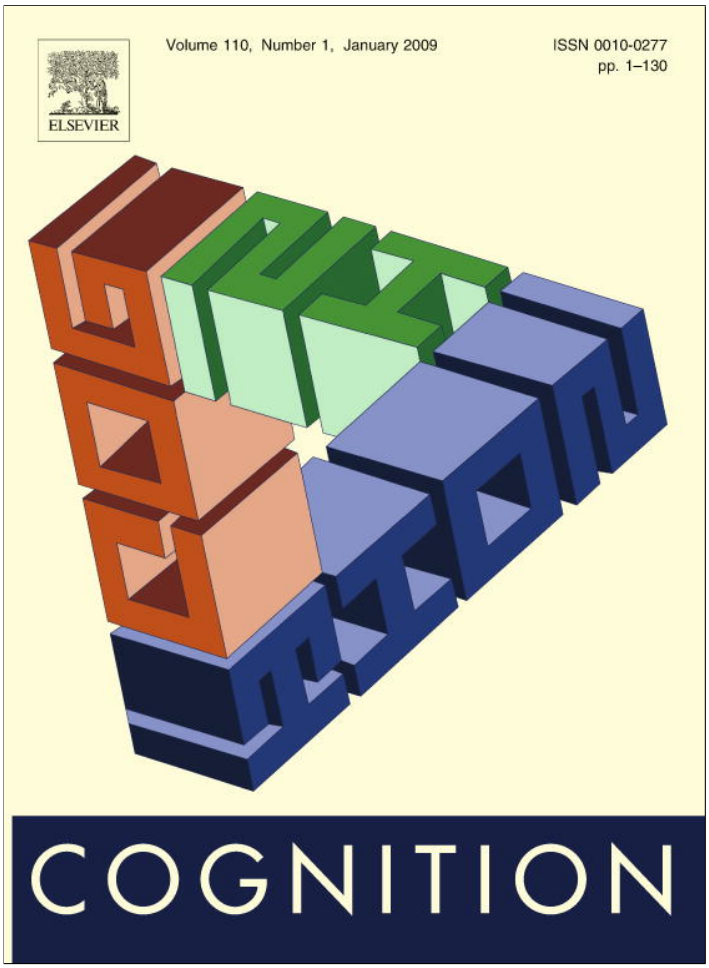

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Embodied and disembodied cognition: Spatial perspective-taking

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ABSTRACT

Although people can take spatial perspectives different from their own, it is widely assumed that egocentric perspectives are natural and have primacy. Two studies asked respondents to describe the spatial relations between two objects on a table in photographed scenes; in some versions, a person sitting behind the objects was either looking at or reaching for one of the objects. The mere presence of another person in a position to act on the objects induced a good proportion of respondents to describe the spatial relations from that person's point of view (Experiment 1). When the query about the spatial relations was phrased in terms of action, more respondents took the other's perspective than their own (Experiment 2). The implication of action elicits spontaneous spatial perspective-taking, seemingly in the service of understanding the other's actions.

1. Introduction

The mind is locked in a body that, at any time, occupies a specific place and faces a specific direction. These undeniable facts form part of the basis for embodied cognition. It is natural, then, to think that an egocentric perspective on space has primacy: that is, that an egocentric perspective is immediate, and that taking other perspectives requires extra mental effort. Indeed, the premise of egocentric primacy pervades theories of spatial cognition (e.g., Golledge, 1992; Hart & Moore, 1973; Levelt, 1989; Piaget & Inhelder, 1956; Pick & Lockman, 1981; Shelton & McNamara, 1997). Yet, to navigate in and communicate about the world, other representations of space are needed. The primacy of egocentric perspective has been challenged by research showing that rats, monkeys, and people on first encountering an environment immediately form multiple representations of space, in particular, allocentric representations (e.g., Graziano & Gross, 1994; Mou, McNamara, Valiquette, & Rump, 2004; O'Keefe & Nadel, 1978; Tipper & Behrmann, 1996; Tversky, Lee, & Mainwaring, 1999). In an egocentric perspective, objects are represented or described with respect to the body, using terms like *front, back, left,* and *right*. In an allocentric perspective, objects are represented or described with respect to each other, using an environmental frame of reference such as north–south–east–west. Indeed, people often spontaneously choose allocentric perspectives to describe environments, even those experienced only from exploration (e.g., Taylor & Tversky, 1996).

