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Observed actions affect body-specific associations between space and valence

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ABSTRACT

Right-handers tend to associate "good" with the right side of space and "bad" with the left. This implicit association appears to arise from the way people perform actions, more or less fluently, with their right and left hands. Here we tested whether observing manual actions performed with greater or lesser fluency can affect observers' space–valence associations. In two experiments, we assigned one participant (the actor) to perform a bimanual fine motor task while another participant (the observer) watched. Actors were assigned to wear a ski glove on either the right or left hand, which made performing the actions on this side of space disfluent. In Experiment 1, observers stood behind the actors, sharing their spatial perspective. After motor training, both actors and observers tended to associate "good" with the side of the actors' free hand and "bad" with the side of the gloved hand. To determine whether observers' space–valence associations were computed from their own perspectives or the actors', in Experiment 2 we asked the observer to stand face-to-face with the actor, reversing their spatial perspectives. After motor training, both actors and observers associated "good" with the side of space where disfluent actions had occurred from their own egocentric spatial perspectives; if "good" was associated with the actor's right-hand side it was likely to be associated with the observer's left-hand side. Results show that vicarious experiences of motor fluency can shape valence judgments, and that observers spontaneously encode the locations of fluent and disfluent actions in egocentric spatial coordinates.

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1. Introduction

Across many languages and cultures, the right is associated with positive and the left with negative (Hertz, 1973). In Spanish, the word "diestro" meaning "right-handed" also means "able," whereas the word "zurdo" meaning "left-handed" derives from the word "zocato," meaning "ugly" and "klutz." English speakers use positive and negative idioms like "my right hand man" and "two left feet," and similar expressions have been reported in English, Italian, Arabic, and Chinese (McManus, 2002).

Yet, despite widespread linguistic and cultural conventions linking "good" with "right," left-handers implicitly associate "good" with "left" (Casasanto, 2009, 2011). Casasanto (2009) proposed that this implicit association arises from patterns of manual motor fluency: People tend to associate "good" with the side of space on which they can perform actions more fluently, typically with their dominant hand. To test this proposal, Casasanto and Chrysikou (2011) tested whether changing someone's patterns of manual motor fluency could change their associations between space and emotional valence (i.e., positivity and negativity), accordingly. They assigned right-handers to perform a bimanual fine motor task while wearing a cumbersome ski glove on one of their hands. After this motor training task, participants who had worn the glove on their left hand, preserving their natural right-handedness, associated "good" with "right." By contrast, participants who had worn the glove on their right hand associated "good" with "left," like natural left-handers. This study validated the proposal that space–valence associations depend on asymmetries in manual motor fluency, and also showed that these associations can be rapidly changed by new patterns of motor experience.

Is motor experience the only way to influence people's space–valence associations? Since the advent of Social Learning Theory (Bandura, 1977), it has been clear that people learn not only directly through acting on the environment themselves, but also vicariously by watching others act (i.e., observational learning). The goal of the present study was to determine whether associations between space and valence depend exclusively on one's own physical experience, or whether they can also be influenced by seeing someone else acting more or less fluently with their right and left hands. In Experiment 1 we tested whether space–valence associations could be changed through vicarious motor experience. In Experiment 2 we changed the viewer's position relative to the actor to determine the perspective

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from which observational learning of space–valence associations occurred, in order to better understand the neurocognitive processes that led the observers' judgments to be influenced by the actors' actions.

2. Experiment 1: observational learning of space–valence associations

2.1. Method

2.1.1. Participants

Students from the Arts Department of the University of Granada ($N = 96$; 48 female; mean age: 24.2 years; range 18–39 years) volunteered to participate and provided informed written consent. All participants were right-handed. Their mean score on the Edinburgh Handedness Inventory (EHI; Oldfield, 1971) was 74.5. Actors and observers (described below) did not differ in gender (24 female in each group), age ($p = .35$) or degree of laterality as measured by the EHI ($p = .64$).

2.1.2. Materials and procedure

Participants were tested in pairs and performed a two-part motor training experiment. Each participant was randomly assigned to either the role of "actor" or "observer." Actors and observers received verbal instructions individually in separate rooms. Observers were told that the aim of the experiment was to test if the presence of a close observer affected negatively the actor's performance on a psychomotor task. Actors were told that their progress would be closely monitored and evaluated by the person observing them.

