Elsevier Editorial System(tm) for Cognition

Manuscript Draft

Manuscript Number: COGNIT-D-05-00417R1

Title: Putting Action in Perspective

Article Type: Brief Article

Keywords: Perspective-taking; Embodied cognition; Action understanding; Language; Spatial reasoning

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Abstract: Embodied approaches to cognition propose that our own actions influence our understanding of the world. Do other people's actions also have this influence? The present studies show that perceiving another person's actions changes the way people think about objects in a scene. In Study 1, participants viewed a photograph and answered a question about the location of one object relative to another. The question either did or did not call attention to an action being performed in the scene. Studies 2 and 3 focused on whether depicting an action in a scene influenced perspective choice. Across all studies, drawing attention to action, whether verbally or pictorially, led observers to encode object locations from the actor's spatial perspective. Study 4 demonstrated that the tendency to adopt the actor's perspective might be mediated by motor experience.

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March 15, 2006

Dear Dr. Mehler,

Attached please find the revision of our manuscript entitled "Putting Action in Perspective." The revised manuscript has a total word count of 2,989 words. My coauthors and I are very grateful to you and the reviewers for your helpful recommendations and concerns. We have used these to guide an improved revision. At your request, we outline the suggestions of the reviewers and our responses to them.

Responses to Reviewer 2's Comments

(1) Reviewer 2 requested that we expand on the following points: "What does it mean to say that the participants are taking the actor's perspective?" and "Why do people seem to take the perspective of the actor here, when other work shows that the egocentric perspective is preferred?" These are very good questions that are of great interest to us and that we wish we more fully could answer. We have attempted to address these questions more fully by including a brief discussion of possible links between motor experience, motor simulation, and perspective-taking in the general discussion:

"Why does perceived action affect spatial perspective? Observers might adopt the actor's spatial perspective because of an underlying simulation of the perceived action. This possibility is supported by the fact that motor experience, which presumably increases the extent to which observers simulate actions (e.g., Calvo-Merino et al., 2005), increases observers' tendency to adopt an actor's perspective."

Responses to Reviewer 3's Comments

(2) Reviewer 3 requested that we be more explicit in the methods sections about how data was collected. We agree that this is an important detail to include and the manuscript now specifies that data from Studies 1 and 3 were collected through Intro Psych questionnaires, distributed in a large course setting. Data from Studies 2 and 4 were collected by an experimenter who approached participants at their dorms and other campus locations.

(3) Reviewer 3 suggested that it would be useful to point out that although referring to the actor verbally in Study 1 did not have a significant effect, the trends were in the right direction. We have addressed this suggestion by making the following modification to the results section of Study 1: "Mentioning the actor in the question slightly increased responses from the actor's perspective and decreased those from a self perspective, but not significantly for either, $F(1, 84) < 1$; $F(1, 84) = 2.47$, $p = .12$, respectively."

(4) Reviewer 3 noted that in Study 3, the proportion of actor-perspective responses is higher than in the previous studies reported and raises a question as to why this might be. We believe this was an excellent observation and have revised the manuscript to address it. Specifically, we note that stimuli for Studies 1 and 2 depicted left-handed actions, while stimuli for Study 3 all depicted right-handed actions – actions which Study 4 suggests are more likely to elicit actor-perspective responses. Thus, to address Reviewer 3's comment, we have made the following revision to the introduction to Study 4:

"What role, if any, does motor experience play in observers' choice of perspective? Does the tendency to adopt the actor's perspective increase if the actor performs actions more similarly to the way participants perform actions themselves? Past research indicates that motor experience influences the extent to which people simulate observed actions (e.g., Calvo-Merino, Glaser, Grèzes, Passingham, & Haggard, 2005). Motor experience, such as handedness, also influences people's perceptual representations of situations (Martin & Jones, 1998; Rubin & Kontis, 1983). Could motor experience also affect the tendency to adopt the actor's spatial perspective? Suggestive evidence comes from comparing Study 3 with Studies 1 and 2. Participants in Study 3 were more likely to adopt the actor's perspective than those in Studies 1 and 2. A notable difference between these studies – besides the actor's rotation from participants – was that the actor in Study 3 reached with his right hand, whereas the actor in Studies 1 and 2 reached with his left hand."

