The effect of emblematic and tool-use gestures on abstractness evaluations of verbal utterances

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Abstract

Gestures often accompany verbal conversation and differ widely in their content and function. Emblematic and tool-use gestures are similar in that they both carry specific meaning, but vary with regard to the abstract-social vs. concrete-tool-related content. Here we investigated the effect of emblematic (EM) and tool-use (TU) gestures on the evaluation of the abstractness of corresponding verbal utterances. We hypothesized that the evaluation of EM and TU utterances will be differentially influenced by meaningful (MF) vs. meaningless (ML) co-verbal gestures. In fact, in addition to significant main effects (EM vs. TU and MF vs. ML), we also found significant interactions between gesture type (EM/TU) and gesture meaning (ML/MF). These results indicate that gesture semantics had a different influence on the evaluations of abstract-social and concrete-tool-use utterances. Whereas subjects were generally able to differentiate between concrete vs. abstract sentence contents, we observed a specific gesture advantage for the evaluation of the abstractness of tool-use utterances as indicated by faster responses (TU-MF faster than TU-ML) and higher concreteness evaluations (TU-MF more concrete than TU-ML). Motor simulation processes as well as more prominent embodied representations of tool-use utterances might be responsible for this gesture type specific effect on the processing and evaluation of speech-gesture information.

Keywords: emblematic gesture, tool-use gestures, abstract language content, subjective evaluations, reaction times

Introduction

Verbal discourse is often accompanied by gestures that communicate information, but differ widely in their content and function (e.g., Goldin-Meadow & Alibali, 2012; Goldin-Meadow, 1999; Iverson, Goldin-Meadow, Ferris, & Palenik, 1998; Kendon, 2004; McNeill, 1992, 2005). One important type of gestures, which are called 'emblems' (Ekman & Friesen, 1969) - or 'emblematic gestures' (Efron, 1972) - (such as the hand signal for 'OK' or the 'thumbs-up' motion) do not bear any physical similarity to what they convey. Even though emblems are meaningful by themselves, they often accompany speech. In everyday communication, emblematic gestures are often used to express information about social life or interpersonal situations. They usually refer to abstract concepts, such as feelings (e.g., the strike gesture), evaluations (e.g., thumbs down) or orders (e.g., beckoning somebody over).

Another type of communicative gestures, iconic gestures (terminology of McNeill, 1992), resemble what they convey, such as when someone holds his hands apart to indicate width, illustrates a shape (e.g., circle) or demonstrates a movement (e.g., a rotation). Iconic gestures generally refer to concrete and descriptive properties of objects rather than abstract interpersonal information (Straube, Green, Jansen, Chatterjee, & Kircher, 2010). They can also illustrate the use of tools (e.g., using a hammer) and are thus often referred to as "tool-use gestures" (Higuchi, Imamizu, & Kawato, 2007; Johnson-Frey, Newman-Norlund, & Grafton, 2005; Ohgami, Matsuo, Uchida, & Nakai, 2004). Tool-use gestures can also be described as specific kind of pantomime gestures (e.g., (Willems, Ozyürek, & Hagoort, 2009) which are - in contrast to other iconic gestures - in general highly understandable even without accompanying speech.

Thus, emblematic and tool-use gestures are similar in that they both carry specific meaning (even without a speech context), but differ with regard to the abstract-social vs. concrete-tool-related content. Although concreteness is not a binary variable, there is some indication that a few factors (especially physical in contrast to interosceptive/emotional features) should broadly distinguish concrete and abstract utterances (e.g., Wiemer-Hastings & Xu, 2005). Since gestures might support especially the processing of communicated physical perceptual features, we investigated the effect of emblematic and tool-use gestures on the evaluation of abstractness of corresponding verbal utterances.

