Getting to the Point: The Influence of Communicative Intent on the Kinematics of Pointing Gestures

David Peeters (david.peeters@mpi.nl)
Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands
International Max Planck Research School for Language Sciences, Nijmegen, The Netherlands
Radboud University, Donders Institute for Brain, Cognition, and Behaviour, Nijmegen, The Netherlands

Mingyuan Chu (mingyuan.chu@mpi.nl)
Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands

Judith Holler (judith.holler@mpi.nl)
Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands
School of Psychological Sciences, University of Manchester, UK

Aslı Özyürek (asli.ozyurek@mpi.nl)
Radboud University, Center for Language Studies, Nijmegen, The Netherlands
Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands

Peter Hagoort (peter.hagoort@mpi.nl)
Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands
Radboud University, Donders Institute for Brain, Cognition, and Behaviour, Nijmegen, The Netherlands

Abstract

In everyday communication, people not only use speech but also hand gestures to convey information. One intriguing question in gesture research has been why gestures take the specific form they do. Previous research has identified the speaker-gesturer's communicative intent as one factor shaping the form of iconic gestures. Here we investigate whether communicative intent also shapes the form of pointing gestures. In an experimental setting, twenty-four participants produced pointing gestures identifying a referent for an addressee. The communicative intent of the speaker-gesturer was manipulated by varying the informativeness of the pointing gesture. A second independent variable was the presence or absence of concurrent speech. As a function of their communicative intent and irrespective of the presence of speech, participants varied the durations of the stroke and the post-stroke hold-phase of their gesture. These findings add to our understanding of how the communicative context influences the form that a gesture takes.

Keywords: Pointing Gesture; Communicative Intent; Gesture Production; Action Planning; Deixis.

Introduction

In everyday communication, people not only use speech but also meaningful hand gestures to convey information. One of the most intriguing questions in gesture research has been why such gestures take the physical form they do (Bavelas et al., 2008; Gerwing & Bavelas, 2004; Krauss, Chen, & Gottesman, 2000). The main focus so far in answering this question has been on gestures iconic in nature, i.e., gestures that in form and manner of execution visually resemble the simultaneously expressed meaning of the linguistic part of an utterance (McNeill, 1985), such as moving up and down one's hand when talking about a basketball game. Typically, such studies have varied aspects of the communicative context, such as the visibility of gestures or the knowledge speaker and listener mutually share. Amongst other things, these studies have shown that speakers design their gestures for particular recipients and produce more (e.g., Alibali, Heath, & Myers, 2001; Bavelas et al., 2008) as well as larger and more precise gestures when communicative intentions are enhanced (e.g., Gerwing & Bavelas, 2004; Holler & Stevens, 2007). Thus, iconic co-speech gestures seem closely linked to the speaker's specific communicative intent, and the particular form an iconic gesture takes depends on the context-bound communicative relation between speaker and addressee (see Holler & Wilkin, 2011).

In contrast, it is unclear how the form of *pointing* gestures changes as a function of the gesturer's communicative intent. Pointing is a foundational building block of human communication (Kita, 2003) and allows us to directly connect our communication to the material world that surrounds us (Clark, 2003). Pointing has received much attention in the literature from an ontogenetic viewpoint because of its role in paving the way for the acquisition of language (Butterworth, 2003; Carpenter, Nagell, & Tomasello, 1998; Tomasello, Carpenter, & Liszkowski, 2007), as well as from a phylogenetic viewpoint with respect to declarative pointing being a uniquely human form of communication in a natural environment (Call & Tomasello, 1994; Kita, 2003; Tomasello et al., 2007). In contrast, the exact form parameters that people vary in the production of pointing gestures in human adult communication remain largely unknown. Therefore, the present study aims at contributing further to our understanding of why adults' index-finger pointing gestures take the particular physical form they do in a communicative context.