(5) Reviewer 3 also noted that one of the more remarkable results presented in this manuscript was the Study 4 finding that motor experience affects observers' likelihood of encoding the actor's spatial perspective. Reviewer 3 suggested other research that is consistent with Study 4's findings. We have included references to this research in the introduction to Study 4 (see point 4), and also in revisions of the general discussion (see point 1).

Again, we greatly appreciate the time and thought you and the reviewers devoted to reviewing and responding to our manuscript. We believe your comments and suggestions have strengthened the work. We hope you agree.

Sincerely,

Sandra Lozano

Running head: PERSPECTIVE-TAKING AND ACTION UNDERSTANDING

Putting Action in Perspective

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Abstract

Embodied approaches to cognition propose that our own actions influence our understanding of the world. Do other people's actions also have this influence? The present studies show that perceiving another person's actions changes the way people think about objects in a scene. In Study 1, participants viewed a photograph and answered a question about the location of one object relative to another. The *question* either did or did not call attention to an action being performed in the scene. Studies 2 and 3 focused on whether *depicting* an action in a scene influenced perspective choice. Across all studies, drawing attention to action, whether verbally or pictorially, led observers to encode object locations from the actor's spatial perspective. Study 4 demonstrated that the tendency to adopt the actor's perspective might be mediated by motor experience.

Keywords: Perspective-taking; Embodied cognition; Action understanding; Language; Spatial reasoning

Putting Action in Perspective

Actions are central to daily life, enabling people to achieve a range of goals, from making a cup of coffee to getting a job. Recent theories have suggested that representations derived from performing actions oneself are used in perceiving others' actions (see Wilson & Knoblich, 2005). These theories are supported by evidence that observing actions, or even just hearing them described, modulates people's ability to perform those actions themselves, suggesting that people covertly simulate observed actions (Blakemore & Frith, 2005; Buccino, Riggio, Melli, Binkofski, Gallese, & Rizzolatti, 2005).

Representations derived from performing actions may also guide how knowledge is organized and used (Wilson, 2002). According to *embodied* approaches to cognition (e.g., Barsalou, 1999; Glenberg, 1997), knowledge is grounded in the perceptual representations that we acquire from active interaction with the world around us. This perceptually grounded knowledge enables simulation of objects and situations, and serves to guide future actions. Embodied approaches are supported by research showing that knowledge about action and knowledge about objects are interlinked (see Barsalou, Niedenthal, Barbey, & Ruppert, 2003). For example, thinking about particular actions makes certain objects more or less available to conscious awareness, and thinking about certain objects makes particular actions more or less available (Borghi, Glenberg, & Kaschak, 2004). Neuroimaging evidence indicates that observing an object, merely to categorize or comprehend it, is sufficient to partially activate action representations (Chao & Martin, 2000; Kan, Barsalou, Solomon, Minor, & Thompson-Schill, 2003). Action is also tied to knowledge about the spatial *relations* between objects. Although

spatial concepts, such as "the mug is *below* the coffee pot", can be thought of in simple geometric terms, people's understanding of them is affected by typical actions, like pouring coffee (Carlson & Kenny, 2005).

If people simulate others' actions using representations for their own, and if people's own actions influence how they think about objects and their relations, then do perceived actions also influence how people think about objects and their relations? The present studies explore this question by asking whether perceived action affects the *spatial perspective* people adopt to encode the locations of objects in a scene. For example, suppose you and another person are sitting across from each other at a table that has a book on it. From your perspective, the book is on the right, but from the other person's perspective, the book is on the left. Whose perspective would you choose to describe where the book is? An obvious answer is that you take you own. But if other people's actions are treated similarly to your own, and your own actions shapes your understanding of the world, then the spatial perspective you take may depend on whether the other person is acting on the book. If the other person reaches for the book, will you encode the other person's perspective, rather than your own? The following four studies systematically test the prediction that other people's actions influence our understanding of objects and their spatial relations.

Study 1: Action versus Static Questions

Participants viewed a photograph of an actor reaching for one of two objects and were asked about the location of one object relative to the other. The influence of action on spatial perspective was tested by asking participants a question that called attention either to action or to static information. If action affects encoding of spatial perspective,

then a question drawing attention to action should promote taking the actor's perspective. However, a question drawing attention to the actor should not have the same effect.

