Gestural expression in narrations of aphasic speakers: redundant or complementary to the spoken expression?

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Abstract

According to the hypothesis that gesture and speech base on a common communicative intention but are two independent production processes, the two communication channels may have a trade-off relationship with one compensating for the other when necessary. In the case of aphasia, this would indicate that gesture can compensate for the deficiencies of the spoken expression.

We present a study in which naïve judges rated narrations of aphasic speakers with respect to only the information of the gestural expression. A second group evaluated exclusively the spoken expression of the same narrations. Comparison of the informational content of the two communication channels revealed that some of the severely impaired patients conveyed more information in the gestural modality than in the verbal modality. These results indicate that gesture can partly compensate for the impaired spoken expression.

Keywords: Aphasia; gesture; compensation

Introduction

Healthy speakers' gesture may add complementary or additional information to their spoken expression (e.g. Beattie & Shovelton, 1999). Under certain circumstances, gesture can even be used to replace speech. When talking to a person who does not speak the same language or in a noisy surrounding, gestures can be employed to compensate for the compromised spoken expression. If a communicative intention cannot easily be conveyed in a verbal utterance, gesture can be used to add the missing information. Studies on spatial expressions lend empirical support for this assumption: Melinger & Levelt (2004) showed that verbal utterances were less explicit with respect to spatial information when they were accompanied by gestures that expressed the critical information. Conversely, Graham & Heywood (1975) showed that speakers used more spatial expression in their spoken output when gesturing was not allowed. These studies describe a trade-off relationship of gesture and speech and they implicate that both modalities are independent, but tightly coordinated processes which originate from a common communicative intention (De Ruiter, 2000; Feyereisen, 1987; Kita & Özyürek, 2003). Other authors claim that the close linkage of temporal and semantic aspects of gesture and speech accounts for a single bimodal production process, throughout which gesture and speech remain inseparable (McNeill, 1985; McNeill, 2005).

Research on gesture in aphasia provides evidence for both views. On the one hand there are studies suggesting that the gestural output parallels the language disorder: Gestures of speakers with severe aphasia are more often opaque and less comprehensible than gestures of speakers with mild aphasia (e.g. Glosser, Wiener, & Kaplan, 1986; Mol, Krahmer, & van de Sandt-Koenderman, in press). Furthermore, gesture characteristics mirror the type of aphasia i.e. the characteristics of the spoken expression (Cicone et al., 1979). Another line of research supports a compensatory use of gestures in aphasia: Speakers with aphasia produce a higher total number of gestures (e.g. Feyereisen, 1983) and more speech-replacing gestures (Herrmann et al., 1988) than healthy speakers.

Apart from the relationship to aphasia, gesture has been shown to be related to non-verbal cognitive capacities like manual praxis (e.g. Borod et al., 1989) or semantic processing (e.g. Hogrefe et al., 2012).

In a recent study by Hogrefe et al. (under revision), naïve raters judged narrations separately for the comprehensibility of gestural and spoken expressions. Comparison of the two communication channels revealed that narrations of two patients with severe aphasia were better comprehensible on the basis of the gestural expression than on the basis of the spoken output. Six patients reached comparable ratings for both communication channels. The analysis did not allow us to draw conclusions on whether the communication channels in these six patients were employed in a redundant or in compensatory way.

In the present study we analyzed gestural and spoken expression of the same participants in more detail. We analyzed main features of the stories that were narrated and evaluated if the aphasic speakers displayed them in either speech or gesture (complementary) or in both communication channels (redundant).

Method

Participants

Sixteen right-handed participants with left hemisphere brain damage participated in the study. Patients are described in detail in Hogrefe et al. (under revision). We assessed aphasia with the Aachen Aphasia Test (Huber et al., 1983), which consists of five subtests (Token Test, naming, comprehension, repetition, and written language) and includes a *communication scale* on which a patient's verbal performance in a semi-structured interview is scored from 0 to 5.[1] Severity of aphasia varied from residual to severe. Furthermore, semantic processing capacities were evaluated with two non-verbal semantic odd-one-out tasks. Finally, apraxia was assessed by pantomime-to-command (Goldenberg et al., 2007). Participants were asked to mime the use of 20 common objects (e.g. cutting with scissors). On the basis of this task, four of the patients (1,2,13,16) were diagnosed as apractic.

All subjects gave informed consent to participate in the study which had been approved by the Ethical Committee of the Bavarian Medical Board.

