Towards an integrated view of gestures related to speech

Elisabeth Ahlsén
University of Gothenburg
Gothenburg, Sweden
eliza@ling.gu.se

Abstract

This study addresses the use of co-speech gestures in informal face-to-face interaction involving persons with and without aphasia (language disorder caused by acquired brain damage). A central question in aphasia research is whether gestures are better preserved when speech is impaired by aphasia and, if this is the case, can compensate for word finding problems in speech. This question is intimately related to the competing views between researchers who believe that gesture and speech are part of one system and generated in a totally interdependent way and researchers who believe that gestures and speech are generated by two different systems. In the first case, compensation would be impossible, whereas in the second case, compensation would be expected. A less categorical stance is suggested, based on an comparative empirical study of co-speech gestures in a database of 400 co-speech gesture produced by persons with and without aphasia.

1 Introduction

There are several reasons for studying co-speech gestures produced by persons with aphasia. (Gesture is here used in a wide sense for communicative body movements), one reason being the controversy concerning if and how the generation of gesture and the generation of speech are related. The idea of gestures possibly being more robust relates to the idea of gestures being evolutionary precursors of speech. There is a strong practical interest in finding out to what extent gestures can or cannot be used for compensation and how this can be used in communication therapy. It is also of great value to families and hospital staff to know more about if and how spontaneous gesturing can be used by persons with aphasia.

The theoretical controversy concerning the gesture-speech relation contains, on the one hand, (i) the view that speech and gesture are inextricably intertwined in development and generation (e.g. the growth point theory, which makes speech and gesture interdependent and simultaneous and which entails that if one is disturbed, so is the other (e.g. McNeill, 21992, 2000, 2007). On the other hand, (ii) the view that gesture and speech generation are two independent separate systems which means that gestures can replace or facilitate speech has been proposed, for example, by (Krauss et al., 2000, Hadar and Butterworth, 1997, Beattie and Shovelton, 2000, 2002, 2004). A less categorical view is that maybe gesture and speech generation are closely related but also to some extent independent. If gestures came earlier in evolution, they can be more robust and, thus, they can be candidates for compensatory use, either replacing words or adding information. Gestures can sometimes be more preserved in aphasia (e.g, Feyereisen et al., 1990, Ahlsén. 1985, 1991). There is, for example, the strong argument for stepwise evolution via less complex and more complex gestures to speech and language (from ”grasping an object” to ”Verb-Argument-structures”) presented by Arbib (2005), which draws on mirror neurons and the fact that Broca’s area developed on top of the mirror neuron (F4) area in the macaque

Related to this controversy, there is also the question whether gesture is mainly for the speaker or mainly for the hearer.

Some earlier findings in pursuing the questions above by studying mainly spontaneous gesture and speech production by persons with aphasia are the following. In persons with aphasia as a group an increase of

gestures in spontaneous speech can be found, compared to a reference group, i.e. a group with aphasia (although not all individuals) used significantly more gestures in spontaneous conversation than a matched group of persons without aphasia. Gestures were used spontaneously with compensatory function. Persons with severe apraxia (practically unable to produce actions, gestures, movements from instructions or to imitate them) still used spontaneous gesturing with compensatory function extensively. (Ahlsén, 1985, Macauley and Handley, 2005). Concerning the relation between action and communication, an Activity based Communication Analysis (c.f. Allwood, 2000, 2002) showed that a person with aphasia acquired a more favorable role and increased communicative ability in an activity which allowed action for communication, than in a pure verbal conversation activity. (Ahlsén, 2002)

Further support for a view that gesture use in aphasia can have a compensatory function was found in a case study of a person (HS) with an initially global aphasia which developed into a Wernicke's aphasia and further into a mainly anomic aphasia over a period of four years. HS was studied during three years of intensive treatment/courses (from 4 to 7 years post onset). Initially, he showed an extensive use of gestures – illustrating, pantomimic and others – together with a severe word finding problems. A decrease in gestures occurred, that paralleled an increased word finding ability (Ahlsén 1991), thus implying that the earlier use of gestures was not a general habit, but a compensatory use which disappeared when it was no longer needed.

The present study takes its point of departure in a perspective of embodied cognition and communication and is investigating gesturing behavior as a window to processing in finding and producing intended words or utterances. More specifically, it focuses on the correlation and complementarity of gestures and words.

The study relates to the following general questions: How much are gestures and words connected/intertwined in production? Are they disturbed in the same way when word finding problems occur? How much can gestures compensate for word finding problems?, and What can gestures tell us about the word finding process? The inclusion of data from persons with aphasia as well as the inclusion of "trouble spots" (see below) is intended to provide further information related to these questions.