There are some preliminary indications that suggest a relation between the form of a pointing gesture and the speaker's communicative intent. Cleret de Langavant et al. (2011) had participants repeatedly point to objects on a table in front of them. Two addressees were always sitting next to the table. At the onset of a communicative block, the participant was instructed to verbally address one of the addressees before the block started and was instructed before each trial of that block to point at a specific object for that addressee, who named the object after observing the participant's gesture. At the onset of a non-communicative block, the participant addressed nobody and was instructed before each trial to point at a specific object without having an addressee (and hence did not receive feedback from an addressee). Compared to the latter, non-communicative condition, the former condition yielded pointing gestures that had a trajectory and endpoint distribution that were tilted away from the addressee, arguably because the addressee's perspective on the target object was taken into account in the form of the gesture.

Everyday pointing gestures generally occur in a context in which two interlocutors share a joint attentional frame in which one person directs the attention of another person towards a location, event, or referent in the perceptual environment (Tomasello et al., 2007). An important prerequisite for a successful referential pointing gesture is that two interlocutors come to perceptually attend to the same entity or location and are mutually aware of the fact that they are both attending to the same thing (Clark, 1996). Therefore, instead of comparing a "communicative" situation (including addressing a listener and receiving verbal feedback) to a "non-communicative" situation (without addressing a listener and verbal feedback), as in Cleret de Langavant et al. (2011), we here compare two situations that are both communicative and differ only in the communicative intent of the speaker-gesturer. As a proxy of the communicative intent of the speaker-gesturer, we manipulate the degree of informativeness of the pointing gesture as a first factor in our design.

A second factor manipulated here is the presence of speech as a second modality. Pointing gestures often come with concurrent deictic speech such as spatial demonstratives (e.g., "this" and "that" in English). In the production of referring expressions, speech and gesture are tightly interconnected (Kendon, 2004; McNeill, 1992) and can be used independently or simultaneously to single out a referent (e.g., Bangerter, 2004), in contrast with iconic gestures that canonically come with speech. In the current study we manipulate the presence of such a second modality (speech) and explore the yet unaddressed question of whether the mere presence of speech as a second modality influences the form parameters people exploit in producing pointing gestures for their addressee, and whether the presence of speech interacts with our manipulation of communicative intent.

The current study looks at different subcomponents (or: parameters) of the pointing gesture. We focus on the planning duration of the gesture, the duration of the stroke and the post-stroke hold-phase, as well as the point in time at which the apex is reached after the visual presentation of a referent (Levelt, Richardson, & La Heij, 1985), and the amount of distance travelled by the pointing finger. Finally we also look at whether the synchronization of speech and gesture changes as a function of communicative intent.

Method

Participants

Twenty-four right-handed native speakers of Dutch (12 female; mean age 20.6), studying at Radboud University Nijmegen, participated in the experiment. They were compensated with 20€.

Experimental Design and Set-up

Participants were seated at a distance of 100 cm from a computer screen that was placed back-to-back with another computer screen (henceforth: the back screen). Stimuli were four white circles in a horizontal line on the top of the screen, mirroring four circles on the back screen. The circles could light up either blue or yellow. A second participant (a confederate; henceforth: the addressee) looked at the back screen and the participant's pointing gesture via a camera. Figure 1 shows the view of the addressee via the camera (converted to a grayscale image). On all trials, participants referred to the circle that lit up. The addressee noted on a paper form to which of the four circles the participant

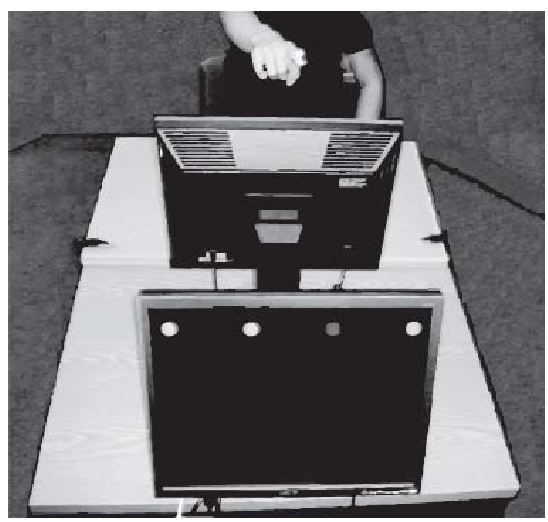

Figure 1: The addressee's view of the back screen and the pointing participant during a non-informative trial.