Egocentric and allocentric perspectives are not the only possible perspectives on space. Importantly, there is my (egocentric) perspective and yours, self and other. People are inherently social beings. Consequently, people find themselves in situations requiring taking another's perspective. One such situation occurs commonly in conversation; for example, when one person asks another where something is. In this kind of situation, people typically favor the other's perspective to their own, (e.g., Mainwaring, Tversky, Ohgishi, & Schiano, 2003; Schober, 1993, 1995). But because in these situations, the descriptions were designed for others, the preference for describing spatial relations from the other's perspective does not imply that taking the other's perspective is immediate or primary.

Could there be spatial situations in which people spontaneously adopt another's perspective rather than their own, even when not communicating to other person? Con-

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Fig. 1. Scenes used in Studies 1 and 2. Participants in Study 1 were shown one of the three scenes, depending on condition: *reaching* scene (a), *looking* scene (b), or *no person* scene (c). Participants in Study 2 were shown only the scene of an actor reaching for an object (a).

versation is only one example of a social situation that encourages perspective-taking. Another situation is interaction of bodies rather than voices. Even simple social interactions, such as accepting a cup of coffee from someone or negotiating the crowd on the street, require anticipating the actions of others in order to coordinate our own. Anticipating others' actions may also help to understand those actions even without the intent or immediate need to respond. Watching a tennis serve, observing how to buy a train ticket in a foreign country, studying an effective public speaker are examples. Taking the perspective of the other may be effective both for planning responses to others' actions and for understanding and learning them. Thus, it is possible that simply seeing another person in a scene near objects in grasping range will elicit some spontaneous perspective-taking.

Would the mere presence of another in a scene with the potential for action elicit taking that person's perspective, without any demand to communicate to that person? This is the first question addressed here, in a simple, direct task. A questionnaire included a photograph of a bottle and a book on a table, with or without a person behind the table (see Fig. 1), below which was a question: In relation to the bottle, where is the book? Would participants respond using their own right and left, or use right and left with respect to the other's perspective? The expectation was that the presence of another person in the scene, especially one related to and likely to use the objects whose spatial relations are queried, would induce some participants to take the other person's perspective rather than their own.

If perspective-taking is related to understanding or anticipating another's actions, then calling attention to action by phrasing a question about the spatial relations between the objects in terms of action should increase perspective-taking. Thus a second study compared static questions like that of the first experiment to action questions.

2. Study 1: mere presence of another elicits spatial perspective-taking

Does the mere presence of a person in a scene with two salient objects placed on a table near the person cause some respondents to spontaneously take the spatial perspective of the other person rather than their own?

2.1. Method

One hundred Stanford and 90 University of Oregon undergraduates were presented with one of the three photographs in Fig. 1 and asked: "In relation to the bottle, where is the book?" The *no person* ($n = 64$) photograph showed a bottle and a book on a table. Two other photographs included a person sitting behind the table, either *looking* ($n = 64$) at the book or *reaching* ($n = 62$) for it. In both studies, the photograph and question were part of a large set of unrelated questionnaires students completed for course credit, at Stanford, a paper booklet, and at University of Oregon, online. There were no differences between Stanford and University of Oregon undergraduates in any of the results in either study so the results were combined.

2.2. Results

The responses were scored as *self* perspective if the answer provided was from the viewer's viewpoint, *other* if the answer was from the person in the scene's viewpoint, and *neutral* if the answer gave spatial information from neither perspective, for example, "next to." Examples of responses scored as *self* include: "right," "on the right," "about a foot to the right," "to the right of the bottle from my perspective." Examples scored as "other" include: "left," "to his left," "to the left according to the way he is facing," "to the left (relative to his perspective)." Four participants (one other perspective and 3 self perspective) used both perspectives in their response, writing, for example, "my right, his left." In those cases, the first perspective mentioned determined the coding category. Examples scored as neutral include: "across the table," "to the side," "parallel," "a foot away." In describing spatial relations, people often avoid using *left* and *right* (e.g., Mainwaring et al., 2003) because these terms are more difficult than other spatial relation terms, like *front, across,* or *near* (e.g., Franklin & Tversky, 1990).

