Memory for emotional faces in naturally occurring dysphoria and induced negative mood

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Abstract

The majority of mood-congruent memory research has confirmed the existence of a memory bias for affectively toned words or phrases. However, the current study investigated a memory bias for emotional facial expressions, in induced and naturally occurring mood states. In experiment 1 twenty-five dysphoric participants and twenty non-dysphoric participants were presented with a set of emotional facial expressions and asked to identify the emotions portrayed by each face. The participants were then tested on recognition memory for these facial expressions. It was found that dysphoric participants correctly identified more happy facial expressions compared with sad and neutral expressions. During the recognition memory phase the dysphoric participants demonstrated superior memory for sad facial expressions and inferior memory for happy expressions relative to non-dysphoric participants. In experiment 2 twenty-four healthy undergraduate students underwent a positive mood induction (group 1), and another twenty-four underwent a negative mood induction (group 2). These participants also took part in the same emotion identification trial and recognition memory phase, same as participants in experiment 1. All participants identified happy facial expressions more accurately than neutral or sad facial expressions. In the recognition phase, group 1 recognised more happy facial expressions, and group 2 recognised more sad facial expressions, supporting the recognition hypotheses. Findings were discussed in terms of Bower's (1981; 1987) Network Theory of Affect.

1. Introduction

Mood can hold a powerful influence on the memory of an individual, and changes in mood can easily challenge an individual's ability to remember information that was learned in the original mood, (Williams, Watts, Macleod, & Mathews, 1997). A prevalent hypothesis that has been tested by researchers is known as the mood-congruence hypothesis. It proposes that information is more likely to be stored and recalled when it is consistent with an individual's current mood, (Blaney, 1986).

Mood-congruent memory bias for emotional stimuli has been consistently reported in depressed individuals (Bradley, Mogg and Williams, 1995). A meta- analytic review on mood-congruent recall of affectively toned stimuli was carried out by Matt et al (1992). They looked at the effect of mood and recall bias in clinically and sub-clinically depressed individuals. They found that the depressed individuals recalled more negative than positive stimuli however there was no differential recall effect for sub-clinically depressed mood. The current study will look at both naturally occurring depressed mood (dysphoria) and induced mood states to investigate whether there is an effect on memory. A bias towards better memory for sad expressions could have important implications for depressed individuals as this would affect the way in which they interact with their environment. Therefore emotion identification and the subsequent memory for emotional facial expressions in depressed individuals is an important area of research.

Denny and Hunt (1992) presented groups of depressed patients and healthy controls with sets of emotional words that were either positively valenced, negatively valenced.or neutral. In the clinically depressed sample a bias towards better memory for negatively valenced affective words as opposed to positively valenced words was found. It was also found that the opposite pattern was evident for the healthy controls. Taking the above in to consideration it would suggest that a similar bias maybe evident in a dysphoric or mood induced sample. Williams et al (1988, 1997) predicted that once emotional faces had been identified as sad expressions the faces would receive greater cognitive resources during elaboration and encoding phases leading to a greater number of associations in memory and thus making them more retrievable.

In addition, research on mood and memory for facial expressions is reported by Gilboa-Schechtman, Erhard-Weiss and Jeczemien (2002). This was the first study to investigate depression and memory for facial stimuli. Memory for neutral, happy, sad and angry facial expressions in individuals suffering from comorbid depression and anxiety (COMs) or from anxiety disorders (ANXs) and in normal controls (NACs) was examined. Participants saw a set of emotional facial expressions and were asked to decide whether they would be interested in meeting the individual displayed in the photograph. In the second phase participants saw the old faces they had seen in phase one, as well as new faces of the same individuals from phase one in different emotional expressions. They were asked to indicate whether they had seen the face during phase one ('old') or not ('new'). It was found that COMs, but not NACs, exhibited enhanced recognition memory of negative compared to non-negative facial expressions. Specifically, it was found that depression was associated with decrease recognition of happy facial expressions and enhanced recognition of angry facial expressions.

