Affirming and rejecting assertions in German Sign Language (DGS)[1]

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Abstract. Response elements (REs) like English *yes* and *no* fulfil two functions. They may affirm or reject a previous utterance, or they may indicate that the response to the previous utterance has positive or negative polarity. In responses to negative sentences, these two functions come apart. Spoken languages investigated so far seem to display different preferences for the interpretation of REs to signal either the positive/negative polarity of the response clause or the affirmation/rejection of the truth of the previous utterance. The present paper investigates the meaning and use of REs in German Sign Language (DGS). We present the results of a discourse completion experiment in DGS, which is the first quantitative study of the response system of a sign language, and provide a preliminary theoretical analysis of this system. Sign languages are of particular interest in this context since they systematically use multiple articulatory channels, which can, in principle, encode truth and polarity at the same time. The results show that DGS employs manual and non-manual REs which encode both truth and polarity, i.e. are ambiguous, as well as REs that encode only truth. The ambiguous REs are used more often to encode truth than polarity, and are rarely disambiguated by simultaneous non-manual REs. Hence, DGS does not use the potential made available by the visual-gestural modality in the domain of response strategies.

1 Introduction

Response particles like English *yes* and *no* may serve two purposes when responding to assertions. They either affirm (*yes*) or reject (*no*) the truth of the asserted content, or they signal whether the response clause has positive polarity (*yes*) or negative polarity (*no*). In responses to positive assertions, those two functions coincide:

(1)	*Antecedent*:	Pete has won the race.	
	Response:	a. **Yes**, he has.	affirmation, positive polarity of response
		b. **No**, he hasn't.	rejection, negative polarity of response

When the antecedent has negative polarity, an affirmative response also has negative polarity and a rejection has positive polarity. Since the two functions of the response particles no longer coincide, either particle can in principle be used to encode the intended meaning:

(2)	*Antecedent*:	Pete hasn't won the race.	
	Response:	a. Yes/no, he hasn't.	*yes* = affirmation, *no* = negative polarity
		b. Yes/no, he has.	*yes* = positive polarity, *no* = rejection

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Languages seem to display different preferences for the use of response particles to signal affirmation/rejection vs. positive/negative polarity. Languages that affirm positive as well as negative assertions with *YES*[2] and reject them with *NO* have traditionally been called *truth-based languages*, while languages that mark the positive polarity of the response clause with *YES* and negative polarity with *NO* are known as *polarity-based languages*. However, rather than follow one strategy exclusively, most languages exhibit a graded preference for one response strategy over the other (Pope, 1976; Jones, 1999; Roelofsen and Farkas, 2015). Some languages have particles that encode a combination of both functions. German *doch* and French *si*, for instance, encode both rejection and positive polarity (they would be appropriate in (2b)). Experimental investigations of a variety of languages confirm that preferences for a given response strategy are gradient rather than categorical (Brasoveanu, Farkas and Roelofsen, 2013; González-Fuente, Tubau, Espinal and Prieto, 2015; Meijer, Claus, Repp and Krifka, 2015; Li, González-Fuente, Prieto and Espinal, 2016; Claus, Meijer, Repp and Krifka, 2017; Goodhue and Wagner, 2015, 2018; Repp, Meijer and Scherf, 2019). Furthermore, there seems to be considerable inter-individual variation (Meijer et al., 2015; Claus et al., 2017; Repp et al., 2019).

The present paper addresses the issue of cross-linguistic variation by providing the first quantitative study of the response system of a sign language. We present data from a discourse completion task conducted in German Sign Language (DGS). The materials were adapted from Claus et al. (2017) to fit the requirements of a production experiment and were translated into DGS. The goal of the study was twofold. On the one hand, it aimed at eliciting the overall inventory of response elements used in DGS to respond to positive and negative assertions. We are using the term *response element (RE)* to refer to any lexical item that is used as a short response to indicate truth or polarity, including particles. On the other hand, the current study aimed at investigating the usage patterns of *YES* and *NO* signs and their alignment with a truth- or polarity-based response strategy. Given that most DGS signers are bilingual to some extent (in DGS and German), contact-induced similarities between German and DGS may be expected. However, since there seems to be great inter-individual variation in German such that a majority of speakers prefer a truth-based response strategy and a minority prefer a polarity-based strategy or have no clear preference (Claus et al. 2017), the precise expectations with respect to the use of *YES* and *NO* in DGS are not so clear. Another contact-induced expectation is that DGS may have a dedicated RE for rejecting negative assertions comparable to German *doch*.

The investigation of a signed language may shed new light on the meaning and use of REs since the visual-manual modality offers multiple visible articulatory channels that are used simultaneously and can in principle encode truth and polarity independently. For spoken languages, it has been shown that gestural components or components with a gestural origin such as head movement play a role in response systems (Esipova, 2019 for Russian; González-Fuente et al., 2015 for Catalan and Russian; Li et al., 2016 for Mandarin). For sign languages, we may hypothesize that non-manual markers such as head nods and head shakes have grammaticalized into REs that occur simultaneously with or replace manual response signs.

[2] We are using italics plus small caps (*YES*, *NO*) to refer to particles in other languages that correspond to English *yes* and *no*.

The paper is organized as follows. Section 2 gives a brief overview of previous experimental findings on REs in English and German, which exemplifies cross-linguistic variation and illustrates the issues of gradable preferences and inter-individual variation. It then presents one of the theories that have been proposed to account for the meaning and use of REs. Section 3 reviews findings on non-verbal features that have been observed to typically accompany verbal REs in spoken languages. Section 4 specifies our expectations for the response system of DGS. Sections 5 and 6 present the discourse completion experiment. Section 7 offers a discussion and concludes.

2 Experimental findings on verbal REs and theories of REs

2.1 Experimental evidence

English responses show characteristics of a polarity-based response system, whereas the majority of German speakers employ response strategies that are closer to a truth-based system. As mentioned, the distinction between polarity-based and truth-based systems is not categorical. A comparison between English and German shows this very nicely. Both languages have been investigated in experimental studies where the acceptability of REs was tested in context-embedded dialogues, or where participants made a forced choice between *YES* and *NO*. The experiments either tested bare particle responses or responses with a particle plus a response clause. The results are summarized in Table 1. We only report findings on responses to negative assertions since no virtually variation is attested in responses to positive assertions (which is expected). We are not considering negative questions as these were not tested in the current study.

For English, several varieties have been tested with slightly different results, which may be due to dialectal variation or/and to the partly different methodologies applied in the studies. Looking at US English, Brasoveanu et al. (2013) found in a forced choice experiment that in affirming responses, both *yes* and *no* are used but *no* is clearly preferred over *yes*. Goodhue and Wagner (2018) report that in an acceptability judgement study for Canadian English *no* was rated as more acceptable than *yes*, but *yes* still had medium acceptability with considerable variation in the judgements. The results for rejections of negative assertionsare not very clear: there does not seem to be a difference between *no* and *yes.* Note, however, that in rejecting responses to negative questions, *yes* received higher acceptability ratings than *no*. Repp et al. (2019) report an acceptability study for UK English, where they observe a stark contrast in affirmations between the high acceptability of *no* and the low acceptability of *yes*. In rejections, *yes* overall was more acceptable than *no* but a quarter of participants rated both *yes* and *no* as acceptable.