2.1.2.1. Training phase. Actors performed the task developed by Casasanto and Chrysikou (2011, Experiment 2). In what was ostensibly a test of psychomotor speed, participants arranged dominos upright on a 120 × 60 cm surface, on 80 equally spaced spots, as quickly as possible for 12 min. The 80 spots were separated by 12 cm. To induce an asymmetry in manual motor fluency, we assigned participants to wear a bulky ski glove on one hand, with the other glove dangling from the same wrist. The actors were instructed to take one domino with each hand from a centrally located box and to place them on the board simultaneously. The dominoes were to be placed upright facing the participant in symmetrical rows on the board, each domino on one spot. Participants were not allowed to use one hand to help the other hand to place the domino correctly. If a domino fell, the participant could not carry on with new dominoes, but rather he had to fix it using only its corresponding hand. Participants could only begin a new row after the previous row had been completed. Participants were monitored to ensure that they followed the instructions. Manipulating the dominoes was thus much more difficult with the gloved hand than with the free hand. As in the original experiment by Casasanto and Chrysikou (2011), accuracy and duration in this task were not recorded.

While the actor completed the task sitting at a table, the observer stood behind the actor, facing the same direction (see Fig. 1, left). Between them there was a distance of 20 cm. The observer was instructed to take mental note of the errors that the actor committed. The participants were also told that the experimenter would be taking written notes of the process in which the actor placed the dominoes and they were told that the observer's should coincide with the experimenter's notes. Debriefing questions confirmed that no observer suspected that