Furthermore, Persad and Polivy (1993) found that depressed psychiatric patients and sub-clinically depressed college students relative to the non-depressed college group made more errors in recognizing the facial expressions. They concluded that depressed participants maybe deficient in the perceptual skills involved in noting and recognizing emotions in others. These findings indicate that depressed individuals are impaired in their ability to decode facial cues rather than impaired in their recognition or memory.

Surguladze et al (2004) further investigated the affect of mood on recognition of emotional facial expressions. In this experiment, patients with major depressive disorder and healthy controls were used. The two groups had to judge the emotion of 100 facial stimuli displaying different intensities of sadness, happiness and neutral expressions presented for short (100ms) and long (2,000ms) durations. It was found that depressed individuals demonstrated subtle impairments in discrimination accuracy and a predominant bias away from the identification as happy of mildly happy expressions. Therefore this indicates that in the present investigation dysphoric and negatively induced participants will correctly identify sad facial expressions in the encoding phase and will be less likely to label happy faces as happy in this phase.

A well known induction experiment into mood congruent memory was conducted by Bower et al (1981). The researchers induced happy and sad moods in 16 college students via hypnosis, and then participants were asked to read a story about two fictional characters. Findings revealed an encoding congruency effect; participants who were initially induced to feel sad recalled more about the sad character. In contrast, the elated participants recalled more information about the happy character.

As performed by Bower et al (1981), Gilligan & Bower (1983) also induced happy and sad moods in their participants using hypnosis. However, in contrast to Bower et al's (1981) study, Gilligan & Bower's (1983) used a memory task that required their participants to make autobiographical associations to phrases while their mood was induced. The participants were then asked to recall the phrases while in a neutral mood. Gilligan & Bower (1983) found that more happy phrases were recalled by the readers who experienced a positive mood induction, and more sad phrases were recalled by readers who had experienced a sad mood induction.

In contrast to the studies of Bower et al (1981) and Gilligan & Bower (1983), Teasdale & Russell (1983) induced the mood of their participants after, rather than before, the memory task. They presented their participants with positive, negative and neutral personality trait words, while they were in a neutral mood. They then used the Velten (1968) procedure to induce depressed or elated mood, and later tested for recall of the word list. Again, findings revealed a mood-congruent memory bias; depressed mood lead to better recall of negative trait words than neutral trait words, whereas elated mood lead to better recall of positive trait words. There was no difference in the recall of the neutral trait words. Furthermore, there have also been a number of studies which have investigated memory bias in healthy participants who have undergone a mood induction (e.g., Bower, Gilligan, & Monteiro, 1981; Clark & Teasdale, 1985; Nasby & Yando, 1982; Mecklenbrauker & Hager, 1984). The researchers generally agree that there is an influence of mood on memory, (Blaney, 1986; Rolls, 1999).

While the previous studies successfully demonstrated the existence of a mood-congruency bias, there are a number of weaknesses which should be noted. Firstly, the majority of these studies used very small sample sizes. For example, Gilligan & Bower (1983) only tested eight participants, and Clark & Teasdale (1983) tested 16 participants. The results obtained from such samples are more likely to be affected by anomalies that may exist in the data set, which would distort the data. Thus, any conclusions based on small samples may not be as reliable as those based on larger samples. Furthermore, very few studies recorded mood-changes following the mood induction, (Matt, Vazquez & Campbell, 1992). Therefore, it cannot be assumed that the mood induction was successful and produced the memory bias that was observed.

It may be possible that the nature of material used in mood-congruent memory research influences the memory bias observed post-mood induction. One of the most recent variations in choice of stimuli used in mood-congruent memory research was exhibited in a study conducted by Ridout et al (2003), who investigated recognition memory for emotional facial expressions in clinically depressed patients. Ridout et al (2003) found superior recognition memory for sad facial expressions in depressed patients, whereas the control participants demonstrated superior memory for happy facial expressions. They also reported no difference in the ability for participants to identify emotion correctly. However, a mood-congruent memory bias in a dysphoric and mood-induced sample, for recognition of emotional faces, is yet to be established.

