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Identity recognition and happy and sad facial expression recall: Influence of depressive symptoms

Françoise Jermann
University of Geneva, Switzerland, and Geneva University Hospitals, Switzerland

Martial van der Linden
University of Geneva, Switzerland, and University of Liège, Belgium

Arnaud D'Argembeau
University of Liège, Belgium, and Belgian National Fund for Scientific Research

Relatively few studies have examined memory bias for social stimuli in depression or dysphoria. The aim of this study was to investigate the influence of depressive symptoms on memory for facial information. A total of 234 participants completed the Beck Depression Inventory II and a task examining memory for facial identity and expression of happy and sad faces. For both facial identity and expression, the recollective experience was measured with the Remember/Know/Guess procedure (Gardiner & Richardson-Klavehn, 2000). The results show no major association between depressive symptoms and memory for identities. However, dysphoric individuals consciously recalled (Remember responses) more sad facial expressions than non-dysphoric individuals. These findings suggest that sad facial expressions led to more elaborate encoding, and thereby better recollection, in dysphoric individuals.

It is well known that depressed patients and people who have a high score for depressive symptomatology, but who are not necessarily clinically depressed (also referred to as dysphoric individuals; Kendall, Hollon, Beck, Hammen, & Ingram, 1987), have problems with the interpersonal domain (e.g., Segrin, 2000; Segrin & Dillard, 1993; Sloan, Bradley, Dimoulas, & Lang, 2002). Dysphoric people rate themselves as having poor interpersonal skills (Segrin & Dillard, 1993), present some impaired social skills (e.g., particular communication behaviours such as slower speech rate, lower speech volume; Segrin, 2000; Segrin & Dillard, 1993), and are less accepted by their interaction partners (e.g., Alloy, Siegel Fedderly, Kennedy-Moore, & Cohan, 1998). Furthermore, it has also been shown that dysphoric people are not as good at social problem solving as non-dysphoric participants (Goddard, Dritschel, & Burton, 1997). All these negative social interactions and poor interpersonal problem-solving skills could constitute a vulnerability, maintenance, or exacerbation factor that influences the course of depressed mood (Davila, Hammen, Burge, Paley, & Daley, 1995; Petty, Sachs-Ericsson, & Joiner, 2004).

Apart from the direct investigation of the interpersonal functioning of depressed and dysphoric people, several studies have explored how socially relevant stimuli are cognitively processed. Faces are highly significant social stimuli that provide a range of information which can be used,

Address correspondence to: Dr Françoise Jermann, 'Geneva University Hospitals, Adult Psychiatry Department, Rue du XXXI décembre 5–8, 1207 Geneva, Switzerland. E-mail: Francoise.Jermann@hcuge.ch

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for example, to recognise people and infer their age, gender, or emotional state (Bruce & Young, 1986). Of all these pieces of information, facial identity and emotional expressions are probably the most salient and important aspects for performing social interactions. A few studies have explored memory for faces with different facial expressions in depressed patients (Gilboa-Schechtman, Erhard-Weiss, & Jeczemien, 2002; Ridout, Astell, Reid, Glenn, & O'Carroll, 2003). However, to the best of our knowledge, no study has explored memory for faces with facial expressions in dysphoric individuals. Gilboa-Schechtman et al. (2002) examined memory for angry, happy, sad, and neutral faces in patients suffering from comorbid depression and anxiety (COMs) or anxiety disorders alone (ANXs) and in normal controls (NACs). During encoding, participants had to say whether they would like to meet the person they saw on the screen (incidental encoding). During the recognition phase, the encoded pictures were presented again, along with pictures of the same people but with different facial expressions. The authors found that COMs had a better recognition score for negative expressions (angry and sad) compared to non-negative facial expressions (happy and neutral), whereas NACs showed the reverse pattern and ANXs showed no memory bias.