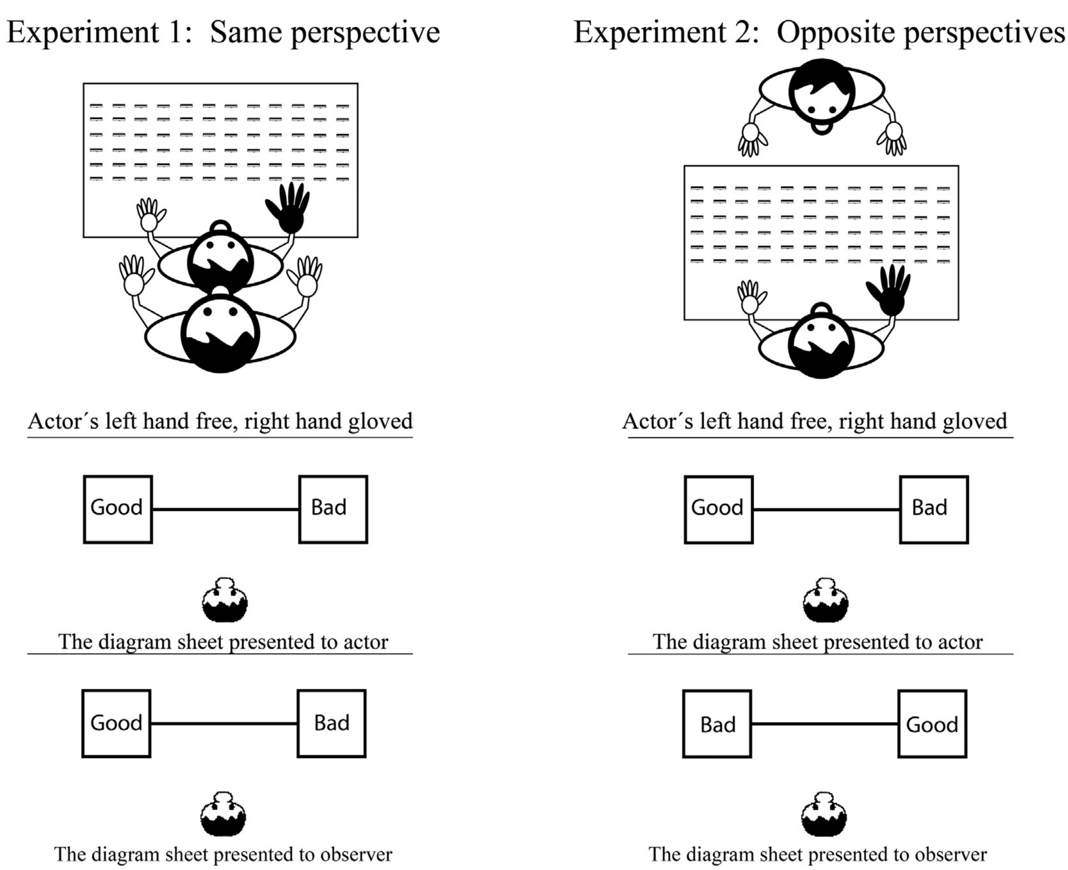

Fig. 1. Experimental set up and summary of main results from Experiments 1 and 2. The boxes in the diagrams were blank when presented to the participants. The words "good" and "bad" above indicate the modal responses given by actors (top row of boxes) and observers (bottom row of boxes) in Experiment 1 (left) and Experiment 2 (right).

they were actually the focus of interest in this study. They all seemed to believe our cover story and did their best to observe closely the performance of the actor.

2.1.2.2. Test phase. After completing the domino task and removing the glove participants returned to their separate rooms, where each completed a Spanish version of the "Bob goes to the zoo" task adapted from Casasanto (2009, Experiment 3). Participants were presented with a diagram, in the center of which was the head of a cartoon character named Bob, seen from above, with one empty box on his left and another on his right (see Fig. 1). Participants were told that Bob was planning a trip to the zoo and that he loved pandas and thought they were good, but he hated zebras and thought they were bad (or vice versa, as animal-to-valence assignment was counterbalanced). Participants were asked to place the good animal in the box corresponding to good things, and the bad animal in the box corresponding to bad things (question order was also counterbalanced, to avoid confounding space and valence with numerical or temporal order). The diagram was removed from view before they responded verbally, in order to prevent manual responses (e.g., pointing). After completing this task, participants answered the following six debriefing questions (three filler questions and two relevant questions): (1) Are you studying Spanish or French? (2) If you had to choose, would you say that today it will be rainy or sunny? (3) Why do you think you placed the good animal in the box that you did? (4) If you had to choose between keeping animals in the zoo or letting them stay free, what would you choose? (5) Do you think that the side of your dominant hand might have influenced your decision to place the good animal in the box that you chose? (6) What do you think this experiment was trying to evaluate? None of the participants suspected that the domino task was expected to influence their performance on the Bob task, or that the experiment was designed to evaluate the influence of the actor on the observer. After the debriefing questions, participants completed the EHI (Oldfield, 1971) to assess their handedness.

2.1.3. Data analysis

Data were analyzed as follows. First, we tested whether participants showed a lateral bias regarding the association between space and valence, i.e., whether there was a preference to locate the good animal on one side more often than on the other. Sign tests were used to assess whether the number of good-is-right and good-is-left responses differed. Second, binomial logistic regressions were used to assess whether there were differences in the number of good-is-right responses between the groups. Comparisons of interest include the effect of glove side for the actors and glove side for the observers, as well as the effect of being the actor versus the observer for each glove side group. A final set of comparisons took the pair actor–observer as unit of analysis and compared the number of pairs who made the same spatial choice with the number who disagreed. The proportion of agreement was compared with chance by means of sign tests, and the effect of glove side was assessed by means of binomial logistic regressions.

2.2. Results and discussion

2.2.1. Actors

92% of actors who wore the glove on their left hand (preserving their natural right-handedness) placed the good animal on the right (*Sign Test*, 22 vs. 2, $p = .001$). By contrast, 83% of actors who wore the glove on their right hand (reversing their usual asymmetry in manual motor fluency) placed the good animal on the left, like natural left-handers (*Sign Test*, 20 vs. 4, $p = .001$). The difference between the preferences of the right- and left-ski glove groups was significant (*Wald* $= 9.64$, $df = 1$, $p = .002$). This finding replicates Casasanto and Chrysikou (2011): a brief experience of a reversed motor fluency changed a clear good-is-right bias into an equally clear good-is-left bias.

2.2.2. Observers

The observers' responses were very similar to the actors'. 87% of observers who watched an actor wearing the glove on the left hand placed the good animal on the right (*Sign Test*, 21 vs. 3, $p = .002$). By contrast, 79% of observers who watched an actor wearing the glove on their right hand placed the good animal on the left (*Sign Test*, 19 vs. 5, $p = .007$). The difference between the preferences of the two groups of observers was significant (*Wald* $= 8.82$, $df = 1$, $p = .003$).