Turning to German, Claus et al. (2017) found in an acceptability judgement study that in affirmations of negative antecedents the majority of participants found *YES* (*ja*) more acceptable than *NO* (*nein*). However, the overall ratings for *NO* were fairly high, and considerable inter-individual variation was attested. Across two experiments testing the acceptability of bare particle vs. particle-plus-full-clause responses to negative assertions, 25% of the participants consistently rated affirmations with *NO* as more acceptable than affirmations with *YES*, and another 8% rated both particles as equally acceptable. In

rejections, *doch* received higher acceptability ratings than *NO,* which received higher ratings than *YES*.

Table 1. Preference patterns reported in the literature for YES and NO in response to negative assertions (e.g. Pete hasn't won the race.)

Speech Act		**English**	**German**
Affirmation	…, *he hasn't*	*no > yes*	*ja > nein* (majority) *nein >/= ja* (minority)
Rejection	…, *he has*	*yes >/= no*	*doch > nein >> ja*

Overall the experimental findings show that although *YES* and *NO* may be used to express both of the functions that REs can have, there are different preferences in English and German. The preferences can differ in strength, i.e. acceptability is often graded. Finally, there is inter-individual variation, even to the extent that speakers have opposite preferences.

2.2 Theories of response elements

There are two main types of theoretical approaches to REs. The first type derives the meaning of *YES* and *NO* in the syntax by analyzing them as remnants of an elided response clause, which is syntactically identical with the antecedent clause. (cf. Van Cranenbroek, 2004; Kramer and Rawlins, 2011; Holmberg, 2013, 2015; Servidio, 2014; Servidio, Bocci and Bianchi, 2018). The second approach generates the meaning of REs at the interface between semantics and pragmatics. Its proponents treat *YES* and *NO* as anaphoric expressions that pick up a proposition introduced by the antecedent clause (Krifka, 2013; Roelofsen and Farkas, 2015; Farkas and Roelofsen, 2019). In this paper, we focus on one of the anaphoric approaches, the so-called *feature model* (Roelofsen and Farkas, 2015; Farkas and Roelofsen, 2019), because this model avoids certain problems encountered by the syntactic accounts (see Claus et al., 2017 for discussion). Furthermore, certain premises of the other semantic-pragmatic account concerning the saliency of the negative and positive propositional discourse referents that are introduced by a negative sentence (Krifka 2013) may not be correct (Claus, Frühauf and Krifka, 2019; also see Farkas and Roelofsen, 2019, for a critical discussion of Krifka, 2013).

The feature model is a linear optimality-theoretic account. In linear optimality theory, constraints are weighted, and non-optimal candidates are not ungrammatical but dispreferred, so that graded acceptability can be modelled (cf. Keller 2000). The feature model derives its name from the fact that it treats REs as the morphological expressions of two types of polarity features that occur on a polarity head in the syntactic structure of a response. The polarity head takes a TP as its complement, which denotes the so-called *prejacent* and can be elided. Both types of polarity features are semantic in nature and purely presuppositional. The first type are the absolute polarity features [+] and [–]. They presuppose that the polarity of the prejacent is positive [+] or negative [–]. The second type are the relative polarity features [AGREE] and [REVERSE]. They presuppose the existence of a unique salient discourse referent in the immediately preceding discourse whose interpretation and polarity are identical with (i.e. [AGREE]) or the opposite of (i.e. [REVERSE]) that of the prejacent.

Cross-linguistic variation in the distribution of *YES*- and *NO*-responses as well as gradient preferences within a language are explained as arising from language-specific feature–RE mappings in conjunction with language-specific optimality-theoretic constraint rankings. The feature–RE mappings are regulated via *feature-mapping rules*. These determine which features or feature combinations map onto which RE. For instance, a language may map [+] onto *YES*, another language may map [+] and [AGREE] onto *YES*, some languages may map the combination [+, REVERSE] (rejecting a negative antecedent) onto a RE, as is the case for German *doch*. The relevant optimality-theoretic constraints are the following:

MAXIMIZE RELATIVE:	Maximize the realization of relative polarity features.
MAXIMIZE ABSOLUTE:	Maximize the realization of absolute polarity features.
MAXIMIZE MARKED:	Maximize the realization of marked polarity features or feature combinations.
EXPRESSIVENESS:	Maximize the expression of feature content.

MAXIMIZE RELATIVE and MAXIMIZE ABSOLUTE specify that a certain type of feature has a high realization need, i.e. must be expressed by a RE. MAXIMIZE MARKED is an instantiation of the general pressure to realize marked features over unmarked features (Horn 1984). The features [–] and [REVERSE] are considered marked features. The markedness of [–] is motivated by the assumption that negative sentences arguably are more difficult to process than positive sentences. [REVERSE] is more marked than [AGREE] because the complement relation is more complex than the identity relation and disagreeing with someone is dispreferred as a conversational move. The feature [+] is marked in the feature combination [+, REVERSE] because it contrasts with the polarity of the antecedent. EXPRESSIVENESS maximizes the amount of information that is expressed by a form, which for the choice of a RE essentially means that REs which express feature combinations are preferred over REs that express only one feature. Finally, Roelofsen & Farkas (2015) assume that it is pragmatically advantageous to avoid ambiguous expressions.

Let us illustrate the mapping rules and the interaction of the optimality-theoretic constraints for English and German. In both languages, [AGREE] and [+] map onto *YES*, [REVERSE] and [–] map onto *NO*. In German, there is an additional mapping of [REVERSE, +] onto *doch*. Looking back at the English dialogue in (2), concretely at the affirmation of the negative assertion in (2a), both *yes* and *no* are allowed by the feature mapping for English: *yes* can be used because it encodes [AGREE] and *no* can be used because it encodes [–]. However, by MAXIMIZE MARKED, *no* should be preferred because it realizes a marked feature. As we saw above, this is indeed what has been found for the acceptability of English *no* and *yes* as affirmations of negative antecedents. For German, the feature mapping for (2a) is the same, but we saw in the previous section that the majority of speakers find *YES* more acceptable than *NO* in such contexts. This can be explained if MAXIMIZE RELATIVE is assigned a higher weight than MAXIMIZE MARKED for those speakers (Farkas and Roelofsen, 2019). If we wish to express this in terms of constraint ranking rather than constraint weights, we could say that MAXIMIZE RELATIVE is ranked higher than MAXIMIZE MARKED (Claus et al., 2017). For English, Repp et al. (2019) propose that MAXIMIZE RELATIVE is essentially not operative (i.e. ranked very low). Rather, MAXIMIZE ABSOLUTE is ranked very highly, higher than MAXIMIZE MARKED. This assumption accounts for the general preference of *yes* over *no* in rejections of negative antecedents observed by Repp et al. Note that in affirmations, where *no* is preferred over *yes*,

no encodes [–], i.e. an absolute feature, which further supports the high ranking/ great weight of MAXIMIZE ABSOLUTE in English. Finally, in German, EXPRESSIVENESS ranks highest/ has the greatest weight: EXPRESSIVENESS >> MAXIMIZE RELATIVE >> MAXIMIZE MARKED. This ranking accounts for the preference of German *doch* ([REVERSE, +]) over *NO* and *YES* in rejections, which express fewer features. This ranking also accounts for *NO* ([REVERSE]) being preferred over *YES* ([+]).