Ridout et al (2003) proposed that emotional facial expressions are socially and biologically important stimuli. Emotional facial expressions are also effective stimuli for memory experiments because, according to Paivio's (1971) dual coding hypothesis, they can be processed via two systems: the imagery and verbal system. For example, a picture can be processed by the imagery system, and also by the verbal system if the individual labels the picture (e.g., the participant labels the face as happy or sad). Paivio (1971) proposed that information retrieval is enhanced if the information is processed via both systems. The two studies in the current paper will allow for both imagery and verbal coding.

A prominent theoretical model that served to explain the findings of the aforementioned research on depressed and induced mood states was offered by Bower (1981), who developed the Network Theory of Affect, (Bower, 1981; Bower, 1987; Bower & Cohen, 1982). It attempts to explain mood-congruence phenomena. It outlines that emotions are viewed as central units (nodes) in a semantic network. Affective nodes have connections to related affective, conceptual and prepositional nodes reflecting related moods, ideas that were formed during learning. For example, nodes representing depressive experiences are assumed to be linked to concepts of failure, low-esteem, lack of interest and sad experiences (Matt et al, 1992).

In a particular mood state, corresponding affective nodes are activated, and activation spreads out to related nodes. The Network theory of Affect suggests that mood congruent information receives superior processing at both encoding and retrieval, thus leading to better recall of congruent as compared to incongruent information. It would be predicted that in the negatively induced group and the dysphoric group the sad faces are more richly connected to activated nodes leading to a denser representation of the incoming information, whereas the incongruent material (happy faces) will be less well elaborated and less well represented. The opposite would apply for the non-dysphoric group and positively induced group (they should recognise more of the happy than sad faces). Moreover, the theory proposes that at retrieval, the activated nodes lead to biased searches and increased availability of mood-congruent materials.

Ridout, Astell, Reid, Glen and O'Carroll's (2003) study was replicated in the present investigation. The study used sixteen clinically depressed participants and sixteen controls. There were two phases of the experiment. In the encoding phase participants were required to correctly identify each emotional facial expression. It was found that there was no disruption in depressed individuals' ability to recognise emotion from facial expressions. However, depressed patients portrayed superior memory for sad facial expressions and inferior memory for happy expressions. The non-depressed individuals demonstrated superior memory for happy expressions and inferior memory for sad expressions relative to neutral.

In conclusion it is evident that emotional facial expressions are important features of the interpersonal environment and are a powerful social stimulus, thus it is important to address the issue of memory bias and emotion recognition as it could be disruptive to a person's interpersonal functioning (Gotlib and Asarnow, 1979) as well as psychological well-being. In addition, Persad and Polivy (1993) concluded that inappropriate reactions to others 'emotions may maintain or increase depression. This is why it is important to establish whether this bias exists within the non-clinically depressed (dysphoric) or in a mood induced population.

If a mood congruent memory bias is found in an induced sample of participants or in the naturally occurring mood state (dysphoria) sample, this would suggest that healthy individuals may be just as vulnerable as clinical patients in experiencing a memory bias in response to facial expressions. Such findings may provide interesting insight into mood-congruent memory in a normal, non-depressed sample of participants, and could hold important implications for the future of cognition and emotion research.

Hypothesis

(Dysphoric Group)

The experimental hypothesis is that in the encoding phase the dysphoric group will correctly identify more sad facial expressions than neutral or happy facial expressions relative to non-dysphoric participants. In addition, the non-dysphoric group will be expected to correctly identify more happy facial expressions than sad and neutral expressions relative to dysphoric participants.

Further, in the recognition memory phase the dysphoric participants will recognise more sad faces compared to neutral and happy facial expressions. The non-dysphoric participants will be expected to recognise more happy facial expressions than sad and neutral expressions.

