Enforced pointing gesture can indicate invisible objects behind a wall

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Abstract

The pointing gesture is regarded as indicating an object or location in the environment. People sometimes point to invisible objects, but the inferential mechanism is not known. This study examined comprehension of pointing with a bent index finger at an invisible object behind a wall. The experimenter pointed at an object using either typical pointing or "enforced pointing" behind a wall that was either opaque or transparent. In enforced pointing, the experimenter moved his arm in an arc movement. The participants guessed which object was being denoted. The wall was also either relatively high or relatively low. When the participants looked at typical pointing, they thought that objects both in front of the wall and behind the wall were being denoted. However, when they looked at enforced pointing, they more frequently thought that objects behind the wall were denoted. People seemed to use pragmatic knowledge on this "enforced" pointing gesture.

Keywords: gesture; declarative pointing; common ground; non-linguistic information

Introduction

The pointing gesture usually indicates direction. If any object or location exists in the indicated direction, such object or location is interpreted as denoted. Clark (2003) discussed use of attention-getting gestures of pointing and placing. He noted that pointing at a referent and placing a referent are both useful ways to convey information about referents. In pointing, a person directs the addressee's attention to the referent object; for example, a customer may point at a package of medicine that is difficult for him or her to reach but is easy for the clerk. In placing, a person puts a referent object in the area of an addressee's attention; for example, a customer may place a package of medicine on the checkout counter where a clerk waits. These communications are possible without saying any words. To communicate smoothly, people must share mutual understanding of pointing at referents and placing referents in different situations. Clark (1996) proposed that people use "common ground" as implicit mutual knowledge in human communication. Previous research has focused mostly on language and verbally describable information included in common ground. Non-verbal information such as gestures must also be comprehended using common ground as to how people use gestures in different situations; however, usage of gestures as common ground has not yet been thoroughly explored. Pointing gestures are often used with demonstratives (Coventry et al., 2008; 2014). Pointing gestures are also used to examine children's inferential ability (Doherty et al., 2004; Kobayashi, 2007). In these studies, the addresser can easily share information about visible objects using visual joint attention and common ground.

Kita (2003) discussed that the semiotic processes—that is, interpretation of a pointing gesture and its referent—and intended meaning of the overall action must be analyzed in interpretation of a pointing gesture. The referent of a pointing gesture can be ambiguous in many situations and in many ways. People must make correct inferences about the observed pointing gesture. Tomasello (2008) discussed that a customer points at an empty glass, and a bartender understands the request of the customer ("Please fill the glass"). In other situations—for example, a client and a glass designer—the client is pointing at an empty glass may be interested in or selects the design of the glass.

Goodwin (2003) suggests that an "activity framework" specifies which features of the environment are relevant for the ongoing activity and, hence, are likely to be the referent of a pointing gesture. Goodwin also suggests that different forms of pointing may correlate with particular types of referents.

Pointing is usually used for visible objects when an indicator and an observer can jointly attend to the same object or location. People sometimes point to invisible objects, but the inferential mechanism is not known. Kobayashi and Yasuda (2015) examined how people interpret the experimenter's pointing with a bent index finger at an invisible object behind a panel. The experimenter pointed at bottles that were placed either in front of the panel or behind the panel using a straight index finger or a bent index finger, and the participants guessed which object was being indicated. In the with-obstacle condition, bent pointing tended to be interpreted as referring to all the objects, both in front and behind the panel. However, this tendency was not observed with straight index-finger pointing. Thus, when the participants looked at

straight pointing, they thought that only the objects in front of the panel were being indicated. However, when they looked at bent pointing, they thought that objects both in front of and behind the wall were being indicated. The significance level of the shape of the pointing finger's effect was substantially large (η^2 = 0.804) and the results suggest that people think bent pointing can refer to objects behind walls, but straight pointing cannot. The study suggests that people have "common ground" in their interpretation of different types of pointing.

