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Research Report

How Social Are Task Representations?

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ABSTRACT—*The classical Simon effect shows that actions are carried out faster if they spatially correspond to the stimulus signaling them. Recent studies revealed that this is the case even when the two actions are carried out by different people; this finding has been taken to imply that task representations are socially shared. In work described here, we found that the "interactive" Simon effect occurs only if actor and coactor are involved in a positive relationship (induced by a friendly-acting, cooperative confederate), but not if they are involved in a negative relationship (induced by an intimidating, competitive confederate). This result suggests that agents can represent self-generated and other-generated actions separately, but tend to relate or integrate these representations if the personal relationship between self and other has a positive valence.*

Tasks play a crucial role in people's lives: People earn their salary by carrying out tasks, and researchers give tasks to the participants of their studies to investigate cognitive processes. Surprisingly, however, very little is known about how people cognitively represent the tasks they pursue. Only recently has the increasing empirical interest in cognitive-control processes generated findings that shed some light on task representations. Particularly important for present purposes, some of these findings have been taken to suggest that task representations are fundamentally social and shared among jointly acting individuals (for overviews, see Knoblich & Sebanz, 2006; Sebanz, Bekkering, & Knoblich, 2006). This claim receives its strongest support from studies on an apparently social version of the classical Simon task.

The standard Simon effect is observed when people carry out spatially defined responses to nonspatial stimulus features, the location of which varies randomly. For instance, imagine that you are pressing a left key in response to a green stimulus and a right key in response to a blue stimulus, and further assume that the stimuli are randomly presented on the left or right of a display. Even though stimulus location is entirely irrelevant for the task, you will nevertheless be faster and more accurate if the green stimulus happens to appear on the left and the blue stimulus on the right than if the green stimulus appears on the right or the blue stimulus on the left (cf. Simon & Rudell, 1967; for an overview, see Lu & Proctor, 1995). In other words, spatial correspondence between stimulus and response facilitates performance. Researchers agree that the Simon effect is due to the match of spatial stimulus and response codes (Wallace, 1971). In the terminology of the theory of event coding (Hommel, Müsseler, Aschersleben, & Prinz, 2001), the stimulus-response rules in a Simon task can be considered as bindings between the relevant stimulus feature (green or blue) and the corresponding response feature (left or right), with the latter representing and controlling the required motor program (see Fig. 1a). If a stimulus appears on the left or right and is coded accordingly, its spatial code matches the code involved in one of the bindings, which will lead to the preactivation or priming of this binding. Accordingly, a left stimulus will prime the left response and a right stimulus will prime the right response. This priming produces facilitation if the stimulus and correct response are spatially corresponding, but response competition if they are not.

In the standard Simon task, the commonly used two response keys are operated by the same person, so that it seems obvious that he or she cognitively represents both stimulus-response alternatives. Recent observations suggest, however, that people may represent responses that another person carries out. In the joint-action condition of Sebanz, Knoblich, and Prinz (2003), pairs of participants shared a Simon task: One participant pressed the left key in response to one color, and the other participant pressed the right key in response to the other color, so that each participant was performing a go/no-go task. In the single-action condition, each participant carried out his or her part of the task in the absence of another person. Only the joint-action condition produced a full-blown Simon effect; that is,

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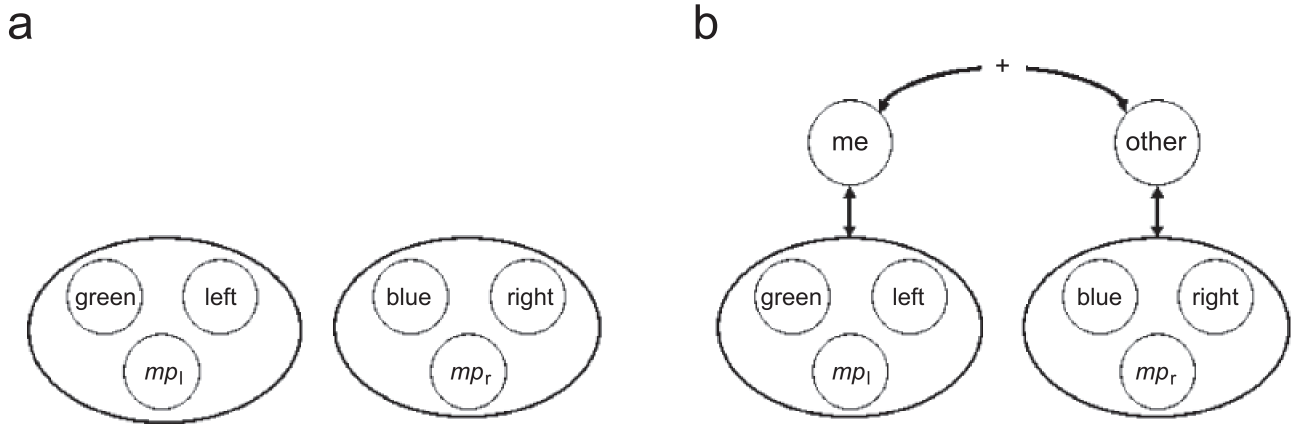