(Mood Induced Sample)

It is predicted that the participants with positively induced mood will demonstrate superior identification of happy facial expressions, relative to neutral and sad facial expressions (as measured by the number of correct identifications). It is hypothesised that the opposite pattern of results will be attained from participants in the negative mood induction (i.e., more correct identifications of sad facial expressions, relative to neutral and happy facial expressions).

It is predicted that participants will demonstrate superior recognition for material that is congruent with their current mood. Thus, it is predicted that participants with positively induced mood will recognise significantly more happy emotional facial expressions, relative to sad and neutral faces. Participants with negatively induced mood will demonstrate the converse pattern of results (i.e., they will recognise significantly more sad faces than happy and neutral).

Experiment 1

In the first experiment we examined the identification of sad, happy and neutral faces in dysphoric and non-dysphoric individuals. Participants were asked to identify the emotion portrayed by each face. After a short distracter task participants took part in a recognition task. During the recognition phase participants were asked to recognize which faces had been seen previously in the encoding phase and which were new faces.

2. Method

2.1 Participants

Twenty- five dysphoric participants who had scored high on the BDI (BDI>10) and twenty non-dysphoric participants that scored low on the BDI (BDI<5) took part in the current study. The participants were undergraduate student volunteers. All participants were recruited by electronic and poster advertisements. The two groups were matched on gender, age (mean age dysphoric group = 20.2, mean age non-dysphoric group = 21.4) and educational achievement as close as possible.

Participants were allocated to either dysphoric or the non-dysphoric group. The participants were asked to complete the BDI and the STAI, self- report questionnaires. On the basis of their results on the BDI they were classified as either dysphoric (BDI>10) or non-dysphoric (BDI<5). The participants that scored between five and ten were excluded from the study. At the end of the study participants were accredited research credit for their participation.

2.2 Materials and Procedure

Beck's Depression Inventory II (Beck, 1996,) was used to allocate participants to either the dysphoric or non-dysphoric group. Further, the State-Trait Anxiety Inventory (STAI) (Spielberger et al 1970) was used in order to measure the extent of the depressed mood and the anxiety experienced by each individual. Moreover, numerical tasks (digit symbol substitution task and Digit span task) (Wechsler, 1981, drawn from WAIS-12) were used in the filled delay period of the experiment.

The stimuli used included 50 grey scale photographic images of different individuals conveying one of three different emotional facial expressions of happiness, sadness or neutrality. The set consisted of equal amounts of happy, sad and neutral facial expressions and equal amounts of male to female ratio. Ridout et al's (2003), Ekman et al (1987).

The computer was loaded with a Superlab program (Version 2.0), which was used to display the sad, happy, and neutral facial expressions. The computer software recorded responses and decision latencies. In the encoding phase participants were required to evaluate the emotion displayed by each face. They were instructed to press the marked keys, whether they considered the emotion displayed to be happy, sad or neutral.

Distracter Tasks

Digit Symbol Task (Wechsler, 1981)

Participants were given a paper with a list of numbers at the top of the page, with corresponding symbols below. A separate table underneath this consisted of a random sequence of digits, with empty boxes below. Participants were asked to draw as many symbols as they could in one minute, corresponding to the digits already provided.

Digit Span Task (Wechsler, 1981)

Participants were informed that they were going to be read a random sequence of numbers (0-9) and asked to repeat these back the same order. The first sequence was 2 digits in length, (e.g., 2-9). There were 2 pairs of digit-sequences per level. As the participant progressed to the next level, the sequences of digits were increased by one digit. The second half of the digit span task consisted of the same format with different numbers. However, participants were asked to say the sequences backwards instead.

Procedure

Participants completed Beck Depression Inventory - II (BDI, Beck 1996) and the State-Trait Anxiety Inventory (STAI). The participants were required to either score below five on the BDI or above ten so that they could be classified as dysphoric or non-dysphoric. Only the participants that met this criteria were able to continue to the next phase of the experiment.