We hypothesized that meaningless (unrelated) or meaningful (related) co-verbal gestures have a different influence on the evaluation of emblematic and tool-use utterances. Overall, evaluations should be faster if utterances are accompanied by meaningful gestures. Furthermore, we expected that the effect of meaningful gestures on the evaluation of abstractness will be more supportive for tool-use gestures (inherently more concrete) than for emblematic gestures (inherently more abstract), since gestures might have a bias to be evaluated as concrete even if they are symbolic, thus leading to abstract utterances being evaluated as more concrete when accompanied by meaningful gestures. This is expected because gestures are inherently physical, visual, motoric and therefore more likely to support judgments about concrete motoric/tool-related utterances and might even distract from the appropriate abstractness evaluations of emblematic utterances.

To test this hypothesis we recorded video clips of an actor performing meaningful and meaningless versions of emblematic and tool-use gestures to corresponding social and tool-related utterances. Twenty healthy subjects were asked to evaluate these videos with regard to abstractness on a 7-point likert scale. As manipulation check, subjects had also to evaluate the content (social or object-related) and the semantic-relatedness between gesture and speech. As additional control variable, familiarity ratings were obtained for each video.

Method

Participants Twenty subjects (12 female, Age: M=23.45, SD=2.54) participated in this experiment. All were native German speakers and received 30€ compensation.

Materials Video clips of an actor performing meaningful and meaningless versions of emblematic (EM) and tool-use (TU) gestures to corresponding social and tool-related utterances were recorded. The actor performed each of the spoken sentences and corresponding meaningful gestures (MF) in a natural and spontaneous way. In a second step the same actor performed unrelated meaningless gestures (ML) to the identical sentences. Meaningless gestures corresponded in complexity to the original gestures and were created in order to be minimally distracting (no mismatch gestures). All video clips were 5s long with at least 0.5 s at the beginning and end of the clip during which the actor neither spoke nor moved (for the same procedure, see Green et al., 2009; Kircher et al., 2009; Straube, Green, Chatterjee, & Kircher, 2011; Straube et al., 2010). Standardized video recording and preparation resulted in an unequal final number of videos per condition.

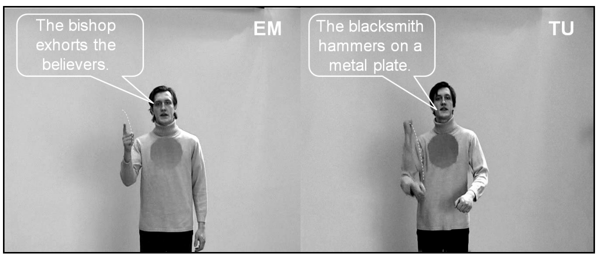

Fig. 1 Stimulus material (meaningful examples)

Procedure After a careful instruction, participants were asked to evaluate 47 emblematic (EM) and 57 tool-use (TU) utterances accompanied by meaningful (MF) and meaningless (ML) gestures (total 208 videos) with regard to abstractness on a 7-point likert scale. As manipulation check, participants further had to evaluate the content (social vs. object-related; **SocObj**) of and the semantic-relatedness (**SemRel**) between gesture and speech on a 7-point likert scale. As additional control variable familiarity ratings (**Fam**) were obtained for each video. Thus, after each video four questions were presented to the participants (e.g. for familiarity ("To what degree does the utterance (content and gesture) seem familiar to you?"; 1=very low to 7=very high). Each question remained on the screen until it had been answered, than the next question appeared.

All 208 videos were presented in a pseudo-randomized order and counterbalanced across subjects. Rating and reaction time data for each question were obtained for the analyses.

Analyses Rating and reaction time (RT) data were analyzed (time locked to the respective question) using the generalized estimating equations (GEE) approach implemented in the PASW software (e.g., Straube, Wolk, & Chatterjee, 2011). The GEE approach was used to account for correlation among repeated measures over time using an AR (1) working correlation structure and robust (sandwich) covariance estimators for the regression coefficients. Predictors included in each model in addition to the intercept were the main effects 'utterance type (EM/TU)' and 'gesture meaning (MF/ML)' as well as the factorial interaction of 'utterance type' and 'gesture meaning'.