Scored responses were converted into two binary variables for analysis: one variable was coded 1 if the response was *self* perspective and 0 if it was not; the second variable was coded 1 if the response was *other* perspective and 0 if it was not. These variables were each analyzed with a one-way Analysis of Variance, followed by two planned contrasts: one comparing the *no person* photograph to the photographs depicting a person (*looking* and *reaching*) and another comparing the *looking* to the *reaching* photograph. For all analyses, the criterion for significance was alpha level less than .05. We report partial eta squared (η_p^2) as an estimate of effect size for significant ANOVA effects, and Cohen's d for significant t-test effects.

The photograph viewed affected the frequency of *other* perspective, $F(2,187) = 8.26$, $p < .05$, $\eta^2 = .08$. As evident

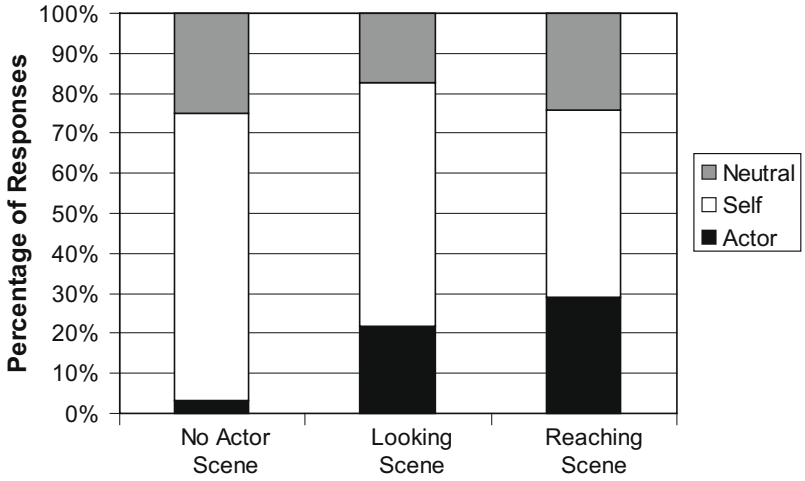

Fig. 2. In Study 1, mean response from an other, self, or neutral perspective as a function of scene.

from Fig. 2, when the scene included a person, about a quarter of participants adopted the viewpoint of the person in the scene ($M = .25$, $SEM = .04$). This was significantly higher than for the scene with no person ($M = .03$, $SEM = .02$), $t(187) = 3.93$, $p < .001$, $d = .57$. There were no differences in other perspective responses between the *reaching* scene ($M = .29$, $SEM = .06$) and the *looking* scene ($M = .22$, $SEM = .05$), $t(187) = 1.09$, $p = .28$. Similarly, the proportion of *self* perspective responses was affected by the photograph participants viewed, $F(2,187) = 4.27$, $p < .05$, $\eta^2 = .04$. Self perspective responses were significantly lower for the scenes including a person ($M = .54$, $SEM = .04$) than the scenes that did not ($M = .72$, $SEM = .06$), $t(187) = -2.43$, $d = .36$, but did not differ significantly for looking ($M = .61$, $SEM = .06$) versus reaching photographs ($M = .47$, $SEM = .06$), $t(187) = -1.65$, $p = .10$. Thus, the presence of a person in a scene did prompt a significant number of spatial descriptions from the other's point of view.

Few participants, 17 out of 126, not out of 148 (13%) of those responding to the photographs that included another person, were explicit as to whose perspective they adopted. That is, they used expressions that specified whose perspective, such as "his," "my," "to the man's left," or "to the left according to the way he is facing." More than twice as many of those taking the other's perspective made explicit reference to whose perspective they used, 9 out of 32 (28%) compared to those taking their own perspective, 8 out of 68 (12%), a difference that is significant the Chi-square ($df = 1$) $= 4.13$, $p < .05$. This suggests that more of those adopting the other's perspective were aware of the ambiguity of the spatial reference terms. Nevertheless, the vast majority of respondents taking their own or the other's perspective saw no need to specify whose perspective they were taking, thus presupposing that others would share that perspective.