3 Gestural response strategies

The present study stands out as the first larger-scale production experiment on any language systematically eliciting a wide range of REs. Previous free production experiments on spoken languages are reported in Li et al. (2016) on Mandarin Chinese and González-Fuente et al. (2015) on Catalan and Russian.[3] Both studies employed a discourse completion task to elicit semi-spontaneous responses to assertions and questions. Li et al. tested rejecting responses only. In addition to the use of REs, both studies recorded prosodic and gestural components of their participants' responses. Participants read a scene-setting passage, then listened to an audio-recorded target sentence (a question or an assertion) and provided a response congruent with the information they received in the scene-setting passage. Their responses were video-recorded.

With respect to the REs that were produced, Li et al. observe for Mandarin Chinese that only *NO*-type REs occur in rejections of negative antecedents. In terms of the feature model, this means that Mandarin Chinese assigns great weight to MAXIMIZE RELATIVE. González-Fuente et al. observe for Catalan that rejections to negative antecedents were primarily encoded with *YES* (*sí*), which could be followed by a clause or not. NO (*no*) was attested in 8% of the rejections but occurred only in combination with *sí*, e.g. *No, sí que ha vingut* (lit.: *no si that has come*, 'No, he has come'). In other words, even in these responses, the absolute polarity feature is overtly expressed. In affirmations of negative antecedents, mostly *YES* is used. In terms of the feature model, these results suggest that Catalan assigns great weight to MAXIMIZE ABSOLUTE. Russian also assigns great weight to MAXIMIZE ABSOLUTE, but this can only be observed in affirmations of negative antecedents, where *NO* (*net*) occurs in 80% of the responses. In rejections of negative antecedents, only *NO* occurs. It seems that *YES* (*da*) in Russian only encodes [AGREE] and not [+].

Since we are interested in the potential overlap of non-manual REs in sign languages and gestural REs in spoken languages, let us turn to the results for these studies for non-manual gestures accompanying *YES* and *NO*. Both studies coded head movements (head nods, head shakes, tilt, turn), eyebrow raises and shoulder shrugs. Li et al. (2016) also coded eyebrow furrowing and movement of the corners of the mouth. Since Li et al. were mainly interested in rejections in Mandarin, their analysis of gestures compared rejections with dialogue turns that were a neutral assertion. The gestures were coded both for responses with *NO* and for responses without *NO*, i.e. for responses that consisted of a positive response clause only. Li et al. found that overall, gestural elements were more frequent in rejections than in assertions (48% vs. 4%). In rejections, head nods were considerably more frequent than head shakes. Head nods occurred in 30% of the rejections with *NO* and in 24% of the rejections without *NO*.

[3] Compared to the current study, the scale and statistical power of these studies is rather small: The data come from 8 speakers of Mandarin Chinese, and 4 speakers of Russian and Catalan each.

Head shakes occurred in 4% and 7%, respectively. Li et al. interpret the head nod as being an expression of a REJECT operator, which needs no verbal lexical expression, i.e. it may simply combine with a positive response clause. Since rejections of positive sentences were not tested, it is difficult to judge if the head nod encodes [+] for the positive response clause or [REVERSE] signalling the rejection.

González-Fuente et al. (2015) only investigated gestures that occurred simultaneously with a RE. They found that both in Russian and in Catalan, gestures were more frequent and/or more emphatic in rejections of negative antecedents than in affirmations of positive antecedents. The contrast was especially strong in eyebrow movement; eyebrow raising occurred in 92% of the rejections of negative antecedents in Catalan (80% in Russian), but only in 57% (38% in Russian) of the affirmations of positive antecedents. Furthermore, like in Mandarin, head nods were the most common head movement when rejecting a negative antecedent in Catalan and Russian, but head nods also frequently accompanied affirmations of positive antecedents. In Catalan, the head nod thus seems to express the same feature as the verbal element *si*, 'yes': [+]. We will call this phenomenon **concord** here: two elements express the same feature. For Russian, Esipova (2019) argues that [AGREE] and [+] map onto a head nod while [REVERSE] and [–] map onto a head shake. Since the head nod thus fills a gap in the Russian response paradigm, which has no RE encoding [+], she proposes that head movements should be treated as linguistic objects proper. They lexicalize independently of the inventory of REs in a language. Esipova also looks at sequential combinations of head movements and lexical REs in Russian and notes (i) a preference for realizing relative polarity features before absolute features and (ii) that head nods encode different features when occurring alone vs. when accompanying a lexical RE. The former seem to only encode [AGREE], while the latter can also encode [+].

4 Response strategies in the visual-gestural modality: Expectations about DGS

Sign languages use various articulators at the same time to express different aspects of meaning simultaneously (Meier, 2002; Aronoff, Meir and Sandler, 2005). Therefore, the interaction of manual and non-manual markers of polarity and truth is especially interesting: DGS could in principle express both truth and polarity manually and non-manually. These manual and non-manual markers can either be used in combination or in isolation. Casual observation suggests that in DGS, the manual sign JA[4] 'yes' is typically accompanied by a head nod while the sign NEIN 'no' is often accompanied by a head shake. While typically considered lexical components of the respective response sign, the two head movements can also be detached from the corresponding manual elements and can be used in isolation. In addition, sentential negation in DGS is obligatorily expressed via a negative head shake that heads a NegP and may spread over (parts of) the corresponding clause (Pfau 2008). DGS is thus a non-manual dominant language, i.e. a language that can express negative polarity only with the non-manual head shake (Pfau and Quer, 2002; Zeshan, 2004). Given these observations, we expect DGS to use manual and non-manual markers in response clauses with a preference for the use of non-manuals for expressing negative polarity.

Another prediction for DGS is that it may express polarity and truth simultaneously with a manual and a non-manual marker. In Section 3, we discussed this option for spoken language

[4] Following sign language glossing conventions, DGS signs are written in (non-italicized) small caps.

and gesture. However, unlike spoken languages, sign languages are well-known for integrating non-manual components into their grammatical system to express various syntactic, semantic and pragmatic features such as in negation, sentence types and information structure (Pfau and Quer, 2010, Wilbur, 2012). Therefore, we expect a systematic interaction of non-manual markers with manual REs in DGS. Concretely, we may formulate the following contrasting predictions. Given that clausal negation is preferentially expressed with a head shake, there might be a response strategy for affirmations of negative antecedents that maps [–] onto a head shake and [AGREE] onto the manual JA. This would result in disambiguation if JA is indeed ambiguous. In contrast, headshakes might not co-occur with JA if we assume there to be *concord* between manual and non-manual elements: head shakes are likely to combine with *NO*-type markers and head nods with *YES*-type markers, or in other words non-manuals and manuals might encode the same features. We will see that this second prediction is borne out by the data. As for other non-manual markers, like brow movements, our study is exploratory. Given the results for Catalan and Russian, where brow movements are gestures that frequently occur in rejections of negative antecedents, we may in principle expect that brow movements may also be used for such a purpose in a sign language.

