

Spatial Correspondence Parameters at the Basis of Transfer of Learning in Social Contexts

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Abstract

Recent works indicated that performing a joint spatial compatibility task with an incompatible stimulus-response mapping affects subsequent joint Simon task performance, eliminating the social Simon effect (social transfer of learning effect or SToL effect). Crucially, the SToL effect was not tuned to the specific identity of the co-actor, and depended on the overlap between the spatial relations of the practice and transfer tasks. Starting from these findings, this study aimed at investigating which spatial relations between stimulus (S), response (R) or participant (P) positions are relevant for the SToL effect to occur. Two experiments were run in which the participant-response associations were incompatible (participants were required to respond with crossed arms), whereas the stimulus-response and stimulus-participant associations were manipulated. We found that learning derived from the practice task did not transfer to the subsequent task when stimulus-response associations were spatially incompatible and stimulus-participant associations were compatible (Experiment 1). However, a SToL effect was evident when stimulus-participant associations were spatially incompatible and stimulus-response associations were compatible (Experiment 2), hence suggesting that the spatial relation between stimulus and participant positions is crucial for the SToL effect to occur.

Keywords: social cognition; joint performance; spatial compatibility; social transfer-of-learning

Introduction

Learning involves the acquisition and modification of new or existing knowledge through the application of which humans may be able to perform new tasks. This knowledge is shaped by the experience humans could acquire alone or in a social context (e.g., Vygotsky, 1978).

As regards individual performance, there is evidence that knowledge acquired in a task (i.e., practice task) can be transferred to and affects the way a subsequent task (i.e., transfer task) is performed. In the transfer-of-learning (ToL) paradigm, developed by Proctor & Lu (1999, see also Iani, Rubichi, Gherri, & Nicoletti, 2009) participants are required to perform a spatial compatibility task with an incompatible stimulus-response (S-R) mapping (i.e., they are instructed to press a right key when a left stimulus is presented and a left key when a right stimulus is presented), followed by a Simon task in which stimulus location is irrelevant and responses have to be emitted on the basis of a non spatial stimulus feature (e.g., color). When the Simon task is performed alone, performance is more efficient when stimuli and responses spatially correspond (corresponding trials) than when they do not correspond (non-corresponding trials). Thus, if participants are instructed to press a right key to a red stimulus and a left key to a green stimulus, their reaction times (RTs) will be shorter and accuracy higher if a red stimulus appears on the left compared to when it appears on the right. The influence of the irrelevant spatial stimulus feature on performance is known as the Simon effect (Simon & Rudell, 1967; Rubichi & Nicoletti, 2006; Rubichi, et al., 1997; Rubichi, et al., 2004; for reviews, see Proctor & Vu, 2006; Rubichi, et al., 2006).

It has been demonstrated that performance on the Simon task could be modulated, that is the Simon effect is reduced, eliminated or reversed, after practicing with a spatially incompatible mapping (e.g., Iani et al., 2009; Proctor & Lu, 1999; Tagliabue, et al., 2000). This is thought to occur because the non-corresponding stimulus-response associations acquired during the transfer task remain active and influence performance in the subsequent Simon task. Hence, the fact that after an incompatible practice the Simon

effect is modulated indicates that performance depends not only on the goals of the task that is currently being performed, but also on immediate prior experience.