referred on each trial. In order to make the deictic act informative in one case but non-informative in the other, the following set-up was used. In both conditions, via a camera, the addressee observed the pointing gesture of the participant, as well as the circles at the back screen providing the corresponding view of the four circles the participant was seeing. This way, the addressee saw which of the four circles the participant pointed at, but without seeing which circle lit up on the participant's side of the screen, a crucial aspect in our manipulation (see below).

We manipulated the informativeness of the gesture (informative versus non-informative) as well as the modality of the deictic act (gesture-only versus gesture + speech) in a 2x2 within participants design. In the informative condition, a circle turned blue or yellow only on the participants' screen but not on the back screen. Therefore the participant's pointing gesture was the only source of information on which the addressee had to base his decision in selecting the circle referred to by the participant. In the non-informative condition, the corresponding circles would light up on both the participant's and the addressee's screen. Thus, the participant's pointing gesture was non-informative, because the addressee saw one of the circles light up on the back screen at the same moment as the participant saw the corresponding circle light up (i.e., even before the onset of the participant's pointing gesture).

The modality factor was manipulated by having participants use either one or two modalities in referring to the circles. In gesture only blocks (G-only), participants pointed to a circle when it turned blue or yellow without producing speech. In gesture + speech blocks (G+S) participants pointed to the circle and said either *die blauwe cirkel* ("that blue circle") or *die gele cirkel* ("that yellow circle"), depending on the color of the circle. Note that, because on every trial only one circle turned blue or yellow, the speech was never informative (neither in the informative nor the non-informative blocks). The rationale for this was that we were interested in the possible effect of the mere presence of speech as a second modality, independently from the informativeness of the deictic act that was manipulated separately in the gesture.

Each trial started with a fixation cross, displayed for 500 ms, followed by the presentation of four white circles. After a jittered period of 500-1000 ms, one of the circles turned yellow or blue. At this point, the participant was allowed to release her finger from a button, pointed to the blue or yellow circle, and named the circle (in the G+S blocks). The experiment consisted of 16 blocks of 20 trials each. Every condition in the experiment was represented by four blocks. The order of presentation of blocks was counterbalanced across participants. In half of the trials a circle lit up yellow, in the other half it lit up blue. The idea behind this was to create a slightly more complex and varied utterances to enhance the ecological validity in this very strictly controlled environment. Each block of 20 trials consisted of ten circles lighting up yellow and ten lighting up blue, equally distributed over the four circles and the four conditions throughout the experiment, in a randomized way.

Procedure

At the arrival of the participant, the experimenter explained that a second participant (i.e., the confederate addressee) would perform a behavioral task on the basis of the participant's gesture. The experimenter showed the participant the computer and form to be used by the addressee and demonstrated that the participant could be seen on the computer screen via a camera. Also, it was explained and shown to the participant that the addressee could only see the arm movement of the participant and the computer screen that was at the back of the computer screen that the participant saw. The addressee could not see the head of the participant, to avoid the participant from conveying information via the head and face. In order to keep participants motivated, it was emphasized that they were in a joint activity with the addressee and that the success of this joint activity depended on how well they worked together. The participant was then seated in a comfortable chair in the dimly-lit experiment room. The height of the screen was adjusted to the height of the eyes of the participant. The button used by the participant was placed at the height of the participant's elbow, 23 cm in front of the participant calculated from the vertical axis corresponding to the position of the participant's eyes. Participants were instructed to always rest their finger on this button, except when making the pointing gesture, which allowed calculating the duration and onset of the pointing gesture. A sensor was placed on the participant's right index finger nail to allow for motion tracking of the pointing movements. Participants' electroencephalogram (EEG) was recorded continuously throughout the experiment. These results will be reported elsewhere.