To ensure that differences between EM and TU are not based on differences in number of video clips, an equal number of 40 videos per condition were selected based on high familiarity ratings for the analyses.

Results

Abstractness rating

For the evaluation of abstract-/concreteness (AbsCon) we obtained a significant main effect for utterance type (TU>EM) and gesture meaning (MF>ML), indicating that tool-use utterances were generally evaluated as more concrete than emblematic utterances and that meaningful gestures were generally evaluated as more concrete than meaningless gestures (see Fig. 2, Tab. 1, 3).

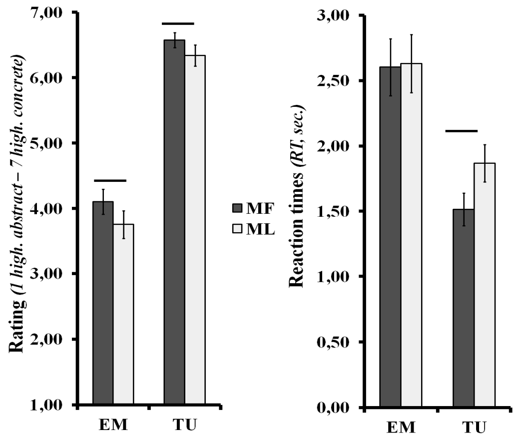

Fig. 2. Results: Abstractness ratings

Analyses of reaction times (RTs) revealed also significant main effects for utterance type (EM>TU) and gesture meaning (ML>MF; see Fig. 2; Tab. 2, 4), indicating faster categorizations of tool-use utterances as well as meaningful gestures. However, in contrast to the rating data we revealed also a sig. interaction (see Tab. 3; effect size: partial eta-square = 0.312) of both factors, indicating faster responses due to MF gestures only in the TU condition (see Fig. 2).

Table 1: Descriptive data of the rating.

	Emblematic				**Tool-Use**			
	Meaningful		***Meaningless***		***Meaningful***		***Meaningless***	
	M	***SE***	**M**	***SE***	**M**	***SE***	**M**	***SE***
AbsCon	4.10	0.19	3.75	0.22	6.58	0.12	6.34	0.16
Fam	6.02	0.10	1.83	0.15	6.02	0.15	1.62	0.12
SocObj	5.65	0.16	5.50	0.17	1.48	0.13	1.47	0.12
SemRel	6.33	0.08	1.72	0.11	6.50	0.08	1.62	0.11

Control variables

Manipulation check (content: social- vs. object-related; meaning: related vs. unrelated to speech content) and control variables (familiarity) have also been analyzed (for statistics see Tab. 1-4). These data support the difference of content (EM vs. TU) and semantic-relatedness (MF vs. ML) between conditions and indicate that ML gesture conditions are generally less familiar then MF conditions (see Tab. 1-4). However, EM and TU did not differ in familiarity.

Table 2: Reaction times of the rating.

	Emblematic				**Tool-Use**			
	Meaningful		***Meaningless***		***Meaningful***		***Meaningless***	
	M	***SE***	**M**	***SE***	**M**	***SE***	**M**	***SE***
AbsCon	2.60	*0.22*	2.63	*0.22*	1.51	*0.13*	1.87	*0.14*
Fam	1.98	*0.22*	1.98	*0.21*	1.49	*0.23*	1.50	*0.20*
SocObj	2.28	*0.21*	2.37	*0.22*	1.76	*0.18*	1.79	*0.18*
SemRel	2.33	*0.15*	2.46	*0.19*	1.97	*0.14*	2.05	*0.16*

To confirm that the observed effects for abstractness ratings and RTs are independent from effects in these control variables, the corresponding rating as well as RT data were included as covariate of no-interest in the GEE models for the analyses of abstractness ratings and RTs, respectively. All reported differences remained significant even after inclusion of these variables.

Table 3: Statistics of the rating data.

