Do repeated references result in sign reduction?

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Abstract

Previous research has shown that repeated references are often reduced compared to initial references. The present study looks at the production of repeated references by signers of Sign Language of the Netherlands (NGT). Participants had to describe figures to an addressee, who had to pick the correct figure from a large group of figures. Several figures had to be described several times. The question was whether there would be reduction in the signed repeated references, as has been found previously for speech and gesture. We found systematic effects of repetition, in that repeated references are shorter, contain fewer signs, and shorter signs than initial references. Moreover, a perception experiment showed that signs produced during repeated references were also considered to be less precise than the signs produced during initial references.

Keywords sign language; repeated reference; reduction

Introduction

Variability is ubiquitous in speech production, with words never pronounced the exact same way more than once. For example, someone might first pronounce the word 'of course' slowly and precisely, followed by an instance where it is pronounced quickly, less precise and more like 'fcourse'. This example of language variability shows that language can be reduced (in this case by shortening and merging words). While various studies have looked at reduction in speech, reduction in signs remains largely unexplored. The present study addresses this point.

Reduction in spoken repeated references

In conversation, people often produce referring expressions to describe objects in the world around us. The production of repeated references occurs when people refer to the same object more than once in the conversation. Research has found that in speech, these repeated references are often reduced in at least two ways (Aylett & Turk, 2004; Bard, et al., 2000; Brennan & Clark, 1996; Clark & Wilkes-Gibbs, 1986; Fowler, 1988; Fowler & Housum, 1987; Galati & Brennan, 2010; Lam & Watson, 2010). Firstly, repeated references to the same target object usually contain fewer words than initial references (Clark & Wilkes-Gibbs, 1986; Galati & Brennan, 2010). Brennan and Clark (1996) claim that this is due to the fact that people establish so-called conceptual pacts as more common ground is established over the course of the conversation (debated in e.g. Horton & Gerrig, 2005). Secondly, repeated references are often also reduced acoustically (Aylett & Turk, 2004; Bard, et al., 2000; Fowler, 1988; Fowler & Housum, 1987; Lam & Watson, 2010). Repeated references, when taken out of context and presented to a listener, have been found to be less recognisable for the addressee because their pronunciation is less clear in repeated references than in initial references (Bard, et al., 2000; Galati & Brennan, 2010). Lieberman (1963) found similar acoustic reduction for redundant words, which were shorter and perceived as less intelligible when taken out of context.

There are two dominant views on the reason why referring expressions may be reduced. On the one hand, reduction in referring expressions may be due to speaker oriented causes, such as production and planning processes (Arnold, 2008; Arnold, Kahn, & Pancani, 2012; Bard, et al., 2000; Bard & Aylett, 2005; Ferreira, 2008). On the other hand, reduction in referring expressions may be due to listener oriented causes, such as communicative strategies (e.g. Aylett & Turk, 2004; Fenk-Oczlon, 2001; Lieberman, 1963; Lindblom, 1990; Zipf, 1949). The use of communicative strategies, with speakers as efficient language users, has been shown by a range of studies (for an overview, see Jaeger & Tily, 2011), including Zipf's (1949) Principle of Least Effort, and Shannon's noisy channel model (1948). More recently, Lindblom (1990), in his H&H theory, claims that speakers adapt to the listener's needs, meaning that redundant speech is reduced as long as 'sufficient discriminability' remains. Jaeger (2010) proposed the hypothesis of Uniform Information Density (UID), which states that 'speakers prefer utterances that distribute information uniformly across the signal (information density)' (Jaeger, 2010:25). What this means is that the interaction between speaker and addressee is optimized by the speaker's lengthening or shortening of an utterance, such that the utterance becomes more uniform and optimal for both speaker and addressee.

It can be argued that the reduction in repeated references that previous studies have found is due to the abovementioned processes: when speakers produce repeated references, they fully reproduce those (auditory) aspects of the referring expression that contain important or new

information and are necessary for quick target identification. The less informative aspects of the referring expression may be reduced or omitted, leading to reduced references.

