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Facial expressions of emotion influence memory for facial identity in an automatic way

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Abstract

Previous studies indicate that the encoding of new facial identities in memory is influenced by the type of expression displayed by the faces. In the current study, we investigated whether or not this influence requires attention to be explicitly directed towards the affective meaning of facial expressions. In a first experiment, we found that facial identity was better recognized when the faces were initially encountered with a happy rather than an angry expression, even when attention was oriented towards facial features other than expression. Using the Remember/Know/Guess paradigm in a second experiment, we found that the influence of facial expressions on the conscious recollection of facial identity was even more pronounced when participants' attention was not directed towards expressions. It is suggested that the affective meaning of facial expressions automatically modulates the encoding of facial identity in memory.

Keywords: facial expression, facial identity, memory, emotion.

The influence of emotion on memory has been abundantly demonstrated using various types of materials, including complex real-life events (e.g., D'Argembeau, Comblain, & Van der Linden, 2003; Talarico, LaBar, & Rubin, 2004), events depicted in film clips or slide shows (e.g., Burke, Heuer, & Reisberg, 1992; Christianson & Loftus, 1991), and lists of words or pictures (e.g., Kensinger & Corkin, 2003; Ochsner, 2000; for a review, see Kensinger, 2004; LaBar & Cabeza, 2006; Phelps, 2004; Reisberg & Hertel, 2004). By contrast, although facial expressions of emotions are among the most important sources of social information (Keltner, Ekman, Gonzaga, & Beer, 2003), their effects on memory have been relatively neglected. Moreover, existing studies have led to contradictory findings, with some studies showing an enhanced memory for positive (happy) relative to negative (sad, angry, fearful) and/or neutral faces in non-depressed and non-anxious individuals (Foa, Gilboa-Schechtman, Amir, & Freshman, 2000; Gilboa-Schechtman, Erhard-Weiss, & Jeczemien, 2002; Kottoor, 1989; Leigland, Schulz, & Janowsky, 2004; Mather & Carstensen, 2003; Ridout, Astell, Reid, Glen, & O'Carroll, 2003), whereas other studies found a better memory for faces with negative rather than positive or neutral expressions (Johansson, Mecklinger, & Treese, 2004; Sergerie, Lepage, & Armony, 2005).

Findings from these studies are unclear, however, with regard to which specific features of the stimuli contributed to memory performance. Because exactly the same photos were used at study and test, performance may have depended as much on remembering pictorial details (i.e., details of the lighting, grain, and flaws of a particular photo) as it did on remembering the faces depicted (cf. Bruce, 1982). Furthermore, although facial identity and expression are probably not processed completely independently (e.g., Ganel & Goshen-Gottstein, 2004; Schweinberger, Burton, & Kelly, 1999), there is nevertheless some separation between the coding of these two types of facial information (Calder & Young, 2005; Ganel & Goshen-Gottstein, 2004). Yet the

memory measures used in the above-mentioned studies did not enable to distinguish between memory for facial identity and memory for expressions. Considering these issues, we have recently developed a task that assesses memory for facial identity and memory for facial expression separately, while avoiding letting pictorial details contribute to memory performance. At study, faces are presented with either a happy or an angry expression; at test, these faces are shown with a neutral expression, intermixed with new neutral faces. Participants are asked to recognize facial identity (i.e., old/new discrimination) and, when a face is judged as "old," they also have to report which expression the face had at study (i.e., happy or angry). Using this task, we found that facial identity was better recognized when faces had displayed a happy rather than an angry expression at study, and this was due to enhancement of the conscious recollection of facial identity rather than feelings of familiarity (D'Argembeau & Van der Linden, 2004; D'Argembeau, Van der Linden, Comblain, & Etienne, 2003a; D'Argembeau, Van der Linden, Etienne, & Comblain, 2003b). With regard to memory for facial expression, the results were less consistent across studies, with some studies showing a better memory for positive than negative expressions (D'Argembeau et al., 2003b; Shimamura, Ross, & Bennett, 2006) and other studies finding no difference (D'Argembeau & Van der Linden, 2004; D'Argembeau et al., 2003a).

This overview suggests that the encoding of facial information in memory, and in particular facial features used to identify a person, is influenced by the type of expression displayed by the faces, with people having a better memory of the identity of faces that were initially encountered with a happy rather than an angry expression. This influence of facial expressions could be explained by several factors, including differences in the perceptual features of different types of facial expressions or differences in their social/emotional meaning. In terms of low-level physical features, there is evidence that happy and neutral expressions are more dissimilar to each other than are angry and neutral expressions (Johnston, Katsikitis, & Carr,

2001; Juth, Lundqvist, Karlsson, & Öhman, 2005). However, our finding that neutral faces were better recognized when they had previously displayed happy rather than angry expressions is difficult to explain entirely in terms of these differences in low-level physical features. It has indeed been found that larger changes in the appearance of a face (e.g., changes in expression or pose) between study and test result in poorer recognition (Bruce, 1982). Consequently, an explanation in terms of the low-level physical features of the expressions would predict that neutral faces should be less well recognized when they had displayed happy rather than angry expressions at study (the opposite of our finding) because modifications in the physical appearance of the faces due to the change of expression between study and test (i.e., from happy or angry to neutral) were presumably greater for happy expressions than for angry expressions.

