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Gesturing by aphasic speakers, how does it compare?

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Abstract

We compared gesturing by aphasic speakers to that of healthy controls, to see if gesture degrades with speech, or can be compensatory. We found that gestures by aphasics were less informative than those of controls, and that gestures by people with severe aphasia were less informative than those by people with mild aphasia. We also found that aphasics tended to use fewer representation techniques in gesture than healthy controls who were asked to use gesture instead of speech. These results suggest that in aphasia, gesture tends to degrade with speech, rather than it being compensatory. This implies that the processes underlying speech and gesture production may be tightly linked or shared.

Keywords: Aphasia, Gesture.

Introduction

Gesture and Speech Production

When speaking, people oftentimes produce hand gestures, which are closely linked to their speech temporally (Chui, 2005), structurally (Kita & Özyürek, 2003), and semantically (e.g. McNeill, 2005). For example, when asking a sales clerk for a sweater, gestures may indicate that we prefer a V-neck, a large front pocket, or one just like the one we are wearing. Both the production of speech and the production of gestures seem to be part of a speaker's communicative effort (Kendon, 2004). Although different functions of gesture have also been recognized, such as facilitating speech production (Krauss, 1998) and supporting cognition (Melinger & Kita, 2007), much empirical evidence has been gathered for the idea that gestures are communicative and are intended as such (e.g. Alibali, Heath, & Myers, 2001; Beattie & Shovelton, 1999).

McNeill (2005) argued that speech and gesture co-express idea units, which develop themselves into utterances. That is, that they are two sides of the same coin. In support of this idea, So, Kita, and Goldin-Meadow (2009) found that if information was lacking in speech, it tended to be missing in gesture as well. However, Melinger and Levelt (2004) found that speakers sometimes divide the content of their message across gesture and speech. They found that if critical spatial information was expressed in gesture, it was more likely to be omitted in speech. This goes well with the idea that gesture and speech production are complementary and can compensate one another, which also underlies the Tradeoff Hypothesis. This hypothesis states that "when speaking gets harder, speakers will rely relatively more on gestures", and vice versa (De Ruiter, Bangerter, & Dings, in press). Yet De Ruiter et al. found only little evidence that people gesture more when speech is harder. Rather, they found that gesture and speech tended to express similar types of information, consistent with the idea that gesture and speech are two sides of a coin.

Gesture Production and Aphasia

In light of the question of whether gesture and speech compensate for one another, it is interesting to study what happens to gesture when speech breaks down, such as in aphasia. Aphasia is an acquired language disorder caused by brain damage. It not only affects verbal expression, but has an impact on all language modalities. In our current study we focus on aphasic people who have severe to mild problems expressing themselves verbally.

Numerous studies have shown that aphasic people still gesture spontaneously and frequently (Rose, 2006). People with fluent aphasia may even gesture more informatively than non-aphasic speakers (Carlomagno, Pandolfi, Martini, Di Iasi, & Cristilli, 2005). Case studies and clinical experience confirm that some aphasic speakers use gesture effectively to communicate (e.g. Goodwin, 2002). This suggests that they may be able to partly compensate for their speech impairment with gesture. Yet does this mean their gesturing is unimpaired?

Studies that looked at gesturing by people with aphasia have mostly used the gesture coding scheme developed by McNeill (2005). For example, Carlomagno et al. looked at the informativeness of iconic gestures, which are gestures that mostly depict entities or movements. Yet when producing an iconic gesture, there are still different ways in which we can depict (Cienki & Müller, 2008). For example, if we want to depict a sweater, we can outline the shape of it, or we can pretend to put it on. And if we are talking about a car, we can move our hands as though steering it, or we can let our hand represent the car, depicting its path with our hand movement. So there is more to say about a gesture's form than just that it is an iconic gesture. And being able to produce a meaningful iconic gesture does not mean that all these different representation techniques are intact. Therefore, to know whether gesture is impaired in aphasia, we need to study both its meaning and its form, and we need to compare aphasic speakers to non-aphasic controls.