After montage of the motion tracking sensor the experimenter picked up the addressee. The addressee was shown the room in which the participant performed the task, greeted the participant, and was seated in a chair in front of a computer in a room adjacent to the participant's room. In order to familiarize the participant with the different conditions and the task, thirty-two test-items (eight per condition) preceded the main experiment as a practice set. Participants received specific instructions to point with or without speech before each block. In addition, before each block, the participant was instructed whether the addressee could also see the same circles light up at the back screen or not during that block. Participants were asked to only move their hand and arm when pointing. During the experiment, participants were allowed to have a short break after every fourth block. Before and during the experiment, the communication between experimenter and addressee was minimal and fully scripted, in order to be constant across participants. After the experiment, the addressee was thanked for participation and left the room. Participants were debriefed, financially compensated, and thanked for participation.

Kinematic recording and analysis

Behavioral and kinematic data were acquired throughout the experiment using experimental software (Presentation, Neurobehavioral Systems, Inc) and a 60 Hz motion tracking system and DTrack2 tracking software (both Advanced Realtime Tracking, Weilheim, Germany). For each trial, the Gesture Initiation Time (i.e. the moment the participant's finger left the button calculated from the moment a circle lit up) was calculated. This measure thus reflected the time it took to plan the pointing gesture. In addition, we collected for each trial the Apex Time (i.e. the moment of the endpoint of the gesture calculated from the moment a circle lit up). The endpoint of the gesture was defined as the point in time where the pointing index finger was at least 7 cm from the button and only moved forward less than 2 mm for two consecutive samples. The Stroke Duration was defined as the interval between the onset of the gesture (i.e., The Gesture Initiation Time) and the moment the apex was reached (i.e., the Apex Time). The Incremental Distance travelled by the pointing index finger was calculated for the complete stroke (similar to Levelt et al., 1985). Further, the Velocity of the hand movement was calculated for each trial on the basis of the Apex Time and the Incremental Distance. The Hold Duration of the pointing gesture was calculated by subtracting the Apex Time from the Retraction Time (i.e., the moment the index finger moved back in the direction of the button for at least 2 mm in two consecutive samples). In the G+S blocks, the Speech Onset Time was calculated from the moment one of the circles lit up. The Synchronization Time was defined as the difference between Apex Time and Speech Onset Time.

Results

Trials on which the Gesture Initiation Time was below 100 ms or above 2000 ms were considered errors and excluded from all analyses (0.7% of total dataset). In addition, trials containing hesitations or errors in the participant's speech were removed from further analyses (0.2% of all data). Separate analyses of variance were performed for each dependent variable with Informativeness (Informative versus Non-informative) and Modality (Gesture-only or Gesture+Speech) as within-subject factors.

A first analysis was performed on the Gesture Initiation Time. This analysis did not yield any significant main or interaction effect. Next, we analyzed the Stroke Duration. This analysis yielded a significant main effect of Informativeness, F (1,23) = 10.97, p = .003, η_p^2 = .32. This effect denoted that the duration of the stroke was significantly longer in the Informative condition (M = 837 ms) than in the Non-informative condition (M = 823 ms). No significant main effect of Modality was found. There was no significant interaction between the two factors. Also an analysis on the Apex Time showed a significant main effect of Informativeness, F (1,23) = 8.15, p = .009, η_p^2 = .26. This effect denoted that the apex was reached significantly later in the Informative condition (M = 1379 ms) than in the Non-informative condition (M = 1359 ms). No significant main effect of Modality was found. There was no significant interaction between the two factors.