The influence of facial expressions may result from their social/emotional meaning rather than their perceptual features. Facial expressions are powerful sources of social information, which enable viewers to quickly infer the feelings and intentions of others, including the liking and approval expressed by happy expressions or the hostility expressed by angry expressions (Keltner et al., 2003). Presumably as a result of the potential cost associated with failing to notice threatening stimuli, negative facial expressions attract attention more effectively than positive ones (e.g., Eastwood, Smilek, & Merikle, 2003; Fox et al., 2000; Öhman, Lundqvist, & Esteves, 2001) and tend to disrupt the processing of other (expression-irrelevant) information (Vuilleumier, Armony, Driver, & Dolan, 2001). Interestingly, it has been found that negative expressions interfere more than positive expressions with the ability to process local features of the faces (Eastwood et al., 2003). Negative facial expressions may therefore attract attention to themselves at the expense of other facial features, including those used to recognize the identity of a person. Conversely, there is evidence that positive facial expressions are processed faster than negative expressions (e.g., Leppänen & Hietanen, 2003, 2004; Silvia, Allan, Beauchamp,

Maschauer, & Workman, 2006), so that encounters with faces with positive expressions may leave more processing resources available to process facial identity. The influence of facial expressions on memory for facial identity may therefore result from the disruptive effects of angry expressions and/or facilitative effects of happy expressions on the processing of facial identity. The role of social/emotional meaning attributed to facial expressions is further emphasized by findings that the influence of expressions on memory for facial identity is modulated by individual differences in social information processing, such as social anxiety (D'Argembeau et al., 2003b) and delusional ideation (Larøi, D'Argembeau, & Van der Linden, 2006).

Existing studies therefore converge to suggest that the social/emotional meaning of facial expression influences the encoding of new facial identities in memory, with memory for facial identity being better when the faces were encoded with a happy rather than an angry expression. The purpose of the present study was to investigate whether this memory advantage for happy faces over angry faces depends on the type of facial information that is attended to when encoding the faces in memory. To show a bias towards remembering faces that had displayed a particular type of expression, facial expression must have been processed, at least minimally, so that it can influence the encoding of facial identity in memory. However, such processing of facial expression and its influence on memory for facial identity may occur relatively automatically, that is, without paying explicit attention to the emotional meaning of facial expressions.[1] There is evidence that emotion influences memory for words and pictures even when the affective charge of the stimuli is not explicitly rated (e.g., Ferré, 2003; Ochsner, 2000) but it is not known whether this is also the case with regard to memory for facial information. The purpose of this study was precisely to examine this issue. In a first experiment, we compared the influence of happy and angry expressions on memory for facial identity and memory for

facial expression when participants made judgments about facial expression versus judgments about facial features unrelated to expression. In a second experiment, we used the Remember/Know/Guess paradigm (Gardiner & Richardson-Klavehn, 2000) to further investigate which memory processes are influenced by facial expressions. In previous studies, we found that the effect of facial expressions on identity memory was specifically due to differences in Remember responses, suggesting that expressions modulate elaborative processing operations during the encoding of facial identity (D'Argembeau & Van der Linden, 2004; D'Argembeau et al., 2003a, 2003b). In Experiment 2, we aimed at investigating whether this influence differs as a function of whether or not facial expression is explicitly assessed. In addition, considering possible interactions between the processing of facial expression and direction of gaze (Adams & Kleck, 2003, 2005), another goal of our second experiment was to explore whether the influence of expressions on identity memory is modulated by the direction of facial display.

Experiment 1

The purpose of our first experiment was to investigate whether the influence of facial expressions on memory for facial identity and expression differs as a function of whether or not attention is directed towards their affective meaning. Participants were presented with faces displaying a happy or an angry expression and were oriented to process some specific aspects of the faces. A first group of participants had to rate the intensity of the expressions displayed, whereas participants from two other groups made judgments about features unrelated to facial expression: some participants had to infer trait information (i.e., intelligence) from the faces, while other participants had to judge a physical feature of the faces (i.e., nose size). Memory for facial identity and facial expression was then assessed for all participants. On the basis of studies that assessed the influence of emotion on memory for words or pictures (e.g., Ferré, 2003;

Ochsner, 2000), we predicted that the influence of facial expressions on memory would be apparent even when participants' attention is not explicitly oriented towards facial expression. In addition, we expected that memory for facial identity would be better following judgments about trait information (intelligence) than following judgments about a physical feature (nose size; Coin & Tiberghien, 1997). Nevertheless, if the influence of facial expressions on memory for facial identity occurs automatically, the difference in memory performance between happy and angry faces should be similar following these two types of judgments.

