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BRIEF REPORT

Embodiment effects in memory for facial identity and facial expression

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Abstract

Research suggests that states of the body, such as postures, facial expressions, and arm movements, play central roles in social information processing. This study investigated the effects of approach/avoidance movements on memory for facial information. Faces displaying a happy or a sad expression were presented and participants were induced to perform either an approach (arm flexion) or an avoidance (arm extension) movement. States of awareness associated with memory for facial identity and memory for facial expression were then assessed with the Remember/Know/Guess paradigm. The results showed that performing avoidance movements increased Know responses for the identity, and Know/Guess responses for the expression, of valence-compatible stimuli (i.e., sad faces as compared to happy faces), whereas this was not the case for approach movements. Based on these findings, it is suggested that approach/avoidance motor actions influence memory encoding by increasing the ease of processing for valence-compatible information.

Recent theoretical developments have called attention to the role of embodiment in cognition, emphasizing, in particular, that states of the body arise during social interaction and play central roles in social information processing (Barsalou, Niedenthal, Barbey, & Ruppert, 2003; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). Many studies have found that body postures, facial expressions, and arm movements influence the processing of social and emotional information, and vice versa (Barsalou et al., 2003; Niedenthal et al., 2005). In particular, the effects of arm flexion and extension have repeatedly been demonstrated (Cacioppo, Priester, & Berntson, 1993). For instance, Neumann and Strack (2000) found that positive words were categorized more rapidly when participants were induced to flex an arm, whereas negative words were categorized more rapidly when participants performed an arm extension. Such findings have been explained by the natural co-occurrence between exposure to affective information and arm movements of flexion or extension (Barsalou et al., 2003; Strack & Deutsch, 2004). In most natural situations, arm flexion represents an approach reaction to encountering a desirable object (to pull it towards oneself), whereas arm extension is an avoidance reaction to encountering undesirable objects (to push them away). It is assumed that through the repetition of these pairings over an individual's lifetime, the processing of affective information is facilitated when it is compatible with the behavior typically used in response to it. In other words, motor cues may activate a motivational orientation of approach or avoidance, which prepares the individual for processing valence-compatible stimuli (Strack & Deutsch, 2004).

Such compatibility effects between motor actions of approach/avoidance and valence of the processed information have been demonstrated for stimulus identification and evaluation (see Barsalou et al., 2003; Niedenthal et al., 2005; Strack & Deutsch, 2004, for reviews). In addition, a few studies showed similar effects in memory for emotionally valenced information. Förster and

Strack (1996, Experiments 1 & 2) examined the effect of head movements and found that participants who were induced to nod (an act of agreement) while incidentally encoding positive and negative adjectives were more likely to subsequently recognize positive adjectives, whereas participants who were induced to shake their heads (an act of disagreement) were more likely to recognize negative adjectives. In a similar vein, Gawronski, Deutsch, and Strack (2005, Experiment 2) found that recognition memory was better for positive than for negative pictures for participants who had performed an arm flexion at the time of encoding, but not for participants who had performed an arm extension. Overall, these findings suggest that motor actions of approach/avoidance facilitate the encoding of valence-compatible stimuli in memory.

The purpose of the present study was twofold. First, since behaviors of approach and avoidance occur frequently in the context of social interactions, we wished to investigate their influence on memory for stimuli that are more socially relevant than the words and pictures that had been used in earlier studies. From this perspective, faces appear to be prime stimuli because they convey a wealth of information that is essential to social interaction, including information that enables one to recognize people (facial identity) and information used to infer their emotional states (facial expression; Bruce & Young, 1986; Calder & Young, 2005). Valence effects in memory for facial information have been demonstrated in earlier studies, which show that the identity and/or expression of new faces are better memorized for faces that display a positive expression than for faces that display a negative expression (D’Argembeau, Van der Linden, Comblain, & Etienne, 2003a; D’Argembeau, Van der Linden, Etienne, & Comblain, 2003b; D’Argembeau & Van der Linden, in press; Shimamura, Ross, & Bennett, 2006). Our first aim in this study was to examine whether motor actions of approach and avoidance can modulate this influence of valence on memory for facial identity and facial expression.