Encoding Phase

In the encoding phase participants saw thirty photographs of emotional facial expressions, on a computer screen (one at a time). There were ten sad faces, ten happy faces and ten neutral faces presented in random order. Each face appeared on screen for 1500ms with 1000ms break between faces. The participants were required to identify the emotion displayed by each face by pressing the appropriate corresponding key.

Filled Delay Period

Participants were asked to complete the digit symbol substitution task digit span task. This took no longer than 6 minutes. Once this was completed participants were allowed to continue the computer task

Recognition Memory Phase

In the recognition memory phase participants were presented with fifty faces. Thirty old faces from the encoding phase and twenty new faces that they had not previously seen They were instructed to press the key labelled "yes" if they had seen the face in the previous trial and "no" if they had not seen itl.

Once the recognition memory phase of experiment was completed participants were thanked for their participation and were debriefed.

Counterbalancing

A counterbalancing measure was also implemented, whereby the individuals who portrayed happy facial expressions in the original set portrayed sad facial expressions in the second set. Those portraying sad faces in the original set portrayed happy faces in the counterbalanced version.

Experiment 2

This experiment was similar to experiment one with the exception that participants in this experiment were in a mood induced state.

Method Two

Design

In the current study, healthy participants were given a happy or sad mood induction using autobiographical memory recall and music. This study made use of a mixed design: 2 (positive/negative induction) x 3 (happy/sad/neutral faces).

Participants

A total of 48 participants that did not take part in experiment 1 took part in the study, with 25 participants (7 males, 17 females; aged between 19 and 24 years; mean age of 20.7) in the positive mood induction group, and 25 participants (7 males, 17 females; aged between 19 and 25 years; mean age of 21.1) in the negative mood induction group. These participants were healthy undergraduate volunteers.

All of the participants were asked to complete Beck’s Depression Inventory II (BDI-II) (Beck, Brown, & Steer, 1996). Results from those who appeared to be suffering from depression were excluded from the experiment as the study was intended to investigate participants with a psychologically healthy background. Thus, those participants scoring above or equal to 15 were excluded from the experiment.

Materials/Apparatus

They were then asked to complete the Beck's Depression Inventory (BDI) (Beck et al, 1996) in order to control for depression within the positive and negative mood induction groups. Participants were also asked to complete the State-Trait Anxiety Inventory for adults (STAI) (Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983) in order to control for anxiety within the participant sample. Participants were given 3 copies of the Mood Visual Analogue Scales (MVAS) throughout the experiment. These provided a quantitative measure of mood change.

The experimental stimuli used in the encoding phase was the same as was used in experiment 1. Two classical CDs of happy (Moonlight Sonata no. 2) and sad music (String Quartet no. 13) by Beethoven (1770/1827) were used in the mood induction procedure. Participants listened to the music using Windows Media Player. The volume remained fixed at the same level (35) for all of the participants.

Procedure

To begin with, positive or negative mood was induced in healthy undergraduate participants.

Positive Mood Induction Phase

Prior to the experiment, participants were asked to come prepared with one positive (happy) and one negative (sad) autobiographical memory. The first 24 participants were allocated to take part in the positive mood induction while the final 24 took part in the negative mood induction.

Participants were asked to complete the MVAS to illustrate their mood before the mood-induction (MVAS at Time 1). They were then instructed that they would be given 4 minutes to think about their positive autobiographical memory that they prepared prior to the experiment, while listening to some music. They were informed to think about this memory in detail (e.g., what happened, where, how they felt, etc). Participants were then asked whether they had any questions before the mood induction. Once all questions were answered, the associated happy classical CD (Moonlight Sonata no. 2, Beethoven (1770/1827)) was played, and the mood induction procedure began. The song was played for 4 minutes, after which participants were asked to complete a separate MVAS (2) to illustrate any possible changes in mood following the mood induction.