Method

Eighty-eight Stanford University undergraduates provided written responses to a questionnaire embedded in a large packet given to Introductory Psychology students. The questionnaire contained a question printed above an 8x11-inch color photograph of someone reaching for one of two objects (see Figure 1-a). Question information was manipulated using a 2 x 2 factorial design: reference to action (*action*, *static*) and to the actor (*actor mentioned*, *no actor mentioned*) were varied between participants. Participants were asked either: "In relation to the bottle, where does he place the book?" (*action*, *actor mentioned*); "In relation to the bottle, where is the book placed?' (*action*, *no actor mentioned*); "In relation to the bottle, where is his book?" (*static*, *actor mentioned*); "In relation to the bottle, where is the book?" (*static*, *no actor mentioned*).

Coding and reporting of results

For this and all subsequently reported experiments, responses were categorized as actor perspective (e.g., "the book is on *his left*"), self perspective (e.g., "the book is on *my right*"), or neutral perspective (e.g., "the book is *next to* the bottle"). Statistical analyses were performed on two binary variables created for each participant: the first equaled 1 if the response was from the actor's perspective and 0 if it was from a self perspective or neutral perspective; the second equaled 1 if the response was from a self perspective and 0 if it was from the actor's or a neutral perspective. For all analyses, the criterion for significance was alpha level less than .05. The *p*-values for insignificant effects are reported only when *F*- or *t*-values are greater than one. For significant ANOVA effects,

we report partial eta squared (η_p^2) as an estimate of effect size. For significant t-test effects, we report Cohen's *d*.

Results and Discussion

Participants were more likely to respond from the actor's perspective if the question referred to *action* ($M = .48$, $SEM = .08$) than to *static* information ($M = .27$, $SEM = .10$), $F(1, 84) = 7.68$, $\eta_p^2 = .14$. They were more likely to respond from a self perspective if the question referred to *static* ($M = .50$, $SEM = .10$) rather than *action* information ($M = .27$, $SEM = .07$), $F(1, 84) = 8.51$, $\eta_p^2 = .15$ (see Figure 2). Mentioning the *actor* in the question slightly increased responses from the actor's perspective and decreased those from a self perspective, but not significantly for either, $F(1, 84) < 1$; $F(1, 84) = 2.47$, $p = .12$, respectively. There was no interaction between reference to action and to the actor, $F(1, 84) < 1$. Thus, questions calling attention to action, but not to an actor, increased the tendency to adopt the actor's perspective.

Study 2: Viewing Action versus Static Scenes

In Study 1, many people adopted the actor's perspective even when asked a question about static information. Could this be because the photograph *depicted* action? Study 2 tested whether depicting action in a scene has the same impact on spatial perspective as asking a question referring to action.

Method

One hundred seventy-seven Stanford undergraduates, in dorms and other campus locations, were approached by an experimenter who presented an 8x11-inch photograph and asked: "In relation to the bottle, where is the book?" Participants saw one of three scenes (see Figure 1). One-third of participants viewed the same scene from Study 1

(*action* scene); one-third viewed a variant in which the actor looked at the object (*static* scene); and one-third viewed a variant with only the objects present (*no actor* scene).

Results and Discussion

The perspective participants adopted was strongly influenced by which scene they viewed (see Figure 3). Two one-way ANOVAs revealed reliable differences among the scenes in the mean number of actor perspective, $F(2, 174) = 19.63$, $\eta_p^2 = .20$, and self perspective responses, $F(2, 174) = 12.98$, $\eta_p^2 = .18$. Planned pairwise comparisons confirmed that the *action* scene elicited reliably more actor perspective responses ($M = .53$, $SEM = .06$) than the *static* scene ($M = .29$, $SEM = .06$), $t(116) = 2.72$, $d = 0.51$, which elicited reliably more actor perspective responses than the *no actor* scene, ($M = .05$, $SEM = .03$), $t(116) = 3.56$, $d = 0.69$. By contrast, the *no actor* scene elicited reliably more self perspective responses ($M = .79$, $SEM = .05$) than the *static* scene ($M = .59$, $SEM = .07$), $t(116) = -2.39$, $d = 0.46$, which elicited reliably more self perspective responses than the *action* scene ($M = .35$, $SEM = .06$), $t(116) = -2.59$, $d = 0.50$. Thus, depicting action in the scene made participants more likely to take the actor's perspective.