Reduction in visual repeated references: gesture and sign language

Taking into account that communication does not only consist of 'spoken' aspects of speech, but can also contain or consist of visual aspects such as gestures (Kendon, 2004; McNeill, 1992) or signs (Stokoe, 2005), we may wonder whether a reduction process such as described above for spoken repeated references also occurs in the visual domain.

Relevant previous research on gesture has looked at the effect of common ground (Gerwing & Bavelas, 2004; Holler & Wilkin, 2009) and repeated references (de Ruiter, Bangerter, & Dings, 2012; Hoetjes, Koolen, Goudbeek, Krahmer, & Swerts, 2011) on gesture production, albeit with inconclusive results. For example, when we look at repeated references, on the one hand, de Ruiter et al. (2012), when testing their tradeoff hypothesis, found that repetition did not affect gesture rate. On the other hand, Hoetjes et al. (2011) found that both speech and gesture were reduced in repeated references.

There has been a range of research on phonological and phonetic aspects of sign language (Crasborn, 2001; Sandler, 1989; Sandler & Lillo-Martin, 2006; Schembri, et al., 2009; Tyrone & Mauk, 2010), starting with Stokoe (2005) in 1960 proposing that signs in sign languages consist of three main parameters (handshape, location and movement). However, hardly any studies have looked at sign language from the perspective of efficient language use. In this light, it is interesting to see how signs behave with regard to reduction in repeated references. We may wonder what the role of signs is compared to speech and to co-speech gesture. On the one hand, considering that signs, like words, usually convey lexical meaning, it might be the case that reduction in sign is similar to reduction in speech, for example with regard to the semantics that are expressed. On the other hand, signs, unlike words but like co-speech gestures, are a means of communication in the visual domain, and there may be aspects of reduction that are modality specific and thus alike between signs and co-speech gestures. Of course, it could also be the case that signs are not reduced in a way comparable to speech or to co-speech gestures, but that signs, if they are reduced, are reduced in a sign-specific manner.

The only experimental study on sign language we are aware of that can be related to the idea of efficiency of language users in the production of repeated references is the work by Tyrone and Mauk (2010) on phonetic reduction in American Sign Language. In their study, Tyrone and Mauk looked at the production of the sign WONDER in two phonetic contexts and at three signing rates. Their results show that sign lowering occurs with increasing signing rate and can, but not necessarily does, occur in specific phonetic contexts. Another study on variation in sign language, by Schembri and colleagues (2009), looked at naturalistic data and also found that sign location can vary with signs produced at lower locations than their citation form. However, neither of these studies takes repetition into account as one of the factors influencing sign production.

In the present study we will look at signs of Sign Language of the Netherlands (NGT), to see whether reduction in repeated references, as previously found for speech and gesture, also occurs in sign language. Considering that NGT is a fully fledged sign language and presumably behaves in many respects as a spoken language, we hypothesize that, as in speech, reduction in repeated references will occur. The question is of course how reduction in signs can be measured. In the present study we have decided to measure reduction by combining methods that have been used previously in studies on speech and on gesture. We will look at sign characteristics that we consider comparable with some of the aspects of speech that have been studied previously when looking at reduction, namely number of words, utterance duration and word duration. We will also take precision into account, which has been done in previous studies on gesture. Therefore, in the present study on sign language we will look at the number of signs, utterance and sign duration and at sign precision. We conducted a production task to analyse the first three attributes. Following Hoetjes et al. (2011), we conducted a perception task to analyse the last attribute, sign precision.

Production experiment

To study reduction in repeated references in Sign Language of the Netherlands (NGT), a data set was created consisting of recordings of participants taking part in a director-matcher task. In this task, the director had to describe an object in such a way that the matcher could identify the object from a range of similar looking figures. In the stimuli, there were several figures that had to be described more than once, leading to repeated references to the same item.

