averaged over the average lengths per speaker). Mouthings that do spread over adjacent signs have an average length of 673 ms and 1.64 syllables (again, averaged over the average lengths per speaker). A *t*-test for paired samples shows that this difference is significant both for milliseconds and number of syllables: $t(44) = 15.075$, $p < .000$ with spreadings being longer in milliseconds, and $t(44) = 6.056$, $p < .000$ with spreading mouthings having more syllables than non-spreading mouthings. (The *t*-tests were conducted excluding the one signer who did not spread any mouthings, and therefore had no average spreading.)

In the whole sample of 5929 mouthings there are 3901 (65.8%) mouthings that consist of only one syllable, such as *naam* 'name' or *doof* 'deaf'. This includes mouthings that are inflected for number (such as *vraag(t)* 'ask' or *weet* 'know' for singular) and mouthings that have undergone temporal reduction, such as *dok* from *dokter* 'doctor' or *groom* from *Groningen*, a Dutch city. Temporal reduction is also found in longer spreadings, such as *vresel* from *vreselijk* 'terrible' or *slechtho* from *slechthorend* 'hard-of-hearing'.

In the spreading part of the sample, 444 out of 810 mouthings (54.8%) consist of one syllable. So while we do find that spreadings on average contain significantly more syllables, a small majority of spreadings still consist of only one syllable. The number of syllables, therefore, cannot explain why mouthings spread, because that would leave the large number of one-syllable

spreading unexplained. Further, just as for spreading over multiple signs and regressive spreading, we did not find any salient differences between the set of Dutch words that occur as non-spreading mouthings and the set of words that occur as spreadings (i.e. there are no inherent features of the Dutch words that cause them to spread). In the following section we will consider another possible explanation for the occurrence of spreadings, namely the length of the source signs.

Length of signs

If mouthings are not particularly long when they spread, is it perhaps the case that the source sign of a mouthing is particularly short, causing the mouthing to overflow to the next manual item? To answer this question, it is necessary to establish the source sign of each mouthing. The Corpus NGT is organised so that annotations for each articulator are independently time-aligned with the video, on different tiers in the ELAN annotation file. Therefore, it is difficult to establish the mutual relations between articulators – in other words, there is no immediate and unequivocal way we can filter out the manual sign that is the source sign for a mouthing. We established the source signs of spreading mouthings by finding all left and right hand gloss annotations that overlapped spreading mouthing annotations, and then took the first gloss on the manual tier as the source sign (or the last gloss on the manual tier in case of regressive spreading). The average length of the signs that are the source of mouthings that spread is 275 ms.

To compare this with the average length of a sign that comes with a mouthing is not a straightforward task. The easiest comparison to make is with the average length of a gloss annotation. In our sample this is 398 ms, but this includes all glosses, also those of signs that do not co-occur with a mouthing or a mouth gesture. And as signs are sometimes held for many seconds, that number may be unrealistically high. Ideally, we would like to compare the average length of a source sign with the average length of a sign that co-occurs with a non-spreading mouthing. But when we extract the latter from our corpus, we get numerous false positives of mouthings that originate in neighbouring signs but overlap with signs that do not have their own mouthing. Since this overlap is only for one or two videoframes the mouthings do not actually spread over that sign (just as in the section ‘Data’), rendering a false positive. The solution was to only include signs that occurred with a mouthing having the same annotation value as that sign. This way SCHOOL with the mouthing *school* was included, as was DEAF (annotated in our corpus as DOOF) with *doof* ‘deaf’. By consequence, mismatching sign/mouthing combinations like THERE with the mouthing *Amsterdam*, or GROUP with the mouthing *klas* ‘class’, were excluded. This leaves us with 2643 signs: 1966 signs with a non-spreading mouthing, and 677 signs with a spreading mouthing. Averaged over average length per signer, the signs that occur with non-spreading mouthings are 347 ms in length, and the signs that occur with mouthings that spread over adjacent signs are 282 ms in length, significantly shorter: $t(44) = 5.393, p < .000$ with source signs of spreadings being shorter than signs co-occurring with non-spreading mouthings.

Discussion

Direction and scope of spreadings

First, we will compare the numbers of mouthings we found compared to the total number of mouth actions in our corpus: we found 5929 mouthings on a total of 7979 mouth actions, or 74% of all mouth actions. This sharply contrasts with the NGT data in Crasborn, van der Kooij et al. (2008), who found that only 39% of their mouth actions consisted of mouthings. The most likely reason for

this is that they only used a narrative register, whereas we used a mixture of narrative and conversational registers. Due to the history of our annotation work, there is an emphasis on the conversational register in our sample (88%, against 12% in a narrative register). As Van de Sande and Crasborn (2009) suggested, register is a significant factor in the use of various types of mouth actions. Mouth gestures often have an expressive quality, and may more easily be yielded in storytelling (and thus a narrative register), whereas mouthings are often informative, and thus more suited for interaction (see also Ebbinghaus & Heßmann, 2001).

The first question we posed was to what extent we find spreading of mouthings over neighbouring signs in NGT. We found that the general conclusion of Crasborn, van der Kooij et al. (2008) holds for the much larger data set from the Corpus NGT we investigated: spreadings are produced by the large majority of the 46 signers in our sample, it is essentially a rightward phenomenon and usually spans one adjacent sign. The extent to which we found spreadings is similar to that in Crasborn, van der Kooij et al. (2008). In percentages, they found between 9.8% and 14.4% spreadings (dependent on age and register) where we found 13.7%. It is thus clear that spreading is fundamental to everyday sign language use in NGT, and not restricted to an occasional signer using a particular register.