Ridout et al. (2003) explored memory for happy, sad, and neutral faces in people with major depression and in control participants. During the encoding phase, participants had to judge whether the faces they saw on the screen were neutral, positive, or negative (incidental encoding). During the recognition phase, the encoded pictures were presented again, mixed up with pictures of other people showing a neutral, happy, or sad facial expression. The results showed that depressed patients recognised more sad faces and fewer happy faces compared to neutral faces. The reverse pattern was evidenced in control participants. Finally, a study measuring event-related brain potential (ERP) suggests that depressed people tend to process negative and positive facial stimuli in the same sustained way, whereas non-depressed participants tend to avoid the elaborative processing of negative stimuli compared to positive stimuli (Deveney & Deldin, 2004; see also Deldin, Deveney, Kim, Casas, & Best, 2001, for similar findings using verbal stimuli).

Although facial identity and facial 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). Gilboa-Schechtman et al.'s and Ridout et al.'s studies clearly show that the influence of positive versus negative expressions on memory for facial information differ in depressed individuals. Yet it remains unclear whether this is predominantly due to differences in memory for facial identity or memory for facial expression, because the tasks used in those studies did not measure memory for these two types of information separately. The purpose of this study was to investigate the influence of depressive symptoms on memory for both facial identity and facial expression of happy and sad faces, and to assess the states of awareness associated with memory to further explore the memory mechanisms that are influenced by dysphoria. To this end we adapted a task we have developed in previous studies that explored the influence of expressions on memory for facial identity and facial expression (D'Argembeau, Van der Linden, Comblain, & Etienne, 2003a; D'Argembeau, Van der Linden, Etienne, & Comblain, 2003b). In this task participants are first presented with faces displaying a particular emotional expression. Afterwards, pictures of the same individuals but with a neutral expression are presented, mixed with other neutral faces. Participants have to recognise the previously encoded identities and, when they recognise one, to recall the facial expression that the person had displayed at study. In addition, for both identity recognition and facial expression recall, the states of awareness associated with memory are assessed with the Remember/Know/Guess procedure (Gardiner, 1988; Tulving, 1985). Participants are asked to indicate whether they are consciously recollecting something related to the encoding episode (e.g., a thought or feeling they had at that time; Remember response, R), whether they have a feeling of familiarity without recollecting anything (Know response, K), or whether they are guessing (Guess response, G). According to Tulving (1985), remembering is characterised by mentally reliving past events in which one was personally involved (autonoetic awareness), whereas knowing corresponds to more abstract knowledge without personal involvement (noetic awareness).

Using this task, we found that facial identity was better recognised when faces had displayed a happy rather than an angry expression at study, and this was due to an enhancement of the conscious recollection of facial identity rather than to feelings of familiarity (D'Argembeau & Van der Linden, 2004; D'Argembeau et al., 2003a, 2003b). The enhanced R responses for happy rather than angry faces may be related to the social/emotional meaning attributed to facial expressions. Most people typically have positive expectations regarding others (e.g., Leppänen & Hietanen, 2003) and hence may better elaborate the encoding of positive rather than negative social stimuli, thereby enhancing the amount of R responses while leaving the K and G responses unaffected (Gardiner & Richardson-Klavehn, 2000). With regard to memory for facial expressions 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). These inconsistencies might be due in part to individual differences between the participants included in the different studies, including psychopathological dimensions such as social anxiety (D'Argembeau et al., 2003b).