Our second aim was to further explore the memory mechanisms that are affected by motor actions of approach/avoidance. There are at least two ways in which motor actions may influence the encoding of valenced information in memory. A first possibility would be that the conscious elaboration of the stimuli is enhanced when the prevailing motor action of the individual is compatible with the valence of these stimuli. That is, people may be motivated to pay more attention to valence-compatible stimuli and/or to process these stimuli more deeply, thereby enhancing memory encoding. Alternatively, motor actions of approach/avoidance may affect memory encoding more automatically, by increasing the ease with which valence-compatible stimuli are processed. Existing data are more consistent with the second hypothesis. In particular, using a dual-task paradigm at encoding, some studies found that performance on the secondary task (i.e., an auditory discrimination task or a finger-dexterity task) decreased when the valence of the words or pictures participants had to memorize was incompatible with their motor actions (Förster & Stepper, 2000; Förster & Strack, 1996, Experiment 3; Gawronski et al., 2005, Experiment 2). These findings suggest that valence-incompatible stimuli were encoded less easily (and thus required more processing resources) than valence-compatible stimuli. It is worth noting, however, that participants' processing resources were voluntarily oriented towards memory encoding in these studies (i.e., intentional learning), so it remains unclear whether similar processing differences occur when stimuli are spontaneously encoded in memory (i.e., in incidental learning conditions). In that regard, another study by Gawronski et al. (2005, Experiment 1) shows that attention tends to be spontaneously attracted by pictures whose valence is incongruent (rather than congruent) with the prevailing motor action.

In this study, we investigated the memory mechanisms that are affected by movements of approach/avoidance using a different approach. In particular, we reasoned that differences in information processing induced by motor actions during an incidental memory encoding task should translate into differences in the states of awareness that are associated with retrieval. While recalling or recognizing an item, people are sometimes able to bring back to mind details concerning the presentation of that item at the time of study (e.g., something they thought or felt at that time), whereas in other cases the item seems familiar but nothing can be recollected about its previous occurrence. These states of awareness can be measured by instructing participants to make a “Remember” response if their experience is of the first type, and a “Know” response if their experience is of the second type (Gardiner, 1988; Rajaram, 1996; Tulving, 1985). The results of various experimental manipulations indicate that Remember responses are enhanced by variables that encourage distinctive or elaborative processing (e.g., deep versus shallow level of processing), whereas Know responses are sensitive to manipulations that affect the ease or fluency of processing (e.g., test targets preceded by semantically related versus unrelated primes; Gardiner, Gregg, Mashru, & Thaman, 2001; Rajaram, 1996, 1998; Rajaram & Geraci, 2000). Drawing on these findings, we reasoned that if motor actions of approach/avoidance influence memory by enhancing the conscious elaboration of valence-compatible stimuli, compatibility effects between stimuli valences and types of motor actions should be manifested in remembering rather than knowing. By contrast, if motor actions do not affect elaborative processing but instead increase the ease of processing for valence-compatible stimuli, compatibility effects should be manifested in knowing rather than remembering.

Method

Participants and design

A total of 40 undergraduate students (24 women, 16 men; mean age = 22.4 years, *SD* = 2.3 years) at the University of Geneva volunteered to participate in the experiment. Twenty participants were allocated at random to each arm movement condition. The experiment consisted of a 2 (arm movement: flexion vs. extension) X 2 (expression valence: happy vs. sad) mixed-model design with arm movement as a between-subjects factor and expression valence as a within-subjects factor.

Materials

Stimuli were selected from the Karolinska Directed Emotional Faces set (Lundqvist, Flykt, & Öhman, 1998). Color pictures of 20 individuals (10 males and 10 females) were used, with each individual being portrayed with three different expressions (neutral, happy, and sad). Theses pictures were divided into two sets (A and B) of 10 individuals (5 women and 5 men). During the study phase, five happy faces and five sad faces were presented, with the use of sets A and B as studied or non-studied items being counterbalanced across participants. Furthermore, within each set, each face was seen with a happy expression by half the participants and with a sad expression by the other half, thus ensuring that the effect of facial expression was not confounded by differences in the memorability of particular facial identities. The stimuli were placed in a pseudorandom but fixed order such that no more than two faces with the same expression occurred in succession. During the test phase, the 20 neutral faces were presented in a pseudorandom but fixed order so that no more than three “old” or “new” faces should occur in succession.