Negative Mood Induction Phase

Participants were asked to complete the MVAS (1), and were next instructed that they would be given 4 minutes to think about their negative autobiographical memory, while listening to some music. They were also informed to think about this memory in detail (what happened, where, how they felt, etc), and finally asked whether they had any questions before the task began. Once all questions were answered, the sad classical CD (String Quartet no. 13, Beethoven (1770/1827)) was played for 4 minutes. After the 4 minutes, participants completed another MVAS (2).

After the mood induction procedure participant were required to judge the valence of the emotional facial expressions which they were presented with (encoding phase).

Following the encoding phase there was a 5 minute distraction task, during which time the participants were asked to complete the Digit Span Task (Wechsler, 1981). The participants were then asked to take part in the recognition task for the faces that were shown in the encoding phase. This procedure was no different from experiment 1 with the exception that mood induced states were looked at rather than naturally occurring mood.

Before leaving, participants who had taken part in the negative mood induction phase were given an additional 4 minutes for the positive mood induction. This was necessary to counter the feelings of sadness elicited in the recall of the negative memory, so as to balance out the emotions experienced during the experiment. Participants were then given a final MVAS (MVAS at Time 3).

3. Results

3.1. Participant Information

Analysis of the participants' characteristics (presented in Table 1) revealed that the two groups did not differ in terms of their age or gender ratios; $t(43)=1.2$, $p>0.05$ and χ^2 (1)=0.5, $p>0.05$ respectively. Moreover, no differences were observed between the two groups on the Digit Symbol Substitution Task (DSST); $t(43)=0.8$, $p>0.05$. However, the non-dysphoric individuals recalled more digit sequences (Mean=16.3, SD=3.2) than did the dysphoric participants (M=14.5, SD=2.9); $t(43)=2.0$, $p=0.053$. Analysis of the participants' self-rated mood revealed that the dysphoric group rated themselves as significantly more depressed (indexed by scores on the BDI) than did the non-dysphoric participants; $t(43)=12.2$, $p<0.001$, but also significantly more state and trait anxious (indexed by the STAI); $t(43)=4.6$, $p<0.001$ and $t(43)=5.1$, $p<0.001$ respectively.

Encoding Phase

Emotion identification times

A 2 (group; dysphoric vs. non-dysphoric) x 3 (type of emotional expression; happy vs. neutral vs. sad) mixed factorial ANOVA was conducted to analyse the participants' emotion identification times. Results revealed no significant main effect of Group and no Group x Type of emotion interaction; $F(1, 43)=0.2$, $p>0.05$ and $F(2, 86)=0.2$, $p>0.05$ respectively. However, there was a significant main effect of Type of emotion; $F(2, 86)=51.5$, $p<0.001$. Subsequent Bonferroni tests revealed that happy expressions were identified significantly faster by all participants (Mean=867ms, Standard Error=32) than were neutral (M=1160ms, SE=36) or sad expressions

(1210ms, SE=38), both tests p<0.001.