A further analysis was performed on the Incremental Distance. No significant main or interaction effect was found. Because the same amount of distance was travelled across conditions, but the apex was reached later in the Informative condition than in the Non-informative condition, the velocity of the pointing gesture must have been lower in the Informative condition compared to the Non-informative condition. Indeed, an analysis on the mean Velocity yielded a significant main effect of Informativeness, F (1,23) = 5.75, p = .025, η_p^2 = .20. The velocity of the pointing gesture was significantly lower in the Informative condition (M = 38.2 cm/s) than in the Non-informative condition (M = 38.7 cm/s). Again, no significant main effect of Modality or interaction between the two factors was found. Another analysis, performed on the Hold Duration, yielded a significant main effect of Informativeness, F (1,23) = 10.17, p = .004, η_p^2 = .31. The Hold Duration was significantly longer in the Informative condition (M = 1235 ms) compared to the Non-informative condition (M = 1143 ms). No significant main effect of

Table 1: Overview of the results per condition in the experiment. Duration in ms is displayed for the Gesture Initiation Time (GIT), Stroke Duration (Stroke), Apex Time (Apex), Hold Duration (Hold), Speech Onset Time (SOT), and Synchronization Time (Sync). Further, the Incremental Distance in cm (Dist) and Velocity in cm/s (Velocity) are provided. The standard error of the mean is indicated between parentheses.

Condition	GIT	Stroke	Apex	Dist	Velocity	Hold	SOT	Sync
Informative								
Gesture-only	534 (21)	834 (30)	1368 (42)	51 (1)	38.5 (1)	1252 (135)		
Gesture + Speech	550 (22)	840 (27)	1389 (39)	51 (1)	37.8 (1)	1219 (121)	1385 (65)	4 (54)
Non-informative								
Gesture-only	532 (22)	819 (29)	1351 (41)	51 (1)	39.0 (1)	1138 (116)		
Gesture + Speech	541 (24)	826 (27)	1367 (40)	51 (1)	38.5 (1)	1149 (106)	1351 (66)	16 (54)

Modality was found. There was no significant interaction between the two factors.

In the G+S conditions, participants referred linguistically to the circle on the screen while pointing. An analysis on the Speech Onset Time with Informativeness as the only within-subject factor revealed a significant main effect, F (1,23) = 6.79, p = .016, η_p^2 = .23. This effect reflected that the speech onset on average took place significantly later in the Informative condition (M = 1385 ms) than in the Non-informative condition (M = 1351 ms). An analysis on the Synchronization Time did not show a significant main effect of Informativeness (p = .16), indicating that the onset of the speech and the apex of the gesture were aligned similarly and independently from the informativeness of the gesture. Table 1 summarizes all results.

Discussion

Research investigating the production of iconic gestures has found that the form of such gestures changes on the basis of the communicative intent of the speaker-gesturer. Importantly, here we show that also in the case of pointing gestures speaker-gesturers exploit different form parameters as a function of their communicative intent. First, the duration of the stroke of pointing gestures was longer in the informative condition, which led to a gesture with a lower velocity and delayed the moment at which the apex was reached. Presumably participants did this in order to be as precise as possible in pointing to a target, which could be achieved by pointing more slowly. An additional benefit would then be that the addressee would have more time to identify towards which referent the gesture was heading. Second, the post-stroke hold-phase of the gesture was maintained longer, presumably in order to assure that the addressee had enough time to identify which referent the speaker pointed to. The form parameters under investigation here were not affected by the presence of deictic speech. Nevertheless, the onset of speech was synchronized with the moment at which the pointing gesture reached its apex.

A previous study compared a communicative to a non-communicative situation and found that people may modify the trajectory and endpoint location of their pointing gesture to single out a referent for their addressee (Cleret de Langavant et al., 2011). The current study takes this research a step further by comparing two situations that are both communicative and identical except for the communicative intent of the gesturer. Cleret de Langavant et al. (2011) did not find a difference in the duration of the pointing gesture when comparing their communicative to their non-communicative condition. Here we did find an effect of communicative intent on the duration of the stroke and the post-stroke hold-phase. Thus, in addition to varying the endpoint location and trajectory of a pointing gesture (as in Cleret de Langavant et al., 2011), people may also use the duration of different sub-components of the pointing gesture in order to communicate effectively.