Method

Participants and design

A total of 72 undergraduate students (34 women, 38 men; mean age = 24.4 years, *SD* = 3.3 years) at the University of Geneva volunteered to participate. The experiment consisted of a 3 (encoding condition: expression, intelligence, nose size) X 2 (facial expression: happy, angry) mixed-model design with encoding condition as a between-participants factor and expression as a within-participants factor. Twenty-four participants were allocated at random to each encoding condition; data from two participants belonging to the intelligence condition had to be discarded due to problems with response recording.

Materials

Stimuli were selected from the Karolinska Directed Emotional Faces (KDEF; Lundqvist, Flykt, & Öhman, 1998). This carefully controlled database includes faces that have been photographed from the same distance, with the background of the pictures, the lighting conditions, and the clothes worn by the individuals portrayed being identical over all pictures. Pictures of 24 individuals (12 males and 12 females) were selected, with each individual being

portrayed with three different expressions (neutral, happy, and angry). In all pictures, face orientation was directed (facing forward). Sixteen faces were presented at study (eight with happy expressions and eight with angry expressions) and the remaining eight faces were used as distractors for the memory test (faces used as studied or non-studied items were counterbalanced across participants). Each studied face was seen with a happy expression by half the participants and with an angry 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.

Procedure

Participants were tested individually. They were told that the study was part of a research program investigating the perception of facial information and that their task would be to make judgments about faces. In the "intelligence" condition, participants were asked to rate the extent to which the persons depicted look intelligent, using a 3-point scale (1 = not at all, 2 = moderately, 3 = very intelligent). In the "nose" condition, participants were asked to rate the extent to which the persons depicted have a smaller or bigger nose than average, also using a 3-point scale (1 = smaller, 2 = average, 3 = bigger). In these two encoding conditions, no mention was made of the emotional expressions of the faces. By contrast, in the "expression" condition, participants were told that faces with happy or angry expressions would be presented and that their task was to rate the intensity of each facial expression, using a 3-point scale (1 = low, 2 = moderate, 3 = high). Participants were not informed of the subsequent memory test in any of the three conditions. The faces were sequentially presented in random order on a computer screen approximately 60 cm in front of the participants. Each face was presented for 5 s, during which participants made their judgment by pressing the appropriate response key.

After all the faces had been presented, participants performed a distraction task for 1 min, 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, although their facial expressions would be different (all the faces were neutral). For each face, they had to decide whether or not they had seen this person before (facial identity recognition), by pressing the appropriate response key (1 = presented, 2 = not presented). In addition, when participants claimed to recognize a face, they were asked to report which expression the face had displayed at study (1 = happy, 2 = angry). The 24 neutral faces were presented in random order and the memory task was self-paced.

After completing the memory task, participants were asked to explain what they thought the purpose of the experiment was. None of them guessed in advance that their memory for the faces would be tested. Participants were then debriefed and thanked for their participation.

Results

Facial identity recognition

The mean proportions of hits for facial identity recognition are shown in Figure 1, as a function of the expression faces had displayed at study (happy vs. angry) and the encoding task (judgments for expression, intelligence, or nose). Since all faces that were presented at test had a neutral expression, false alarms (FAs) could not be calculated separately for happy and angry faces. The mean proportions of FAs were .17 (*SD* = .16), .22 (*SD* = .17), and .17 (*SD* = .18) in the expression, intelligence, and nose conditions, respectively; there was no significant difference between the three conditions, $F(2, 67) = 0.74$, $p = .48$.

A 2 (facial expression) X 3 (encoding task) analysis of variance (ANOVA) on the proportions of hits yielded a significant main effect of facial expression, $F(1, 67) = 10.19$, $p = .002$, showing that facial identity was better recognized when faces had displayed a happy rather than an angry expression at study. The main effect of encoding task was also significant, $F(2, 67) = 7.71$, $p < .001$. This revealed that facial identity was better recognized when faces had been rated for intelligence or expression, as compared to nose, $F(1, 67) = 10.96$, $p = .002$, and $F(1, 67) = 11.99$, $p < .001$; there was no difference between the intelligence and expression conditions, $F(1, 67) = 0.01$, $p = .94$. There was no interaction between facial expression and encoding task, $F(2, 67) = 0.21$, $p = .81$.