A very small number, 9 out of 126 (7%) participants who viewed a photograph with a person in it seemed to be using the person in the photograph like a landmark, typically in redundant descriptions, for example, "under the man's hand, to his left of the bottle" or "to the right of the bottle, but to the left of the person sitting," but also "by the man's left hand" and "to the right of the man."

2.3. Discussion

Students viewed a photograph of a person seated at a table looking at or reaching for one of two objects or a photograph of the table and objects alone. They were asked to report the spatial relations between the two objects. When the scene included a person, about a quarter of the students described the spatial relations from that person's point of view. The others either took a neutral perspective (around 30%), avoiding the difficult terms, *right* and *left*, or took their own perspective, avoiding reversing *right* and *left*. Given the difficulty of using right and left from one's own perspective, reversing right and left to take another's perspective is notable. Why would a quarter of the participants go to this effort? Unlike the Schober (1993, 1995) and Mainwaring et al. (2003) studies, in this study, there was no communication partner whose spatial perspective and cognitive load were to be considered. What's more, the implicit recipient of the spatial description is the experimenter, whose perspective is the same as the participants'.

Some may be concerned that the perspective-taking may be attributable in part to task demands. Some participants may have thought the experimenter wished them to use the person in their responses. However, the person can be included in the response without taking the person's perspective, specifically, using the person as a landmark. The book's location could have been described as *right* or *left* of the person, with respect to the viewer's perspective, in accordance with Levinson's relative perspective (Levinson, 1996), and a small number of respondents did just that. Nevertheless, it is possible that some participants did perceive a demand to take the other's perspective. One goal of the next experiment is to test that conjecture.

Given that the implied message recipient shares the participant's perspective, that participants want to finish the task easily and quickly, and that using *left* and *right* from another's perspective is effortful, the frequency of

spontaneously adopting the opposing perspective of the other is impressive, even if it is not a majority. Seeing a person eying or reaching for an object may generate an expectation that the person will act on the objects. The desire to understand or anticipate the person's actions may encourage taking the perspective of the person likely to act. This account could lead to the prediction that the *reaching* scene should elicit more perspective-taking than the *looking* scene, which was not the case. However, the suggestion of action may have been strong enough in the *looking* photograph. Calling further attention to action by asking a question implying action may serve as a stronger suggestion of action, and elicit more perspective-taking. This possibility is examined in the second study.

Supposing that instead of a person in the scene there had been an inanimate object such as a coffee pot or a doll; would participants spontaneously take the "point of view" of the inanimate object? This seems improbable. When asked to take the perspective of inanimate objects, people easily do so (e.g., Bryant, Tversky, & Franklin, 1992) but it is as if they are imagining themselves in that position. If, as tested in the next experiment, emphasizing action increases perspective-taking, then the likelihood of spontaneously adopting the perspective of an inanimate object would seem even lower.

3. Study 2: highlighting action increases perspective-taking

The presence of a person in a scene prompts some viewers to adopt the person's perspective in describing spatial relations in the scene. Both understanding action and responding to it might be facilitated by taking the perspective of an actor. Would asking a question that calls attention to action increase this effect? Here, participants viewed the photograph of the person reaching for one of two objects and, as before, were asked about the location of one object relative to the other. The influence of action on spatial perspective was tested by questions that called attention either to action or to static information. If emphasizing action affects encoding of spatial perspective, then a question drawing attention to action should promote perspective-taking more than a question drawing attention to static information. The task demand conjecture was tested by questions that did or did not call attention to the other person.

3.1. Method

Thirty-three Stanford University and 121 University of Oregon undergraduates were presented with the photograph in Fig. 1 showing a person at a table reaching for one of the two objects on the table. Participants were asked one of four questions about the spatial relations between the objects. Two of the questions mentioned action: "In relation to the bottle, where does he place the book?" ($n = 39$) and "In relation to the bottle, where is the book placed?" ($n = 37$). The other two questions implied no action: "In relation to the bottle, where is his book?" ($n = 38$) "In relation to the bottle, where is the book?" ($n = 40$). Note that one version of each question type mentioned the person in the scene and the other did not. The photograph and question were embedded with unrelated questionnaires and completed for course credit.