Sebanz and colleagues (Sebanz, Bekkering, & Knoblich, 2006; Sebanz, Knoblich, & Prinz, 2003) have shown that the Simon effect occurs even when the Simon task is shared between two agents with each one responding only to one stimulus color (from now on, social Simon effect). In the social variant of the Simon task, one participant has to press the left key in response to green stimuli and the other participant has to press the right key in response to red stimuli, so that each participant is performing a go/no-go task. The observation of a social Simon effect provides evidence that, although each participant is responsible for only half of the task and hence for only one response alternative, they tend to represent the co-actor's task and to integrate self and other's task into a common representation (see also Ferraro et al., 2012). Starting from these evidences, two studies (Milanese, Iani, & Rubichi, 2010; Milanese, Iani, Sebanz, & Rubichi, 2011) investigated, by means of the social transfer of learning (SToL) paradigm, whether and to what extent specific contextual determinants influence the way knowledge acquired in a given task could be transferred to a subsequent one. Milanese et al. (2010) modified the transfer of learning paradigm used in individual context. In their modified paradigm (from now on, the SToL paradigm), two participants performed together the spatial compatibility task (practice task) and the Simon task (transfer task) one after the other. They found that individually and jointly acquired stimulus-response associations acquired in the practice task remained active and transferred to the joint Simon task leading to an elimination of the joint Simon effect, whereas jointly acquired stimulus-response associations did not transfer to individual task performance. In other words, transfer-of-learning effects were maximal only when both practice and transfer tasks took place in a social setting, suggesting that what was transferred was not only what was specifically practiced, but also aspects of the interactive context in which learning took place.

Milanese et al. (2011) further investigated the elements of the contexts that needed to remain constant for transfer between a jointly performed practice task and a subsequent joint transfer task to occur, that is the identity of the co-actor and the spatial relation between the two co-actors. Results showed that a spatially incompatible practice performed jointly with another person influenced performance on a subsequent joint Simon task even if the co-actor's identity changed (Experiment 1), whereas when participant's position changed from the practice to the transfer task (that is, participant sitting on the left in the practice session sat on the right in the transfer session, the opposite was true for the other participant), the social-transfer-of-learning effect did not occur (Experiment 2). To sum up: the SToL effect was not tuned to the specific identity of the co-actor, and depended on the overlap between the spatial relations of the practice and transfer tasks.

Starting from these results, one might wonder which specific spatial relations are really necessary in order to obtain the modulation of performance on the subsequent joint Simon task. We know that in the solo condition, the non-corresponding link between stimulus and response positions is crucial. What does it happen when the joint task requires a further spatial determinant that is the participant's position? In other words, what does it happen if participants are required to take into consideration both the position of the response-key and the position of their body? To this aim, we performed two experiments, using the SToL paradigm, in which we manipulated the spatial relation between the stimulus, the response and the participant. For sake of clarity, the position of the response-key referred to the right/left button location on the keyboard, and the participant's position referred to the left/right displacement of the participant's body with respect to the center of the table. In both experiments the participant-response associations were incompatible (participants were required to respond with crossed arms), whereas the stimulus-response and stimulus-participant associations were manipulated. In the practice session of Experiment 1, stimulus-response associations were spatially incompatible, while stimulus-participant ones were spatially compatible. We achieved this by requiring participants to respond with their arms crossed to the stimulus which was contralateral with respect to the position of the response-key (i.e., for instance, participants sitting on the left responded by pressing the right key to the left stimulus). In the practice session of Experiment 2, stimulus-participant associations were spatially incompatible, while stimulus-response ones were spatially compatible. In this experiment, participants were required to respond with their arms crossed to the stimulus that was contralateral with respect to their sitting position (i.e., for instance, participants sitting on the left responded by pressing the right key in response to the right stimulus). These manipulations will allow us to define which incompatible association is crucial for the SToL effect to occur.

Experiment 1

Method

Participants Sixteen students (1 male; 4 left-handed; age range: 19-26 years) of the University of Modena and Reggio Emilia took part in Experiment 1 for partial fulfillment of course credit. They reported normal or corrected-to-normal vision and were naïve as to purpose of the study. Once selected, they were randomly paired.

Apparatus and stimuli As in Milanese et al. (2010, 2011), stimuli in the spatial compatibility task were white solid squares (4.5 X 4.5 cm), whereas stimuli in the Simon task were red or green solid squares (4.5 X 4.5 cm). All stimuli were presented on a black screen, 9.5 cm to the left or to the right of a central fixation cross (1 X 1 cm). Stimulus presentation was controlled by an IBM computer. In both tasks, responses were executed by pressing the "z" or "c" keys of a standard Italian keyboard with the left or right

index finger, respectively. In the spatial compatibility task participants' hands were crossed (the participant sitting on the left pressed the right key with his/her left hand; the participant sitting on the right pressed the left key with his/her right hand). Viewing distance was about 60 cm.