Cocks, Dipper, Middleton and Morgan (2010) drew a detailed comparison between gestures produced by a speaker (LT) with conduction aphasia and those of non-aphasic speakers. They found that LT's gestures during word finding problems differed from those accompanied with fluent speech by herself and the control speaker. For example, most of those gestures outlined shapes. They also found that the differences in LT's gesturing paralleled the differences in her speech, suggesting that although LT could still use gesture effectively, her gesture production was impaired, much like her speech production. Cocks et al. call for a study in which iconic gestures of a larger number of aphasic and non-aphasic speakers are compared. This is what we do in our current study.

Present Study

To assess whether or not gesture tends to be impaired in aphasic speakers, we compare gestures by 26 people with milder or more severe aphasia to those of 17 non-aphasic controls. New to our approach is the combination of a detailed gesture analysis with a larger number of aphasic speakers. In addition, we not only compare gestures of aphasic speakers to those of control speakers, but also to gestures produced by controls when they were asked to communicate by gesture alone. This gives us insight into how people with an unimpaired gesture production system would compensate for speech with gesture.

First, we look at the intelligibility of gestures. If aphasic speakers compensate for speech with gesture, we expect their gestures will be more informative than those of non-aphasic speakers, who can rely on speech more. Also, the more impaired speech, the more informative gesture will be. Alternatively, if speech and gesture are two sides of a coin, and therefore also break down together, the opposite is expected. We test this by means of three perception experiments, in which we separately assess the informativeness of verbal and nonverbal communication of people with milder and more severe aphasia and healthy controls, on an easier and harder communication task.

Second, we present a detailed analysis of the iconic and deictic gestures produced by aphasics and controls, zooming in on their representation techniques. If their gesturing is unimpaired, the techniques used by aphasic speakers may resemble the techniques used by non-aphasic speakers. If aphasic speakers compensate for speech with gesture, the techniques they employ may be similar to those of non-aphasics who are asked to communicate without speech. On the other hand, if their gesturing is impaired, this may affect some techniques more than others, and therefore aphasic speakers may prefer different techniques than non-aphasic speakers or gesturers, and there may be differences in the techniques used by people with milder and more severe aphasia.

Perception Experiments

Material

We used video clips of 26 native Dutch stroke patients with aphasia (17 male). Types of aphasia included: Global (8), Broca (2), Wernicke (3), Anomic (1), Conduction (1), and non-classifiable (7). For 4 patients the type of aphasia was not known. The mean age was 56 years, range 37 – 70. The mean time post-onset was 24 months, range 1 – 152. All patients gave their informed consent for the use of their data for research purposes.

The patients were performing an experimental version of the Scenario Test (Van der Meulen, Van de Sandt-Koenderman, Duivenvoorden, & Ribbers, 2009). This test measures a person's ability to functionally communicate, in a dialogue setting. The clinician takes part in the communication process and actively suggests the use of alternative means of communication, such as gesture. We used data from two subtasks. In the sweater task, the patient is explained a scenario in which they are in a store and want to buy a sweater. The clinician talks about a sales clerk approaching and asking: "How may I help you?". The patient is then to communicate as though addressing the sales clerk, for example by saying: "I would like to buy a sweater". In the accident task, the information to be conveyed is more complex. The clinician explains a scenario in which the patient witnessed an accident, in which a car hit a biker. A police officer then approaches the patient asking: "What happened?". The patient is then to explain what took place, as though addressing the officer.

Apart from the videos of aphasic speakers, we also used video data of non-aphasic controls, who were matched for age and educational level, and did the same test items with a trained tester. They were allowed to speak on one subtask (verbal control) and were asked to communicate using gesture exclusively on the other (nonverbal control).

We cut out fragments of the videos of all people performing the two subtasks, starting right after the final question posed by the clinician, and stopping right before the next change of turn. Out of these fragments, we made three stimulus movies for our perception studies: one containing all fragments of aphasic speakers, one containing all fragments of the verbal controls, and one with all fragments of the nonverbal controls. For the aphasic speakers and the verbal controls, we created three versions of these stimulus movies: one with just the video image and no sound, one with sound and blank video, and one with both image and sound. The clips of the nonverbal controls were video image only, that is, without sound.