2 Method

A corpus of 400 co-speech gestures associated with the production of content words and phrases in persons with and without aphasia was extracted from a corpus of video-recorded face-to-face interaction.

Two types of gesture contexts were included in two separate sub-corpora.

(i) The Verb-Noun (VN) Context: Gestures with representing/illustrating associated to the production of main Verbs and Nouns in fairly fluent speech

(ii) The Own Communication Management (OCM) Context_ Gestures associated with problems of word finding/word production involving other overt signs of own communication management (OCM) i.e. choice and change operations (cf. Allwood et al. 1990, Allwood et al. 2007).

The two subcorpora were identified with the purpose to study co-speech gestures both as related to verb and noun production (as examples of typical categorematic/content words) and to overtly manifested "trouble spots" in word finding/speech production.

For each of the two contexts a subcorpus of 100 gestures produced by persons with aphasia (The Aphasia corpus) and 100 gestures produced by persons without aphasia (The Reference corpus) was selected. Data was selected from 10 persons in each category. The corpus, thus contained four subcorpora with 100 co-speech gestures in each.

The corpus in total was coded according to the following coding schema.

- Share of noun versus verb context (for the VN context)
- Function (representational and/or OCM)
- Choice or change function (for the OCM context)
- Timing: stroke before, simultaneous with and/or after spoken "target word" (where a target word could be identified)
- Body part: 2 hands, 1 hand (left or right), head
- Gaze direction: towards the interlocutor or averted (specified for direction)

- Semantic features of content: shape, location, action, event
- Complexity features of hand movement: change of hand shape, complex hand-finger movements

Interrater reliability was ensured by originally coding an extended number of examples and subsequently chosing 100 examples for each of the four subcorpora where codings were in agreement between the two coders.

3 Results

A summarizing overview of the results is presented in Table 1 below.

Coded feature	Aph	Ref
Share of noun vs. verb context	49/51	44/56
Function: (repr in OCM context)	>30%	>30%
Choice vs. change function –	77/39	76/38
Gesture stroke before/simult. with word (VN context)	18/66	17/61
2 hands/1 hand		
VN context	32/64	46/54
OCM context	6/80	29/67
Head		
OCM context	35	12
Gaze at IL/averted		
VN context	70/30	96/4
OCM context	26/61	89/4
Semantic features:		
shape	36	26
location	23	13
action/event	60	72
Complex hand-finger movement	12	21

Aph = Aphasia database
Ref = Reference database

Table 1. Summary of results for selected features of gestures in relation to speech.

The share of noun versus verb contexts for gesturing turned out to be fairly similar for the aphasia and reference databases. However, the reference database contained more verb contexts than noun contexts, while this tendency was not as strong in the aphasia database. Furthermore, both the databases contained a number of action gestures for nouns as well as a number of shape gestures for verbs. This can mainly be explained by an action orientation of certain nouns, like ”keyboard”, which is illustrated by typing finger movements and an object/place orientation for certain verbs, like ”to bike”, which can be illustrated by a pointing gesture outlining a wheel.

In the verb-noun context, all the gestures contained illustrating/representational features. In the OCM context, however, the gestures tended to be self-activating, but a substantial share of these gestures (more than 30%), depending on the restrictions of the definition of illustrating feature as including some metaphoric gestures or not) also contained an illustrating/ representational feature, this tended to be somewhat more frequent in the aphasia database.

In the OCM context, the share of gestures with choice and change function, respectively, was the same in both the databases.

The timing of the gesture stroke in relation to the spoken ”target word” in the verb-noun context was the same in both the databases. Most often, the gesture stroke was simultaneous with the spoken word, but it can be noted that in 17-18% of the cases the gesture stroke preceded the spoken word.

As expected, the aphasia database contained more one-hand gestures, using the left hand, than the reference database. This applies to both of the contexts and, in general,, this can be seen as a consequence of an earlier or to some extent remaining right arm-hand hemiplegia. This, does, however, imply that the aphasia database contained less right hand and bimanual gestures. Especially bimanual gestures have been taken as a feature indicating an increased complexity of the gestures, compared to one-hand gestures.