Study 3: Viewing an Actor versus an Observer

In the studies reported so far, participants viewed an actor offset 180° from them, so their own perspective was the reverse of the actor's perspective (e.g., left vs. right). One aim of the present study was to determine whether the preference to adopt the actor's perspective generalizes to situations when the actor is offset 90° from the participant, so that adopting the actor's perspective requires accessing a different spatial concept (*left/right* instead of *front/back*). Another aim was to see whether the preference to adopt the actor's perspective generalizes to situations where more perspectives are available,

adding that of an observer positioned directly across from the actor at a viewing angle of 90° from the participant.

Method

Two hundred thirty-two Stanford undergraduates provided written responses to a questionnaire embedded in a large packet given to Introductory Psychology students. A question was printed above an 8x11-inch color photograph of a scene. All scenes contained a target person designated the "actor." Scene information was manipulated using a 2 x 2 x 2 factorial design: the actor either reached for one of two objects or did not (*action*, *static*), was alone or accompanied by a static observer (*one person*, *two people*), and was positioned on the *right* or *left* side of the table (see Figure 4). All *action* scenes depicted ipsalateral right-handed action.

Responses were coded for whether they encoded the target's (actor's) perspective (e.g., "on the right"), self perspective (e.g., "in front of the bottle"), observer perspective (e.g., "on the left"), or neutral perspective (e.g., "close to the bottle"). Analyses were performed on binary variables created for taking an actor's, self, or observer's perspective.

Results and Discussion

Participants were reliably more likely to respond from the actor's perspective for the *action* scenes ($M = .77$, $SEM = .06$) than for the *static* scenes ($M = .23$, $SEM = .08$), $F(1, 224) = 122.24$, $\eta_p^2 = .39$ (see Figure 5), but were more likely to respond from a self perspective for *static* scenes ($M = .72$, $SEM = .09$) than for *action* scenes ($M = .11$, $SEM = .07$), $F(1, 224) = 88.91$, $\eta_p^2 = .23$. Neither the number of people in the scene nor the location of the actor (*left* vs. *right* side of the table) influenced the tendency to take the

actor's perspective or a self perspective, for both $F(1, 224) < 1$, and no interactions were reliable.

Participants rarely took the observer's perspective, whether or not the actor in the photo was reaching ($M = .05$, $SEM = .01$) or not ($M = .07$, $SEM = .02$), $F(1, 224) < 1$. In fact, responses from an observer perspective were as unlikely when the observer was in the scene ($M = .06$, $SEM = .02$) as when he was not ($M = .06$, $SEM = .03$), $F(1, 224) = 1.50$, $p = .19$. This was not because the observer was inherently less interesting than the actor: when the actor was static and accompanied by an observer, participants were equally likely to take the perspective of the actor ($M = .04$, $SEM = .02$) as the observer ($M = .04$, $SEM = .02$), *paired-t*$(25) = 0.00$.

Thus, scenes that depicted *action* resulted in adopting the actor's perspective, even when the actor was rotated 90°. Taking the actor's perspective was unaffected by the presence of the observer in the scene.

Study 4: Viewing Right- versus Left-Handed Action

What role, if any, does motor experience play in observers' choice of perspective? Does the tendency to adopt the actor's perspective increase if the actor performs actions more similarly to the way participants perform actions themselves? Past research indicates that motor experience influences the extent to which people simulate observed actions (e.g., Calvo-Merino, Glaser, Grèzes, Passingham, & Haggard, 2005). Motor experience, such as handedness, also influences people's perceptual representations of situations (Martin & Jones, 1998; Rubin & Kontis, 1983). Could motor experience also affect the tendency to adopt the actor's spatial perspective? Suggestive evidence comes from comparing Study 3 with Studies 1 and 2. Participants in Study 3 were more likely to

adopt the actor's perspective than those in Studies 1 and 2. A notable difference between these studies – besides the actor's rotation from participants – was that the actor in Study 3 reached with his right hand, whereas the actor in Studies 1 and 2 reached with his left hand.

Study 4 tested whether right- and left-handed participants would be more likely to adopt the perspective of actor with the same handedness as themselves. Participants described a photograph depicting an actor reaching with the left or right hand, either ipsilaterally or contralaterally.