Memory for facial expression

Memory for facial expression was assessed by determining the probability that a participant correctly recalled a facial expression conditionalized upon correct facial identity recognition. This was done by dividing the number of correct responses for each type of expression (happy vs. angry) by the number of correct identity recognitions for that type of expression. Mean proportions are shown in Figure 2, as a function of the type of expression and encoding task. A 2 (facial expression) X 3 (encoding task) ANOVA yielded a significant main effect of encoding task, $F(2, 67) = 7.67$, $p < .001$. Facial expression was better recalled by participants who had judged expression at study than by participants who had judged intelligence or nose size, $F(1, 67) = 8.47$, $p = .005$, and $F(1, 67) = 13.77$, $p < .001$; there was no difference between the intelligence and nose conditions, $F(1, 67) = 0.52$, $p = .47$. The main effect of facial expression was not significant, $F(1, 67) = 2.29$, $p = .13$, nor was the interaction between expression and encoding task, $F(2, 67) = 0.01$, $p = .99$.

Discussion

Faces that had displayed a happy expression at study were better recognized than faces that had displayed an angry expression, both for participants who explicitly processed the affective meaning of facial expressions and for participants who processed facial features unrelated to expression. These findings support the idea that the influence of expressions on memory for facial identity occurs automatically, in the sense that it does not require to pay explicitly attention to the emotional meaning of expressions. For participants who processed features other than expression, recognition performance was higher following judgments about trait information than following judgments about a specific physical feature, which is consistent with previous studies that investigated the effects of learning instructions on face recognition (for review, see Coin & Tiberghien, 1997). Nevertheless, despite this general effect of learning instructions, the influence of facial expressions was equivalent for participants who judged trait information and participants who judged a physical feature. This finding is also consistent with the view that expressions influence memory for facial identity in an automatic way.

With regard to memory for facial expression, we found that paying explicit attention to facial expression resulted in better memory performance, which suggests that facial expressions themselves are not encoded automatically in memory. Furthermore, contrary to what was observed for facial identity, there was no significant difference between memory for happy and angry expressions, whatever the encoding condition. As we have already mentioned, previous studies that compared memory for positive versus negative facial expressions have led to conflicting findings, with some studies showing a better memory for positive than negative expressions (D'Argembeau et al., 2003b; Shimamura et al., 2006) and other studies finding no difference (D'Argembeau & Van der Linden, 2004; D'Argembeau et al., 2003a). Although the reasons for these inconsistencies remain to be investigated in detail, they might be explained, at

least in part, by individual differences between the participants included in the different studies, in particular regarding psychopathological dimensions such as social anxiety (D'Argembeau et al., 2003b).

Experiment 2

Our first experiment indicates that facial expressions influence memory for facial identity even when participants' attention is oriented towards facial features other than expression. In a second experiment, we aimed to replicate this finding and to further explore the memory processes on which it is based. When people report that they have encountered someone before, their recognition may be accompanied by the subjective experience of remembering the previous encounter or only by a feeling of familiarity. Using the Remember/Know paradigm to assess these subjective experiences (Gardiner & Richardson-Klavehn, 2000), we had previously found that the influence of facial expressions on memory for facial identity was due to differences in Remember rather than Know responses (D'Argembeau & Van der Linden, 2004; D'Argembeau et al., 2003a, 2003b). Since Remember responses are sensitive to elaborative and distinctive processing operations during encoding (e.g., Dewhurst & Conway, 1994; Gardiner, 1988; Mäntylä, 1997; Rajaram, 1996), these findings suggest that facial identity is processed more elaborately and distinctively when faces display happy rather than angry expressions. In Experiment 2, we investigated whether the influence of facial expressions on Remember responses differs as a function of whether or not facial expression is explicitly assessed at encoding.

Another goal of Experiment 2 was to explore whether the influence of facial expressions on memory for facial identity differs as a function of the direction of facial display. There is evidence that direct (as opposed to averted) gaze captures attention (Senju & Hasegawa, 2005)

and enhances memory for facial identity (Mason, Hood, & Macrae, 2004; Vuilleumier, George, Lister, Armony, & Driver, 2005). Furthermore, gaze direction seems to modulate the processing of facial expression (Wicker, Perrett, Baron-Cohen, & Decety, 2003). In particular, it has been found that direct gaze enhances the processing of facially communicated approach-oriented emotions (such as anger and joy), whereas averted gaze enhances the processing of facially communicated avoidance-oriented emotions (such as fear and sadness; Adams & Kleck, 2003, 2005). Consequently, the influence of happy and angry expressions might be more pronounced when these expressions are directed towards the observer rather than averted. To investigate this possibility, one group of participants in Experiment 2 was presented with directed happy and angry faces, whereas another group was presented with averted faces. In both groups, half of the participants were asked to judge the intensity of facial expression, whereas the other half made judgments about inferred trait information (i.e., intelligence).