Fig. 1. Task representations according to the theory of event coding and our proposed theoretical extension. According to the theory of event coding (a), a relevant stimulus feature (e.g., ''green'' or ''blue'') and response feature (e.g., ''left'' or ''right'') are integrated into an event file (i.e., a cognitive binding; represented here by a boldface oval), along with the associated motor program (mp_l for pressing the left key or mp_r for pressing the right key). Stimulus and response codes are activated by matching stimuli or ''thoughts'' (e.g., stimuli with the feature ''green'' or ''blue'' or the feature ''left'' or ''right''). Activation of a code, in turn, induces activation of the associated motor program. In our theoretical extension (b), individuated (i.e., personally attributed) event files interact according to the relationship between the actor (represented by the ''me'' code) and the coactor (represented by the ''other'' code).

people performed better if the stimulus appeared on the side of the response key they operated. According to Sebanz et al., this kind of "interactive" Simon effect suggests that each participant represented the stimulus-response rules and action plans of both agents involved. Thus, people may represent stimulus events irrespective of their intended target and may represent an action irrespective of who is carrying it out. If this is the case, preventing oneself from carrying out the other person's action should require an effort. Indeed, electrophysiological findings suggest that there is more response inhibition in the no-go trials of the joint-action condition than in those of the single-action condition (Sebanz, Knoblich, Prinz, & Wascher, 2006; Tsai, Kuo, Jing, Hung, & Tzeng, 2006).

Even though these observations are consistent with the idea that task representations are socially shared, other findings seem less consistent with this view. If the interactive Simon effect is a social phenomenon, it should be sensitive to the manipulation of social variables and depend on an agent's appreciation of the social aspects of a given situation. However, if anything, the available data show the opposite. For instance, the effect remains the same (Sebanz et al., 2003) or even increases (Sebanz, Knoblich, & Prinz, 2005) if the information flow between the jointly acting participants is diminished by hiding the actors' hands from view and having them wear earplugs (which prevents the processing of auditory action feedback). Along the same lines, the occurrence and size of the effect does not depend on whether the coactor is in the same room: It occurs if, and only if, the coactors execute alternative actions (Sebanz et al., 2003; Tsai et al., 2006). Finally, the effects do not differ between healthy participants and individuals with autism, even though the latter are known to have considerable difficulties processing social information (Sebanz, Knoblich, Stumpf, & Prinz, 2005).

Given that the available evidence provides an ambiguous picture of the social nature of the interactive Simon effect, we were interested to see whether we could demonstrate a modulation of the effect by an unequivocally social factor. According to various authors (e.g., Aron, Aron, Tudor, & Nelson, 1991; Greenwald et al., 2002; Heider, 1958), the valence of interpersonal relations has a particularly strong impact on the way people cognitively represent and structure attributes and actions of themselves and of others. The perception of a positive relationship between oneself and another person is assumed to affect one's evaluation of things, actions, and attributes related to this other person (cf. Andersen & Chen, 2002). If the interpersonal relationship is experienced to be positive, then the things that the other person likes, the actions that he or she performs, and the attributes he or she has also tend to be positively evaluated. However, if the interpersonal relationship is experienced to be negative, then the things that the other person likes, the actions that he or she performs, and the attributes he or she has tend to be devalued (Heider, 1958). Moreover, positive relationships lead to a reduced self-other distinction (Aron et al., 1991), whereas negative relationships increase this distinction and stimulate concept-segregation processes that weaken the connection between attributes and actions related to oneself and those related to the disliked person (Greenwald et al., 2002). Applied to present purposes, these findings imply that creating a negative relationship between an actor and a coactor might reduce the interactions between the actor's representations of his or her part of the task and those of his or her coactor's part of the task. In other words, a negative relationship between jointly acting participants might reduce or eliminate the interactive Simon effect. We tested this hypothesis by attempting to induce positive and negative relationships between coactors in an interactive Simon task.

METHOD

Participants

Twenty-eight healthy young adults (25 females, 3 males; mean age = 20.6 years), all students from Leiden University, participated for partial fulfillment of course credit or a financial reward (€6).