In this study, we investigated whether depressive symptoms modulate the influence of expressions on memory for facial identity and facial expression, and explored in more detail which memory mechanisms are affected, by means of the RKG paradigm. There is evidence that R responses are specifically reduced in dysphoria. In particular, a recent study that investigated recognition memory for neutral words showed that dysphoric participants recollected fewer words than control participants (fewer R responses) while the amount of K responses remained unaffected (Ramponi, Barnard, & Nimmo-Smith, 2004). However, to our knowledge, no study has examined memory for valenced material in depression or dysphoria by means of the RKG procedure. There is robust evidence that depressed and dysphoric people show a memory bias when explicit memory tasks are used (mostly evidenced with verbal material), whereas there are contradictory findings when implicit memory tasks are used (Barry, Naus, & Rehm, 2004; Matt, Vázquez, & Campbell, 1992). This led several authors to argue that memory biases are apparent in depression and dysphoria when elaboration or conceptual processing is implicated (Watkins, Martin, & Stern, 2000; Williams, Watts, MacLeod, & Mathews, 1997). More specifically, Williams et al. (1997) suggested that depressed people allocate more processing resources to the encoding of negatively valenced stimuli, which creates a greater number of associative links between these stimuli and other material stored in memory and hence facilitates subsequent retrieval. The RKG procedure provides an ideal tool to test this hypothesis. It is indeed known that R responses are sensitive to manipulations of elaborative processing at encoding, such as level of processing (Gardiner, 1988) or divided attention (Gardiner & Parkin, 1990), whereas K responses are unaffected by these variables. To the extent that faces with a sad expression trigger more elaborative processing in dysphoric individuals (e.g., induce more negative thoughts), they should lead to an enhanced recollection of facial identity and/or expression (more R responses). By contrast, K responses should not be affected by depressive symptoms.

METHOD

Participants

The sample was composed of 234 French-speaking young adults from the community (almost all Caucasian). Most of them were students at the University of Geneva, where the study took place; they were recruited by word of mouth. The remaining participants were acquaintances. Ages ranged from 18 to 44, with a mean age of 26.15 ($\pm$5.25). The mean number of years of education was 15.27 ($\pm$2.19) and 62% of the sample was female. All administration sessions were conducted individually. No compensation of any kind was given for participation. The severity of the participants' depressive symptoms was measured with the Beck Depression Inventory II (BDI-II; Beck, Steer, & Brown, 1996; Editions du Centre de Psychologie Appliquée, 1998). The BDI-II is a 21-item self-report measure of depression symptoms, which has good psychometric properties (minimum score is 0 and maximum score is 63). Participants completed this scale at the end of the experimental session (see below). The mean BDI-II score for the sample was 7.63 ($\pm$6.87). A score of between 0 and 11 corresponds to a minimum level, a score of between 12 and 19 corresponds to a mild depressive state, a score of between 20 and 27 corresponds to a moderate depressive state, and a score higher than 28 corresponds to severe depression (Beck et al., 1996).

Materials

Colour face stimuli were taken from the Karolinska Directed Expressional Faces set (KDEF; Lundqvist, Flykt, & Öhman, 1998). The KDEF is composed of photographs of 70 Caucasian actors (35 women and 35 men) who are expressing seven different facial expressions (fear, anger, disgust, joy, sadness, surprise, and neutral). Size and background colour were the same for all the pictures and all actors wore the same kind of shirt. A subset of 36 identities (18 women and 18 men), each depicted once with a sad facial expression, once with a neutral expression, and once with a happy expression, was pre-selected by the authors (108 photographs). A pre-test with an independent group of 20 university students was then conducted on the pre-selected photographs. Faces were presented one by one in the centre of a screen and students had to rate the intensity of the facial expression of each picture on a Likert scale ranging from -7 (sad) to 0 (neutral) to $+7$ (happy). A face was considered to represent a neutral facial expression if the mean rating score was between -1.9 and 1.9. Above and below these values the facial expression was considered to be either sad or happy. A final set of 60 faces (20 identities—10 women and 10 men—with each identity depicting a sad, a neutral, and a happy facial expression) was selected. The mean rating for the sad faces in the final set was -3.17 (± 0.90), the mean rating for the neutral faces was -0.11 (± 0.13), and that for the happy faces was 3.48 (± 0.83).

The final set of 20 identities was then divided into two subsets (set A and set B) of 10 identities each (5 women, 5 men). Photos in sets A and B were matched for physical similarity (e.g., hair colour and length; face shape) by the first author. For half of the participants set A was used as studied items and set B as unstudied items, and for the other participants set B was used as studied items and set A as unstudied items. Within each set each face was seen with a happy facial expression by half of the participants and with a sad facial expression by the remaining participants. Doing this made it possible to look for the effect of facial expression unconfounded by differences in the memorability of particular people's faces. Stimuli were placed in a pseudorandom but fixed order such that no more than two pictures with the same facial expression occurred in succession. Two presentation orders were created: the photos were presented in one order for half of the participants (from each set) and in the reverse order for the other half.