3.2. Results and discussion

As before, the responses were scored as *self* perspective if the answer was from the viewer's viewpoint, *other* if the answer was from the person viewpoint, and *neutral* if the answer was from neither perspective, for example, "next to." Five participants (4 *self* and 1 *other* perspective) specified both perspectives. Again, the first perspective given determined the coding category. Binary variables were again created based on the scored responses. Each of these variables was analyzed using a factorial Analysis of Variance with question types as factors: mentioning action crossed with mentioning the person in the scene.

When the spatial questions referred to action, the frequency of taking the other's perspective increased. Fig. 3 shows that more participants took the other person's perspective when the question referred to *action* ($M = .50$, $SEM = .06$) than when it referred to *static* information ($M = .33$, $SEM = .05$), $F(1,150) = 4.35$, $p < .05$, $\eta^2 = .03$. Notably, when the question mentioned action, approximately 50% of the participants took the other's perspective and only 20% took their own perspective. In contrast, more, but by no means all, participants took a self perspective when the question referred to *static* ($M = .44$, $SEM = .06$) than to *action* information ($M = .22$, $SEM = .05$), $F(1,150) = 8.37$, $p < .01$, $\eta^2 = .05$. The proportion of participants taking each perspective for the static questions replicated the findings of Study 1. Altogether, calling attention to action increased the frequency of adopting the other's perspective but calling attention to the person did not.

In contrast to referring to action, referring to the person in the scene had no effects on the tendency to take the other's ($F(1,150) < 1$) or one's own perspective ($F(1,150) = 1.48$, $p = .23$). There was a significant interaction on the frequency of adopting a self perspective, $F(1,150) = 8.65$, $p < .01$, $\eta^2 = .05$. When the actor was mentioned in the question, referring to action yielded fewer self perspective responses ($M = .08$, $SEM = .04$) than static phrasing ($M = .50$, $SEM = .08$). However, when the actor was not mentioned, referring to action yielded equivalent numbers of self perspective responses ($M = .38$, $SEM = .08$) as static phrasing ($M = .38$, $SEM = .08$). This interaction did not hold true for the proportion of other perspective responses, $F(1,150) < 1$. Overall, referring to the person in the scene did not increase the proportion of *other* perspective responses.

As before, the spatial descriptions were sometimes more complex than simple "to the right." Twenty-one percent of the respondents were explicit as to whose perspective they adopted, higher than in the first study. In contrast to the first study, the proportion of respondents who specified their perspective did not depend on the perspective chosen; the proportion of explicit perspective was essentially the same for *self* (27%) and *other* (30%), Chi-square ($df = 1$) = .07, $p = .79$. Proportion of those making their perspective explicit also did not differ depending on whether

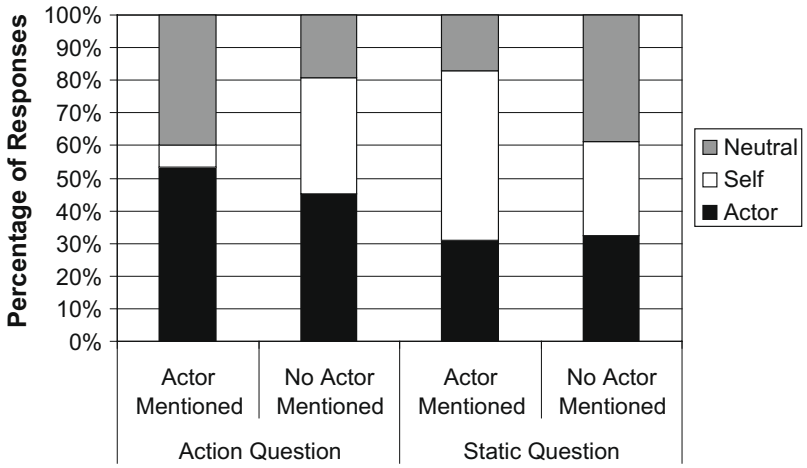

Fig. 3. In Study 2, mean response from an other, self, or neutral perspective as a function of question type.

the question specified *action* (20%) or *static* information (23%), Chi-square (df = 1) = .26, p = .61. However, more participants made their perspective explicit (27%) when responding to questions that referred to the actor than when responding to questions that did not refer to the actor (16%), an effect that was marginally reliable, Chi-square (df = 1) = 3.12, p = .08. Six participants overall used the person as a landmark, half of those in redundant descriptions.