Stimuli and Apparatus

The experiment was controlled by a personal computer attached to a color monitor. A small (0.5 × 0.5 cm) dark-gray square was presented in the center of the computer screen throughout an experimental block and served as a fixation point. The stimulus on each trial was either a green or a blue circle (1.5 cm in diameter) that was presented to the left or right of the fixation point. The color and location of the circle varied randomly, but both colors and locations appeared equally often across the experiment. Viewing distance was about 60 cm. Responses were made by pressing the "z" or "?" button of the computer keyboard with the left or right index finger, respectively.

Subjective Measures

Subjective feelings of happiness, anxiety, nervousness, irritation, and insecurity were informally assessed at the end of the experiment.

Task and Procedure

The experiment consisted of a 45-min session in which participants made timed discriminative responses to the color of the circle. In the *noninteractive condition*, participants operated both response keys, pressing the left key in response to a green circle and the right key in response to a blue circle. In the *interactive condition*, they only pressed the left key in response to a green circle. Circles remained on the screen until the response was given or 1,500 ms had passed. Intervals between subsequent stimuli varied randomly between 1,750 and 2,250 ms in steps of 100 ms. Participants were instructed to ignore the location of the stimulus and to base their response exclusively on its color. Responses were to be given as fast as possible while keeping error rates below 15% on average; feedback was provided at the end of a trial block. The task consisted of 6 blocks of 60 trials (30 with spatial stimulus-response correspondence and 30 with noncorrespondence). The first block served as a practice block.

All participants received the instructions from the same lab assistant. Participants performed the practice block and first two experimental blocks on their own, using both left and right keys to discriminate circle colors (noninteractive condition). They were then introduced to a new "researcher" (a confederate) and asked to proceed jointly with the experiment, performing the last three experimental blocks together with the confederate (interactive condition). In the interactive condition, the participant responded only to green stimuli, by pressing the left response button, and the confederate responded only to blue stimuli, by pressing the right key.

Half of the participants were confronted with a nicely and cooperatively acting confederate, and the other half were confronted with a confederate who acted intimidating and competitive. The "nice" confederate took a seat on the right of the participant, acted very politely, and behaved in a very calm and reassuring way (smiling and giving positive feedback such as "you are doing a good job" and "it is not too difficult, is it?"), even when a participant made a mistake. The "intimidating" confederate took the same seat, but kept glancing sternly at the hands and responses of the participants, was very authoritarian, and behaved in a tense manner (e.g., not smiling, giving negative feedback such as "you have to respond quicker" or "you are too slow"), particularly when the participant made a mistake. At the end of the experiment, participants were debriefed and asked how they felt. All participants who had performed the task with the intimidating confederate reported feelings of insecurity and irritation, whereas the participants who had interacted with the friendly confederate reported pleasant feelings only.

RESULTS

The significance criterion for all analyses was set to $p < .05$. We first analyzed the first two (noninteractive) experimental blocks to test whether participants from both groups showed a standard (i.e., noninteractive) Simon effect. Mean reaction times (RTs) and square-root-transformed error rates were computed from these data as a function of the not-yet-induced relationship (positive vs. negative) and spatial stimulus-response correspondence. Only correspondence produced a reliable effect on RTs, $F(1, 26) = 42.82, p < .001, \eta_p^2 = .62$, and error rates, $F(1, 26) = 24.87, p < .001, \eta_p^2 = .49$. The effects of group and the group-by-correspondence interaction were not significant, all Fs(1, 26) < 1. In both groups, responses were faster and more accurate with stimulus-response correspondence (positive-confederate group: mean RT = 396 ms, error rate = 3.3%; negative-confederate group: mean RT = 376 ms, error rate = 2.8%) than with noncorrespondence (positive-confederate group: mean RT = 424 ms, error rate = 6.8%; negative-confederate group: mean RT = 407 ms, error rate = 5.4%). Thus, both experimental groups showed comparable standard Simon effects in RTs and error rates.

Next, we analyzed the data from the interactive blocks in the same way. Participants in the negative-confederate group responded faster than participants in the positive-confederate group (309 ms vs. 338 ms, respectively), $F(1, 26) = 11.07$, $p = .003$, $\eta_p^2 = .30$. A main effect of correspondence on RT, $F(1, 26) = 21.27, p < .001, \eta_p^2 = .45$, indicated that responses were generally faster with stimulus-response correspondence