This study examined comprehension of pointing with a bent index finger at an invisible object behind a wall. The present study examined participants' interpretation of the experimenter's pointing at an object using either typical pointing or "enforced pointing" behind a wall that was either opaque or transparent. In enforced pointing, the experimenter moved his arm in arc movement. The participants guessed which object was being denoted. The wall was also either relatively high (28 cm) or relatively low (14 cm). We examined the effect of pointing movement because this iconic movement may suggest the indicator's intention of "overriding the wall." We examined the transparency of the wall because, if the wall is transparent, "overriding" intention may look ambiguous. The reason is that objects behind the transparent wall can be indicated without such effortful movement. However, if the wall is opaque, the "overriding" intention may be naturally understood. We also examined the height of the wall. The enforced pointing movement was more easily understood when a relatively high (28 cm) wall was used than when a relatively low (14 cm) wall was used.

Methods

Participants

Sixteen Japanese undergraduate university students (*M* age = 22.0 years; *SD* = 0.816; 1 female) participated. The experiment was conducted in accordance with Tokyo Denki University's code of ethics.

Experimental setting

Fig. 1 shows the experimental setup. On the table, there were 4 small bottles (W: 3 cm × H: 7 cm) designated 1, 2, 3, and 4 with a different color on each bottle. Bottles were placed 10 cm apart. Bottle #1 was placed 75 cm away from the edge of the side of the table where the experimenter sat. The experimenter sat on one side of the table and wore a black sun visor during the experiment so that participants could not see the experimenter's gaze direction. The participant sat at the table at a right angle to the experimenter. The panel (W: 14 cm × H: 28 cm) was placed in the middle of the table between bottles #2 and #3. Participants were randomly assigned to all conditions.

The experimental conditions consisted of two types each of pointing (2: typical vs. enforced), visibility (2: visible vs. invisible), and position (2: lengthwise vs. widthwise).

Regarding the pointing condition, "typical pointing" was when the experimenter pointed at the referent with his arm extended horizontally and his index finger kept bent (Fig. 2); "enforced pointing" was when the experimenter pointed at the referent with his arm moving in arc and his index finger kept bent (Fig. 3).

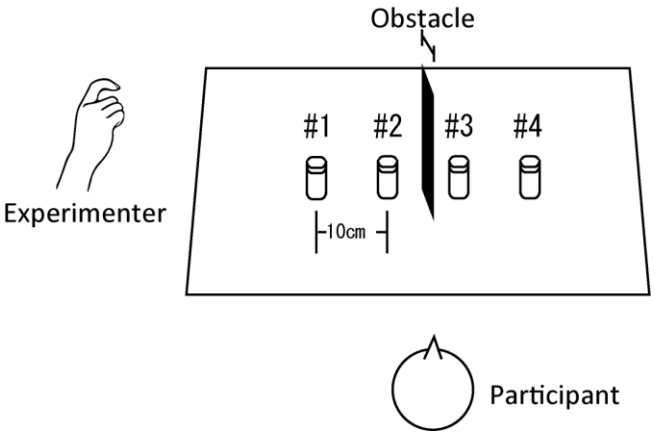

Fig. 1: Experimental setup in "invisible" with "lengthwise" conditions. Objects were placed 10 cm apart.