We then investigated the frequencies of occurrence, direction and scope of spreading, and the inclusion of PTS. We found that all phenomena are omnipresent in the data, also on the level of the individual signer. Leftward spreading or spreading over multiple signs is by no means an idiosyncratic phenomenon. No effects were found for age, region, gender or being a native signer. The variation between the individual signers is substantial: the percentage of spreadings varies between 0% (the one signer for whom only 19 mouth actions were annotated) and 22.7%. Given this variability, it is possible that an effect for specific social and/or other variables will be found in a (much) larger sample of signers, but given our results it seems safe to conclude that these effects will not be substantial.

Summing up, we found no obvious sociolinguistic factors that can explain why mouthings spread as they do. All signers use mouthings, and all signers spread a portion of those over one or more adjacent signs, with a small proportion (5%) spreading regressively so that a mouthing starts at a moment when the hands are still busy with another sign. The variation in frequency is largely a signer-bound phenomenon.

Spreading over PT and relative length of spreadings

The second main question related to the timing of spreadings. Is there a preference for mouthings to spread over prosodically light elements like clitics, or does it occur over heavier elements as well? We found that 58% of all spreadings do so over a PT, and that there is a very high correlation between spreading in general on the one hand, and spreading over PTS on the other.

PTS are an easy target for mouthings to spread over, because they do not have lexical content themselves. As Sutton-Spence (2007, p. 152) put it: ‘Deictic pronouns have no need for a mouthing to specify their meaning, because the referent is either present during the utterance or has been identified in the previous sign’. On the other hand, it is possible that mouthings may put an unwanted emphasis on the meaning of a sign. A point towards a third person who is present could mean ‘John over there’. Without a mouthing, a signer knows what it means, but adding a mouthing like ‘John’ or ‘there’ might emphasise a part of the meaning a bit and thus have the unintended effect of altering the communicative intent.

Finally, we wanted to know if spreading would be merely an articulatory coincidence, a problem in aligning articulations of different lengths, where longer mouthings may push themselves over the end boundary of a short sign to spread over the next sign. Mouthings that spread over

adjacent signs turned out to be significantly longer than mouthings that did not, both when measured in syllables as well as in milliseconds. But since single-syllable mouthings also frequently spread, syllable length cannot be the only explanation for the spreading behaviour. The length in milliseconds, however, can give us an indication to the possibility of it being one of the factors involved. We found a substantial correlation between the lengths of spreading and non-spreading mouthings on the signer level, meaning that there is a signer-independent relation between the length of non-spreading mouthings and the length of spreading mouthings. The important conclusion here is that, on average, spreading mouthings do take up more time than non-spreading mouthings. The question remains: does this happen because the signs are short, or because the mouthings are long? In other words: are mouthings altered to match the hands, making the hands the head of the mouth (Boyes Braem & Sutton Spence, 2001)? We have not looked in detail at the Dutch words that spread over adjacent signs, but we have no reason to believe that they are different from non-spreading mouthings. Although we do not have detailed numbers as yet, there are numerous examples in our data set of Dutch words that appear both in spreading mouthings as in non-spreading mouthings. Taken together, these findings suggest that spreading mouthings are not incidents of motor planning of different articulators. This leaves open the possibility that indeed spreading mouthings serve to demarcate short prosodic domains, tying together manual signs that morpho-syntactically belong together, just as Sandler (1999) first proposed for ISL.

Conclusion

We replicated the results of Crasborn, van der Kooij et al. (2008) with a much larger corpus of 46 participants in an everyday language use setting. We found that both the use of mouthings and the spreading of mouthings over adjacent signs are not idiosyncratic phenomena: all signers do it, in all sorts of combinations of signs and mouthings. Clearly, it is a fundamental characteristic of everyday sign language use in NGT. Spreading mouthings are not accidental. In a corpus study like the present one, one is dependent on the corpus metadata to be able to discover patterns that are related to properties such as age of acquisition. For the Corpus NGT, limited information was available on the details of language development for each signer, for both the signed and the spoken language. The available information on deafness in the immediate family (see section 'Participants', above) is not necessarily very informative about the relative quantity of language input to the child in the signed and the spoken language. For the creation of new corpora, we recommend this as an important point of attention that may benefit all studies based on the corpus.

Now that we showed the omnipresence of spreading, further research is needed to seek explanations for why spreading occurs. Sandler (1999) proposed the prosodic word as the outcome of a cliticisation process, and found supporting evidence in the spreading of mouthings. Does spreading match other prosodic cues such as spreading of the non-dominant hand? To what extent do the rhythmic structure of both signs and mouthings influence each other? A detailed analysis of the morphosyntactic and prosodic context is needed to provide answers to these questions. Further, psycholinguistic and neurolinguistic studies could involve experiments to clarify the mechanisms underpinning the spreading of mouthings: to what extent are they linked in the mental lexicon and to what extent can they be linked ad hoc in the production of new sentences? A final interesting question is why PTS are sometimes cliticised with the preceding sign and its spreading mouthing, but at other times are pronounced as independent signs, without a mouth action or sometimes even with their own mouthings. Answering this may further clarify the prosodic structure of signed languages and the way a sign language mixes with the surrounding spoken language. Our knowledge about this type of code-mixing will help us to better understand the language acquisition

process of both the signed and the spoken language in bimodal bilinguals, whether in first or second language acquisition (see e.g. van den Bogaerde & Baker, 2008).

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Note

1. All glosses in this paper refer to NGT signs. In our corpus these glosses currently are in Dutch, but in this paper we use English translations. Bilingual annotations will be available in the near future.

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