Method

Participants and design

A total of 80 undergraduate students (50 women, 30 men; mean age = 21 years, *SD* = 2.4 years) at the University of Liège volunteered to participate. The experiment consisted of a 2 (encoding condition: expression vs. intelligence) X 2 (face orientation: directed vs. averted) X 2 (facial expression: happy vs. angry) mixed-model design with encoding condition and face orientation as between-participants factors and facial expression as a within-participants factor. Twenty participants were allocated at random to each group.

Materials and procedure

The stimuli were the same as those used in Experiment 1, except for participants in the averted face condition. For this condition, we used pictures that portrayed exactly the same individuals as in Experiment 1 (also with happy, angry, or neutral expressions) but whose faces were oriented 45° to the right instead of being oriented towards the observer. Both eyes and the whole mouth were clearly visible, and eye gaze was congruent with facial orientation. The procedure was similar to Experiment 1, with the following modifications. First, at study, the faces were presented for 4 s instead of 5 s. This was done because most ratings (93%) for intelligence and expression in Experiment 1 were made in less than 4 s (M = 2,401 ms, SD = 982 ms) and we wanted to minimize the possibility that, once they had finished rating each face, participants would process facial features other than the one they were asked to attend to. Second, in the test phase, states of awareness associated with facial identity recognition were assessed with the Remember/Know/Guess paradigm. Detailed instructions about Remember, Know, and Guess responses were provided, based on those used by Gardiner and colleagues (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., an association, a thought, a 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 presentation. Finally, they were asked to make a Guess response if they were unsure whether or not the face had been presented at study. Memory for facial expression was not assessed.

Results

The mean proportions of overall recognition, Remember, Know, and Guess responses are presented in Table 1, as a function of encoding task, facial expression, and face orientation.

Separate 2 (encoding task) X 2 (facial expression) X 2 (face orientation) ANOVAs were carried out for overall recognition and for Remember, Know, and Guess responses. With regard to overall recognition, there was a main effect of facial expression, $F(1, 76) = 10.25$, $p = .002$, showing that faces that had displayed a happy expression at study were better recognized than faces that had displayed an angry expression. All other main effects and interactions were not significant (all *p*s > .18). An analysis of total amount of FAs did not reveal any significant effect of encoding condition or facial orientation, nor was there any interaction between these two factors (all *p*s > .47).

For Remember responses, the ANOVA yielded a significant effect of facial expression, $F(1, 76) = 9.92$, $p = .002$, a significant effect of encoding task, $F(1, 76) = 15.93$, $p < .001$, and a significant interaction between facial expression and encoding task, $F(1, 76) = 4.06$, $p = .047$. As illustrated in Figure 3, in the intelligence condition, Remember responses were more frequent for faces that had displayed a happy expression than for faces that had displayed an angry expression, $F(1, 76) = 13.34$, $p < .001$, whereas there was no difference between the two types of faces in the expression condition, $F(1, 76) = 0.64$, $p = .43$. All other main effects and interactions were not significant (all *p*s > .10). The ANOVA for Know responses did not yield any significant main effect or interaction (all *p*s > .18). With regard to Guess responses, there was a significant effect of encoding task, $F(1, 76) = 14.43$, $p < .001$, showing that participants in the expression condition produced more Guess responses than participants in the intelligence condition. Finally, analyses of Remember, Know, and Guess FAs did not reveal any significant effect of encoding condition or facial orientation, nor was there any interaction between these two factors.

Discussion

With regard to total recognition performance, the results of Experiment 2 replicate those of Experiment 1, showing equivalent recognition performance following judgments of trait information and judgments of facial expression, and better recognition of happy faces than of angry faces in both conditions. However, examining the states of awareness associated with memory revealed that facial identity recognition was more frequently associated with Remember responses and less frequently associated with Guess responses following judgments about intelligence than following judgments about expression. In addition, Remember responses were more frequent for happy than for angry faces following judgments about intelligence but not following judgments of expression. Insofar as Remember responses reflect more elaborate and distinctive processing operations at encoding (Dewhurst & Conway, 1994; Gardiner, 1988; Mäntylä, 1997; Rajaram, 1996), these findings suggest, firstly, that rating expression reduced elaborative processing of facial identity compared to rating intelligence and, secondly, that facial identity was processed more elaborately for happy than for angry faces when facial stimuli were rated for intelligence but not when they were rated for expression. A possible explanation of these findings is that explicitly orienting attention towards facial expression facilitates the encoding of this information in memory (cf. Experiment 1) but disrupts elaborative encoding of facial identity, therefore resulting in a global decrease in Remember responses that supersedes the influence facial expression otherwise has on these responses (see the General Discussion section for further discussion of this issue).[2] In any case, the findings clearly indicate that the influence of facial expressions on memory for facial identity does not require explicit assessment of the affective meaning of the expressions. On the contrary, explicit rating of facial expressions may even reduce their impact on the conscious recollection of facial identity.