Participants

The director-matcher task was done by a total of 14 signers of NGT. The group of participants consisted of 5 male and 9 female speakers, with an average age of 46 years old (range 26-60 years old). The average length of time that the participants had been signing NGT was 23.5 years (range 2-50 years). Participants would take part twice in the experiment; first they were randomly assigned the role of either director or matcher and they would switch roles after doing the experiment once.

Stimuli

Two picture grids, each containing 16 pictures, were used by each director. Each picture grid showed either pictures of people, or pictures of furniture items. The two different domains (people and furniture) were used since previous studies on referring expressions had shown them to be efficient domains for making people produce referring expressions (Koolen, Gatt, Goudbeek, & Krahmer, 2011;

Van Deemter, Gatt, van der Sluis, & Power, in press; Van der Sluis & Krahmer, 2007) .

Each picture grid was used for 15 trials, adding up to a total of 30 trials. For the first 15 trials, a people picture grid was used, for the last 15 trials a furniture picture grid was used. Since the participants would do the experiment twice, once in the role of director and once in the role of matcher, two sets of picture grids were used, with different pictures on each picture grid, making sure that the same picture never had to be described across roles. In each trial, there was one target object (marked by a red square around the object), surrounded by 15 distractor objects, which had to be described by the director. The crucial manipulation in the task was that several pictures had to be described repeatedly: in each of the picture grids there were two pictures that had to be described three times. Repeated references to the same object were never one straight after the other. This means that descriptions of other objects were given in between the initial and repeated descriptions of the critical objects. An example of a trial with object description can be seen below in figure 1.

"CHAIR, RED, NOT LEFT, SIDEWAYS TO THE RIGHT, LITTLE BIT BIGGER."

Figure 1. Picture grid showing a trial, followed by gloss of example initial description of the target object.

Procedure

The director and the matcher were seated at a table opposite each other. A camera was positioned behind the matcher filming the upper body and hands of the director. The director had a laptop screen to her side and the matcher had a picture card in front of her. The director and matcher could see each other directly, but could not see each other's screen or card. The director was presented with a trial on the computer screen and was asked to provide a description of the target object in such a way that the matcher could distinguish it from the 15 distractor objects. The matcher had a picture card filled with the same 16 objects in front of her, which was not visible to the director. The matcher's card showed the same objects as on the director's screen, but these objects were ordered differently for the director and the matcher. This means that the director could not use the location of the target object on the grid as part of the description. This was explicitly communicated to the directors. Once the correct object was found, the director went on to the next trial. The entire task took the participants about 20 minutes. After conducting 15 trials from the people domain and 15 trials from the furniture domain, the director and matcher would switch roles to conduct the experiment again, using the other set of picture grids.

Data analysis

For the purpose of the current analyses, the first and third (hence initial and repeated) descriptions of the four objects that had to be described three times were annotated and analysed. These four objects were never described in the first or last trial. The focus on the initial and repeated descriptions means that the current analyses are based on a data set which consists of eight descriptions (two initial and two repeated descriptions for each of the two picture grids) for each of the 14 participants, leading to a total of 112 object descriptions. We used the multimodal annotation programme ELAN (Wittenburg, Brugman, Russel, Klassmann, & Sloetjes, 2006) to annotate the signs. We looked at the duration of the complete descriptions, the number of lexical signs that were produced in the descriptions and the duration of the signs. A separate perception experiment was used to measure sign precision, which will be discussed below under Perception experiment.

The experiment consisted of a 2 x 2 x 2 design with factors Domain (levels: people, furniture), Repetition (levels: initial, repeated), and Picture (levels: one, two). We tested for significance using repeated measures ANOVAs by participants (F_1) and by items (F_2).