In the recognition phase 20 neutral faces (10 previously studied identities and 10 new identities) were presented. Stimuli were placed in a pseudorandom but fixed order such that no more than three previously studied or "new" faces and no more than two previously studied faces with the same expression at study occurred in succession. Two different recognition orders were created. Half of the participants (from each set) saw one order, and the other half saw the other.

Procedure

The session began with the study phase of the memory task. Participants were seated in front of a 15-inch computer screen at about a distance of 50–70 cm (stimuli were 14.5 cm in height and 10.5 cm in width). Each face was presented for 5 seconds at study. Participants were instructed to look carefully at the faces, in order to be able to recognise them afterwards (intentional encoding, without mentioning the presence of facial expressions). After this encoding phase participants were presented with the recognition test. They were told that they would see faces and that some of them represented people they had been shown initially, although the expression of the faces had changed (all faces were neutral). Once a face appeared, they had to decide whether or not they had seen it before (identity recognition). When they recognised a particular identity, they then had to report their state of awareness: "I remember" (R), "I know" (K), or "I guess" (G). Participants received detailed instructions about the distinction between R, K, and G responses before the recognition phase. These instructions were adapted from those used by Gardiner and colleagues (Gardiner, Ramponi, & Richardson-Klavehn, 1998). Briefly, participants were told that an R response should be given to any face that, at the time it was recognised, brought back to mind something they had consciously experienced (e.g., an association, a thought, a feeling). Each time participants gave an R response they had to justify it. In contrast, participants were asked to make a K response if the face felt familiar but they were unable to recollect details of its prior exposure. Finally, they were asked to make a G response if they were unsure whether or not the face had been presented in the study phase. When participants recognised an identity they were also asked to try to recall the facial expression the face had displayed at encoding. They were told that some of the faces they had seen in the study phase had a happy facial expression and other faces a sad expression. Their responses to the facial expressions also had to be characterised by "I remember", "I know", or "I guess". They were asked to make an R response if they could consciously recall seeing the expression of the face, and if they could remember what the expression looked like. Each time participants gave an R response they had to justify it. Participants were asked to make a K response if they believed that the face had the expression but they could not consciously recollect what the expression looked like. They were asked to make a G response if they had no idea what the expression had been and they were guessing. All the responses were made orally and each face remained on the screen until participants responded. The experimenter pressed the space bar to go on to the next trial. There was no time constraint for making the judgements (and thus response time was not recorded). The session ended with the collection of some personal information (age, gender, number of years of education) and the completion of the BDI-II.

RESULTS

Data were analysed using both a dimensional and categorical approach. First, following a dimensional conceptualisation of depression (depressive symptoms, as assessed by the BDI-II, occur along a latent continuum; e.g., Ruscio & Ruscio, 2000, 2002), we computed correlations between BDI-II scores and memory measures over the entire sample. However, considering the possibility advanced by some authors (e.g., Ramponi et al., 2004) that there might be qualitative differences in information processing between non-dysphoric and dysphoric individuals, we also used an extreme group approach to analyse the data, by comparing participants in the upper and lower quartiles for BDI-II scores. People scoring 3 or less constitute the "non-dysphoric group" ($n = 78$; 43 F and 35 M) and people scoring 11 or more constitute the "dysphoric group" ($n = 65$; 47 F and 18 M). The mean BDI-II score for the non-dysphoric group was 1.56 ($SD = 1.14$) and the mean score for the dysphoric group was 16.65 ($SD = 5.96$). The mean BDI-II scores of each group differed significantly, $t(141) = 21.89$; $p < .001$. The groups did not differ regarding age (mean for non-dysphoric group: 26.48, $SD = 5.42$; mean for the dysphoric group: 25.99, $SD = 5.27$), $t(141) = 0.55$; $p = .59$, and number of years of education (mean for non-dysphoric: 15.59, $SD = 2.09$; mean for the dysphoric group: 14.94, $SD = 2.49$), $t(141) = 1.70$; $p = .09$. There was no correlation between age or number of years of education and memory performances (all $r < .10$; all $p > .15$), except that the proportion of K responses produced for happy expressions was related to years of education ($r = .18$; $p < .05$). Initial analyses showed that the reported effects for identity recognition and memory for facial expression were similar for women and men, so data from women and men are combined in the reported analyses.

