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Social modulation of spatial judgment: The case of line bisection task

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ABSTRACT

Our actions are influenced by the social context in which they are performed, specifically it has been shown that observing others' actions influences the execution of the same action.
In the present study, we examined whether and to what extent observers are influenced by the presence and performance of another person in a visual spatial task, using a line bisection paradigm in which two participants performed the task in turns while sitting in front of each other. Thirty pairs of participants took part in the experiment, which was divided into a non-social and a social session. In the latter, each participant was alternately an agent (performing the task) and an observer (evaluating covertly the other's performance). Results show that the leftward bias (pseudoneglect) in the line bisection task was significantly reduced when the task was performed in the social session, although the bias (both in the non-social and in the social session) was observed only when the left hand was used. Moreover, a dissociation between performance and perception was observed: the judgment given to the other's performance (which visually deviated in the direction opposite to one's own bias due to the spatial arrangement of participants and their facing vantage points) was significantly in disagreement with one's own performance.
Overall, our results demonstrate that the other's presence influences our own action during a line bisection task and that spatial judgments on other's performance can modulate our own performance, even when coordination between participants is not required. Results are discussed in relation to social influence and perspective taking in the general framework of interpersonal resonance.

1. Introduction

Most of our actions are not performed in isolation, but are influenced by the social context in which they take place, in particular by others' actions. Neuroimaging studies have demonstrated the presence of a specific brain mechanism that underlies motor simulation during action observation: the "mirror neuron" system. Simply observing an action activates a corresponding representation in the observer's action system (for a review see Rizzolatti & Craighero, 2004). Thus, visually perceiving an action is thought to activate corresponding motor programs (Massen & Prinz, 2007). Recently, Uithol, vanRooij, Bekkering, and Haselager (2011), have specified how the mirror system supports the judgments of what others can do and see. The term motor resonance refers to the matching of one's own action to another's and describes a mechanism of emulation, in which viewing an action performed by another leads to activation of brain networks in the viewer that represent that action. Uithol et al. (2011) have identified two different interpretations of the notion of resonance that they called intrapersonal and interpersonal resonance. Intrapersonal resonance occurs within an individual: a perceptual representation of observed action is activated and at the same time coupled with a motor representation (Rizzolatti, Fogassi, & Gallese, 2001). This notion is supported by the common coding theory (Hommel, Müsseler, Aschersleben, & Prinz, 2001) in which perception and action share common underlying representations. In interpersonal resonance, there is a functional equivalence between the motor representation of the observer and the actor, emphasizing shared goals or action plans across the two individuals (Wilson & Knoblich, 2005; see also Szpak, Nicholls, Thomas, Laham, & Loetscher, 2015). Behavioral studies have also investigated the influence exerted by the observation of others on our actions, and the ideomotor theory can be taken into account to explain this interaction. The ideomotor theory states that observing an action activates corresponding representations in the action system of the observer, thus observing an action would facilitate the execution of the same action (Greenwald, 1970; James, 1890; Jeannerod, 1999; Prinz, 1997; Brass, Bekkering, & Prinz, 2001; Jordan & Knoblich, 2004; Knoblich & Jordan, 2002, 2003) or of the complementary action (e.g., Ferraro et al., 2012). It suggests that actions performed by others might become represented and have a specific impact on one's own action. Several tasks have been used to investigate how the presence of others can influence our own actions. For example, in

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joint action contexts, Sebanz, Knoblich, and Prinz (2003), using a simple spatial compatibility task, have shown that sharing a task is quite similar to performing it on one's own, at least when two complementary actions are distributed across the two persons. In fact, observers represent the actions of others in the same way they represent their own actions and incorporate them in action planning. Specifically, even when coordination is not required, co-actors take into account particular aspects of each other's tasks and include each other's actions in their planning. Interestingly, these motor representations exert their effects also in perceptual-motor learning (Milanese, Iani, & Rubichi, 2010; Milanese, Iani, Sebanz, & Rubichi, 2011; Lugli, Iani, Milanese, Sebanz, & Rubichi, 2015) and in observational learning, with (Ferraro et al., 2012) or without (Iani, Rubichi, Ferraro, Nicoletti, & Gallese, 2013) a human model to observe. Given the extensive influence of motor resonance representations, here we aimed at investigating the effect of motor resonance on the spatial judgment when one acts in front of another person performing the same action, and the two act alternately as performers and judges. We tested whether, and to what extent, performance is influenced by motor resonance using a paradigm that has never been exploited in this context, the line bisection task.

The line bisection task is one of the most frequently used paradigms to study visuospatial neglect, typically manifested in patients as a consequence of a lesion of the right inferior parietal lobe (e.g. Vallar & Perani, 1987). During this task, neglect patients bisect horizontal lines significantly to the right of the veridical center due to their lack of awareness of space at their left. Neurologically intact subjects bisect lines generally erring to the left of the veridical center, a phenomenon named for the first time by Bowers and Heilman (1980) as 'pseudoneglect' (for a review see Jewell & McCourt, 2000), which may reflect a leftward attention bias, supported by a right hemisphere dominance in the control of spatial attention (Heilman & van den Abell, 1980).