Procedure The experiment consisted of two consecutive sessions: a practice session and a transfer session. Participants first performed a joint spatial compatibility task (practice session) with an incompatible mapping (stimulus positions were mapped incompatibly to response-key positions, that is participants were required to respond to the contralateral stimulus with respect to the response-key position). Each participant was instructed to respond to only one of the two stimulus locations by pressing the contralateral key (by crossing their arms) and refraining from responding when a stimulus appeared in the alternative position. Hence, half of the participants responded to left stimuli by pressing a right key, whereas the other half responded to right stimuli by pressing a left key (see Fig. 1). After a 5-min rest, participants were administered a joint Simon task (transfer session), in which the red and green stimuli were always location-irrelevant trials. Participants were instructed to respond to only one stimulus color by pressing the key at their disposal. For half of the participants, instructions required to press the right key in response to red stimuli and the left key in response to green stimuli, whereas for the other half instructions required to respond with the opposite stimulus-response mapping. Each participant kept the same position in both practice and transfer tasks, but changed the response position from the practice to the transfer task. That is, for instance, the participant sitting on the left and responding with the right key in the practice session sat on the left and responded with the left key in the transfer session (see Fig. 1).

In both tasks, a trial began with the presentation of the fixation cross at the center of a black background. After 1000 ms the stimulus appeared to the left or to the right of the fixation. In the spatial compatibility task, the stimulus remained visible for 600 ms, and the maximum time allowed for a response was 1200 ms. In the Simon task, the stimulus remained visible for 800 ms and the maximum time allowed for a response was 1000 ms. The inter-trial-interval was 1 s, and it was initiated immediately after the response was made.

The spatial compatibility task was composed of 12 training trials and 300 experimental trials divided into 3 blocks. The Simon task consisted of 12 training trials and 160 experimental trials divided into two blocks of 80 trials each. For both tasks, instructions stressed both speed and accuracy of performance.

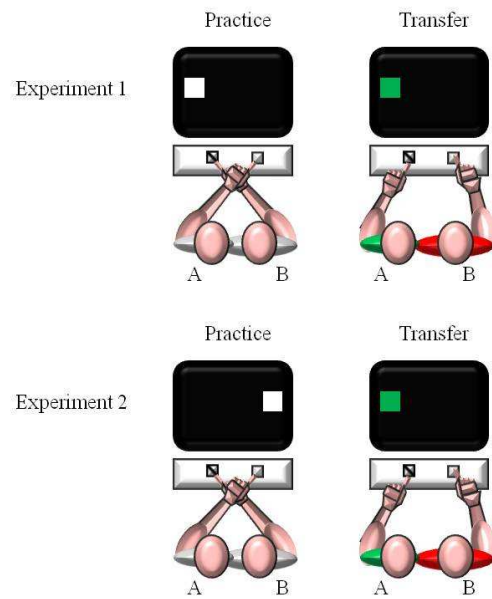


Figure 1: Schematic representation of the experimental conditions used in the two experiments. In the practice session the participant sitting on the left (A) was required to press the right key in response to the left stimulus (participant-response and stimulus-response associations were spatially incompatible and the stimulus-participant association was compatible, Experiment 1) or to the right stimulus (participant-response and stimulus-participant associations were spatially incompatible and the stimulus-response association was compatible, Experiment 2). In both experiments, each participant kept the same sitting position in both practice and transfer tasks, while the position of the response-key changed.

Results and discussions

Since our predictions concern performance in the joint Simon task, for the current and the following experiment we report only the data for the Simon task (transfer session). Correct reaction times (RTs) were submitted to a repeated-measures Analysis of Variance (ANOVA) with Correspondence (corresponding vs. non-corresponding) as within-subject factor.