2.2.3. Comparisons of actors and observers

The strength of the good-is-right bias did not differ between the group of actors that wore the glove on their left hand and the group of observers who watched them (*Wald* $= 0.20$, $df = 1$, $p = 0.66$); likewise, the strength of the good-is-left bias did not differ between the group of actors that wore the glove on their right hand and the group of observers who watched them (*Wald* $= 0.26$, $df = 1$, $p = 0.87$). We also compared the numbers of actor–observer pairs who agreed in their answers, placing the good animal on the same side of space: 79% of actor–observer pairs agreed in the left glove condition, and 71% of pairs agreed in the right glove condition. The difference between these conditions was not significant (*Wald* $= 0.68$, $df = 1$, $p = 0.41$). In each condition, the percentage of pairs who agreed was greater than chance (Left glove condition: *Sign Test*, 19 vs. 6, $p = 0.02$; Right glove condition: *Sign Test*, 17 vs. 6, $p = 0.03$; Fig. 1, left).

In summary, the actors' data show that space–valence associations can be changed (at least temporarily) by brief changes in manual motor experience (see also Casasanto & Chrysikou, 2011). The observers' data show that nearly identical changes in space–valence associations can be effected by brief observation of another person's fluent and relatively disfluent manual motor actions.

Since the actor and observer shared the same spatial perspective in Experiment 1, however, it was not possible to determine whether the observers were internalizing the actions they observed from their own egocentric perspective, in terms of a relative spatial coordinate system centered on their own body, or from the actor's perspective using a relative coordinate system centered on the actor's body. We conducted Experiment 2 to distinguish these possibilities, and thereby constrain hypotheses about the mechanisms by which this observational learning effect arises.

3. Experiment 2: space–valence associations from whose perspective?

Many everyday interactions with other people occur face to face, in which case actors and observers do not share the same perspective. How does perspective affect the vicarious influence of motor fluency on space–valence associations? Experiment 2 was identical to Experiment 1, with one exception: the observers watched the actors while standing in front of them, face-to-face, rather than behind them. If observers' space–valence associations were computed from the actors' perspective then the results of Experiment 2 should closely match those of Experiment 1: Pairs of actors and observers should tend to agree on which side of the diagram is the "good" side and which is the "bad" side. Alternatively, if observers' space–valence associations were computed from their own egocentric perspectives then the results of Experiment 2 should differ from those of Experiment 1: Pairs of actors and observers should systematically disagree about which side of the diagram is the "good" side and which is the "bad" side.

3.1. Method

3.1.1. Participants

Participants were again students from the Arts Department of the University of Granada ($N = 96$; 68 female; mean age: 21.3 years old, age range: 18–30 years) volunteered to participate after providing informed written consent. All participants were right-handed (Mean

EHI: 74.1). There were no significant differences between actors and observers in gender (33 females were actors, 35 were observers), age ($p = .23$) or degree of laterality as measured by the EHI ($p = .64$). None of them had taken part in Experiment 1.

3.1.2. Materials and procedure

Materials and procedures were identical to Experiment 1, with one exception: the observer in Experiment 2 stood in front of the actor, face-to-face. Between them there was a distance of 80 cm.

3.2. Results and discussion

3.2.1. Actors

The actors' results were similar to those of Experiment 1. 96% of actors who wore the glove on their left hand placed the good animal on the right (*Sign Test*, 23 vs. 1, $p = .001$). By contrast, 80% of actors who wore the glove on their right hand placed the good animal on the left (*Sign Test*, 19 vs. 5, $p = .007$). The difference between the preferences of the right- and left-glove groups was significant (*Wald* = 8.236, $df = 1$, $p = .004$).

3.2.2. Observers

Unlike Experiment 1, the observers' responses in Experiment 2 were strikingly different from the actors'. Only 12.5% of observers who watched an actor wearing the glove on the left hand placed the good animal on the right (*Sign Test*, 21 vs. 3, $p = .0003$): whereas the actors who wore the glove on the left showed a good-is-right bias, the observers who watched them showed a good-is-left bias. Likewise, only 4.2% of observers who watched an actor wearing the glove on their right hand placed the good animal on the left (*Sign Test*, 23 vs. 1, $p = 0.001$). The difference between the patterns of responses in the two groups of observers was significant (*Wald* = 8.85, $df = 1$, $p = .003$).