Results

Firstly, it was found that speakers take significantly less time (in seconds) to describe repeated references (M = 14.46, SD = 1.46) compared to initial references (M = 24.24, SD = 2.25), F_1 (1, 13) = 35.15; p < .001, F_2 (1, 4) = 22.30, p < .01. For the mean number of signs it was found that speakers produce significantly fewer signs in repeated references (M = 5.57, SD = .32) compared to initial references (M = 8.16, SD = .56), F_1 (1, 13) = 42.5; p < .001, F_2 (1, 4) = 16.59, p < .05. Moreover, the average duration (in seconds) of signs is shorter in repeated references (M = 1.2, SD = .054) than in initial references (M = 1.47, SD = .074), F_1 (1, 13) = 15.1; p < .01, F_2 (1, 4) = 20.17, p < .05. In sum: we find systematic effects of repetition, in that repeated references are shorter, contain fewer signs, and shorter signs than initial references. These effects were the same for both domains (furniture and people) and for all pictures; in particular, we found no significant interaction between the factors repetition and domain or repetition and picture. To illustrate, figures 2 and 3 below show a case of reduction in the description of a target object from the furniture domain. In the initial description, the participant takes longer and uses more signs and more precise signs (to

be discussed in the perception experiment below) than in the repeated description.

"SOFA, THREE SEATS, ASKEW, BIG, TO THE RIGHT, TO THE SIDE"

Figure 2. Still and gloss of initial description of a sofa, lasting 48 seconds. Sign depicted in still is SOFA, with a fairly large extension and well defined edges (see arrows).

"SOFA, GREEN, TURNED AROUND, THREE SEATS"

Figure 3. Still and gloss of repeated description of the same sofa as in figure 2, lasting 17 seconds. Sign depicted in still is SOFA, with smaller extension than in figure 2 and without well defined edges (see arrows).

Conclusion production experiment

The results show that several aspects of NGT were reduced in repeated references. Repeated references produced by signers of NGT were shorter than initial references, and repeated references in NGT contained fewer and shorter signs than initial references. This means that, at least for the aspects taken into account here, repeated references in NGT behaved as previous studies found for repeated references in speech. Repeated references by signers of NGT, containing predictable information, were produced in a more efficient way than initial references.

Perception experiment

Since it is difficult to define objective measures with which to measure sign precision, a perception experiment was set up in which participants had to judge, in a forced choice task, which sign they considered to be the most precise, looking at pairs of video clips with signs produced in either initial or repeated references.

Participants

Twenty-seven first year university students, who had no knowledge of NGT, took part as partial fulfillment of course credits. Non-NGT speaking participants were used on purpose, so that the participants would not know the lexical meaning of the signs but would only judge the signs on their perceived precision.

Stimuli

The participants were presented with a PowerPoint presentation in which they saw 40 pairs of video clips. Each pair of video clips was presented on one slide. Both video clips showed the same sign, produced by the same signer of NGT, about the same object, as described in the director-matcher task, except in one video clip the sign was produced in an initial reference and in the other video clip the sign was produced in a repeated reference. The order in which the participants were presented with initial versus repeated signs in the video clip pairs was counterbalanced over pairs of video clips (so it was not the case that for each pair the first video clip they saw was always the sign produced in an initial reference).

Procedure

The participants had to watch the pairs of video clips, one video clip at a time, and were allowed to watch a video clip more than once if they wanted to. The task was to choose for each pair of video clips which sign they considered to be the most precise (the sign in video clip A or B). The task was a self-paced forced choice task and even though the participants were allowed to watch the video clips more than once, they were encouraged to go with their first intuition. The only instruction they were given was to choose which sign they considered to be the "most precise". No details were given to suggest what the participants should base this judgment on.

Data analysis

For each pair of video clips, each sign that was considered to be the most precise received a point from each participant. Statistical analyses consisted of repeated measures ANOVAs over proportions, by participants (F_1) and by items (F_2).

Results

In line with our earlier results, we find that signs produced during repeated references (M = .33, SD = .04) were considered to be less precise than the signs produced during initial references (M = .67, SD = .04), F_1 (1, 26) = 121.29, p < .001, F_2 (1, 78) = 41.21, p < .001. The effect was the same for both domains (furniture and people).