Since we conducted a free production study (similarly to Gonzales-Fuente et al., 2015 and Li et al., 2016), we further expect that other REs than *YES* and *NO* will be used. DGS inter alia has the manual signs STIMMT (lit.: *be.correct*, 'that's correct') and FALSCH ('wrong'), whose translation equivalents in German unambiguously encode the relative features [AGREE] and [REVERSE]. Yet these REs have not been investigated systematically in quantitative investigations, so we know little about their use. It might well be the case that unambiguous REs are used more often after negative antecedents than after positive antecedents because ambiguity could be avoided this way – in spoken languages as well as in sign languages.

A final point is language contact. In DGS, one prominent area of influence of spoken German is mouthing. DGS uses mouthing in various contexts, either as an additional non-manual phonological feature of a sign (especially with nouns and verbs) or to disambiguate manually ambiguous signs (Boyes Braem and Sutton-Spence, 2001). So DGS has the potential to combine manual and non-manual REs with a specific mouthing borrowed from German. The mouthing may correspond to the meaning of the RE (i.e. *ja* 'yes' and *nein* 'no'), which would be an instance of concord. Alternatively, it may specify another RE. An example for the latter would be the use of the mouthing *doch* in combination with JA or NEIN or a non-manual RE to express the feature combination [REVERSE, +]. Finally, a signer may use mouthings in isolation as a reaction to positive and negative antecedents. Such uses may either be analyzed as an instance of language switch or as the omission of the corresponding manual material.

5 Discourse completion task: Method

The experiment in this study used the same materials as the acceptability studies for German reported in Claus et al. (2017). There were some adaptations of the materials to fit the lexical needs of DGS and to provide culturally appropriate contexts for the DGS community. Participants in the study watched short video sequences in DGS and engaged in dialogues with a person in the video while they were being video-recorded themselves. The participants' task was to complete each dialogue by producing a polar response to a negative

or positive assertion made by the person in the video. Participants were free in their choice of words. This method enabled us to answer the research questions raised in the introductory section: (i) What is the inventory of REs in DGS? (ii) What response strategies are used in responses to negative assertions, where the two functions that the REs *YES* and *NO* in principle fulfil come apart? (iii) How do manual and non-manual markings combine?

Participants. 24 (near-) native signers of DGS[5] (18 to 55 years, $M = 32$, 6 male) participated in the experiment either at the University of Cologne or at the University of Göttingen. Fourteen signers live in North Rhine Westphalia, four in Berlin, three in Hesse, and one in Lower Saxony. All participants evaluate their command of German as at least good. They were reimbursed for their participation.

Materials and design. The study contained 48 experimental items (lexicalizations) and one practice item. Each item started with a native signer of DGS narrating a situation involving the two characters Peter and Alex. Then Peter, played by another native DGS signer, appeared in the video, facing the participant. He made an assertion. Participants were asked to take the role of Alex and produce a polar response to Peter's assertion. The information for responding truthfully to the assertion was always given in the narrator's description of the situation. Peter's assertion had either positive or negative polarity (factor: antecedent). The participants' responses either affirmed or rejected Peter's assertion (factor: speech act). The experiment thus had a 2×2 design resulting in four experimental conditions. The items were distributed over two lists. The factor antecedent was manipulated within participants and between items: 24 of the lexicalizations contained a negative assertion, 24 contained a positive assertion. All participants saw all lexicalizations. The factor speech act was manipulated within items and between participants: which assertions were affirmed and which were rejected varied systematically over the two lists. The order of items in each list was pseudorandomized and presented in regular or in reversed order. A sample item is shown in (3). Here participants are expected to reject a negative assertion.

(3) *Narrator:* Peter and Alex are elementary school teachers. They are organizing a school party with the help of some of the parents. Alex just learnt that the parents have already bought the beverages. A little later, Peter and Alex discuss the tasks assigned to the parents.
Peter: The parents haven't bought the beverages yet. (negative assertion)

All assertions were transitive sentences. Positive assertions contained the temporal adverbial FRÜHER 'before, in the past' while negative assertions contained the negator NOCH-NICHT 'not yet'.

Procedure. Participants were welcomed by a proficient or a native signer in DGS. They sat in front of a computer screen and received instructions by watching a video in DGS. In the video, another proficient DGS signer explained the task with the help of a sample item and a number of possible response elements. Participants were encouraged to respond spontaneously as if they were having a natural conversation. After a practice trial, they received feedback before starting the experiment. They moved through the experiment at their own pace, advancing via mouse-click. They were recorded by a video camera located

[5] Age of acquisition of DGS at or before age 5.

next to and slightly above the computer screen. One experimental session lasted approximately two hours and participants were instructed to take breaks as needed.

6 Discourse completion task: Results

The data were annotated in ELAN (Wittenburg et al., 2006) for the presence and type of RE(s) that were produced as well as accompanying non-manuals, specifically mouthing, head nod and head shake, as well as brow raise and brow furrow. Of the 1152 recordings, 871 (75.6%) could be used for analysis. Two recordings were excluded because of technical problems. 72 items (6.3%) were excluded due to high error rates: in the three lexicalizations these items occurred in (3 × 24 participants), the signs proved not to be sufficiently conventionalized. A further 90 items (7.8%), produced by two participants, were excluded because the participants did not perform the task they were asked to perform. One participant was not engaging in the conversation but commented on whether or not the claim produced in the antecedent clause was correct. The other participant did not respond to the antecedent but retold the situation. Finally, any remaining items where the answer clearly was not correct were excluded (117 items, 10.2%). Whether or not an answer was correct was decided on the basis of what the participant uttered after a RE, e.g. an explicit response clause.

Participants produced up to four utterance-initial REs, which were regularly followed by further linguistic material: a response clause or an explanation. Utterance-final REs were also produced – also up to four. In the following, we only present results for the first and the second utterance-initial RE (henceforth *RE1* and *RE2*). For the statistical analysis, we fitted general linear mixed effects models with a binomial logit function (R package lme4, Bates, Mächler, Bolker and Walker, 2015). The *p*-values that we report for these data are based on the Kenward-Roger approximation (lmerTest; Kuznetsova, Brockhoff and Christensen, 2017). Antecedent and speech act were fixed factors. Both factors were sum-to-zero contrast coded. Participant and lexicalization were random factors. Where possible (i.e. in the absence of convergence problems), we fitted maximal models including slopes for the random factors. Below we indicate the type of model by abbreviations, e.g. m^{int} for model with only intercepts, $m^{p.sl:SA}$ for model with participant slope for speech act (and with intercept for lexicalization).