Emotion identification accuracy

A 2 (group) x 3 (type of emotional expression) mixed factorial ANOVA was conducted to analyse the participants' emotion identification accuracy (illustrated in figure 1). This analysis revealed a significant main effect of Group; such that dysphoric participants correctly identified fewer emotional expressions correctly (Mean=81.7%, Standard Error=2.5) than did the non-dysphoric (M=89.9%, SE=2.8); F(1, 43)=4.7, p<0.05. Results also revealed a significant main effect of Type of emotional expression; F(2, 86)=20.5; p<0.001. Follow up analyses (using Bonferroni tests) revealed that, overall, participants identified significantly fewer sad expressions correctly (M=73.4%, SE=3.1) than happy (M=94%, SE=2.4) or neutral (M=90%, SE=2.5); both tests p<0.001. However, these findings were qualified by a significant interaction between group and type of emotional expression; F(2, 86)=5.1, p<0.01. Separate one-way repeated measures ANOVA for each group revealed that accuracy of the dysphoric individuals' emotion identification differed as a function of the type of emotional expression; F(1, 48)=21.9, p<0.001. Subsequent Bonferroni tests revealed that they correctly identified fewer sad expressions than neutral or happy; p<0.01 and p<0.001 respectively. They also correctly identified more happy expressions than neutral, p<0.05. There was also evidence that the emotion identification accuracy of the non-dysphoric individuals varied as a function of the type of emotional expression presented; F(1, 38)=4.4, p<0.05. Follow up analyses, using Bonferroni tests, revealed that they identified significantly more neutral expressions than sad, p<0.01. They also demonstrated a non-significant tendency towards more accurate identification of happiness relative to sadness, $p=0.1$. Between group comparisons, using Bonferroni corrected t-tests, revealed that dysphoric individuals correctly identified significantly fewer sad expressions than did the non-dysphoric participants, $t(43)=2.8$, $p<0.01$. They also identified fewer neutral expressions correctly than did the non-dysphoric participants, but this difference was not significant once the alpha had been adjusted for multiple comparisons, $t(43)=2.2$, $p>0.016$. The two groups did not differ in their recognition of happiness, $t(43)=0.8$, $p>0.05$.

Statistical control for anxiety

As the dysphoric participants were also significantly more state and trait anxious than the non-dysphoric individuals it is important to establish if these differences were contributing to changes in emotion identification accuracy. Correlational analyses revealed that the percentage of sad expressions correctly identified was significantly negatively related to BDI score, State anxiety score and Trait anxiety score; $r(45)=-0.34$, $p<0.05$, $r(45)=-0.36$, $p<0.05$ and $r(45)=-0.4$, $p<0.01$ respectively. In order to establish the relative contributions of these variables a stepwise multiple regression analysis was conducted with the participants BDI and STAI scores entered as predictor variables and the percentage of sad expressions correctly labelled entered as the dependent variable. The results of this analysis revealed a significant model that accounted for around 20% of the variance; R^2=019, R^2 adjusted=0.17, $F(1, 43)=10.1$, $p<0.01$. The only significant predictor that remained in the model was trait anxiety score, Beta=-0.44, $p<0.01$. Correlational analyses also revealed that the percentage of neutral expressions correctly identified was significantly negatively correlated with BDI score and the state & trait scores of the STAI; $r(45)=-0.34$, $p<0.05$, $r(45)=-0.42$,

$p<0.01$ and $r(45)=-0.46$, $p<0.01$ respectively. The results of a stepwise multiple regression revealed a significant model that accounted for around 20% of the variance; $R^2=0.21$; R^2 adjusted=0.19, $F(1, 43)=11.5$, $p<0.01$. The only significant predictor that remained in the model was trait anxiety; beta=-0.46, $p<0.01$. Correlational analysis revealed that the percentage of happy expressions correctly identified was not significantly related to the measures of self-reported mood, all tests $p>0.05$.