There was also a considerable difference in the gaze direction during gesture production between the aphasia and reference databases, for both the contexts, although even more pronounced for the OCM context. The reference group in general upheld mutual eye contact with their interlocutors during gesturing, although somewhat less in the OCM

context than in the verb-noun context. The persons with aphasia, on the other hand, showed much more gaze aversion during gesturing in both the contexts, even in almost all the cases in the OCM context. Gaze aversion is generally taken as a sign of increased cognitive load and this is, then, an obvious feature related to word production and gesturing for persons with aphasia, even when no other overt signs of word finding problems are shown, as in the verb-noun database. It can also be noted that the gaze aversion can be further divided into subgroups like looking out into the air, looking down at the table, looking at one's own gesturing hands and seemingly looking at an imagined object or scene. The latter two of these subgroups did not occur in the reference database and can provide some cues related to the word-search/word-finding process. For example, looking at one's own gesturing hands has been interpreted as directing the gaze of the interlocutor to the gesture (cf. Gullberg and Kita, 2009) and can also relate to self-activation of information with the help of gesturing.

Some features of gesturing in both the databases were the occurrence of illustrating features in mainly self-activating gestures during word search and the occurrence of gesture strokes before the spoken word. There were, thus, certain possibilities of conveying compensating information via gesturing, when words are failing. Other common features were the action and object bias of a word sometimes overriding the related noun and verb word classes in the type of gesture, and the increased gaze aversion in cases of own communication management. Some differences were that the aphasia database, specifically, contained more one-hand gestures using the left hand (caused by hemiplegia), more gaze aversion, and more varied direction of gaze in cases of gaze aversion..

So what is the content of the gestures in the databases? When we turn to the semantic features of content, we find that the order of preference is the same in both the databases, with illustration of action/event being the most frequent feature, often accompanied by other functional features and some complexity on arm-hand movements, while illustration of action is less frequent and illustration of location, especially in relation to body, even less frequent. The two latter features co-occur quite often. In the aphasia database, however, the difference between action and object related gestures is smaller than in the reference database and there is, thus, more use of object and location features in the gestures produced by persons with aphasia.

4 Discussion

There are important similarities between the reference and aphasia databases in our study, which point to similar processing of both groups in generating gesture and speech production. It further points to a great deal of preserved gesture production in the persons with aphasia. Since the number of sampled gestures in the two databases was the same, no conclusions about the amount of gesturing can be drawn in this study, only about the features of gestures in relation to speech and they seem to be similar to a great extent. (There are, however, findings of an increased use of gestures by persons with aphasia in informal communication, cf. Ahlsén, 1985, Lott, 1999), although the frequency of gesture is likely to be subject to individual differences as well as other influences, such as the activity type. Although gestures and speech seem to mostly be generated in close relation, it is not immediately determinable from this overview analysis how much they are interdependent during the completion of the expression. The findings that the gesture stroke sometimes occurs before the spoken word and that some of the self-activating gestures related to own communication management in speech contain illustrating/representing semantic features indicate a possible discrepancy in timing as well as semantic content between gesture and word in the actual expression. The cases where a person with aphasia looks at his/her own gesturing hands or an imagined object or scene also point to a possible function of the gesture in evoking the spoken expression in the production of the speaker and/or the comprehension of the interlocutor. It seems likely that gestures can have a double function in both being of help for the producer and the recipient (or co-producer). See also studies by Rauscher, et. al. (1996), Kita (2000), Melinger and Kita, (2006), Ruiter (2006) and Morrel-Samuels and Krauss (1992).

There are, thus, features of co-speech gestures that make it possible for them to fill some compensatory functions. This does not, however, entail that the gestures are

necessarily intact, i.e. there is no evidence in the data that gesturing is not *at all* affected by the aphasia, even if gesturing is to a great extent functioning adequately in relation to speech. There are certain findings in our data that suggest that gesturing might be affected, in a primary and/or possibly secondary manner, in the persons with aphasia. These findings are that the semantic features of gestures are more related to objects, shapes and location in relation to the body and less related to action and complex functional movements in the aphasia database than in the reference database. The complexity of one-hand gestures produced by persons with traces of hemiplegia seems generally lower than that in the reference data, making this secondary influence hard to distinguish from a possibly more primary influence of a lower semantic complexity. From this overview data analysis, it can, thus, both be hypothesized that gestures in the aphasia group can be somewhat affected in relation to the aphasia (in a primary as well as a secondary way) and that gestures have the potential for compensatory use in cases of word finding problems. There is a possibility for some inter-dependence, as well as for a certain independence between gesture and speech.

There are a number of caveats related to overview results and necessitating a further, more detailed study of each co-speech gesture in its context. One such caveat is that while it is important to capture co-speech gestures in informal face-to-face interaction, this also involves a certain variation in the topics of discussion and there is some variation in topics between the two databases. Individual personalities and ways of expression of the subjects can also, to some extent, influence the selected databases, even though the selection was based on consecutive occurrences in 10 different persons for each of the two databases. Most of this possible influence was probably eliminated by the sampling procedure, but there might still be some differences and this will be the subject of further studies of the vocabulary co-occurring with the gestures.