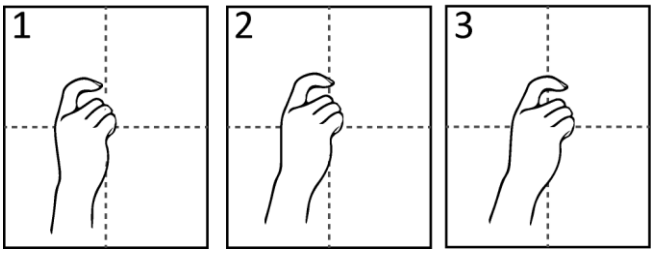

Fig. 2: Flow of typical pointing

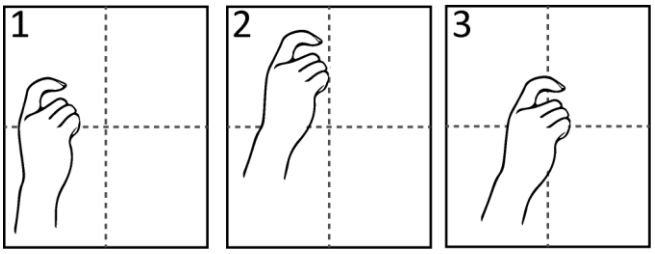

Fig. 3: Flow of enforced pointing

Regarding the visibility condition, "visible" meant that a transparent panel was used; the experimenter and the participant could see all bottles. "Invisible" meant that a black opaque panel was used; the experimenter could not directly look at bottles #3 and #4. The participant could see all bottles. In the obstacle position condition, the height of the "lengthwise" obstacle was 28.0 cm, and the width was 14.0 cm. The height of the "widthwise" obstacle was 14.0 cm, and the width was 28.0 cm. For example, in the "visible" with "lengthwise" obstacle condition, there was a

small transparent lengthwise panel on the table (Fig. 4a). In the "invisible" with "widthwise" obstacle condition, there was a small black opaque widthwise panel on the table (Fig. 4b).

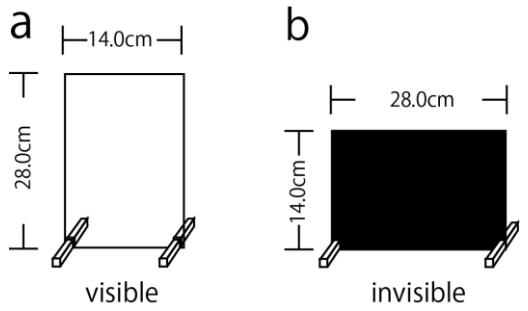

Fig. 4: Each type of obstacle; "a" is used in "visible" with "lengthwise" conditions and "b" is used in "invisible" with "widthwise" conditions.

Procedure

First, the experimenter and the participant looked at all the bottles placed on the table. Then, the participant sat on the experimenter's chair and looked at the table. Then, the experimenter put the panel between bottles #2 and #3, and the participant again looked at the table. Thus, the participant experienced the experimenter's view in both visible and invisible obstacle conditions.

In the typical pointing with invisible widthwise obstacle condition, the experimenter put the black-opaque widthwise panel between bottles #2 and #3 and said to the participant, "I cannot see bottles #3 and #4. Now, I will point at one of the four bottles." Then, the experimenter pointed at bottle #3 using the typical index finger. Next, the experimenter pointed at bottle #3 continuously and said, "Now, I am pointing at something. What is the color of the bottle you would guess I am pointing at?" The participant responded orally using the bottle color. The bottle corresponded to the distance from the edge of the table: Bottle #1's distance was 75 cm; #2, 85 cm; #3, 95 cm; and #4, 105 cm. All bottles were of different colors, and bottle positions were randomized. In addition, the experimenter wore a sun visor so that the participant could not see the experimenter's eye gaze.

In the enforced pointing condition, the procedure was the same as with the typical pointing except that enforced pointing was used. In the visible condition, the procedure was the same as with the invisible condition except that the visible condition was used. In each block, the experimenter pointed at bottle #3, and there were 24 trials in all. Overall, the order of color bottles of these blocks was counterbalanced between the participants.

The experimenter's pointing was trained to show the same pointing gesture in either the typical pointing or the enforced pointing in the aspects of speed of movement. In addition, the angle of his forefinger maintained the same shape (Fig. 2 and 3).