Procedure

Participants were tested individually. They sat at a table and received instructions for the arm movement, according to the procedure developed by Cacioppo et al. (1993). In the arm flexion condition, participants were instructed to place their palms on the bottom of the table, to lift so that they felt a tension in their arms, and to maintain this tension on the table. In the arm extension condition, participants were instructed to place their palms on the top of the table, to press so that they felt a tension in their arms, and to maintain this tension on the table. Each face was then shown to the participants on a computer screen approximately 60 cm in front of them. They were asked to look carefully at the faces and to judge whether they would trust the person depicted. No mention was made of the emotional expressions of the faces or of the subsequent memory test. Each face was presented for 2 s and was followed by a 2-s blank screen during which participants made their judgment orally by saying “yes” or “no.”

After all the study faces had been presented, participants were instructed to relax their arms, and then they received the instructions for the memory test. They were told that they would see a series of faces, some of which represented people they had been shown initially though their facial expression had changed (all the faces were neutral). For each face, they had to decide whether or not they had seen this person before (facial identity recognition); then their state of awareness was assessed with the Remember/Know/Guess paradigm (Gardiner & Richardson-Klavehn, 2000). In short, participants were told that a Remember response should be given to any face which, at the time it was recognized, brought back to mind something they had consciously experienced (e.g., a thought or feeling) at the time it was presented. In contrast, they were asked to make a Know response if the face felt familiar but they were unable to recollect any details about its prior exposure. Finally, they were asked to make a Guess response if they were unsure whether or not the face had been presented in the study phase. Then, memory for facial expressions was assessed. Participants were told that the faces they had seen in the study phase displayed either a happy or a sad expression. For faces whose identity was claimed to be recognized, participants were asked to report which expression the face had displayed at study (happy or sad), and they also had to classify their responses according to the Remember/Know/Guess paradigm. Specifically, they were instructed to make a Remember response if they were able to consciously recollect the expression (i.e., if they could remember what the expression looked like). In contrast, they were asked to make a Know response if they believed that the face had displayed a particular expression but could not consciously recollect its appearance or a Guess response if they were unsure what the expression had been. This distinction between Know and Guess responses was admittedly less clear-cut than in the case of facial identity recognition, however, essentially because of the particular nature of the expression memory task (i.e., a forced-choice recall task). Considering this issue, we decided to analyze data concerning facial expression with Know and Guess responses collapsed into a single category.

Results

Trustworthiness judgments

We first analyzed trustworthiness judgments to investigate whether motor actions of approach/avoidance influenced the perception of facial stimuli at encoding. Proportions of “yes” responses were submitted to a 2 (arm movement: flexion vs. extension) X 2 (expression valence: happy vs. sad) analysis of variance (ANOVA). There was a main effect of expression valence, $F(1, 38) = 43.24$, $MSE = .06$, $p < .001$, which showed that happy faces were more frequently judged as “trustworthy” (mean proportion of “yes” responses = .70, $SD = .22$) than sad faces (mean proportion of “yes” responses = .34, $SD = .27$). However, there was no main effect of arm movement and no interaction, Fs < 1.