Identity recognition

A corrected recognition score was calculated for total recognition, Remember responses, Know responses, and Guess responses by subtracting the percentage of false alarms (FAs; new identities falsely recognised as studied identities) from the percentage of hits (studied identities correctly recognised) (% hits–% FAs). Subtractions were done separately for Remember, Know, and Guess responses. Since FAs could not be calculated separately for happy and sad faces (as all faces presented at the recognition stage were neutral), the global FA rates were subtracted. For the whole sample the total mean proportion (and standard deviation) of FAs was 0.16 (0.16); the mean proportion of FAs was 0.04 (0.08) for R responses, 0.05 (0.08) for K responses, and 0.07 (0.09) for G responses. Mean corrected recognition scores (total, R, K, and G) for happy and sad faces are presented in Table 1. Pearson correlations between the BDI-II scores and these corrected recognition scores are also shown in Table 1. A significant negative correlation was evidenced between the BDI-II score and the proportion of Guess responses for identities that had been presented with a happy facial

TABLE 1
Identity recognition

		Total population ($n = 234$)			*Upper and lower quartile: Means (SD)*	
		Means (SD)	*Pearson correlation (r)*	*p* value	*Non-dysphoric group* ($n = 78$)	*Dysphoric group* ($n = 65$)
Happy encoded faces	Total	0.64 (0.25)	.01	.87	0.66 (0.22)	0.66 (0.29)
	R	0.42 (0.28)	.10	.11	0.39 (0.29)	0.47 (0.30)
	K	0.19 (0.24)	−.01	.92	0.20 (0.26)	0.19 (0.23)
	G	0.03 (0.18)	−.13	.05	0.07 (0.23)	0.00 (0.15)
Sad encoded faces	Total	0.60 (0.27)	.04	.56	0.62 (0.24)	0.66 (0.30)
	R	0.37 (0.29)	.11	.11	0.35 (0.26)	0.43 (0.29)
	K	0.20 (0.23)	−.04	.55	0.21 (0.24)	0.20 (0.23)
	G	0.03 (0.17)	−.07	.30	0.06 (0.18)	0.03 (0.18)

Corrected (% hits –% FAs) mean proportions (and standard deviations) and mean amounts (and standard deviations) of R, K, and G responses for the whole population and for the non-dysphoric group and the dysphoric group (upper and lower BDI-II score quartiles). Pearson correlations between BDI-II score and memory measures.

expression at study. No other correlation reached significance.

Results regarding identity recognition based on the upper and lower quartile groups are the following. For the non-dysphoric group the total mean proportion (and standard deviation) of FAs was 0.14 (0.16), and the mean proportion of FAs was 0.03 (0.07) for R responses, 0.04 (0.06) for K responses and 0.07 (0.11) for G responses. For the dysphoric group the total mean proportion (and standard deviation) of FAs was 0.15 (0.16), and the mean proportion of FAs was 0.04 (0.07) for R responses, 0.05 (0.06) for K responses and 0.06 (0.08) for G responses. Mean corrected recognition scores for the non-dysphoric and dysphoric groups are shown in Table 1.