3.2.3. Comparisons of actors and observers

The pattern of responses in the actor groups now differed significantly from their corresponding observer groups (Left glove condition: *Wald* = 8.84, $df = 1$, $p = .003$; Right glove condition: *Wald* = 8.23, $df = 1$, $p = .003$; Fig. 1, right).

In summary, changing the point of view of the observer caused a dramatic change in the actor–observer agreement between Experiment 1 and Experiment 2. When actors wore the ski glove on the right hand they tended to associate "good" with "left," whereas their observers tended to associate "good" with "right" (and vice versa, for actors who wore the glove on the left hand).

4. General discussion

In the two experiments, we showed that people's associations between space and valence are strongly influenced by manual motor fluency — but not necessarily by the fluency with which they, themselves, can perform manual actions. Participants assigned to be "actors," who first performed a bimanual fine motor task with either their right or left hand encumbered by a bulky glove, later associated "good" with the side of their free hand and "bad" with the side of their gloved hand in a subsequent diagram task. Observers who stood behind the actors during the motor task and shared their spatial perspective showed a nearly identical pattern of responses as the actors. Observers who stood face-to-face with the actors, whose spatial perspectives were reversed from the actors', showed nearly the opposite pattern of responses from the actors they observed: If an actor wore the glove on the left hand, and therefore gave a good-is-right response, the observer was likely to give a good-is-left response on the subsequent diagram task. Together, these results show that implicit space–valence associations can be rapidly changed on the basis of asymmetries in manual motor fluency, no matter whether these motor asymmetries are experienced directly through motor action or vicariously, through action observation.

One previous study (Kominsky & Casasanto, 2013) has examined the roles of observation and perspective taking in the computation of space–valence mappings. Participants saw a static picture of a man facing away from the viewer (shared spatial viewpoint) or facing toward the viewer (opposite spatial viewpoint). Empty boxes were placed symmetrically on the man's left and right, as in the diagram task used here. Participants were explicitly asked to take the man's perspective, and to indicate which boxes he would associate with "good" and "bad." Right-handed participants assigned "good" to the right side of the man. In another experiment the man in the picture was wearing a sling on either his right or left hand, indicating that his arm was impaired, and implying that motor actions on that side of space would be relatively disfluent. In this case, participants assigned "good" to the side of space nearest his free arm and "bad" to the side of space nearest his impaired arm. Whether or not the participant (i.e., the observer) and the man shared a viewpoint, space–valence mappings were computed from the man's perspective rather than the participants' own. Kominsky and Casasanto's (2013) study left open a question addressed by the present study: do observers *spontaneously* compute space–valence mappings from other people's spatial perspectives or from their own? The data from Experiment 2 offer a clear answer. Unlike Kominsky and Casasanto's participants, here the observers in Experiment 2 tended to spatialize "good" and "bad" on the basis of the fluent and disfluent actions they saw construed from their own egocentric spatial perspective.

Why do we believe that the Bob task reveals implicit associations between space and valence, even though the task required explicit judgments? A full discussion of this issue has been provided elsewhere (Casasanto, 2009; de la Fuente, Casasanto, Román, & Santiago, 2014). In short, we know that this task reveals implicit space–valence associations because most participants are unable to make the correct reason for their responses explicit. In a previous study in Spanish left- and right-handers, when participants were asked why they placed the good animal in the chosen box, most participants answered "I don't know," and only a small percentage (2% — 2 out of 100 participants) guessed the main factor that drove their choices: handedness (de la Fuente et al., 2014). After performing another version of the Bob task, US participants with pronounced right or left hemiparesis underwent a funneled debriefing, at the end of which they were asked, "Do you think that the way you use your hands had anything to do with the way you responded on this task?" One hundred percent of the participants denied that it did, even though 92% of them placed the "good" animal on the side of their more fluent hand (Casasanto & Chrysikou, 2011, Expt 1). To summarize this point, debriefing data from several experiments indicate that participants' explicit responses on the "Bob goes to the zoo" task are guided by implicit associations between space and valence — associations which most people are unable to make explicit even when prompted to do so.