Insofar as direct (as opposed to averted) gaze enhances the processing of facial expressions of joy and anger (Adams & Kleck, 2003, 2005), we expected to find a more

pronounced influence of these expressions when they were directed towards the observer rather than averted. However, the influence of expressions on identity memory was not modulated by facial orientation. This might simply indicate that gaze orientation and facial expression do not interact to influence the encoding of facial identity in memory. However, it should be emphasized that we manipulated eye gaze as a component of the direction of the whole face display, whereas most studies that demonstrated an influence of gaze direction manipulated eye gaze while keeping the orientation of the whole face constant (Adams & Kleck, 2003, 2005; Mason et al., 2004; Vuilleumier et al., 2005). Using stimuli similar to those used in the present experiment, Juth et al. (2005) found that the influence of facial expressions on attention was not modulated by facial orientation. However, as pointed out by these authors, two factors are confounded in these stimuli: the orientation of the gaze and the orientation of the whole face. Therefore, studies that disentangle these two factors should be conducted before definitely concluding that gaze orientation and facial expression do not interact to influence the encoding of facial identity in memory.

General Discussion

The main goal of this study was to assess the influence of facial expressions on memory for new facial identities and to investigate whether this influence varies according to the types of facial information that are attended to when encoding the faces in memory. When encountering unfamiliar persons, a wealth of useful social signals can be derived from their faces, including information about their sex, age, inferred personality traits, intentions and emotions and information used to encode their identity (Bruce & Young, 1986; Calder & Young, 2005; Haxby et al., 2000). During a social encounter, one may favor the processing of one type of facial information over another, which has consequences for the efficiency of the encoding of different

types of facial information in memory. Previous studies have, for instance, shown that instructions to attend to specific aspects of facial stimuli such as personality traits, gender, or a physical feature have considerable effects on memory for facial identity (Coin & Tiberghien, 1997). We replicated these findings in Experiment 1, showing that identity recognition is better following judgments about trait information than judgments about a physical feature. Despite this overall difference, in both encoding conditions, faces were better recognized when they had previously displayed happy rather than angry expressions. Furthermore, the influence of facial expressions in these two conditions was equivalent to the influence observed when participants' attention was explicitly directed towards facial expression. On the whole, these findings support the conclusion that facial expressions influence memory for facial identity in a relatively automatic manner, that is, without requiring the explicit assessment of the affective meaning of the expressions.

The examination of states of awareness associated with facial identity recognition in Experiment 2 suggests that the explicit rating of facial expressions may even reduce their impact on the conscious recollection of facial identity. Indeed, identity recognition was more frequently associated with Remember responses for happy faces that for angry faces when the stimuli had been rated for trait information at encoding but not when they were rated for facial expression. The lack of influence of facial expressions in the latter condition seemed to result from a decrease in Remember responses following judgments about facial expression compared to judgments of trait information. These findings are particularly interesting because Remember responses are probably more sensitive than overall recognition performance to differences in elaborative and distinctive processing that occurred at encoding (Dewhurst & Conway, 1994; Gardiner, 1988; Mäntylä, 1997; Rajaram, 1996). The results therefore suggest that explicitly attending to facial expression enhanced memory for this facial information (cf. Experiment 1) but disrupted

elaborative processing of facial identity, which may have superseded the impact facial expressions otherwise have on the elaboration of facial identity processing.

The influence of facial expressions observed when attention was not explicitly oriented towards expression may reflect the spontaneous implementation of different processing strategies in response to the encounter of angry versus happy faces. When attention is not explicitly oriented towards facial expression, people may spontaneously focus on facial expression to a greater extent when being confronted with angry faces than with happy faces. This would result in a reduced elaboration of facial identity, similar to what is observed when attention is explicitly oriented towards facial expression. As already noted, there is indeed evidence that threatening stimuli such as faces with angry expressions attract attention to themselves and disrupt the processing of other (expression-irrelevant) information (Eastwood et al., 2003; Fox et al., 2000; Öhman et al., 2001; Vuilleumier et al., 2001). Conversely, people typically view others as sources of reward and expect positive interactions, which may facilitate the processing of positive social signals such as those conveyed by facial expressions (Leppänen & Hietanen, 2003, 2004; Silvia et al., 2006) and hence leave more resources available for processing other social cues, such as facial identity. Different types of facial expressions may therefore spontaneously orient processing resources to different types of facial information, with angry expressions orienting attention predominantly to the expressions themselves, whereas positive expressions enable the processing of a wider variety of facial features, including those used to recognize a person's identity. The reduced conscious recollection of the identity of faces that had displayed an angry expression might thus reflect a spontaneous constriction of the focus of attention towards threatening expressions themselves, which perturbs elaborative encoding and hence the conscious recollection of facial identity. This hypothesis could be tested in future studies by measuring visual scanpaths during the encoding of faces displaying happy versus angry expressions (e.g.,

Horley, Williams, Gonsalvez, & Gordon, 2004), and by examining relationships between these measures and subsequent memory for facial identity.