Series of 2 (Valence: happy vs sad) × 2 (Group: non-dysphoric vs dysphoric) ANOVAs were conducted separately for total recognition scores and R, K, and G responses. Regarding total recognition, there were no significant main effects of Valence or Group and no significant Valence × Group interaction [Valence: $F(1, 141) = 1.24$; $p = .27$; Group: $F(1, 141) = 0.17$; $p = .68$; interaction: $F(1, 141) = 0.65$; $p = .42$]. For R responses, the ANOVA showed no main effect of Valence, $F(1, 141) = 2.40$; $p = .12$. The Group factor approached significance, $F(1, 141) = 3.69$; $p = .057$, but there was no Valence × Group interaction, $F(1, 141) = 0.01$; $p = .93$. The ANOVAs for K and G responses showed no significant main effects of Valence or Group and no significant Valence × Group interaction [K responses: Valence: $F(1, 141) = 0.08$; $p = .78$; Group: $F(1, 141) = 0.15$; $p = .70$; interaction: $F(1, 141) = 0.01$; $p = .91$. G responses: Valence: $F(1, 141) = 0.41$; $p = .52$; Group: $F(1, 141) = 3.28$; $p = .07$; interaction: $F(1, 141) = 0.88$; $p = .35$].

Facial expression recall

Memory for facial expression was assessed by determining the probability that a participant would correctly recall a facial expression conditional upon correct facial identity recognition. This was done by dividing the number of correct responses for each type of expression (happy vs sad) by the number of correct identity recognitions for that type of expression. The mean proportions of correct recall for happy and sad facial expressions for the whole sample are reported in Table 2, along with the mean proportions of R, K, and G responses. Pearson correlations between the BDI-II scores and total, R, K, and G responses are also displayed in Table 2. The results show a positive correlation between the BDI-II scores and total proportions of correctly recalled sad facial expressions. By contrast, BDI-II scores did not correlate with the proportions of correct responses for happy expressions. A positive correlation was also evidenced between the BDI-II scores and proportions of R responses for sad expressions but not for happy expressions. There was no significant correlation between BDI-II scores and proportions of K or G responses.

As with identity recognition, analyses based on the upper and lower quartile groups were also carried out. The mean proportions of correctly recalled happy and sad facial expressions for each

TABLE 2
Facial expression recall

		Total population (n = 234)			*Upper and lower quartile: Means (SD)*	
		Means (SD)	*Pearson correlations (r)*	*p* value	*Non-dysphoric group (n = 78)*	*Dysphoric group (n = 65)*
Hits for happy facial expressions	Total	0.69 (0.25)	−.03	.70	0.70 (0.24)	0.69 (0.24)
	R	0.20 (0.23)	.09	.19	0.18 (0.22)	0.22 (0.25)
	K	0.22 (0.23)	.02	.81	0.18 (0.20)	0.24 (0.25)
	G	0.27 (0.25)	−.12	.06	0.34 (0.26)	0.23 (0.26)
Hits for sad facial expressions	Total	0.70 (0.23)	.16	.02	0.66 (0.25)	0.75 (0.23)
	R	0.22 (0.24)	.19	.004	0.17 (0.21)	0.29 (0.26)
	K	0.22 (0.25)	.05	.45	0.19 (0.22)	0.21 (0.25)
	G	0.26 (0.25)	−.08	.21	0.30 (0.23)	0.25 (0.27)

Mean proportions (and standard deviations) and mean amounts (and standard deviations) of R, K, and G responses for the whole population and for the non-dysphoric group and the dysphoric group (upper and lower BDI-II score quartiles). Pearson correlations between BDI-II score and memory measures.

group are reported in Table 2, along with the mean numbers of R, K, and G responses.