Results

Fig. 5 shows the participant's responses when the experimenter pointed at the object in each pointing and each visibility condition. A 2 (Pointing: typical, enforced) × 2 (Visibility: visible, invisible) × 2 (Position: lengthwise, widthwise) three-way ANOVA was performed with the number of the bottle that the participant responded as the dependent measure. There was a marginally significant main effect of Pointing, $F(1,15) = 3.479$, $p = .08$, $\eta^2 = 0.050$. There was also a significant interaction of Pointing × Visibility, $F(1,15) = 5.497$, $p < .05$, $\eta^2 = 0.015$.

To explore the significant Pointing ×Visibility interaction, the simple main effects of Pointing within each Visibility and Visibility within each Pointing were analyzed. The simple main effect test revealed that there was a significant difference between typical pointing and enforced pointing in the invisible obstacle, $F(1,15) = 7.120$, $p < .05$, $\eta^2 = 0.106$. There was also a marginally significant difference between the visible and invisible obstacles in typical pointing, $F(1,15) = 3.407$, $p = .08$, $\eta^2 = 0.029$. Other effects were not significant (all $p > .05$).

When enforced pointing was used ($M = 2.958$, $SE = 0.166$), participants interpreted a farther bottle as being indicated than when the typical pointing was used ($M = 2.427$, $SE = 0.175$) in the invisible obstacle condition.

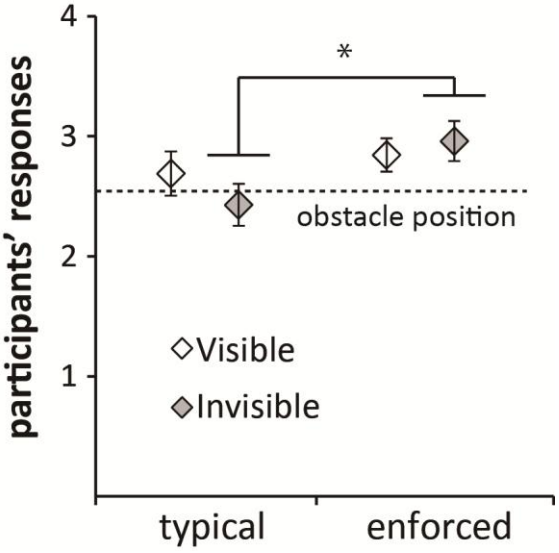

Fig. 5 Participants' responses when the experimenter pointed at bottle #3 using each type of pointing in each visibility and position condition. * denotes a significant difference. Error bars denote the standard errors of the means.

Discussion

This study examined comprehension of pointing with an enforced movement of a bent index finger at an invisible object behind a wall. The study examined participants' interpretation of an experimenter's pointing using either typical pointing or "enforced pointing" at an object behind a wall that was either opaque or transparent. In enforced pointing, the experimenter moved his arm in an arc movement. The participants guessed which object was being denoted. The wall was also either relatively high (28 cm) or relatively low (14 cm).

When the participants looked at typical pointing, they thought objects both in front of the wall and behind the wall were being denoted. However, when they looked at enforce pointing with an opaque wall, they more frequently thought objects behind the wall were denoted. The height of the wall did not have any effect in this experiment.

Participants interpreted that enforced pointing could "override" the wall if the wall was opaque. They might think enforced pointing suggested an overriding trajectory (Fig. 6) to point to an invisible object behind the wall. However, for the objects behind the transparent wall, enforced pointing was not necessary. Thus, this enforced movement was sufficiently informative for participants to interpret the indicator's intention to "override" the wall. That seems to be the reason why the height of the wall had no effect.

The study suggested that people use an indicator's arm movement and the features of the environment to comprehend the referent of pointing. The result suggests that we have "common ground" in terms of interpretation of different types of pointing. Furthermore, we think the linguistic-cognitive framework presented by Relevance Theory (Sperber & Wilson, 1995; Wilson & Sperber, 2004) may be applied to our result. Discussing Relevance Theory from a biological perspective, Scott−Phillips (2010) stated that humans' and other animals' every signal carries a presumption of its own optimal pertinence. Here, non-verbal signals such as human gestures can be processed as relevant signals in addition to utterances.