Facial identity recognition

The mean proportions of Remember, Know, and Guess responses for facial identity recognition are presented in Table 1. Two (arm movement) X two (expression valence) ANOVAs were performed separately for Remember, Know, and Guess responses. For Remember responses, there was a main effect of expression valence, $F(1, 38) = 15.09$, $MSE = 0.02$, $p < .001$, showing that faces that had been encoded with a happy expression received more Remember responses than faces seen with a sad expression. The main effect of arm movement approached statistical significance, *F*(1, 38) = 3.73, *MSE* = 0.10 *p* = .06, but the arm movement by expression valence interaction was not significant, *F*(1, 38) = 0.02, *MSE* = 0.02. In contrast, there was a significant interaction between arm movement and expression valence for Know responses, *F*(1, 38) = 5.67, *MSE* = 0.03, *p* = .02. Know responses were more frequent for sad faces than for happy faces in the arm extension condition, *t*(19) = –2.22, *p* = .04, *d* = .51, but not in the arm flexion condition, *t*(19) = 1.04, *p* = .31, *d* = .24. The main effects of expression valence and arm movement were not significant, *F*(1, 38) = 1.12, *MSE* = .03, and *F*(1, 38) = 2.18, *MSE* = .05. Finally, Guess responses were marginally more frequent for sad faces than for happy faces, *F*(1, 38) = 3.20, *MSE* = 0.02, *p* = .08, but the effect of arm movement was not significant, *F*(1, 38) = 1.30, *MSE* = 0.02, and the interaction was not significant either, *F*(1, 38) = 0.03, *MSE* = 0.02.

(Table 1 about here)

Memory for facial expressions

We computed measures of states of awareness associated with memory for facial expressions that were conditionalized upon correct facial identity recognition. Specifically, the number of correct Remember responses or Know/Guess responses for each type of expression (happy vs. sad) was divided by the total number of correct identity recognition for that type of expression. Know and Guess responses were collapsed into a single category for these analyses (see Method). Mean proportions are shown in Table 2.

(Table 2 about here)

Two (arm movement) X two (expression valence) ANOVAs were performed separately for Remember and Know/Guess responses. Remember responses were more frequent for happy than for sad expressions, *F*(1, 38) = 5.55, *MSE* = 0.03, *p* = .02. There was no effect of arm movement and no interaction, *F*s < 1. In contrast, there was a significant interaction between arm movement and expression valence for Know/Guess responses, *F*(1, 38) = 11.67, *MSE* = 0.06, *p* =

.002. Correct Know/Guess responses were more frequent for sad than for happy expressions in the arm extension condition, $t(19) = -3.14$, $p = .005$, $d = .72$. In the arm flexion condition, correct Know/Guess responses were numerically more frequent for happy than for sad expressions, but the difference was not statistically significant, $t(19) = 1.57$, $p = .13$, $d = .36$. The main effects of expression valence and arm movement were not significant, $F(1, 38) = 1.93$, $MSE = .06$, and $F(1, 38) = 1.84$, $MSE = .12$.

Finally, we examined whether the increased proportion of Know/Guess “sad” responses in the arm extension condition simply reflected a response bias or whether it was sensitive to the expressions that were actually displayed by the faces at study. To investigate this issue, we examined whether participants in the arm extension condition reported Know/Guess “sad” responses more often for faces that had actually displayed a sad expression at study (correct “sad” responses) than for faces that had displayed a happy expression (incorrect “sad” responses). Correct Know/Guess responses ($M = .65$, $SD = .27$) were more frequent than incorrect Know/Guess responses ($M = .22$, $SD = .28$), $t(19) = 4.92$, $p < .001$, $d = 1.13$, indicating that the Know/Guess responses for sad expressions produced by participants in the arm extension condition were not simply due to a response bias but were accurate to some extent.

Discussion

This study investigated whether motor actions of approach/avoidance modulate the encoding of facial information in memory. In an incidental memory encoding task, participants performed either an arm flexion movement or an arm extension movement while they were presented with faces that displayed happy or sad expressions. Then, neutral faces of the same individuals were presented, intermixed with new neutral faces, and the states of awareness associated with memory for facial identity and facial expression were assessed. Participants who performed an arm extension movement reported more Know responses when recognizing the identity of faces that had displayed a sad (rather than a happy) expression at study, whereas this was not the case for participants who performed an arm flexion movement. In a similar vein, memory for sad expressions was associated with more Know/Guess responses than memory for happy expressions for participants who performed an arm extension movement but not for participants who performed an arm flexion movement. Additional analyses indicated that the increase in Know/Guess responses for sad expressions in the arm extension condition was not simply due to a response bias. Furthermore, although trustworthiness judgments made at study were affected by expression valence, this influence was similar in both arm movement conditions, which suggests that the memory effects associated with motor actions of approach/avoidance were not simply due to differences in the interpretation of the stimuli. Finally, we found that Remember responses were more frequent for happy faces than for sad faces, for both facial identity recognition and facial expression recall. However, this effect of expression valence was not modulated by movements of approach/avoidance.