Conclusion perception experiment

The results show that signs produced in repeated references were considered to be less precise than signs produced in initial references. Therefore, it can be concluded that there was also reduction in repeated references when it comes to sign precision.

Discussion and conclusion

Summarizing the results from the production and perception experiments, we found reduction in repeated references in sign language. We found that repeated references were shorter, contained fewer and shorter signs, and that signs produced in repeated references were considered to be less precise than signs in initial references.

The present results on sign language can be tied in with previous findings, both on speech and on gesture, that language users tend to be efficient by reducing predictable information (e.g. Jaeger, 2010). Relating the results to previous work on speech, we showed that repeated references were shorter and contained fewer signs than initial references, in line with work by Clark and Wilkes-Gibbs (1986) and Galati and Brennan (2010). The result that signs in repeated references were shorter can be related to previous work on speech by Aylett and Turk (2004) and by Lam and Watson (2010) where it was found that predictable speech (through redundancy or repetition) had a shorter duration than unpredictable speech. Our finding that signs in repeated references were considered to be less precise can be viewed to be an extension of the work by Bard et al. (2000), who found that repeated references had a less clear pronunciation than initial references.

When we compare the results from the present study with previous work on co-speech gestures, we can also see clear links. It has been found that gestures with common ground are less precise (Gerwing & Bavelas, 2004) and contain less semantic information (Holler & Wilkin, 2009) than gestures without common ground. This can be related to our findings that signs in repeated references were considered to be less precise and that repeated references in NGT contained fewer signs than initial references. Work on the effect of repeated references on gestures (Hoetjes, et al., 2011) found that repeated references may cause reduction in the number of gestures, as was found in the present study for the number of signs. Moreover, their finding that gestures in repeated references were considered to be less precise than gestures in initial references, can be directly mapped onto the present results for signs. Importantly, the reduction found in the current study can be tied in with work on language efficiency and cannot be explained through a general reduction of descriptions over time (with participants becoming more 'sloppy' in the course of the experiment). In short, the present study is the first study on sign language that shows that signers of NGT behave similarly when describing repeated references as to what previous studies have found for speech and gesture by speakers of spoken languages.

Due to the fact that hardly any previous work has been done on reduction in sign language, the method used in the current study was inspired by relevant previous work on speech and gesture. We looked at fairly rough and modality independent (i.e. applicable to speech, gesture and sign) measures such as duration of the description and number of signs and not at more sign-specific aspects such as exact sign location (as has been done by e.g. Tyrone & Mauk, 2010). Despite the fact that our measures were not based on sign characteristics per se, we were still able to find that reduction in sign language occurred. This shows that it is possible to use such modality independent methods to study reduction in repeated references.

Naturally, the current study leaves room for some discussion. In the perception experiment, we used participants with no knowledge of NGT to judge the precision of signs produced in the production experiment. This was done purposefully, so that the participants were not in any way influenced by the lexical meaning of the signs and could focus only on the precision judgment task. There are reasons to assume that the use of non-NGT signers is indeed a reasonable approach. Research has shown (Brentari, Gonzalez, Seidl, & Wilbur, 2011) that non-signers have a high degree of sensitivity to visual prosodic cues of a sign language. However, future work could include NGT signing participants in the perception experiment. Also, if using NGT signing participants in future work, another possibility would be to set up the task slightly differently by asking participants to judge a sign's intelligibility, as in Bard et al.'s (2000) work on speech, instead of judging its precision.

In sum, the analyses done presently are the first of its kind to show us not only that we can use analyses from related work on speech and gesture and adapt them to analyse signs in repeated references, but also that signers of NGT reduced their repeated references. In fact, the ways in which these repeated references were reduced in NGT are quite similar to what has been found previously for speech and gesture. It is well know that speakers of non-signed languages are communicatively efficient by reducing repeated information, both in speech and in co-speech gestures. This study has shown, for the first time, that signers can design their utterances to be efficient in the same ways.

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