As social beings, people often are in situations that require them to overcome their own position in space in order to adopt another person's spatial perspective and to process visuospatial information assuming a different frame of reference. One proposal of visuospatial information processing is that it may rely on at least two different frames of reference: egocentric and allocentric (for a review see Landis, 2000). Egocentric spatial representations of an object depend on the object's position relative to the viewer's body. In this frame of reference the terms left and right refer to the observer. Allocentric spatial representation is a concept that includes representations of space in world-centered coordinates. In this case the terms left and right refer to the object itself and are independent of the observer. In devising the present study, we hypothesized that line bisection could also provide a simple and novel way for investigating the effects of the different frames of reference (egocentric and allocentric) associated to the representation of one's own actions and to the representation of others' actions.

We thus carried out an experiment in which healthy participants performed line bisection tasks in two different sessions: one in isolation and one in a social condition involving taking turns. In the non-social session each participant performed the task alone, allowing us to collect data on the baseline spatial bias associated to line bisection. In the social session, each participant performed the task alternating with another person situated in front of her/him. As the two participants sat in front of each other and the line to be bisected was positioned equidistantly on a table between the two, the line appeared identical from either point of view, and its centre, whose position had to be determined by participants, could be considered a common spatial goal disregarding the specific perspective of each participant. However, despite the veridical centre could be taken as a (theoretical) landmark common to the two participants, we expected that the perceptual centre as determined by the bisection of one participant, due to pseudoneglect to her/his left, should necessarily appear incorrect from the point of view of the other participant (whom would perceive it to the right in her/his coordinates) when s/he would be given the opportunity to judge the other's bisection. As we wanted to examine whether the performance would differ from the non-social baseline, we first compared the magnitude of the bisection error in the non-social and in the social conditions. Moreover, during the social session we asked each participant to evaluate covertly the performance of the other participant, by expressing a judgment immediately after the other person had bisected the line. By comparing the performed bisection and the judgment about the bisection as performed by the other participant, we expected to find either incongruence between motor responses and perceptual judgments, thus supporting the prevalence of a purely egocentric frame of reference in both conditions, or congruence between first-person performance and judged correctness of the other's performance, supporting the adoption of an egocentric frame of reference in first-person performance and the adoption of an allocentric frame of reference in the perceptual judgment, as it could be predicted by the ideomotor theory applied to the specific case of perspective taking involved in the present task (Frith & Frith, 2012; Zacks & Michelon, 2005). In addition, the magnitude and direction of the perceptual judgments could allow us to estimate whether and how any observational bias could influence subsequent performance.

2. Method

2.1. Participants

Sixty participants (30 females; mean age = 24.83; SD = 3.46; range = 18–32) took part as unpaid volunteers in the experiment. Hand preference was assessed using the Italian version of the Edinburgh Handedness Inventory (Salmaso & Longoni, 1985). The participants had visual acuity of 20/20 or corrected-to-normal.

2.2. Stimulus materials

Stimuli were black lines (150 mm long, 1 mm thick), each printed centrally on a horizontally-oriented A4 sheet (14.9 × 21 cm).

2.3. Procedure

Participants were split into thirty pairs of the same sex (15 male pairs, 15 female pairs), each participant in a pair convening to the laboratory at the same time. The experiment consisted of two consecutive sessions: one non-social session and one social session. In the non-social session each participant was separately asked to bisect printed lines with a pencil. Thirty trials were administered (15 with the right hand and 15 with the left hand) while the participant sat at the long side of a table (80 × 160 cm) in the absence of the other participant (see Fig. 1A). Each stimulus was presented in the center of the table by the experimenter, who stood behind the participant and passed each sheet to her/him, one at a time. The starting position of the hand and pencil at each bisection was not controlled. In the social session each participant in a pair sat at one of the long sides of the same table, facing the other participant, and performed the bisection with a pencil (see Fig. 1B). Also in this session 30 trials were administered (15 with the right hand and 15 with the left hand), in turns with the other participant. In the social session, besides active bisections by the two participants, perceptual data were collected, taking advantage of the fact that when one participant performed the bisection (agent), the other participant observed the event as it took place (observer). The first type of data collected in the social session consisted thus in the bisection performance by all participants when they took the role of agent, being watched by the other in the role of observer. The other type of data consisted in the judgment by all participants when they took the role of observer, and could evaluate the bisection performed by the agent. We decided to record covertly the judgment by the observer, who could take notice of her/his impression about the position of the agent's bisection by making a single forced choice between three possible alternatives on a response sheet: the response could be "center" (if the agent's bisection was judged as correct), "left" (if the agent's bisection