Method

Two hundred Stanford undergraduates, in dorms and other campus locations, were approached by an experimenter who presented a 8x11-inch photograph of an actor (female) reaching for an object (see Figure 6) and asked: "In relation to the book, where is the bottle?" A 2 x 2 x 2 factorial design was used, where hand used in the photo (*right*, *left*), participant's dominant hand (*right*, *left*), and side of the body reached to (*ipsilateral*, *contralateral*) were varied between participants. After participants answered the target question, the experimenter asked them whether they were right-or left-handed and recorded their response. Of the two hundred participants, 176 were right-handed and 24 were left-handed.

Results and Discussion

Handedness of participants interacted with the hand used by the actor, such that participants adopted the actor's perspective more often when the actor reached with the same hand as their dominant one (see Figure 7). *Right*-handed participants were more likely to respond from the actor's perspective if she used her *right* ($M = .67$, $SEM = .05$)

rather than her *left* hand vs. (M = .18, SEM = .03), whereas *left*-handed participants were more likely to respond from the actor's perspective if she used her *left* (M = 1.00, SEM = .00) rather than her *right* hand (M = .00, SEM = .00), $F(1, 196) = 69.08$, $\eta^2 = .27$. In contrast, *right*-handed participants were more likely to respond from a self perspective if the actor used her *left* (M = .64, SEM = .06) rather than her *right* hand (M = .14, SEM = .04), whereas *left*-handed participants were more likely to respond from a self perspective if the actor used her *right* (M = 1.00, SEM = .00) rather than her *left* hand (M = .00, SEM = .00), $F(1, 196) = 70.95$, $\eta^2 = .27$. The effects for left-handed participants are surprising given that they have inevitably observed more right-handed actions in their life than left-handed ones. This suggests that the tendency to adopt the actor's perspective derives from experience *doing* rather than observing action.

The effects were not due to a simple bias for right-handed participants to say "right" and for left-handed participants to say "left" Such a bias would have led participants to use an actor's perspective for ipsilateral reaches, but a self perspective for contralateral reaches, because both could have been described by right-handed participants as "right" and left-handed participants as "left." But whether a reach was *ipsilateral* or *contralateral* did not differ affect responses from an actor perspective (M = .44, SEM = .05 vs. M = .43, SEM = .05) or a self perspective (M = .40, SEM = .05 vs. M = .38, SEM = .05), for both $F(1, 196) < 1$, nor did it interact with any other factors. Moreover, *right* and *left*-handed participants did not differ in their overall likelihood of responding from an actor's perspective (M = .43, SEM = .06 vs. M = .50, SEM = .06) or a self perspective (M = .38, SEM = .08 vs. M = .50, SEM = .07), for both $F(1, 196) < 1$. In

sum, an individual's motor experience affected the tendency to adopt an actor's perspective in describing a scene.

General Discussion

According to the view that cognition is embodied, our understanding of others' actions relies on sensorimotor experiences of performing those actions ourselves (e.g., Barsalou, 1999; Glenberg, 1997; Wilson & Knoblich, 2005), and our actions guide how we think about objects and situations (Wilson, 2002). The present research tested a prediction that derives from these proposals: that *other people's actions* influence how we think about objects and situations. Collectively, the present findings suggest that perception of another person in action changes the way people encode spatial relations among objects. Perceiving action leads people to encode objects from the actor's spatial perspective. These findings are surprising given the common assumption that people encode spatial relations from an egocentric perspective, and that this perspective is the natural one to take (e.g., Hart & Moore, 1973; Piaget & Inhelder, 1956).

Why does perceived action affect spatial perspective? Observers might adopt the actor's spatial perspective because of an underlying simulation of the perceived action. This possibility is supported by the fact that motor experience, which presumably increases the extent to which observers simulate actions (e.g., Calvo-Merino et al., 2005), increases observers' tendency to adopt an actor's perspective.

Embodied approaches to cognition generally consider how people's own actions shape the way they think about objects and situations. The present findings suggest that embodied knowledge about objects and situations might be based on observed actions as well as self-performed ones. A possibility to consider for future research is whether

adopting the actor's perspective – perhaps as a consequence of action simulation – is in fact functional: thinking about the world from an actor's perspective might facilitate understanding and predicting the actor's actions (e.g., Hard, Lozano, & Tversky, in press).

Acknowledgments

We thank Herb Clark, Lera Boroditsky, and Daniel Casasanto for their advice, Jonathan Winawer, Adam November, and Patrick Hard for help in stimuli creation, and the following grant: N000140210534 to Stanford University.