Did responses reflect observers' covert motor simulations of the actors' actions, or did they reflect (non-motoric) associations between locations in space and positive or negative outcomes? These accounts are not mutually exclusive. On the first of these possibilities, observers may have been covertly mirroring the observed actions, and inferring the hedonic consequences of their simulated right- and left-hand actions. Overt imitation of others' actions is common, and appears to be highly automatic (Chartrand & Bargh, 1999). Imitation can occur using the same effector as in the observed action (a right hand action is imitated with the right hand; Chong, Cunnington, Williams, & Mattingley, 2009), or using the ipsilateral effector (a right hand action is imitated with the left hand; Koski, Iacoboni, Dubeau, Woods, & Mazziotta, 2003), but the latter "specular imitation" is more natural and produces stronger activation in brain areas belonging to the mirror system (Koski et al., 2003). Under the motoric account, when actors fumbled with dominoes using a gloved right hand, observers who shared their spatial viewpoint (Experiment 1) would have covertly simulated performing this disfluent action with their own right hand; by contrast, observers assigned to the opposite spatial viewpoint (Experiment 2) would have simulated performing the disfluent action specularly, with their own left hand. Thus, actors and observers who were facing the same direction would compute similar space–valence associations; actors and observers who were facing opposite directions would compute opposite space–valence associations.

While this motor account would be consistent with "embodied" theories of action understanding (e.g., Buccino et al., 2001), a plausible purely spatial alternative exists. Perhaps observers learned to associate negative outcomes (i.e., clumsy actions, frustrated actors, falling dominoes) with one side of egocentric space, and positive outcomes (i.e., fluent actions, neatly arranged dominoes) with the other side. This alternative account does not require any motor simulation in the observers. The present data do not discriminate between the motor and spatial accounts. Moreover, as mentioned above, the two accounts are not mutually exclusive. Further studies are needed to determine whether and to what extent the effect of vicarious motor fluency on space–valence associations is mediated by motoric or spatial representations in the observer. However, given the highly automatic nature of action imitation in humans (Chartrand & Bargh, 1999; Heyes, 2011), and the finding of independent spatial and imitative priming effects in imitation tasks (Catmur & Heyes, 2011; Wiggett, Downing, & Tipper, 2013), the possibility that the present results will be mediated exclusively by spatial representations seems unlikely.

Independently of the exact internal mechanisms that lead to the reported effect in observers, the present findings pose a new puzzle. The majority of people are right-handed, and many everyday interactions with other people occur face to face. Therefore, right-handed observers often see right-handed actors face to face acting fluently with their right hand – which corresponds to the observer's left side. Why does this vicarious experience not cause right-handed observers to associate good with left? The simplest answer is that, outside of the lab, observers are not passive as they were in our experiments; they are continually performing motor actions of their own. It seems likely that actual motor fluency (based on one's own actions) has a stronger influence on space-valence associations than observed motor fluency. Furthermore, many social interactions do not occur face-to-face (e.g., actors and observers may be side by side while walking, driving in a car, or sitting in a classroom, a concert hall, etc.). Thus, the locations of observed motor actions in left-right space are variable, as are the relationships between the bodies of actors and observers. One's own body, therefore, provides the most reliable spatial frame of reference for constructing fluency-based associations between space and valence.

The discovery that observed motor actions can influence space–valence associations could potentially hold the key to explaining a previous finding that has remained poorly understood. Across several experiments, the good-is-left association in left-handers has been found to be stronger than the good-is-right association in right-handers (Casasanto, 2009; Casasanto & Henetz, 2012). To the extent that observers tend to encounter actors face to face, as in Experiment 2, our results suggest a novel explanation for the greater strength of the good-is-left mapping. Both right- and left-handed observers tend to see a majority of right-handed actors, since most people are right-handed (McManus, 2002). When right-handers observe right-handed actors, face to face, who are acting more fluently with their dominant hand and less fluently with their non-dominant hand, this vicarious experience of motor fluency contradicts the right-handed observers' own motor experience, potentially weakening their good-is-right association. By contrast, when left-handers observe right-handed actors face to face, this vicarious experience of motor fluency reinforces their own motor experience, potentially strengthening their good-is-left association.

To conclude, this study shows that it is possible to change space–valence associations by a vicarious experience of motor fluency, and that observers code that experience in egocentric coordinates. Although implicit associations between left-right space and valence are "body-specific" (Casasanto, 2009, 2011), these results suggest that our emotional responses to stimuli we encounter in the spatial environment may be shaped by the specifics of other people's bodies, as well as our own bodies.

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