Acknowledgements

We want to thank the Swedish Research Council for supporting this study (grant VR421 2006 1434)..

References

Ahlsén, E. (1985). *Discourse Patterns in Aphasia. Gothenburg Monographs in Linguistics* 5, University of Gothenburg, Department of Linguistics.

Ahlsén, E. (1991). "Body communication and speech in an Wernicke's aphasic - A longitudinal study", *Journal of Communication Disorders* 24, 1-12.

Ahlsén, E. 2002. Speech, vision and aphasic communication. In, Mc Kevitt, P., O'Nualláin, S. & Mulvihill, C. (eds) *Language, Vision and Music*. Amsterdam: John Benjamins, pp. 137-148.

Allwood, J. (2000). An Activity Based Approach to Pragmatics". In Bunt, H., & Black, B. (Eds.) *Abduction, Belief and Context in Dialogue: Studies in Computational Pragmatics*. Amsterdam, John Benjamins, pp. 47-80.

Allwood, J. (2001). Capturing Differences between Social Activities in Spoken Language. In Kenesei, I., & Harnish, R.M. (Eds.) *Perspectives on Semantics, Pragmatics and Discourse*. Amsterdam: John Benjamins, pp. 301-319.

Allwood, J., Ahlsén, E., Lund, J. & Sundqvist, J. (2007). Multimodality in own communication management. In J. Toivanen & P. Juel Henrichsen (Eds*.) Current Trends in Research on Spoken Language in the Nordic Countries*, Vol. II:, Oulu: Oulu University Press, pp. 10-19.

Arbib, M. (2005). From monkey-like action recognition to human language: An evolutionary framework for neurolinguistics. *Behavioral and Brain Sciences*, 28(2):105--124.

Beattie G.W., Shovelton H. K. (2004). Body Language. *Oxford companion to the mind*. Oxford University Press.

Beattie, G.W., & Shovelton, H. K. (2000). Iconic hand gestures and predictability of words in context in spontaneous speech. *British Journal of Psychology, 91*, 473-492.

Beattie, G.H., & Shovelton, H.K. (2002). An experimental investigation of some properties of individual iconic gestures that mediate their communicative power. *British Journal of Psychology, 93*, 179-192.

Feyereisen, P., Bouchat, M.-P., Dery, D., & Ruiz, M. (1990). The concomitance of speech and

manual gesture in aphasic participants. In E. Hammond (Ed.), *Cerebral control of speech and limb movements* (pp. 15–21). North Holland: Elsevier Science.

Gullberg, M. and Kita, S. (2009). Attention to speech-accompanying gestures: Eye movements and information uptake. *Journal of Nonverbal Behavior* 33(4): 251-257.

Hadar, U. & Butterworth, B. (1997. Iconic gesture, imagery and word retrieval in speech. *Semiotica*, 115, 147-172.

Kita, S. (2000). How representational gestures help speaking. In D. McNeill (Ed.), *Language and gesture: Window into thought and action*, pp.162–185. Cambridge, UK: Cambridge University Press.

Krauss, T. M., Chen, Y. & Gottesman, R. F. (2000). Lexical gestures and lexical access: a process model. In D. McNeill (Ed.), Language and gesture (pp. 261-283). New York: Cambridge University Press.

Lott, P. (1999). *Gesture and Aphasia*. Bern: Peter Lang.

Macauley, B.L. & Handley, C. (2005). Conversational gesture production by aphasic patients with ideomotor apraxia. *Contemporary Issues in Communication Sciences and Disorders 32*, 30-37.

McNeill, D. (1992). *Hand and Mind.* Chicago : The University of Chicago Press.

McNeill, D. (2000). *Language and gesture*. Cambridge : Cambridge University Press.

McNeill, David (2007). *Gesture and Thought*. Chicago: University of Chicago Press.

Morrell-Samuels, P. & Krauss, R. M. (1992) Word familiarity predicts temporal asynchrony of hand gestuers and speech. *Learning, Memory, and Cognition* 1992, Vol. 18, No. 3, 615-622.

Rauscher, F.H. **,** Krauss, R.M., & Chen, Y. (1996). Gesture, speech and lexical access: The role of lexical movements in speech production. *Psychological Science*, 7 (4), 226-231.

De Ruiter, J.P. (2006). Can gesticulation help aphasic people speak, or rather, communicate? *Advances in Speech-Language Pathology 8(2)* p.124-127.