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Figure Captions

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

Figure 2. In Study 1, mean response from an actor, self, or neutral perspective as a function of question type and actor reference.

Figure 3. In Study 2, mean response from an actor, self, or neutral perspective as a function of scene.

Figure 4. Scenes used in Study 3: the actor reaching for the object (*action, one person*) (a), the actor reaching for the object, with an observer (*action, two people*) (b), the actor not reaching for the object (*static, one person*) (c) the actor not reaching for the object, with an observer (*static, two people*) (d). Half the participants saw scenes in which the actor was positioned on the right side of the table instead of the left. All *action* scenes depicted right-handed action.

Figure 5. In Study 3, mean response from an actor, observer, self, or neutral perspective as a function of scene.

Figure 6. Scenes used in Study 4: *ipsilateral right-handed action* (a), *contralateral right-handed action* (b), *ipsilateral left-handed action* (c), and *contralateral left-handed action* (d).

Figure 7. In Study 4, mean response from an actor, self, or neutral perspective as functions of side of the body action was performed on and whether the hand the actor acted with matched (dominant) or mismatched (nondominant) a participant's handedness.

Figure 1

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Figure 2

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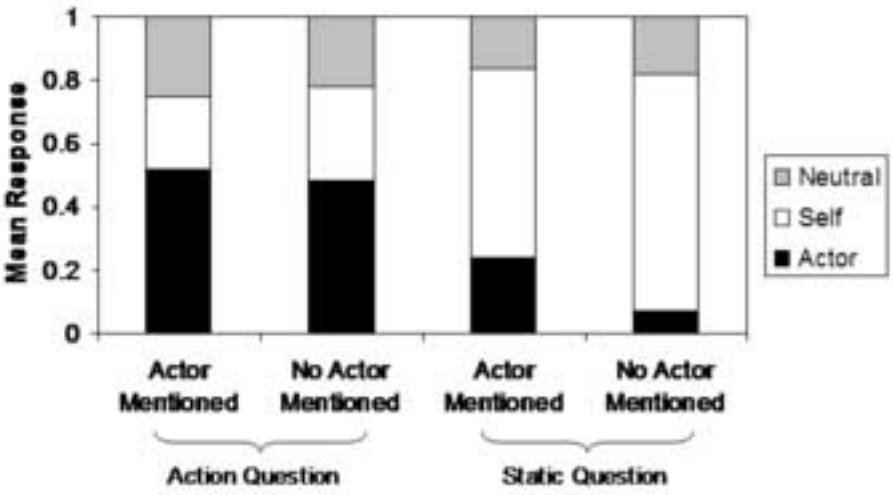

Figure 3

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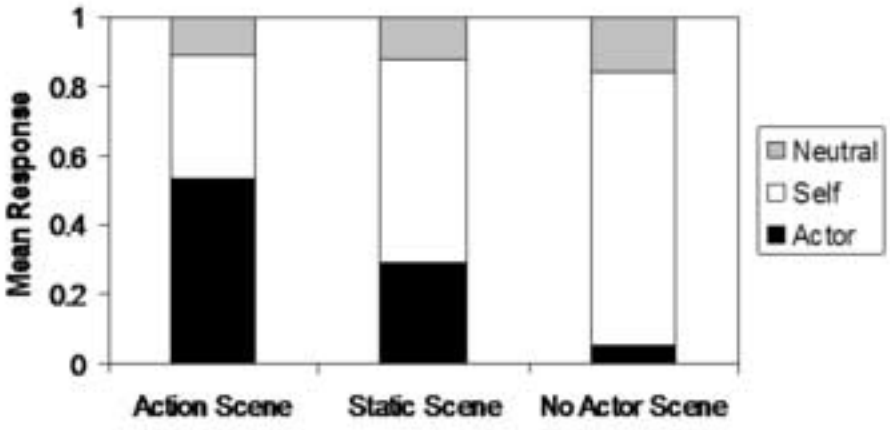