It can be said that the study suffers from reduction of pointing situations. The study investigated only the interpretation of enforced pointing in the controlled experiment. It is necessary to study the production in addition to the interpretation of enforced pointing in a more real human environment.

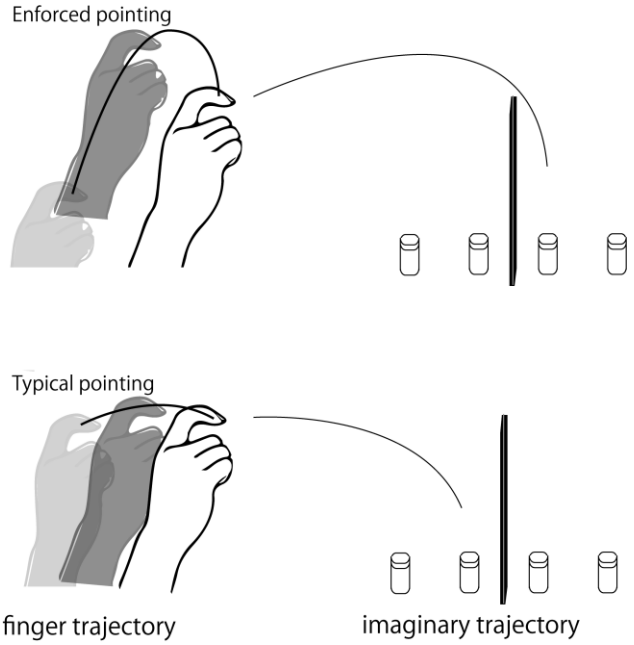

Fig 6: Pointing trajectories

Acknowledgments

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References

Clark, H. H. (1996). Using language. Cambridge UK: Cambridge University Press.

Clark, H. H. (2003). Pointing and placing. In S. Kita (Ed.), Pointing. Where language, culture, and cognition meet (pp. 243-268). Hillsdale NJ: Erlbaum.

Clark, H. H., Schreuder, R., & Buttrick, S. (1983). Common ground at the understanding of demonstrative reference. Journal of Verbal Learning and Verbal Behavior, 22, 245-258.

Coventry, K. R., Griffiths, D., & Hamilton, C. (2014). Spatial demonstratives and perceptual space: Describing and remembering object location. Cognitive Psychology, 69, 46-70

Coventry, K. R., Valdés, B., Castillo, A., & Guijarro-Fuentes, P. (2008). Language within your reach. Near-far perceptual space and spatial demonstratives. Cognition, 108, 889-895.

Doherty, M. J., Anderson, J. R., & Howieson, L. (2009). The rapid development of explicit gaze judgment ability at 3 years. Journal of Experimental Child Psychology, 104, 296-312.

Goodwin, C. (2003). Pointing as situated practice. In S. Kita (Ed.), Pointing: Where language, culture, and cognition meet (pp. 217-241). Hillsdale NJ: Erlbaum.
Kita, S. (Ed.). (2003). Pointing: Where language, culture, and cognition meet. Hillsdale NJ: Erlbaum.
Kobayashi, H. (2007). The effect of touching object parts on learning novel object part names among young children and adults. Studies in Language Sciences, 6, 61-76.
Kobayashi H., & Yasuda T. (September, 2015). Pointing to an invisible object behind a wall: Comprehension of pointing with a bent index finger. Proceedings of the EuroAsianPacific Joint Conference on Cognitive Science (pp. 477-481), Torino, Italy.
Scott-Phillips, T. C. (2010). The evolution of relevance. Cognitive Science, 34(4), 583-601.
Tomasello, M. (2008). Origins of human communication. Cambridge UK: MIT Press.
Tomasello, M. (2014). A natural history of human thinking. Harvard University Press.