Gesture elicitation

Gestures were elicited by a narration task. The stimulus materials consisted of seven short video clips. The first video clip served as a warm-up in which the experimenter gave feedback and asked questions to encourage participants to talk more vividly, if necessary. It was followed by three clips each taken from Mr. Bean-stories and from Sylvester and Tweety cartoon stories. The durations of the clips varied between 30 sec and 90 sec. The video clips were presented on a notebook computer. Participants were asked to retell the stories immediately after presentation in a vivid and descriptive manner, so that someone who had not seen the video should be able to understand what the story is about. Gesturing was not mentioned in the instruction.

[1] 0 = no comprehensible utterances and manifest impairments in comprehension; 1 = patient communicates through incomplete, mostly incomprehensible utterances; the listener has to guess or ask for more information; 2 = talking about familiar topics is possible with help of the communication partner, but the patient is frequently not able to convey the message; 3 = the patient is able to talk about problems of everyday life with only little support and conversation is difficult due to obvious language impairments; 4 = the fluency of speech production is reduced and / or some language impairments exist; 5 = no disturbance of verbal communication and / or minimal difficulties with speaking and / or patient reports difficulties with language that are not evident for the communication partner (paraphrased from AAT manual; Huber et al., 1983)

Analysis I

Information Contained in Gestural vs. Spoken Expression

Assessment of Information Contained in the Gestural Expression Comprehensibility of gestures was evaluated with a recognition task. The procedure is described in detail in Hogrefe et al. (under revision). Naïve healthy participants served as judges. The judges passed a familiarization procedure with the stimulus films. Afterwards, they were presented video tapes of patients narrating the contents of the stimulus clips, with sound tracks turned off. After each narration they had to indicate on a questionnaire which film had been retold (forced-choice paradigm). Subsequently and relevant for the present study, they were presented a list of the main features of the stories (e.g., taking a picture; polishing the buttons, dusting off the jacket) and were asked to check which of them they had detected. The six films contained a total of 43 features. Each film was evaluated by three different raters resulting in 18 judgments per patient. We calculated the percentage of correctly identified features for each film and averaged these recognition rates over the correctly recognized films (Feature Ratio). Features were included in the analysis only in cases of correct recognition of the films.

Assessment of Information Contained in the Spoken Expression Six native speakers of German judged the information content and comprehensibility of audio recordings of the narrations in the verbal condition. Three raters judged narrations of eight patients (2,3,5,6,9,10,11,15), whereas the other three judged narrations of the remaining eight patients (1,4,7,8,12,13,14,16). Due to problems with the microphone, three of the narrations of patient 9 had no sound. In this case the remaining three narrations were presented twice. Data of this patient was excluded from the second analysis. The narrations were presented in a randomized order, and the judges evaluated them with the same questionnaires and procedures as had been used for evaluation of the gestural output.

Results I

We evaluated the information contained in the gestural and the spoken expression separately (see methods). The *Feature Ratios* varied between 0 and 70 % (mean 38, SD 17) for the co-speech gestures, and between 16 % and 81 % (mean 39, SD 21) for the spoken expression.

There was no significant correlation between the *Feature Ratios* of the spoken expression and of the accompanying gestures. In the group analysis, *Feature Ratios* did not differ significantly from each other.

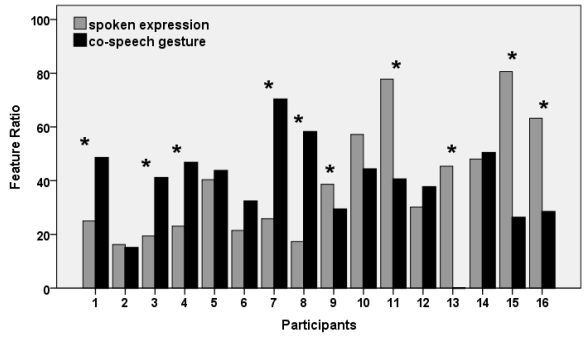

Figure 1: Features ratios of spoken (grey) and gestural (black) expression. Asterisks indicate a significant difference between the modalities measured on the basis of 18 judgments per modality and participant.

The evaluation of individual patterns on the basis of the 18 judgments per person and modality with the Mann-Whitney-U Test revealed that 5 of the patients conveyed more information in the gestural channel, whereas 5 patients displayed more information in the spoken expression. For 6 patients there was no difference between modalities (compare figure 1; participants are ordered according to their scores on the verbal communication scale of the Aachen Aphasia Test, with the most severe aphasia on the left side).

Predictors of the *Feature Ratios* *Feature Ratios* of co-speech gesture correlated with scores of the pantomime-to-command task ($r = .67$, $p < .005$) indicating an impact of apraxia on the ability to express comprehensible information through gestures. By contrast, *Feature Ratios* of the spoken expression correlated with all subtests and the verbal communication scale of the Aachen Aphasia Test (all $r > .56$, all $p < .05$).