6.1 The first response element (RE1)

759 utterances (87.1%) contained at least RE1. There were more RE1 in affirmations than in rejections (88.8% vs. 85.4%; b = -0.22, SE = 0.11, z = -2.04, $p < 0.05$; $m^{p.sl:A}$). Participants used thirteen different manual RE1, three of which occurred only once. A manual RE1 could be accompanied by non-manuals or not. Participants also used non-manuals without a manual as RE1. There were seven different such non-manual RE1, two of which occurred only once. Figure 1 gives an overview of the distribution of the different RE1 across the conditions. It shows that signers regularly produced REs that seem to express only the relative feature [AGREE]: these REs only occur in affirmations, e.g. STIMMT ('that's correct'). Signers also regularly produced REs that seem to express only the relative feature [REVERSE]: these REs only occur in rejections, e.g. STIMMT-neg ('that's not correct') or various signs for FALSCH ('wrong'). There were two REs that correspond to German *doch*: they only occured in rejections of negative utterances. These were the manual DOCH (n = 2) and the mouthing *doch*

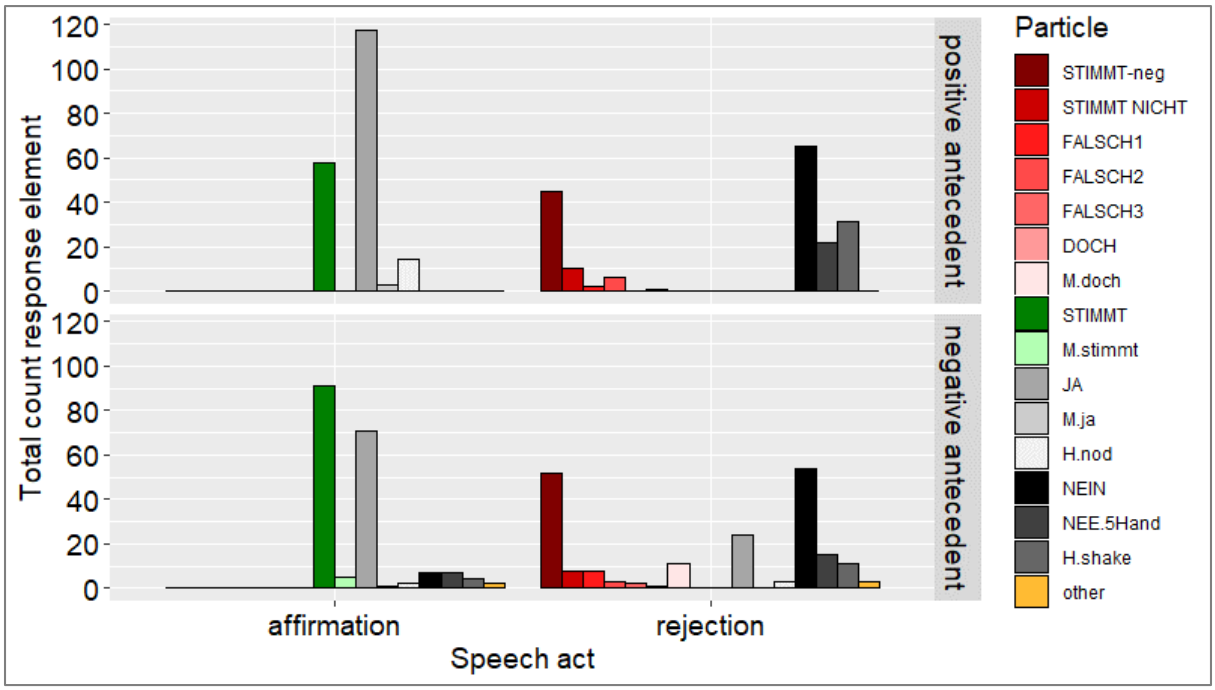

Figure 1. RE1 produced in the discourse continuation task. Green colours indicate that the RE was used unambiguously as an affirming RE, red colours mark unambiguously rejecting REs, other colours mark ambiguous elements with lighter shades indicating a YES-similarity and darker shades indicating a NO-similarity. 'M' indicates that the RE is a mouthing. 'H' means that the RE is a head movement.

(*n* = 11). The mouthing *stimmt* was the only RE1 that occurred only in affirmations of negative antecedents (*n* = 5). Many RE1 were ambiguous, e.g. JA ('yes'), the head nod, NEIN ('no'), NEE.5Hand ('no'), and the headshake. Below we detail the results for those ambiguous RE1 that were produced in a sufficiently high number to allow generalizations about their meaning and use. Table 2 gives an overview of the frequency of occurrence for these RE1.

Table 2. Distribution of ambiguous RE1 that are used frequently (total counts | proportion in the relevant speech act: columns add up to 100% together with non-frequent ambiguous and with unambiguous RE1; standard deviation between brackets)

RE1	Total	*positive antecedent*		*negative antecedent*	
		affirmation	*rejection*	*affirmation*	*rejection*
JA	212	117 | .61 (.49)	| -	71 | .37 (.49)	24 | .12 (.33)
NEIN	126	- | -	65 | .36 (.48)	7 | .04 (.19)	54 | .28 (.45)
NEE.5Hand	44	- | -	22 | .12 (.33)	7 | .04 (.19)	15 | .08 (.27)
head shake	46	- | -	31 | .17 (.38)	4 | .02 (.14)	11 | .06 (.23)

The manual marker JA occurred in affirmations of positive antecedents, and in affirmations and rejections of negative antecedents. We fitted a model for negative antecedents only. After negative antecedents, JA occurred marginally more often in affirmations than in rejections (*b* = -2.15, *SE* = 1.15, *z* = -1.87, *p* = 0.06; m^{int}). Thus, JA seems to encode [AGREE] as well as [+], with a preference for [AGREE]. The manual marker NEIN occurred in rejections of positive

antecedents, and in affirmations and rejections of negative antecedents. We tried to fit a model for negative antecedents, which only converged when item was removed as a random factor. By this model, NEIN occurred more often in rejections than in affirmations (b = 3.46, SE = 1.44, z = 2.39, $p < 0.05$; $m^{p.int}$). Hence, NEIN seems to encode [REVERSE] as well as [–], with a preference for [REVERSE]. The other, less frequent RE1 that potentially are *NO*-elements, i.e. the manual NEE.5Hand and the head shake are similar to NEIN in their distribution. All these elements seem to be able to express [REVERSE] and [–], with a preference for the realization of [REVERSE].

To further investigate the role of ambiguity in the choice of RE1, we pooled all ambiguous RE1 (*YES*-/*NO*-type) and compared their frequency of occurrence with the pooled unambiguous RE1. Figure 2 indicates that except in affirmations of negative antecedents, ambiguous RE1 were produced more frequently overall than unambiguous RE1. The statistical analysis of the frequency of choice of ambiguous RE1 revealed that participants produced fewer ambiguous RE1 after negative than after positive antecedents (b = -0.50, SE = 0.19, z = -2.61, $p < 0.01$; m^{int}).