Responses in corresponding trials (328 ms) were faster than responses in non-corresponding trials (350 ms), $F(1,15) = 48.18$, $p < .001$, see Fig. 2. The significant 22-ms Simon effect indicates that the joint Simon task was not influenced by prior joint performance on the spatial compatibility task¹. Thus, practice on a spatial compatibility

¹In order to understand whether the 22-ms social Simon effect found in Experiment 1 was influenced by prior practice, we compared the data of this experiment with the data of the baseline condition of Milanese et al. (2010)'s Experiment 1 in which a 14-ms social Simon effect was evident. Correct RTs for the two conditions were submitted to an ANOVA with Correspondence (corresponding vs. non-corresponding trials) as within-subject factor and Condition (baseline vs. Experiment 1) as between-

task with an incompatible association between the participant and the location of the response-key is not sufficient to produce SToL. These results suggested that stimulus-participant associations may play a crucial role in the occurrence of the SToL effect.

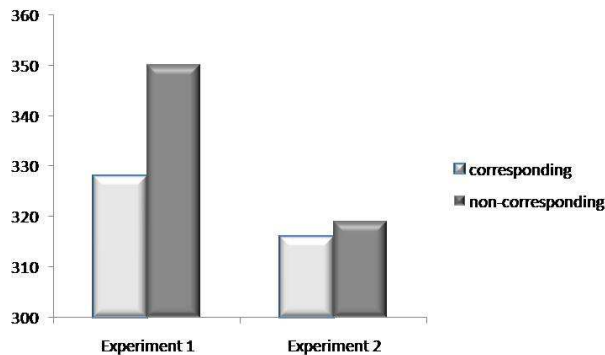


Figure 2: Means reaction times (ms) for the transfer session of Experiments 1 and 2 as a function of stimulus-response correspondence.

subjects factor. The Correspondence x Condition interaction did not reach significance, $F(1,30)=2.91$, $p=.10$, indicating that the effects found in the two experiments did not differ. Based on this result, we can safely conclude that in our Experiment 1 there was no evidence of SToL.

Experiment 2

Method

Participants Sixteen new right-handed students of the University of Modena and Reggio Emilia (all female; age range 19-20 years), selected as in the previous experiment, took part in Experiment 2.

Apparatus and stimuli and procedure Apparatus and stimuli were the same as in Experiment 1, whereas the procedure varied as follows. Participants performed the joint spatial compatibility task with a different incompatible mapping: stimulus positions were mapped incompatibly to participants seating position, that is participants were required to respond to contralateral stimuli with respect to their seating position. Each participant was instructed to respond to only one of the two stimulus locations by pressing the contralateral key (by crossing their arms) and refraining from responding when a stimulus appeared in the alternative position. Each participants kept the same position in both practice and transfer tasks, while the position of the response-key changed. That is, for instance, the participant sitting on the left and responding with the right key in the practice session sat on the left and responded with the left key in the transfer session (see Fig. 1).

Results and discussion

Correct RTs were submitted to an ANOVA with Correspondence as within-subject factor. RTs did not differ between corresponding (316 ms) and non-corresponding trials (319ms), $F < 1$ (see Fig. 2). The lack of a significant Simon effect is indicative of SToL. This result can be taken as an indication that it is the spatial association between the stimulus and the participant acquired during the practice task that is crucial for the occurrence of the SToL effect, while stimulus-response associations are irrelevant.

Additional analysis

In order to compare the Simon effect found in the two experiments, we ran an ANOVA with Correspondence (corresponding vs. non-corresponding trials) as within-subject factor and Experiment (Experiment 1 vs. Experiment 2) as between-subjects factor. Responses in corresponding trials (322 ms) were faster than responses in non-corresponding trials (334 ms), $F(1,30)=25.64$, $p<.001$. The main effect of Experiment was nearly significant, $F(1,30)=3.64$, $p=.07$, showing that responses were slower in Experiment 1 (339 ms) than in Experiment 2 (317 ms). The Correspondence x Experiment interaction was significant, $F(1,30)=15.23$, $p<.001$, indicating that the 22-ms found in Experiment 1 differed from the 3-ms (non-significant) effect found in Experiment 2.