4. General discussion

In the present studies, participants were asked to describe spatial relations between salient objects in a scene. The mere presence of a person in the scene with the potential of interacting with the objects encouraged many respondents to take that person's spatial perspective, describing the locations of the objects from the other's right or left, despite the cognitive difficulty of using and reversing left and right. Phrasing the question about the spatial relations between the objects in terms of action caused virtually half the respondents to take the other's perspective, more than double the number who took their own perspective. In contrast to other studies showing perspective-raking in spatial descriptions (e.g., Mainwaring et al., 2003; Schober, 1993, 1995), the present participants were not explicitly or implicitly communicating with the other. To the extent that there was implicit communication in the task, it was to the experimenter, who shared the participant's perspective.

Why do many viewers spontaneously take the perspective of another person, and why does calling attention to action augment that effect? When a scene has objects and no person, answering the question is simply a matter of determining the spatial relations between the objects, and the most prominent referent is one's own body. However, when the scene includes a person, even though the question is only about the spatial relations between the objects, it may be preceded by an attempt to make sense of the entire scene, especially the role of the person in the scene. That sense-making would increase to the extent that the person is perceived to be potentially interacting with the objects, and even more, when the question implies action. Understanding the role of the person in interaction with the objects would be helped by taking that person's perspective.

Effective social interaction depends on perspective-taking. Social interactions entail responding to the actions of others, whether those actions are verbal or physical. Anticipating how to behave in social situations may be promoted by perspective-taking, by considering the actions of others from their point of view. Speaking to others, understanding others, and reacting to others all require some comprehension of what the world looks like to them. Perspective-taking is undoubtedly an effective strategy in social situations and might occur spontaneously in anticipation of social interaction. Consequently, seeing another person in a scene might prompt thinking about the world from the other's perspective.

Might describing the spatial situation from the other's point of view be mediated by the mirror neuron system (e.g., Gallese, Keysers, & Rizzolatti, 2004; Rizzonlatti, Fadiga, Gallese, & Fogassi, 1995)? Social interaction is a layered phenomenon as are perspective-taking and the mirror neuron system. Thinking about the world from another's point of view can be literal, that is, spatial, or figurative, that is, metaphoric. Here, we examined literal spatial perspective-taking, finding that it increased when action was implied. That kind of perspective-taking was interpreted as subserving understanding potential action. The phenomena observed here were high-level and cognitive, reflected in and affected by language. The kinds of metaphoric perspective-taking underlying understanding another's political views or emotional state may be very different, the former likely to be expressed in appropriate inferences and the latter in empathetic facial expressions. It would be an interesting if surprising extension of embodied cognition if attitudinal or emotional perspective-taking also promoted spatial perspective-taking. Although all may involve forms of neural resonance, evidence suggests that emotional and action perspective-taking activate quite different brain systems (Gallese et al., 2004; Jackson, Meltzoff, & Decety, 2006; Lamm, Batson, & Decety, 2007). Assuming the other's position in space is

likely to improve action understanding, but does not seem relevant to understanding attitudes or emotions.

Collectively, the present findings show that the mere presence of another person in a scene changes the way people think about the spatial relations among objects in the scene. Although not all participants took the perspective of the person in the scene instead of their own perspective, a majority did when the question focused attention on action. Given that there were no demands, explicit or implicit, to take the other's perspective, this result discounts claims that an egocentric perspective is primary and natural (e.g., Eppley, Morewedge, & Keysar, 2004; Hart & Moore, 1973; Levelt, 1989; Piaget & Inhelder, 1956). On the contrary, in some situations, taking the other's perspective appears to be more natural and spontaneous than taking one's own.

Much has been said about embodied cognition (e.g., Barsalou, Niedenthal, Barbey, & Ruppert, 2003; Borghi, Glenberg, & Kaschak, 2004). The present results show that the deep meaning of embodied cognition is that it enables disembodied thought (e.g., Tversky, 2005). Here, people overcame their own embodied position in space to take an imaginary one, they escaped the entrapment of minds in bodies and bodies in views on space through imagination. What's surprising and significant is that people spontaneously take other perspectives despite the very real presence of their own.

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