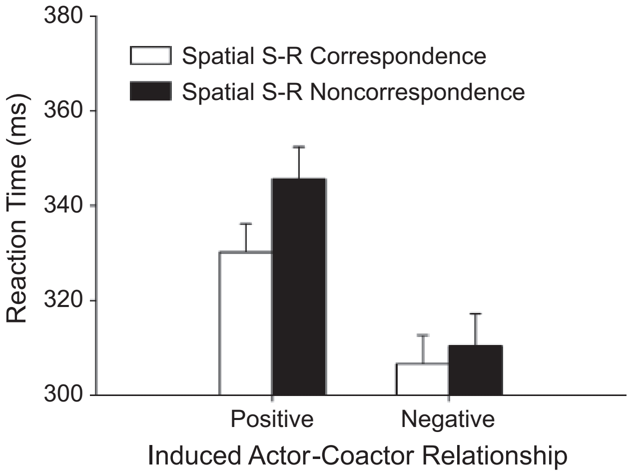

Fig. 2. Mean reaction time as a function of induced affective actor-coactor relationship and spatial stimulus-response (S-R) correspondence. Error bars show standard errors of the means.

than with noncorrespondence (318 vs. 328 ms). Overall, error rates on corresponding trials (0.41%) and noncorresponding trials (0.89%) were comparable, $F(1, 26) = 2.52$, $p = .125$, $\eta_p^2 = .09$, and did not differ between groups ($F < 1$). More important, a significant interaction indicated that the correspondence effect on RT differed between groups, $F(1, 26) = 7.86$, $p = .009$, $\eta_p^2 = .23$. Follow-up analyses confirmed that the 16-ms correspondence effect observed in the positive-confederate group was significant, $F(1, 13) = 17.07$, $p = .001$, $\eta_p^2 = .57$, whereas the 4-ms effect in the negative-confederate group was not, $p > .05$, $\eta_p^2 = .24$. Thus, we observed an interactive Simon effect for participants in a (presumably) positive relationship with their coactor, but not for participants in a negative relationship (see Fig. 2).

DISCUSSION

We hypothesized that positive relations may facilitate interactions between representations of actions related to oneself and to others, whereas negative relations prevent such interactions (Aron et al., 1991; Greenwald et al., 2002). If our hypothesis was correct, the interactive Simon effect should have been more pronounced in agents involved in a positive relationship with their fellow agent than in agents involved in a negative relationship. Our findings are consistent with this expectation: The interactive Simon effect was restricted to the participants confronted with a likeable coactor who was thought to create a positive relationship. In contrast, creating a negative relationship did not just reduce the interactive Simon effect, but eliminated the interactive Simon effect altogether. The fact that the negative relationship led to faster responses than the positive relationship (which shows that participants took the speed-related comments of the confederate to heart) rules out the possibility that the elimination of the Simon effect was due to a lack of motivation or emotional distraction. Moreover, given that faster responding commonly results in an increased Simon effect (Hommel, 1993), the speedier responses in the negative-confederate group cannot account for the elimination. Accordingly, we take the present findings as the first unequivocal demonstration that the interactive Simon effect is mediated by a social variable.

The observation that the interactive Simon effect can be eliminated entirely by manipulating the social relationship between actor and coactor challenges the assumption that task representations are necessarily socially shared and that joint actions rely on such shared representations, as claimed by Knoblich and Sebanz (2006). Rather, it seems that task components that one carries out oneself and components that one observes other people performing are, or at least can be, represented separately. However, these representations seem to be linked to representations of the responsible agents (such as the "other" and "me" nodes in Fig. 1b), and whether or not the task representations interact depends on the relationship between these agents. Hence, whether or not people share the representation of a task seems to depend on how much they like (or otherwise relate to) their coactor. Because we compared the impact of positive and negative relationships, but did not include a neutral control group, it remains an open question whether the sharing of task representations is a continuous function of the affective quality of the interactor relationship, so that task sharing gradually increases as the relationship gets more positive. Alternatively, if the interactor relationships in previous studies varied from neutral to friendly (because this is how participants are typically treated), it is also possible that task sharing is obtained as long as the relationship is not negative.

In any case, a dependency of task sharing on the interactor relationship would have considerable empirical implications and social consequences. For instance, a negative interpersonal relationship might be expected to make self-attributions of actions more accurate than other-attributions and to block automatic mimicry and imitation behavior. Given that mimicry commonly increases liking between interaction partners (Chartrand & Bargh, 1999), this blocking would serve to stabilize the negative quality of the relationship. Furthermore, being exposed to other people's actions has been considered to induce uncertainty about agency (i.e., who is performing the perceived action), which is apparently resolved by a neural network involving the anterior fronto-medial cortex and the temporo-parietal junction (Brass, Derrfuss, & von Cramon, 2005). If the activation of the network is correlated with uncertainty about agency, and if this uncertainty is more pronounced in positive relationships, the network may be more activated in positive relationships than in negative relationships. Finally, even though some degree of diversity in working environments is beneficial (Kochan et al., 2003), teaming up and collaborating with likeable colleagues sharing at least some interests and personal traits would not only lead to a better and more productive working atmosphere, but would change the way joint tasks are represented—which may facilitate the transfer of ideas and reduce the emphasis on personal authorship and competition.

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