As a final point, it should be noted that it is likely that, at least for some trials, participants had enough time to process facial features other than the one they were asked to attend to, even though we decreased presentation time of the faces in Experiment 2 to minimize this possibility. In fact, we are inclined to believe that, insofar as happy and angry expressions tend to increase or decrease the elaboration of facial identity processing, reducing the possibility of elaboration by using very short presentation times might diminish the influence of facial expressions. If it was indeed the case, it would indicate that the influence of expressions on memory for facial identity is not automatic in a "strong" sense (i.e., independent of top-down factors), but corresponds instead to the notion of "weak automaticity," which refers to task-irrelevant or involuntary processing (cf. Pessoa, 2005).

In summary, the present experiments replicate previous findings that faces are better recognized when they have previously been encountered with happy rather than angry expressions, and they further indicate that this influence of facial expressions does not require explicit assessment of the affective meaning of expressions. On the contrary, enhanced conscious recollection of the identity of happy faces compared to angry faces was apparent only when attention was not oriented towards the affective meaning of expressions. We suggest that in the latter condition, angry faces tend to spontaneously orient attention to facial expressions themselves, which disrupt elaborative encoding and hence conscious recollection of facial identity. More generally, this interpretation fits well with proposals that negative stimuli tend to constrict the breadth of attention towards indices of threat, whereas positive stimuli tend to broaden the breadth of attention (Derryberry & Tucker, 1994). Our findings could reflect the

memory consequences of such a modulation of attentional scope in response to the encounter of valenced social signals.

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Footnote

[1] In this study, we do not use the term “automatic” to designate complete independence from top-down factors, such as attention and task instructions (“strong” automaticity). Instead, it is used to refer to the less strict notion of task-irrelevant or involuntary processing (“weak” automaticity; cf. Pessoa, 2005).

[2] An anonymous reviewer raised the interesting possibility that happy faces could have been perceived as being more intelligent than angry faces, so that they received greater attention at study and were better recollected subsequently. Happy faces were indeed rated as being more intelligent than angry faces in the present experiment (M = 2.05, SD = 0.29 vs. M = 1.75, SD = 0.40), $t(38) = 3.38$, $p = .002$. However, differences between the two types of faces concerning intelligence ratings did not correlate with differences in memory, either for overall recognition ($r = .11$, $p = .50$) or Remember responses ($r = .08$, $p = .65$). Therefore, the memory effects evidenced in the present experiment do not seem to be related to differences in perceived intelligence of the faces.

Table 1

Mean Proportions (and Standard Deviations) of Remember, Know, and Guess Responses for Facial Identity Recognition in Experiment 2

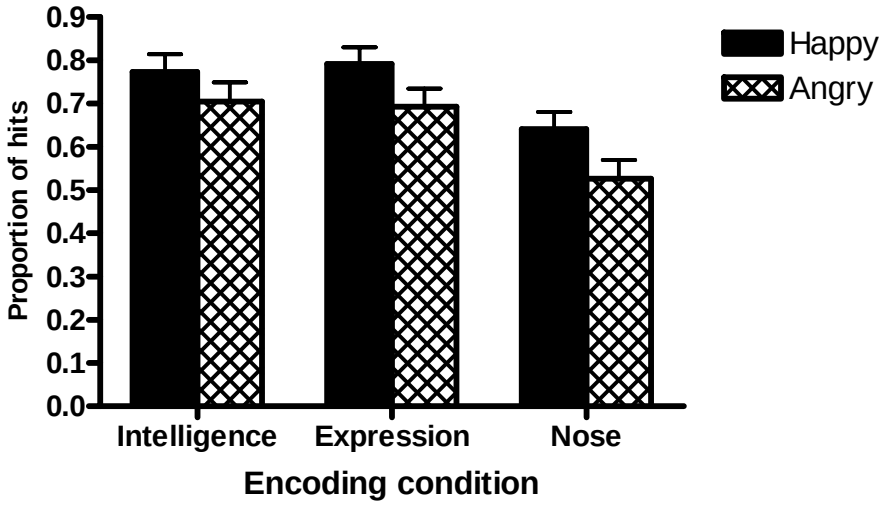
	Intelligence condition			Expression condition		
Face orientation	Happy	Angry	FAs	Happy	Angry	FAs
Directed						
Remember	.58 (.30)	.46 (.31)	.10 (.12)	.25 (.21)	.23 (.19)	.04 (.07)
Know	.12 (.20)	.13 (.23)	.08 (.14)	.26 (.24)	.23 (.27)	.09 (.12)
Guess	.07 (.12)	.06 (.09)	.06 (.10)	.19 (.21)	.14 (.14)	.11 (.12)
Total	.77 (.22)	.65 (.26)	.24 (.23)	.70 (.24)	.60 (.26)	.24 (.21)
Averted						
Remember	.53 (.27)	.39 (.23)	.06 (.11)	.36 (.25)	.33 (.20)	.09 (.15)
Know	.22 (.21)	.20 (.13)	.08 (.12)	.22 (.21)	.20 (.21)	.09 (.12)
Guess	.04 (.07)	.11 (.10)	.08 (.11)	.15 (.13)	.13 (.14)	.09 (.10)
Total	.79 (.18)	.70 (.22)	.22 (.19)	.73 (.21)	.66 (.22)	.27 (.22)