Raters and Task

Raters were native Dutch students from Tilburg University. They performed a forced choice task, in which they were asked to judge whether the person in each clip of the stimulus movie was communicating that they wanted to buy a sweater, or that they had witnessed a car accident.

We did three separate perception studies, with different raters. In the first study, we used the stimulus movies of the aphasic speakers only. Raters saw the video clips without sound, heard the audio clips without video, or saw and heard the video clips with sound. The second perception study was similar, but with the stimulus movies of the verbal controls instead. Finally, we also did a perception test with the stimulus movie of the nonverbal controls.

Analysis

Based on their score on the ANTAT test (Blomert, Koster, & Kean, 1995), which is similar to the Scenario test but in which only verbal communication attributes to a patient's score, the aphasic speakers were divided into two groups. Speakers with a score below 30 (out of 10 – 50) were labeled as speakers with severe aphasia, and speakers with a score above 30 were labeled as speakers with mild aphasia. Clearly, this division serves our statistical analysis rather than it being meaningful at the level of an individual speaker. There were 11 speakers in the mild aphasia group and 15 in the severe aphasia group. Since we ran our perception experiments separately, we present three separate analyses of variance. For pairwise comparisons we used the LSD method, with a significance threshold of .05. Our dependent variable in each analysis is the ratio of correct answers to all answers, averaged over raters.

Results

Table 1 shows the means and standard deviation of the ratio of correct answers, for clips from each group of 'speakers', for either task, and for each modality in which they were shown to the raters. Performance at chance level would render a score of .5. We first present an analysis of the study with clips from the two groups of aphasic speakers. We performed an ANOVA with Group (Severe aphasia, Mild aphasia) and Task (Sweater, Accident) as within factors and Modality (Visual, Audio, Audiovisual) as a between factor. There were 15 raters in each cell, 45 in total.

All factors showed a main effect. The ratio of correct answers was higher when judging speakers with mild aphasia (M = .89) compared to speakers with severe aphasia (M = .70), $F(1, 42) = 205.70$, $p < .001$. It was also higher when judging clips from the accident task (M = .82) than of the sweater task (M = .77), $F(1, 42) = 10.16$, $p < .01$. Performance was worse with the visual presentation (M = .66), compared to the audio-visual (M = .88) and audio presentation (M = .85), $F(2, 42) = 68.78$, $p < .001$. The difference between the latter two showed a trend towards significance, $p = .07$.

Table 1: Means and standard deviations of the ratio of correct answers.

		Ratio Correct per Modality		
Group	Task	Visual	Audio	AV
Severe Aphasia	Sweater	.51 (.16)	.74 (.10)	.73 (.11)
	Accident	.66 (.10)	.75 (.10)	.84 (.10)
Mild Aphasia	Sweater	.79 (.13)	.90 (.05)	.96 (.07)
	Accident	.70 (.14)	1.0 (.00)	1.0 (.00)
Verbal Control	Sweater	.78 (.14)	1.0 (.00)	1.0 (.00)
	Accident	.74 (.11)	.99 (.03)	1.0 (.00)
Nonverbal Control	Sweater	.95 (.06)	-	-
	Accident	.90 (.06)	-	-

The interaction between Group and Modality was not significant, $F < 1$. There was a three-way interaction between Group, Task and Modality, $F(2, 42) = 14.01$, $p < .001$. Gestures of speakers with mild aphasia were particularly more informative than those of people with severe aphasia on the sweater task, whereas the difference in informativeness of speech was larger on the accident task.

Our next analysis compares the judgment of clips from speakers with mild aphasia to that of clips from the controls when they were allowed to speak (verbal controls). We used an ANOVA with Task as a within factor and Group and Modality as between factors. For clips from aphasic speakers, there were 15 raters per cell, and for clips from non-aphasic speakers there were 16 raters per cell, summing up to 93 raters in total.