Discussion

It is well known that in the ToL paradigm, when the practice task is performed in a solo condition, what is acquired and transferred to the subsequent Simon task is an association between stimulus and response-key positions (Proctor & Lu, 1999; see also Iani, et al., 2009).

The results of previous studies (e.g., Milanese et al., 2010, 2011) seem to suggest that in social settings a crucial factor for the occurrence of transfer-of-learning effects may be the type of relation between the participant and the stimulus positions acquired during practice rather than the relation between stimulus and response-key positions. The present study was aimed at assessing the relative contribution of the spatial relations between stimulus and response-key, between stimulus and participant or rather between participant and response-key positions in the occurrence of the SToL effect. More specifically, the participant-response associations were always incompatible (participants were required to respond with crossed arms), whereas stimulus-response and stimulus-participant associations were manipulated. In this way we were able to investigate independently whether crucial for the SToL effect to occur is the incompatible association between stimulus-response positions (Experiment 1) or between stimulus-participant positions (Experiment 2).

We found a SToL effect when participant-response and stimulus-participant associations were spatially incompatible and stimulus-response associations were compatible (Experiment 2). No evidence of SToL was found when participant-response and stimulus-response associations were spatially incompatible and stimulus-participant association were compatible (Experiment 1).

The present findings suggest that the incompatible association between the positions of the stimulus and of the participant may be crucial for the emergence of the SToL effect. It would seem, thus, that in a joint setting, where participants are (implicitly) required to take into account the presence of another person, the participant's position acquires greater relevance than in a solo setting. These results point to an intriguing and debated issue remained open so far: do correspondence effects emerging in joint setting depend on the relationship not only between stimuli and responses but also between stimuli and responding agents?

Recently, Philipp and Prinz (2010; see also Liepelt, et al., 2010) proposed that the joint compatibility effect may rely not only on the stimulus-response spatial correspondence (as is known to be crucial for the standard Simon effect to occur), but also on social correspondence, that is the one between stimulus and responding agents. According to these authors, when the Simon task is shared between two acting individuals, space may be used as an indication of whose turn it is. This would mean that a stimulus appearing on the left does not bring to the automatic activation of the left response, but rather is perceived as a stimulus signaling that the person sitting on the left is in charge of responding.

Starting from this account, our study investigated whether social correspondence may play a crucial role also in the SToL effect. It should, however, be noted that in Philipp and Prinz's study, the positions of the participant and of the response-key always corresponded and hence the correspondence between stimulus and response-key position could not be distinguished from the correspondence between the stimulus and the responding agent. In the current study, we separated the positions of the response-key and of the participant, as in the practice task participants were required to respond with crossed arms. In this way we were able to investigate independently whether crucial for the SToL effect to occur is the incompatible association between stimulus and response-key positions (Experiment 1) or between stimulus and participant positions (Experiment 2). Based on the findings of the current study, the observation of a null joint Simon effect in the transfer task could be the result of the acquisition and subsequent transfer of the incompatible link between the stimulus and participant positions. In other words, as the present results suggest, the SToL effect in these studies may rely not only on the spatial association correspondence between stimulus and response, differently from the individual condition (ToL effect), but also, and crucially, on the incompatible link between the stimulus and participant positions. These results underline the importance of both spatial and social features. Indeed, it seems that acting in a social context increases the importance of the participants' position with respect to the stimulus.

To conclude, in this study, we used the social transfer of learning paradigm to identify which elements of the context need to remain constant for social transfer-of-learning effects to occur. This issue is not trivial, because sometimes the practice context (i.e., the context in which we implicitly acquire new knowledge) and the transfer context (i.e., the subsequent context in which we utilize the acquired knowledge) are not identical and may differ in several aspects. The results of this study are particularly relevant since they provide insights on the way we represent another's task (and how we integrate the other agent information about action with our information, see Knoblich & Jordan, 2003) in particular joint action situations.

Acknowledgments

This work was supported by MIUR PRIN (project 2008ZN5J5S).

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