Figure captions

Figure 1. Proportions of hits for facial identity recognition in Experiment 1.

Figure 2. Proportions of correct responses for memory for facial expression in Experiment 1.

Figure 3. Proportions of Remember responses for facial identity recognition in Experiment 2.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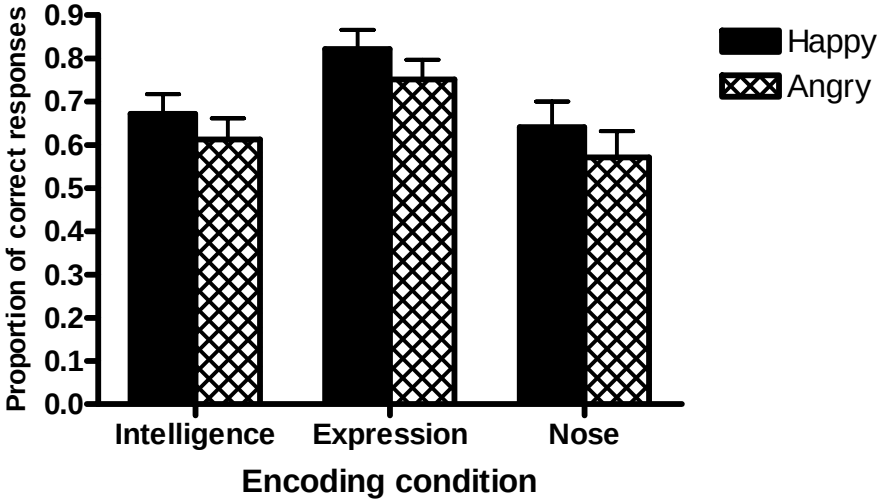
Proportion of hits
Intelligence
Expression
Nose
Encoding condition
Happy
Angry


Proportion of correct responses
0.9
0.8
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Intelligence
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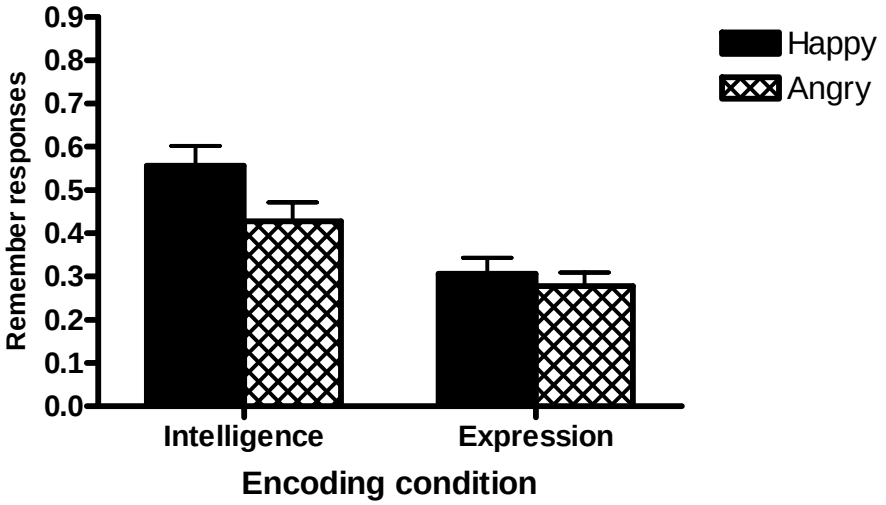
Nose
Encoding condition
Happy
Angry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Remember responses
Happy
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Encoding condition