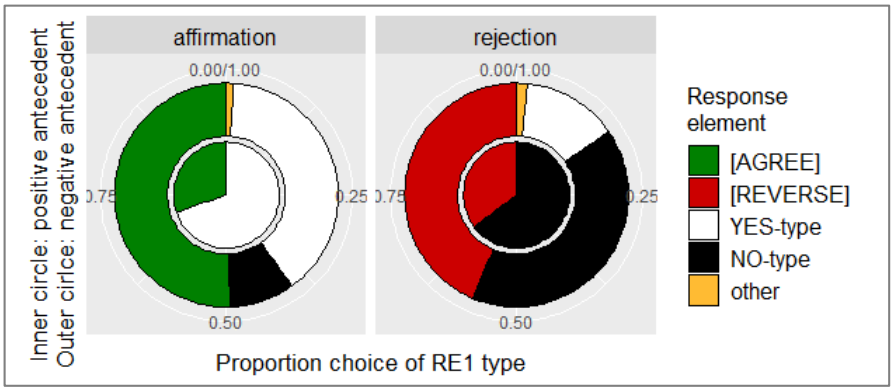

Figure 2. Proportion of ambiguous (NO/YES-type) vs. non-ambiguous types of RE1. The inner circle in both facets gives the proportion for positive antecedents, the outer circle for negative antecedents.

6.2 Non-manuals on RE1

Out of the 759 manual RE1, 698 (92.0%) co-occurred with at least one simultaneous non-manual marker. Overall, there were more RE1 accompanied by at least one non-manual in affirmations than in rejections (94.8% vs. 89.1%; b = -0.53, SE = 0.17, z = -3.11, $p < 0.01$; $m^{p.sl:A}$) but the different non-manuals showed different distributions.

343 RE1 (45.2%) were produced with simultaneous **mouthing**. Mouthings occurred more often after negative than after positive antecedents (50.1% vs. 39.6%, b = 0.35, SE = 0.16, z = 2.19, $p < 0.05$; $m^{p.sl:SpA+A}$).

479 RE1 (63.1%) occurred with a **head movement**. There were more RE1 with a head movement in rejections than in affirmations (69.8% vs. 56.5%; b = 0.40, SE = 0.20, z = 2.04, $p < 0.05$; $m^{p.sl:SA+A}$). There were 229 **head nods** (32.8%) and 250 **head shakes** (33.0%). Figure 3 illustrates the distribution of nods and shakes in the experimental

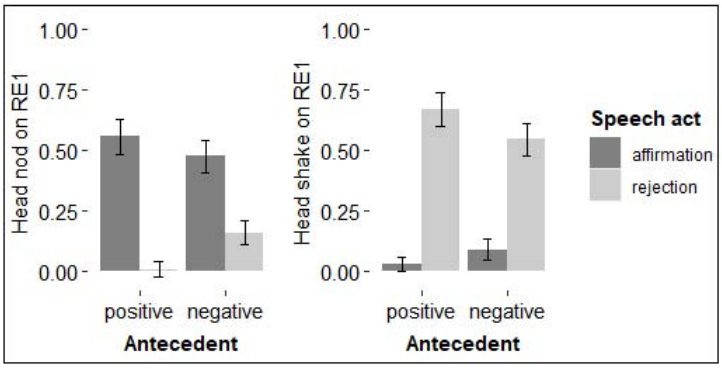

Figure 3. Proportion of RE1 that occurred with head nod (left) or head shake (right) by experimental condition.

conditions. After positive antecedents, RE1 with head nods occurred only in affirmations, and RE1 with head shakes only in rejections. After negative antecedents, nods and shakes occurred in both speech acts but with different frequencies. After negative antecedents, nods occurred more often in affirmations than in rejections (b = -1.69, SE = 0.44, z = -3.81, p < 0.001; $m^{p.sl:SpA}$); head shakes occurred more often in rejections than in assertions (b = 2.2218, SE = 0.3123, z = 7.113, p < 0.001; $m^{i.sl:SpA}$).

217 RE1 (31.1%) were produced with a **brow movement**. There were 91 brow raises (13.0%) and 126 brow furrows (18.1%). Figure 4 illustrates their distribution over the experimental conditions. For **RE1 with brow raises**, there was a main effect of the factor antecedent (b = 0.54, SE = 0.16, z = 3.47, p < 0.001), which was modulated by an interaction of antecedent and speech act (b = 0.59, SE = 0.15, z = 3.79, p < 0.001; m^{int}). Resolving this interaction revealed that the effect of antecedent was not significant for affirmations. For rejections, even a model with only random intercepts was a singular fit. Removing item as a factor resulted in a model by which there were more RE1 with a brow raise in rejections after negative antecedents than after positive antecedents (b =1.17, SE = 0.25, z = 4.76, p < 0.001; $m^{p.int}$). For **RE1 with brow furrows**, the random factor item also was removed to avoid a singular fit (b =1.64, SE = 0.57, z = 2.86, p < 0.01, $m^{p.sl:SpA}$). By this model, there were more RE1 with brow furrows in rejections than in affirmations.

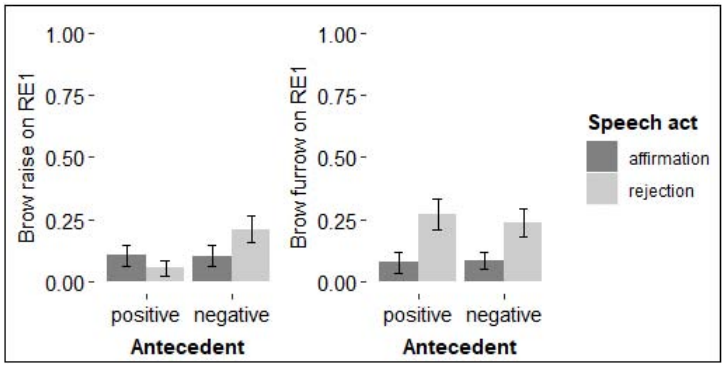

Figure 4. Proportion of RE1 that occurred with brow raise (left) or brow furrow (right) by experimental condition.

To further investigate the combination of RE1 with a non-manual, we explored which *types* of manual markers (in terms of their semantic-pragmatic function) were combined with the various non-manuals. Recall from Section 4 that manual and non-manual markers can in principle be used to express different features simultaneously. Therefore, we were particularly interested in whether or not manual and non-manual marker show **concord**, i.e. encode the same or different features.

Mouthings on RE1 overwhelmingly showed concord: 297 out of the 343 RE1 with mouthing (86.6%) were of the same type, i.e. both signalling [AGREE] (n = 125), both signalling [REVERSE] (n = 119) or both being principally ambiguous, that is being *YES*-type (n = 39) or *NO*-type (n =15). There were two kinds of non-concord. First, a [REVERSE]-type RE1 was accompanied by an [AGREE]-type mouthing 11 times. All these occurrences were combinations of the manual STIMMT-neg ('that's not correct') with the mouthing *stimmt* ('that's correct') i.e. the mouthing did not express the negation. This is not unexpected given that mouthings are frequently truncated variants of the spoken language signal from which they are borrowed. Eight of these combinations occurred in rejections of positive antecedents, three occurred in rejections of negative antecedents. Second, a *YES*-type RE1 was accompanied by a [REVERSE]-type mouthing 20 times. All these were combinations of the manual JA with the mouthing *doch*, and they occurred in rejections of negative antecedents. Other combinations were spurious.