Series of 2 (Valence: happy vs sad) × 2 (Group: non-dysphoric vs dysphoric) ANOVAs were conducted separately for total, R, K, and G responses. Regarding total proportions, there was no main effect of Valence or Group [Valence: $F(1, 141) = 0.12$; $p = .73$; Group: $F(1, 141) = 2.34$; $p = .13$] but the Valence × Group interaction approached significance, $F(1, 141) = 3.32$; $p = .07$. For R responses, there was no main effect of Valence, $F(1, 141) = 2.40$; $p = .123$, but the ANOVA yielded a significant main effect of Group, $F(1, 141) = 6.46$; $p < .05$, and the Valence × Group interaction approached statistical significance, $F(1, 141) = 3.43$; $p = .066$. As we had a priori hypotheses regarding differences in R responses, planned comparisons were conducted to further explore the interaction. The comparisons showed that the dysphoric group recalled more sad expressions with R responses than the non-dysphoric group, $F(1, 141) = 9.96$; $p < .01$. By contrast, there was no difference between the two groups with regard to happy expressions, $F(1, 141) = 0.96$; $p = .33$. Moreover, dysphoric participants produced significantly more R responses for sad expressions than for happy expressions, $F(1, 141) = 5.31$; $p < .05$, whereas there was no such difference within the non-dysphoric group, $F(1, 141) = 0.05$; $p = .82$.

The ANOVA for K responses showed no significant main effects of Valence or Group and no significant Valence × Group interaction [Valence: $F(1, 141) = 0.19$; $p = .66$; Group: $F(1, 141) = 1.70$; $p = .194$; interaction: $F(1, 141) = 0.42$; $p = .52$]. For G responses, the ANOVA showed no main effect of valence, $F(1, 141) = 0.26$; $p = .61$. However, there was a significant Group effect, $F(1, 141) = 5.74$; $p < .05$, showing that the dysphoric group gave fewer G responses than the non-dysphoric group. There was no Valence × Group interaction, $F(1, 141) = 1.07$; $p = .30$.

Finally, we assessed whether the influence of depressive symptoms on memory for sad expressions was truly based on memory processes or whether it simply corresponded to a response bias (i.e., a tendency to answer "sad" without actually recalling facial expressions). To this end, we examined the responses participants gave for the expression of identities that had been falsely recognised. A total of 169 participants made one or more FAs for identity recognition. We calculated the proportion of "sad" responses given for these falsely recognised faces (number of "sad" answers/number of FA). In the whole sample, the mean percentage of "sad" answers was 53% (i.e., at the chance level). There was no correlation between proportions of "sad" answers and BDI-II scores, $r(169) = -.02$; p = .81. For the extreme groups, the mean proportion of "sad" answers was 0.58 ($SD = 0.41$) for the non-dysphoric group and 0.49 ($SD = 0.43$) for the dysphoric group; the difference between the two groups was not significant, $t(93) = 0.10$; $p = .32$. These results indicate that the better memory for sad expressions in the dysphoric group was not simply due to a response bias.

DISCUSSION

The aims of this study were to investigate the influence of depressive symptoms on memory for the identity and expression of happy and sad faces, and to further explore the memory mechanisms that underlie this influence. With regard to identity recognition the results showed only one significant association, namely that the more depressive symptoms people reported, the less likely they were to give correct G responses for identities that had been encoded with a happy facial expression. Regarding memory for facial expression there was a positive association between depressive symptoms and the conscious recollection (R responses) of sad expressions. Furthermore, analyses using extreme groups (upper vs lower quartile on the BDI-II) showed that dysphoric individuals consciously recalled more sad facial expressions than non-dysphoric individuals. Within the dysphoric group more sad facial expressions were consciously recalled than happy facial expressions, whereas there was no difference between the two types of expressions in the non-dysphoric group. The influence of dysphoria was limited to conscious recollection (R responses) of sad facial expressions; there was no group difference for feelings of familiarity (K responses).

Previous studies found that clinically depressed patients showed better recognition performances for negative faces than for non-negative faces (happy and/or neutral), whereas the reverse pattern was evidenced in normal controls (Gilboa-Schechtman et al., 2002; Ridout et al., 2004). Our study shows that even sub-clinical depression (dysphoria) influences memory for facial information and the findings also help to further clarify which facial features are predominantly affected. We used a task that enabled us to assess memory for facial identity and facial expression separately, and found that depressive symptoms specifically affected memory for the expression, rather than the identity, of sad faces. Moreover, this influence was due to conscious recollection (as assessed by R responses) rather than feelings of knowing. In so far as R responses are sensitive to elaborative processing operations at study (e.g., Gardiner, 1988; Gardiner & Parkin, 1990), these findings fit well with the idea that depressive symptoms are associated with increased elaborative processing of negatively valenced stimuli (Williams et al., 1997). In particular, sad expressions might trigger more associations (e.g., negative thoughts) in dysphoric individuals, which creates a greater number of associative links between the expression and other material stored in memory and hence facilitates subsequent recollection.