	Tests of Model Effects					
	Gesture		***Meaning***		***Interaction***	
	WCS[1]	*Sig.*	**WCS**	***Sig.***	**WCS**	***Sig.***
AbsCon	132.84	***<0.001***	12.31	***<0.001***	1.06	*0.303*
Fam	2.69	*0.101*	450.12	***<0.001***	3.99	***0.046***
SocObj	566.95	***<0.001***	10.57	***0.001***	8.23	***0.004***
SemRel	0.91	*0.340*	1036.98	***<0.001***	16.00	***<0.001***

Additionally, the analyses had been performed for all 208 videos and revealed the same result pattern, indicating stable differences between conditions. Ceiling effects are unlikely to account for an absent gesture effect on EM utterances considering the standard errors for the respective conditions, which were even higher for EM than for TU. Moreover, we performed a control analysis excluding trials with RTs longer than 2 seconds. Even in this analysis the interaction between factors remained significant.

Table 4: Statistics of the reaction time data.

	Tests of Model Effects					
	Gesture		***Meaning***		***Interaction***	
	WCS[1]	***Sig.***	**WCS**	***Sig.***	**WCS**	***Sig.***
AbsCon	50.473	***<0.001***	6.846	***0.009***	9.028	***0.003***
Fam	53.674	***<0.001***	0.002	*0.966*	<0.001	*0.989*
SocObj	16.248	***<0.001***	0.843	*0.358*	0.333	*0.564*
SemRel	11.126	***0.001***	1.227	*0.268*	0.149	*0.700*

Discussion

Human communication is composed of both spoken words and non-verbal actions such as gestures. Here we demonstrated the interaction of speech and gesture semantics during the evaluation of utterance abstractness. Whereas subjects are able to differentiate between concrete vs. abstract sentence contents as well as social vs. tool-related information independent of gesture meaning, we observed a specific gesture advantage for the evaluation of abstract-/concreteness for tool-use utterances as indicated by faster RTs and higher concreteness evaluations. These results indicate that corresponding gesture semantics had a different influence on evaluations of abstract-social and concrete-tool-use utterances.

In line with our hypothesis, our data suggest that meaningful gestures bias participants' evaluations towards higher concreteness values even if utterances are abstract-social. This apparently less accurate decision for utterances of the emblematic condition might be due to a better grounding of verbal information into an embodied motor representation (Chatterjee, 2010; Glenberg & Kaschak, 2002; Roy, 2005), if sentences are accompanied by meaningful co-verbal gestures. Thus, an abstract utterance appears more concrete to the participant, if it is accompanied by a meaningful emblematic gesture.

However, a behavioral advantage in terms of reduced reaction times occurred only for meaningful gestures which accompanied tool-use utterances. Motor simulation processes (Green et al., 2009; Péran et al., 2010) as well as a more prominent embodied representation of tool-use utterances (Aziz-Zadeh, Wilson, Rizzolatti, & Iacoboni, 2006) might be responsible for this gesture type specific effect on the evaluation of speech-gesture information.

The neural processes that underlie the perception and comprehension of co-verbal gestures have received

[1] WCS=Wald Chi-Square

increasing interest in the field of neuroscience (e.g., Ozyürek & Kelly, 2007; Ozyürek, Willems, Kita, & Hagoort, 2007; Straube, Green, Bromberger, & Kircher, 2011; Straube et al., 2010; Straube, Green, Weis, Chatterjee, & Kircher, 2009; Willems, Hagoort, & Ozyürek, 2007). Thus, future imaging studies might be able to support this interpretation by demonstrating different effects of gesture type and sentence content in perceptual, motor as well as language related brain regions.

Acknowledgments

This research project is supported by a grant form the 'Deutsche Forschungsgemeinschaft' (DFG: Ki 588/6-1), and from the 'Von Behring-Röntgen-Stiftung' (project no. 59-0002). B.S. is supported by the BMBF (project no. 01GV0615). We thank Janine Plonka for help with data acquisition and Isabelle Rondinone for the creation of the example figures.

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