Head movements on RE1 showed complete concord with RE1 after positive antecedents. After negative antecedents, there mostly was concord but there was one systematic exception (see the end of this paragraph) as shown in Figure 5. In affirmations of negative antecedents [AGREE]-type RE1 occurred with head nods 59 times and with a head shake only once, *YES*-type RE1 occurred with head nods 33 times and with a head shake only once, *NO*-type RE1 occurred only with head-shakes (n = 12). In rejections of negative antecedents, *NO*-type RE1 occurred only with head shakes (n = 55), and *yes*-type RE1 only occurred with head nods (n = 16). [REVERSE]-type RE1 occurred with a head shake 53 times, and with a head nod 11 times. The last combination is the one systematic non-concord combination. 10 of these 11 cases involved a non-manual RE1, namely the mouthing *doch*. The 11th case involved the manual marker DOCH. Of the 20 combinations of a *YES*-type RE1 (JA) with the mouthing *doch* (see above), 14 were additionally accompanied by a head nod, i.e. the head nod showed concord with RE1 and the mouthing showed non-concord.

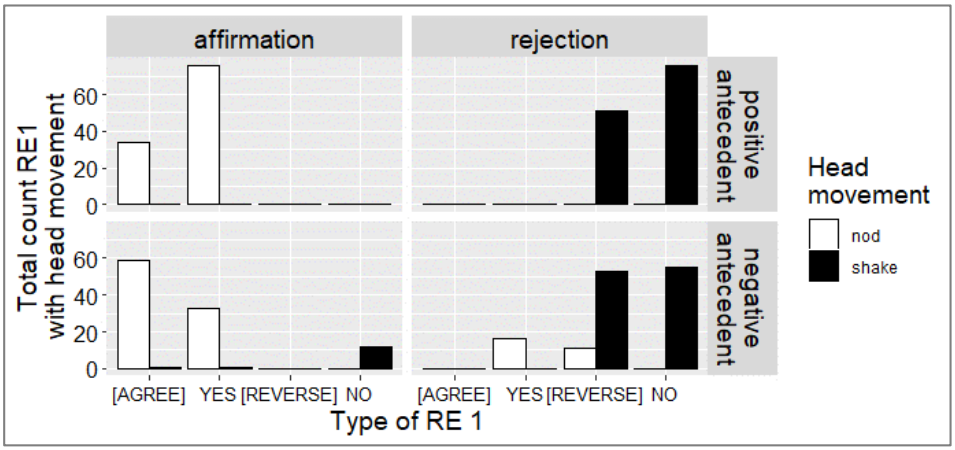

Figure 5. Head movement on RE1. Distribution by RE1 type.

The type of **brow movement** did not seem to correspond directly with a certain type of RE1, see Figure 6. Still, in rejections, where brow movements were most frequent, they mostly occured on *NO*-type RE1. And on these, brow furrows seemed to occur more often than did brow raises.

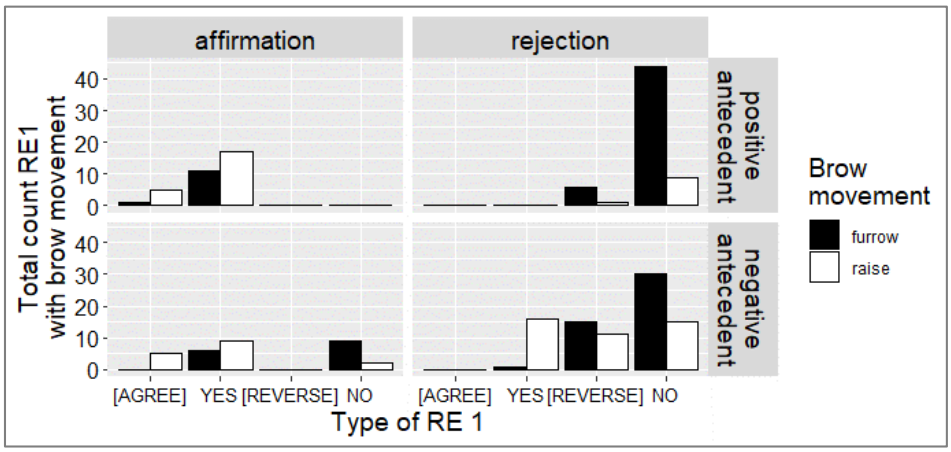

Figure 6. Brow movement on RE1. Distribution by RE1 type.

6.3 Combination of RE1 and RE2

160 utterances (18.4% of all utterances, 21.1% of utterances with RE1) contained a second RE (RE2). Descriptively, there were more RE2 in affirmations (30.1%) than in rejections (12.2%). Since even the simplest model with all random factors was a singular fit, we fitted a

model without the factor item, which confirmed the descriptive observation (b = 0.63, SE = 0.10, z = 6.12, p < 0.001; $m^{p:int}$). Participants used eight different manual RE2 and one mouthing (*ja* 'yes'), see Figure 7. By far the most frequent RE2 was the manual STIMMT 'that's correct' (n = 97, 60.1% of RE2).

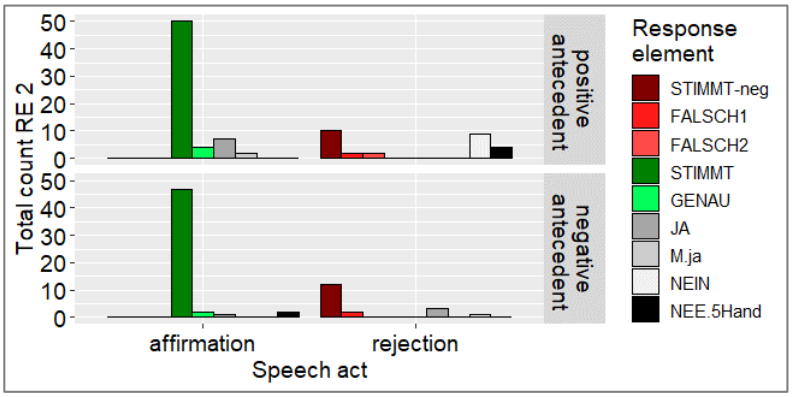

Figure 7. RE2 across the conditions (total counts)

Relation between RE1 and RE2. There were 37 different combinations of RE1 and RE2. The most frequent combinations were those involving STIMMT. In affirmations of positive antecedents, STIMMT followed JA 43 times and a head nod 7 times. In affirmations of negative antecedents, STIMMT followed JA 38 times, a head nod once, the mouthing *ja* once, and a head shake 3 times. To assess the potentially disambiguating role of RE2, we coded all RE1 and RE2 for ambiguity. RE2 has a potentially disambiguating function when it follows an ambiguous RE1 and is itself non-ambiguous. RE2 had this potential function more often in affirmations than in rejections (b = -0.93, SE = 0.35, z = -2.70, p < 0.01; $m^{p.sl:A\times SpA}$). This effect most probably is a consequence of the frequent occurrence of STIMMT after *YES*-type RE1, which is only appropriate in affirmations. Notably, there was no effect of antecedent whatsoever and no interaction (z < 0.36, p > 0.7). Whether or not non-ambiguous RE2 occurred more often after ambiguous vs. non-ambiguous RE1 in the different conditions could not be tested statistically due to the low number of data. Descriptively, a non-ambiguous RE2 followed an ambiguous RE1 more often than it followed a non-ambiguous RE1 (86.5% vs. 44.4%) but to what extent this interacts with speech act or antecedent needs to be tested in future research.