These findings extend earlier studies (Förster & Strack, 1996; Gawronski et al., 2005), by showing that motor actions of approach/avoidance influence memory for socially relevant information, such as facial identity and facial expression. Furthermore, the data provides information regarding the specific memory mechanisms that are modulated by movements of approach/avoidance. Insofar as Know responses are sensitive to fluency or ease of processing (Rajaram, 1996; Rajaram & Geraci, 2000), our results suggest that facial identity was processed more fluently during the recognition task when arm movement had been compatible with stimulus valence at study. Similarly, influences of arm movements on Know/Guess responses for facial expression memory might also reflect differences in processing fluency when recalling facial expression. Since the retrieval conditions were exactly the same in the two arm movement conditions, increases in processing fluency at the time of retrieval were very likely due to differences in stimulus processing at the time of encoding. Movements of approach/avoidance may have prepared the person for processing valence-compatible stimuli, thereby increasing the ease with which these stimuli were processed (Strack & Deutsch, 2004). This facilitated processing at the time of encoding may in turn have caused valence-compatible stimuli to be processed more fluently at retrieval, thus enhancing the frequency of Know responses for facial identity recognition and Know/Guess responses for facial expression recall.

It should be noted, however, that the compatibility effects that were observed in this study were asymmetrical. Participants who performed an arm extension movement showed compatibility effects in Know responses for facial identity and in Know/Guess responses for facial expression, with responses being more frequent for sad faces than for happy faces in the two cases. By contrast, although responses were in the predicted direction (i.e., numerically more frequent for happy faces than for sad faces), the difference failed to reach statistical significance for participants who performed an arm flexion movement. This asymmetry might be simply due to the fact that in both conditions happy faces gave rise to a strong increase in remembering, as compared to sad faces; thus, there was less opportunity to detect an additional enhancement due to the arm flexion manipulation. As discussed in earlier studies (D'Argembeau et al., 2003a, 2003b; D'Argembeau & Van der Linden, in press), the influence of expression valence on Remember responses might reflect a tendency for most people to process more thoroughly stimuli that convey positive rather than negative social signals. Interestingly, the results of the present study suggest that this enhanced elaborative processing for positive facial information is not modulated by movements of approach/avoidance.

To conclude, this study shows that motor actions of approach/avoidance influence incidental memory encoding for the identity and the expression of faces. Furthermore, our findings suggest that this modulatory influence results from increases in ease of processing for valence-compatible faces, rather than differences in conscious elaboration, an interpretation which fits well with the idea that motivational orientations have a direct effect on information processing (i.e., not mediated by reflective processes; Strack & Deutsch, 2004).

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Table 1

Mean Proportions (and Standard Deviations) of Remember, Know, and Guess Responses for Facial Identity Recognition

	Arm Flexion			Arm Extension		
Response	Happy	Sad	False alarms	Happy	Sad	False alarms
Remember	.48 (.26)	.35 (.27)	.04 (.06)	.34 (.20)	.22 (.24)	.06 (.10)
Know	.21 (.19)	.16 (.18)	.11 (.10)	.19 (.19)	.32 (.21)	.06 (.07)
Guess	.09 (.14)	.14 (.16)	.06 (.09)	.05 (.09)	.11 (.15)	.06 (.08)

Table 2

Mean Proportions (and Standard Deviations) of Remember and Know/Guess Responses for Memory for Facial Expression

	Arm Flexion		Arm Extension	
Response	Happy	Sad	Happy	Sad
Remember	.26 (.24)	.20 (.22)	.27 (.28)	.14 (.21)
Know/Guess	.48 (.22)	.37 (.30)	.40 (.37)	.65 (.27)