Alternatively, our findings might be interpreted in terms of the role of embodiment in social and emotional information processing (Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). There is evidence that emotional expressions tend to be imitated by observers, which facilitates the perception of emotional meaning and evokes empathic responses (Niedenthal, 2007). In addition, embodied responses have been shown to influence memory for valenced stimuli (D'Argembeau, Lepper, & Van der Linden, in press; Förster & Strack, 1996; Gawronski, Deutsch, & Strack, 2005). It has been found that dysphoric and non-dysphoric individuals differ in their facial electromyography (EMG) reactivity to viewing facial expressions (Sloan et al., 2002). It might therefore be speculated that differences in embodied responses resulting from dysphoria contributed to influence memory for facial expressions. More specifically, sad expressions may have triggered more embodied responses (mimicry) in dysphoric people, thereby facilitating subsequent memory. This interpretation is highly speculative, admittedly, but might be worthy of exploration in future studies.

We also have to explain how depressive symptoms influenced memory for sad expressions, without affecting the recognition of facial identities that were encoded with these expressions. Although facial identity and expression are not processed independently (e.g., Ganel & Goshen-Gottstein, 2004; Schweinberger et al., 1999), there is nevertheless some separation between the coding of these two types of facial information (Calder & Young, 2005; Ganel & Goshen-Gottstein, 2004). In fact it appears that the processing of faces depends on two types of properties: invariant and changeable properties (Ganel & Goshen-Gottstein, 2004). Invariant facial properties comprise the unique facial configuration specific to an individual and are important for face identification. Facial expressions correspond to variations in this configuration created by the modification of changeable properties. It could be hypothesised that differences in memory encoding in dysphoric participants (e.g., differences in elaborative processing and/or embodied responses) might specifically target the changeable properties of faces that characterise sad expressions. By contrast, identity recognition itself might not be affected by depressive symptoms because it crucially depends on the processing of invariant characteristics of the faces that were not the focus of dysphoric participants' processing. These hypotheses could be explored in future studies, for example by measuring visual scan-paths during the encoding of faces displaying happy versus sad expressions, and by examining relationships between these measures and subsequent memory for facial identity and facial expression.

Finally, although the task we used in the present study had several advantages, it should also be acknowledged that it presents some limitations. First, the number of stimuli was rather small (10 stimuli at encoding), which might reduce the reliability of the test. Moreover, there was no baseline condition (encoding faces with a neutral expression) that could serve as a reference point for interpreting memory performances for faces with facial expressions. It should be noted, however, that adding a condition with neutral faces is practically difficult to implement in our paradigm because presenting the same neutral faces at both study and test would obviously boost performances compared to emotional faces (for which there was a change in pose between study and test; see Bruce, 1982). A possible solution would be to make changes in pose between study and test that are unrelated to expression (e.g., changes in orientation or lighting).

In conclusion, this study provides evidence that dysphoric individuals show a specific memory bias consisting of an enhanced recollection of sad facial expressions. Exploring the influence of depressive symptoms on memory for facial expressions is particularly interesting since depressed mood is associated with difficulties in interpersonal functioning (e.g., impaired social problem solving, negative self-evaluation regarding social competence, and negative evaluation of social partners; Segrin & Dillard, 1993; Tse & Bond, 2004). The memory pattern that we observed may play a role in these difficulties. Specifically, remembering sad facial expressions from past interactions could influence future social behaviours as well as current mood, since sad facial expressions are social stimuli that transmit low gratification and low reassurance. This memory bias could therefore be a maintenance and/or exacerbation factor for depressed mood and social interaction difficulties.

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