There was a main effect of Group, $F(1, 87) = 4.05$, $p < .05$. The ratio of correct answers was higher when judging clips from the verbal controls (M = .92) compared to those of speakers with mild aphasia (M = .89). There also was a main effect of Modality, $F(2, 87) = 115.78$, $p < .001$. Performance was worse in the visual modality (M = .75), compared to the audio (M = .97) and audiovisual modality (M = .99). The interaction between Group and Modality was not significant, $F < 1$.

There was a two-way interaction between Modality and Task, $F(2, 87) = 15.75$, $p < .001$. In the visual modality, performance was slightly better on the sweater task, whereas in the audio modality it was slightly better on the accident task. There was a three-way interaction between Group, Modality, and Task, $F(2, 87) = 7.09$, $p < .001$. When judging aphasic speakers, raters experienced a benefit from access to visual information on top of audio information for the sweater task. There was no such benefit for the accident task, or when judging verbal controls, because performance on the audio only clips was already at ceiling.

Lastly, we present an analysis comparing the judgment of visually presented clips of the controls when they could speak and when they could not speak (nonverbal controls). There were 16 raters in each cell, 32 in total. Task was again the only within factor. There was a main effect of Group,

$F(1, 30) = 24.84$, $p < .001$. The ratio of correct answers was higher for clips of nonverbal controls ($M = .93$) compared to clips of verbal controls ($M = .77$). We did not find a main effect of Task, $F < 1$, but there was an interaction between Group and Task, $F(1, 30) = 8.85$, $p < .01$. For verbal controls, performance was better on clips of the sweater task whereas for nonverbal controls performance was better for clips of the accident task.

Discussion

Clips from speakers in the mild aphasia group were judged more accurately than clips from speakers in the severe aphasia group for audio, video, and audiovisual clips. This indicates that nonverbal communication may break down with verbal communication, rather than it taking on the role of verbal communication. This is confirmed by the fact that clips from verbal controls were in turn judged better than those of the mild aphasia group, independent of whether they were presented visually, auditory, or audiovisually.

The almost perfect scores on the clips of nonverbal controls show that, in principal, gesture can largely compensate for speech on this simple judgment task. It therefore seems that people with (severe) aphasia cannot use gesture as freely as healthy controls to compensate for speech. Yet although generally the audio information was more informative than the visual information, the audiovisual presentation sometimes rendered still higher scores. This shows that information in gesture and speech was not fully redundant either. For some aphasic speakers, seeing them too was apparently more informative than just hearing them. This may mean that gesture did take on some of the communicative burden.

Seeing a speaker of course provides more information than just gestures. We think however that gesture was the most important nonverbal cue in our clips. Since many people hardly spoke intelligibly, lip movements for instance were not very informative.

Gesture Analysis

We coded the (co-speech) gestures in each of the clips used in our perception studies, starting with the scheme by McNeill (2005). We coded all movements of the hands that seemed relevant to the communication task and that co-occurred with speech. Since the gestures, or rather pantomimes, of the nonverbal controls always occurred without speech, these were coded despite the absence of speech. We currently focus on *representational gestures*, that is, gestures referring to the content of the message being conveyed. In our current sample these consisted of *iconic* and *deictic* gestures. Deictic gestures for example include locating objects in the gesture space and pointing gestures.

Based on work by Müller (2008), we further coded all iconic gestures into three categories, based on the representation technique used to depict. Gestures that outlined something in the gestures space, either by showing its contour (2D) or molding its shape (3D) were labeled as *outlining/molding*, for example drawing the outline of a sweater in the air. Gestures that depicted the handling of a virtual object, such as holding the hands up as if using a steering wheel to depict a car, were labeled as *handling*. Gestures in which the hands represented an object, or in which the entire body depicted the body of another person were labeled as *object/enact.* Examples are moving an upright hand forward and then flipping it horizontally, to depict that a biker fell, or shifting the upper body from a vertical to a horizontal position, depicting the same event. Although theoretically possible, we found it too opaque to code deictic gestures into these categories. Therefore, such gestures were only labeled as *deictic.*

Analysis

We conducted 4x2 ANOVAs with Group (levels: Severe aphasia, Mild aphasia, Verbal control, Nonverbal control) and Task (levels: Sweater, Accident) as fixed factors. Pairwise comparisons were done using the LSD method, with a significance threshold of .05. Our dependent variables are the mean proportion of gestures of a certain category that 'speakers' in a certain group produced. This is because we are interested in the extent to which the different representation techniques are used by each group, rather than in overall differences in gesture frequency.