Participants temporally aligned the onset of the deictic linguistic expression with the moment the pointing gesture reached its apex, regardless of whether the gesture was informative or not. This finding is in line with previous studies showing such temporal alignment of pointing and speech (e.g., Levelt et al., 1985; McNeill, 1992) and with models of speech and gesture production that underline the synchronization of speech and gesture (e.g., De Ruiter, 2000; Krauss et al., 2000). Here we show that this temporal synchrony between deictic speech and gesture is maintained irrespective of the speaker-gesturer's communicative intent.

We found a similar effect of communicative intent in situations where people only used gesture to communicate, compared to situations where speech and gesture were concurrently produced (Clark, 1996; Kendon, 2004). However, in our study, speech was purposefully never informative and very similar across trials, and there is indeed evidence that deictic speech can interact with the form of a simultaneously produced gesture (e.g., Gonseth, Vilain, & Vilain, 2012). It is therefore possible that whenever speech itself is informative enough to single out a referent, speaker-gesturers no longer design their concurrent gesture to be maximally informative. Future research needs to shed more light on the influence of speech-gesture interaction on the form of deictic gesture and speech while manipulating the informativeness of the speech.

In general, the results of our study fit well with models of speech and gesture production that allow for a role of the speaker-gesturer's communicative intent in modulating the exact form of a gesture, such as the Sketch model (De Ruiter, 2000) and the Interface model (Kita & Özyürek, 2003). Conversely, our data would argue against models of speech and gesture production that question whether the speaker's communicative intent plays a role in determining the form of a gesture (e.g., Krauss et al., 2000). In our study, participants had the communicative intention of producing a pointing gesture towards a referent, either accompanied with referential speech or not. The Sketch model, which explicitly describes the production of pointing (in addition to other types of gesture), underlines that upon the intention to produce a pointing gesture, conventions such as which hand shape and finger to use can be retrieved from a knowledge store (called a "gestuary" by De Ruiter, 2000) in memory. This representation of the pointing gesture in the gestuary is only a template or abstract motor program, and there are a number of degrees of freedom that can be varied depending on the context in which the pointing gesture is performed. According to this model, in our study, participants retrieved a pointing gesture template from memory and subsequently exploited the duration of both the stroke (and as such the velocity and the moment the apex was reached) and the post-stroke hold-phase of the gesture as free parameters. Our study thus suggests that duration is a free parameter that people use to vary the execution of their pointing gesture, and further specifies in which specific components of the gesture duration is indeed varied.

The form a pointing gesture takes not only depends on the gesturer's communicative intent. Research has shown that it also depends on physical factors such as the spatial location of a referent. For instance, people may raise their pointing arm and hand higher when a referent is more distant (Wilkins, 2003). Furthermore, the form of a gesture depends on cultural factors. In different cultures, different body parts are used for pointing (Kita, 2003; Wilkins, 2003). Finally, it may depend on socio-pragmatic factors. In a corpus study on Lao speakers, Enfield, Kita, and De Ruiter (2007) observed a distinction between relatively big points in which the whole arm is outstretched and relatively small points in which the hand is the main articulator. They argue that this difference in form is related to the pragmatic function of the utterance a gesture occurs in. Big points would do the primary work of an utterance, such as pointing out the location of an object, whereas small points would occur in utterances in which speech is central, adding a background modifier on the basis of social factors such as the common ground between interlocutors (p. 1738). Future studies could investigate interactions between such different physical, cultural, socio-pragmatic, and communicative factors.

To conclude, our study showed that people exploit the duration of the stroke (and as such its velocity and the moment the apex is reached) and the post-stroke hold-phase of their pointing gesture to communicate effectively. Thus, the form of a pointing gesture varies as a function of the speaker-gesturer's communicative intent. Similarly to iconic gestures, the form of pointing gestures is dependent, among other factors, on the context-bound communicative relation between speaker-gesturer and addressee.