Analysis II

Does Gesture Convey Complementary or Redundant Information as Compared to the Spoken Expression?

The mere comparison of the *Feature Ratios* for the gestural and the spoken expression does not allow determining the relationship between the two communication modes. To find out if gestures convey complementary or redundant information we analyzed the answers of the judges in more detail by determining separately for each feature if it was comprehensible in the gestural and / or the spoken expression. Each of the 43 features was evaluated by three judges and was regarded as comprehensible if it was at least marked by two of them. If a film was not recognized correctly, features were regarded as incomprehensible. Accordingly, we determined four scores:

- *No information*: number of features that were incomprehensible in both modalities
- *Redundant*: number of features that were recognized in both modalities
- *Gestural expression only*: number of features that were recognized exclusively in the gestural expression
- *Spoken expression only*: number of features that were recognized exclusively in the spoken expression

Results II

The four scores differed significantly from each other (Kruskal-Wallis-Test, $\chi^2_{(3)} = 59$, $p < .001$). Figure 2 illustrates the distribution of the four scores across the patient group.

To determine if the aphasic speakers use gestures primarily in a compensatory or in a redundant way, we compared the number of features that were expressed in both modalities (*redundant*) vs. the number of features that were expressed exclusively in gesture (*gestural expression only*). There was no significant difference between these two scores when the entire group was considered.

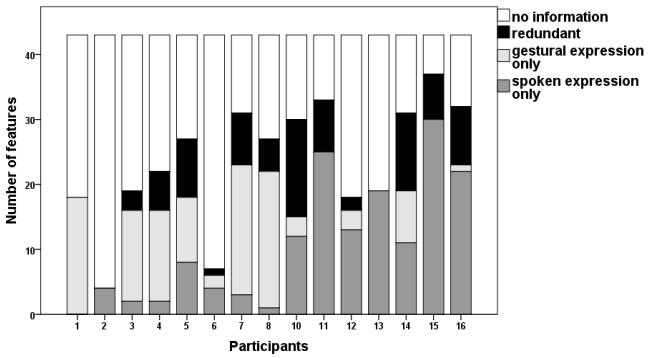

Figure 2: Distribution of features across modalities: features not captured in any of the modalities (*no information*), features recognized in gestural and in spoken expression (*redundant*), features only recognized in the gestural modality (*gestural expression only*), features only recognized in the spoken modality (*spoken expression only*).

To evaluate whether speakers with more severe aphasia, relied more on gestural communication, we divided the patients into two subgroups: The first group scored below 3 on the verbal communication scale of the Aachen Aphasia Test and, hence, displayed more severe aphasia (patients 1 to 8). The second group scored 3 or more on this scale indicating milder degrees of severity of the language disorder (patients 10 to 16). The comparison of the two scores (*gestural expression only* vs. *redundant*) revealed that patients with severe aphasia conveyed more information with *gestural expression only* (Mann-Whitney-U Test, $Z = -2.3$, $p < .001$). Conversely, the group with less severe aphasias used gesture more often in a redundant way with gesture expressing the same information as spoken expression (Mann-Whitney-U Test, $Z = -3.69$, $p < .001$).

Discussion

In the case of aphasia gesture can partly compensate for verbal deficiencies. Some participants with severe aphasia conveyed more information in gesture than in speech. Furthermore, most of the times the information contained in their gestural communication did not appear in the spoken output, indicating that these speakers used gesture mainly in a complementary way. This finding supports the assumption that gesture and speech are largely independent communication channels that can – at least to a certain degree – compensate for each other if necessary. On the other hand, speakers with milder forms of aphasia conveyed more information in spoken expression and gestures that occurred in these speakers were mostly redundant to the content of the spoken expression. Presumably, these speakers do not have to rely on gestural means for communication as their verbal capacities still are sufficient for conveying the content of the stories.

There remains, however, the possibility that the gestural output of aphasic patients does not differ between patients, but that the variability of verbal expression determines whether gestures are redundant or complementary to the spoken utterance. Future research should address this possibility. In particular, comparison to healthy speakers might reveal whether participants with aphasia convey more information through gesture than healthy speakers do.

Finally, in this study limb apraxia predicted the successful use of gestural communication. However, within the apractic participants we found individual differences that might be accounted for by other cognitive capacities like awareness or working memory. Both, the complementary use of gestures and the influence of apraxia on gesturing support the assumption that successful gestural communication in patients suffering from brain damage depends on non-verbal cognitive capacities.

Even though aphasic speakers may not use gesture in the same way as healthy speakers (Cocks et al., 2011; Mol et al., in press), gestures can be regarded as an important resource for communication in aphasia.

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