Results

Table 2 provides an overview of the proportion of gestures produced of each type, by each group of participants on either task. Table 2 also shows the mean number of gestures produced of these types combined. Overall, more gestures were produced on the accident than on the sweater task, $F(1, 78) = 13.09$, $p < .001$. There also was a main effect of group $F(3, 78) = 8.42$, $p < .001$. The two groups of aphasic speakers did not differ significantly in the mean number of representational gestures produced. They produced more gestures than the verbal controls and fewer than the nonverbal controls.

Outlining/molding gestures were produced more with the sweater task than with the accident task $F(1, 65) = 4.18$, $p < .05$. Although there was no main effect of Group, post hoc analysis showed that people with severe aphasia produced a larger proportion of outlining/molding gestures than people with mild aphasia. There was no significant interaction between Group and Task, yet on the accident task, the severe aphasics also produced significantly more outlining/molding gestures than the verbal and nonverbal controls.

Handling gestures were produced more on the sweater than on the accident task, $F(1, 65) = 9.92$, $p < .01$. This is because the nonverbal controls were the only group who made considerable use of these gestures on the accident task, significantly more so than any other group. For the sweater task, there were no significant differences in the proportion of handling gestures between the groups.

Table 2: Means and standard deviations of the proportion of each gesture type, for each group and either task.

	Proportion of gestures per Group and Task							
	Severe Aphasia		Mild Aphasia		Verbal Control		NonVerbal Control	
	Sw N=15	Acc N=15	Sw N=11	Acc N=11	Sw N=8	Acc N=9	Sw N=9	Acc N=8
Outlining/Molding	.33 (.36)	.30 (.42)	.11 (.20)	.11 (.16)	.33 (.47)	.00 (.00)	.29 (.27)	.06 (.12)
Handling	.09 (.22)	.03 (.06)	.13 (.35)	.00 (.00)	.33 (.47)	.00 (.00)	.23 (.22)	.12 (.15)
Object/Enact	.00 (.00)	.05 (.16)	.00 (.00)	.09 (.14)	.00 (.00)	.00 (.00)	.05 (.10)	.48 (.15)
Deictic	.58 (.40)	.61 (.41)	.77 (.37)	.80 (.24)	.33 (.47)	1.0 (.00)	.43 (.17)	.34 (.16)
Mean N Gestures	2.3 (2.6)	4.6 (4.1)	3.0 (3.4)	5.7 (3.8)	.88 (1.1)	2.1 (1.8)	4.9 (1.5)	11 (8.9)

Object/enact gestures were produced more on the accident task than on the sweater task, $F(1, 65) = 29.08$, $p < .001$. There also was a main effect of Group, $F(3, 65) = 21.09$, $p < .001$, and significant interaction between Group and Task, $F(3, 65) = 13.25$, $p < .001$. The nonverbal controls produced a larger proportion of *object/enact* gestures than all other groups. This difference was larger on the accident task.

Deictic gestures were produced more on the accident task, $F(1, 65) = 4.34$, $p < .05$. There also was a main effect of Group, $F(3, 65) = 4.86$, $p < .01$ and a significant interaction, $F(3, 65) = 3.52$, $p < .02$. Post hoc analysis showed that on the accident task, the nonverbal controls produced smaller proportions of deictic gestures than any other group, and the verbal controls produced more deictics than the severe aphasics. On the sweater task, there were no significant differences between the groups, though the moderate aphasics tended to produce more deictics than the verbal and nonverbal controls, *p values* < .06.