As for concord between RE1 and RE2, there were 7 instances of non-concord combinations. In affirmations of a negative antecedent there was [AGREE]^{RE1} + *NO*-type^{RE2} (n = 1, STIMMT + NEE.5Hand), and *no*-type^{RE1} + [AGREE]^{RE2} (n = 3; head shake + STIMMT). In rejections of negative antecedents, there was [REVERSE]^{RE1} + *yes*-type^{RE2} (n = 3, mouthing *doch* + JA).

7 General discussion and conclusion

The discourse completion experiment shows that DGS signers use a wide variety of both manual and non-manual REs. Concentrating on RE1 alone, we found that some REs are unambiguous because only one polarity feature maps onto them. For instance, only [AGREE] maps onto STIMMT, and only [REVERSE] maps onto FALSCH. Furthermore, there are feature combinations that map onto a RE1: [+, REVERSE] maps onto the mouthing *doch* and onto the manual DOCH but these RE1 were used infrequently. Other RE1 are ambiguous because two polarity features map onto them. Both [+] and [AGREE] map onto JA and onto the head nod, but head nods were infrequent without a manual RE1. Both [–] and [REVERSE] map onto NEIN, onto NEE.5Hand and onto the head shake.

Regardless of the articulator which produces them, ambiguous REs preferentially realize relative features. This suggests that MAXIMIZE RELATIVE is assigned great weight in DGS and that the head shake and the head nod are subject to this constraint. With respect to the head shake, this finding is surprising because the head shake also expresses sentential negation in DGS. Therefore, we had hypothesized that it would preferably realize the absolute feature [–], i.e. negative polarity. This was not the case. Overall, it seems that DGS is quite similar with respect to the high ranking of MAXIMIZE RELATIVE to the ambient contact language German, but recall that we do not have data yet about head movements in German. In any case, DGS seems to differ from the spoken languages reviewed in Section 3 in its use of the head nod. Mandarin, Catalan and Russian regularly use head nods in rejections with or without verbal REs, which is not the case in DGS.

EXPRESSIVENESS seems to be a constraint with small weight in DGS – certainly with a smaller weight than in German. In rejections of negative antecedents, the most frequent response strategies were NO-type REs (NO, NEE.5Hand, head shake), which only realize [REVERSE] in these contexts, and unambiguous [REVERSE]-type REs (STIMMT-neg, STIMMT-NICHT, FALSCH). As already mentioned, REs that express the feature combination [+, REVERSE] – mouthing *doch* and DOCH – were rare. Still, from the point of view of language contact it is notable that *doch*-like REs did occur, clearly suggesting influence from German. What is also notable in this context is that the two occurrences of the manual DOCH were accompanied by a head nod, which plausibly realizes [+] in rejections of negative antecedents. Exactly the same combination of feature realizations occurred in the more frequent combinations of JA [+] with mouthing *doch* [+, REVERSE]. As a matter of fact, 20 out of 24 occurrences of JA in rejections of negative antecedents were accompanied by this mouthing. This suggests that JA on its own is not regularly used as a rejection. Note that if combined with DOCH/*doch*, JA and the head nod most likely are redundant: DOCH/*doch* never occurred after positive antecedents, i.e. DOCH/*doch* cannot be purely rejecting and only encode [REVERSE]. Combinations of a RE1 with a non-manual such that one element expresses [+] and the other [REVERSE], e.g. a head nod combined with STIMMT-neg did not occur, except for the combination of STIMMT-neg with the truncated mouthing *stimmt*. We do not consider the latter as a realization of [+]. Neither did combinations occur where one element expresses [–] and the other [AGREE], e.g. a head shake combined with STIMMT. In sum, these findings suggest that following preference order for REs in rejections of negative antecedents: *NO*-type <>[REVERSE]-type > [+, REVERSE]-type > *YES*-type. An evaluation of this finding in terms of the feature model is a challenge because the realization of [+, REVERSE] by DOCH/*doch* violates no constraint that the realization of [REVERSE] would not also violate if MAXIMIZE RELATIVE has great weight in DGS, for which there is plenty of evidence. Neither a realization of [+, REVERSE] nor of [REVERSE] violates MAXIMIZE RELATIVE or MAXIMIZE MARKED; EXPRESSIVENESS penalizes [REVERSE] rather than [+, REVERSE]. For the time being we are assuming that there might be a lexicalization issue here: only few speakers use DOCH/*doch* at all so that these REs do not enter the candidate space for an optimality-theoretic evaluation.

The finding that in rejections of negative antecedents, *NO*-type and [REVERSE]-type RE1 were equally frequent may be considered surprising from the point of view of ambiguity avoidance: if ambiguity is to be avoided, [REVERSE]-type REs should be more frequent than *NO*-type REs. Considering that *NO*-type REs probably are used in responses to polar questions

whereas [REVERSE]-type RE plausibly are not, *NO*-REs might be used regularly after assertions simply because they are very frequent REs anyway. This issue needs to be tested in future research. Still, we did find some evidence for the pressure to avoid ambiguity. Overall, ambiguous RE1 were used less frequently after ambiguity-inducing negative antecedents than after positive antecedents. Furthermore, we found that in affirmations, JA was often followed by a disambiguating [AGREE]-RE2. Although this combination occurred both after positive and after negative antecedents, its frequent occurrence suggests that there is a need for non-ambiguity. Since a second RE can thus reduce the ambiguity of an otherwise ambiguous response, sequential combinations of REs must form part of the candidate space for an optimality-theoretic analysis of response strategies and should receive theoretical attention in future work. The same holds for potentially disambiguating follow-up sentences, which we have not considered here at all. A final aspect concerning ambiguity avoidance is the finding that RE1 occurred with, rather than without a non-manual more often after negative than after positive antecedents (mouthings) and more often in rejections than in affirmations (brow movements). The latter finding is not unexpected insofar as rejections are considered to be marked because disagreeing with an interlocutor is a dispreferred discourse move. Brow movements might be well-suited to signal such markedness because they generally result in the increased prominence of a linguistic structure. This has been shown for brow raises across a number of sign languages (Pfau and Quer, 2010). Also, as we saw in Section 3 for Mandarin, Russian, and Catalan, gestural elements in spoken language response systems may fulfil similar highlighting functions.

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