Acknowledgments

We thank Albert Russel for technical assistance. JH was supported through Marie Curie Fellowship #255569 as well as through ERC Advanced Grant #269484 INTERACT.

References

Alibali, M. W., Heath, D. C., & Myers, H. J. (2001). Effects of visibility between speaker and listener on gesture production: Some gestures are meant to be seen. *Journal of Memory and Language, 44,* 169-188.

Bangerter, A. (2004). Using pointing and describing to achieve joint focus of attention in dialogue. *Psychological Science, 15,* 415-419.

Bavelas, J., Gerwing, J., Sutton, C., & Prevost, D. (2008). Gesturing on the telephone: Independent effects of dialogue and visibility. *Journal of Memory and Language, 58,* 495-520.

Butterworth, G. (2003). Pointing is the royal road to language for babies. In S. Kita (Ed.), *Pointing. Where language, culture, and cognition meet.* Mahwah, NJ: Lawrence Erlbaum.

Call, J., & Tomasello, M. (1994). Production and comprehension of referential pointing by orangutans (Pongo pygmaeus). *Journal of Comparative Psychology, 108,* 307-317.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development, 255, Vol. 63,* 1-174.

Clark, H. H. (1996). *Using Language*. Cambridge: Cambridge University Press.

Cleret de Langavant, L., Remy, P., Trinkler, I., McIntyre, J., Dupoux, E., Berthoz, A., & Bachoud-Lévi, A.-C. (2011). Behavioral and neural correlates of communication via pointing. *PLoS ONE, 6:3,* e17719.

De Ruiter, J. P. (2000). The production of gesture and speech. In D. McNeill (Ed.), *Language and gesture.* Cambridge: Cambridge University Press.

Enfield, N. J., Kita, S., & De Ruiter, J. P. (2007). Primary and secondary pragmatic functions of pointing gestures. *Journal of Pragmatics, 39,* 1722-1741.

Gerwing, J. & Bavelas, J. (2004). Linguistic influences on gesture's form. *Gesture, 4,* 157-195.

Gonseth, C., Vilain, A., & Vilain, C. (in press). An experimental study of speech/gesture interactions and distance encoding. *Speech communication*.

Holler, J., & Stevens, R. (2007). An experimental investigation into the effect of common ground on how speakers use gesture and speech to represent size information in referential communication. *Journal of Language and Social Psychology, 26,* 4-27.

Holler, J., & Wilkin, K. (2011). An experimental investigation of how addressee feedback affects co-speech gestures accompanying speakers' responses. *Journal of Pragmatics, 43,* 3522-3536.

Kendon, A. (2004). *Gesture: Visible action as utterance.* Cambridge: Cambridge University Press.

Kita, S. (2003). *Pointing. Where language, culture, and cognition meet.* Mahwah, NJ: Lawrence Erlbaum.

Kita, S., & Özyürek, A. (2003). What does cross-linguistic variation in semantic coordination of speech and gesture reveal?: Evidence for an interface representation of spatial thinking and speaking. *Journal of Memory and Language, 48,* 16-32.

Krauss, R. M., Chen, Y., & Gottesman, R. F. (2000). Lexical gestures and lexical access: A process model. In D. McNeill (Ed.), *Language and gesture.* Cambridge: Cambridge University Press.

Levelt, W. J. M., Richardson, G., & La Heij, W. (1985). Pointing and voicing in deictic expressions. *Journal of Memory and Language, 24,* 133-164.

McNeill, D. (1985). So you think gestures are nonverbal? *Psychological Review, 92,* 350-371.

McNeill, D. (1992). *Hand and Mind: What gestures reveal about thought.* Chicago: University of Chicago Press.

Tomasello, M., Carpenter, M., & Liszkowski, U. (2007). A new look at infant pointing. *Child Development, 78,* 705-722.

Wilkins, D. (2003). Why pointing with the index finger is not a universal (in sociocultural and semiotic terms). In S. Kita (Ed.), *Pointing. Where language, culture, and cognition meet.* Mahwah, NJ: Lawrence Erlbaum.