Discussion

Clearly, the aphasic speakers were not using the same techniques to depict in gesture as the healthy controls who were not allowed to speak. This was most apparent on the accident task. While the nonverbal controls made frequent use of object/enact and handling gestures, the aphasics hardly used these techniques when trying to describe the car accident. For example, the nonverbal controls used their hand to represent a biker that first drove and then fell (the hand changing orientation), or they pretended to be the biker that fell, moving their upper body sideways. Aphasic speakers did not tend to use these object/enact techniques. Also, the nonverbal controls held their hands as though steering a car or a bike (handling). In our data sample, the aphasic speakers never did this. So the aphasic speakers did not make use of the techniques of object/enact and handling to compensate for their speech impairment, despite these techniques being very suitable to replace speech.

Both the verbal and the nonverbal controls produced a considerable proportion of outlining/molding gestures on the sweater task, indicating that on this task, this technique is suitable for producing co-speech gestures as well as to replace speech. Many people were outlining features of a sweater, such as a V-neck or sleeve length, with respect to their own body. Both groups of aphasics also used this technique on the sweater task, showing some similarity with the controls in the representation techniques used.

However, neither control group used outlining/molding much on the accident task. The nonverbal controls hardly used molding gestures to depict vehicles like cars, or bikes. Yet the aphasics did sometimes do this, instead of using techniques like object/enact or handling, like the nonverbal controls did. This may indicate that outlining/ molding was the only way of depicting in gesture that was available to most aphasics. The severe aphasics made more use of outlining/molding gestures than the mild aphasics, which may indicate a greater need to depict in gesture, possibly due to more word finding problems.

It thus may be the case that most aphasic speakers were unable to use the techniques of handling and object/enact to depict on the accident task. However, the verbal controls did not use these techniques on the accident task either. Therefore, given the task, these techniques may be more common for gestures replacing speech (pantomimes) than for co-speech gestures. It would be interesting to test whether aphasics can make use of these techniques when asked to pantomime. Although many aphasics were unsuccessful in explaining the accident scenario verbally, their attempts at speaking may have caused them to produce co-speech gestures rather than pantomimes. Our current data do not reveal whether aphasics would use different techniques when using pantomime.

General Discussion

Our perception studies showed that gestures produced by speakers with aphasia were less informative than gestures by non-aphasic speakers and by non-aphasics who used gesture instead of speech. Moreover, gestures by people with more severely impaired speech were less informative than those of people with milder speech impairment. It therefore seems that aphasic speakers could not compensate for their impaired expressivity in speech by gesturing.

Our analysis of gesture form showed that most people with aphasia may not be able to use all possible techniques for depicting in gesture freely. It seems that especially techniques which require access to conceptual knowledge of the thing depicted (object/enact and handling), were used relatively little by people with aphasia, while techniques using perceptual features (outlining/molding) were still available. There may thus be a problem translating conceptual knowledge into uttered speech and gesture (see McNeill & Duncan, 2010).

The finding that people with severe aphasia predominantly use outlining/molding to depict in gesture is consistent with the case study by Cocks et al. (2010), who found that LT used this type of gesturing frequently with difficulties in speech. This finding could be of use in clinical settings. For example, such gestures may be particularly suitable for training purposes. Also, it may facilitate understanding when others are aware that aphasic speakers use these gestures more widely than non-aphasic speakers.

Our studies into the informativeness of gesture, and our analysis of gestural representation techniques both suggest that like speech, gesture is impaired in most people with aphasia. It therefore seems that gesture and speech production are likely to break down together. This makes it likely, though not necessary, that the processes of speech and gesture production draw on many of the same resources, and share an underlying process (McNeill, 2005). Although further research is needed to study the links between gesture and speech production, our study contributes to the accumulating evidence that these links are tight, rather than gesture and speech production largely being separate processes. This unfortunately limits aphasic speakers' ability to communicate through co-speech gestures. Despite these limitations, some of the gestures they produce are informative, and add information on top of speech.

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