Figure 4

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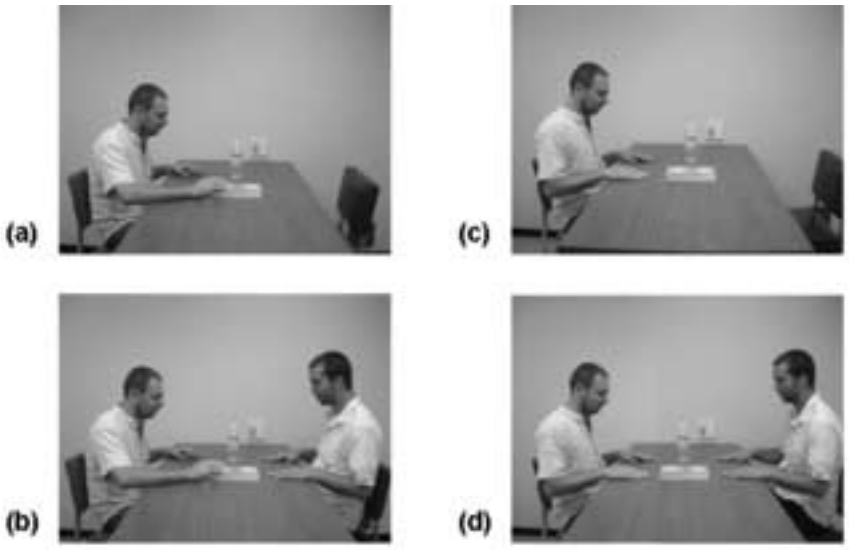

Figure 5

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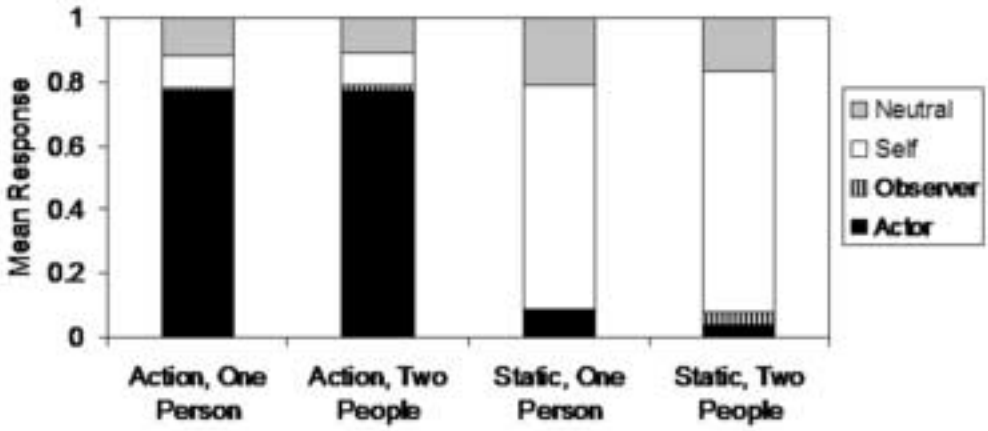

Figure 6

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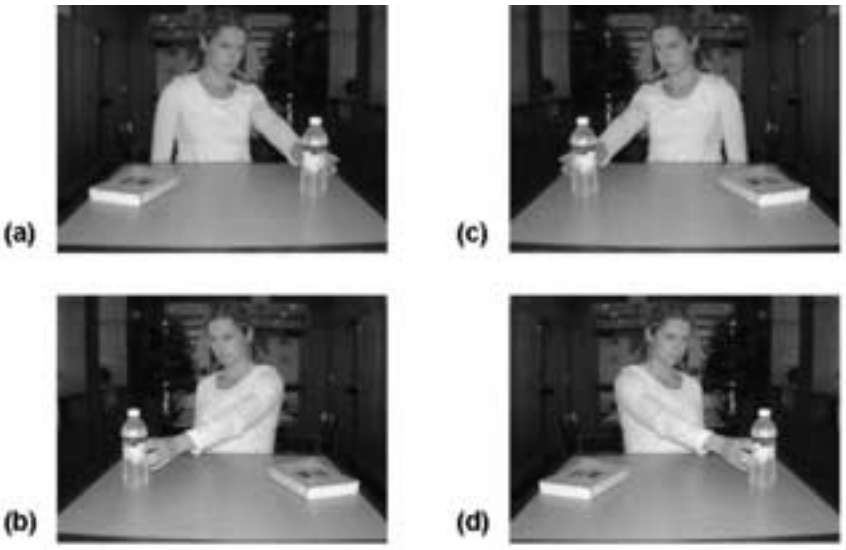

Figure 7

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