Recognition Memory Phase

The percentage of correct responses made by the participants during recognition memory testing (illustrated in figure 2) was analysed using a 2(group) x 3(Type of emotion) mixed factorial ANOVA. Results revealed there was no difference between the groups in terms of the total number of correct responses during memory testing; $F(2, 86)$ 2.5, $p>0.05$. However, there was a significant main effect of Type of emotion; $F(2, 86)=14.4$, $p<0.001$. Follow up analyses, using Bonferroni tests, revealed that participants made significantly more correct responses to sad faces (Mean=80.4%, SE=1.5) than happy (M=67.6, SE=2) or neutral (M=67.5, SE=2.7); both tests $p<0.001$. Memory for happy and neutral expression did not differ significantly, $p>0.05$. Nevertheless, these results need to be considered in the light of a significant Group x Type of emotion interaction; $F(2, 86)=11.1$, $p<0.001$. Further investigation of this interaction was conducted using separate one-way repeated measures ANOVA for each group. Results of these analyses revealed that the percentage of correct responses made by the non-dysphoric participants during the recognition memory phase did not differ as a function of the type of emotional face, $F(2, 48)= 0.9$, $p>0.05$. Conversely, the percentage of correct recognition responses made by the dysphoric participants differed significantly as a function of the type of emotional face; $F(2, 48)=24.5$, $p<0.001$. Follow up analyses, using Bonferroni tests, revealed that dysphoric individuals made significantly more correct responses to sad faces (M=85.2%, SE=1.5) than happy (M=59.6%, SE=3.1) or neutral (M=64%, SE=3.7); both tests $p<0.001$. Between group comparisons, using Bonferroni corrected independent t-tests, revealed that dysphoric individuals made significantly more correct memory responses to sad faces than did the non-dysphoric participants, $t(43)=3.3$, $p<0.01$. Conversely, dysphoric participants made significantly fewer correct memory responses to happy faces than did the non-dysphoric individuals, $t(43)=4.0$, $p<0.01$. The two groups did not differ in their memory for the neutral faces, $t(43)=1.3$, $p>0.05$.

Statistical control for anxiety

As dysphoric individuals were significantly more state and trait anxious than participants in the non-dysphoric group it is important to assess the influence of anxiety upon recognition memory for the emotional faces. Correlational analyses revealed that the percentage of correct responses to sad faces was significantly positively related to BDI score; $r(45)=0.36$, $p<0.05$. However, accurate memory for sad faces was not related to either state or trait anxiety, both tests $r(45)=0.2$, $p>0.05$. The results of a stepwise multiple regression, with BDI & STAI scores entered as predictor variables and percentage of correct responses to sad faces as the dependent variable, revealed a significant model that accounted for around 13% of the variance; $R^2=0.13$, R^2 adjusted=0.11; $F(1, 43)=6.5$, $p<0.01$. BDI score entered as the only significant predictor, Beta=0.36, $p<0.01$. Correlational analyses revealed that the percentage of correct memory responses for neutral faces was significantly negatively related to the participants' trait anxiety scores, $r(45)=-0.3$, $p<0.05$. Accurate memory for neutral faces was not related to depression (BDI scores) or state anxiety; $r(45)=-0.16$, $p>0.05$ and $r(45)=-0.24$, $p>0.05$ respectively. A stepwise multiple regression revealed a significant model that accounted for around 8% of the variance in memory accuracy for neutral faces, $R^2=0.08$, R^2 adjusted=0.07; $F(1, 43)=4.1$, $p<0.05$. Trait anxiety entered as the only significant predictor; Beta=-0.3, $p<0.05$. Correlational analysis revealed that the percentage of correct memory responses for happy faces was significantly negatively related to depression (BDI scores) and trait anxiety; $r(45)=-0.4$, $p<0.01$ and $r(45)=-0.43$, $p<0.01$ respectively. However, accurate memory for happy faces was not related to state anxiety, $r(45)=-0.2$, $p>0.05$. A stepwise multiple regression revealed a significant model that accounted for around 20% of the variance in the correct memory responses for happy faces, $R^2=0.18$, R^2 adjusted=0.17; $F(1, 43)=9.5$, $p<0.01$. Trait anxiety entered as the only significant predictor, Beta=-0.43, $p<0.01$.

Results (study 2)

Participant characteristics

Analysis of the personal characteristics of the participants in the two groups (illustrated in table 2) revealed no significant differences between the groups on age, sex ratio, depression (BDI score), state anxiety (STAI state score) or trait anxiety (STAI trait score), all tests $p>0.05$.

Analysis of the effectiveness of the mood induction procedure

Perceived sadness

A 2 (Group; induced positive mood vs. induced negative mood) x 2 (Time of rating; baseline vs. post mood induction) mixed factorial ANOVA was conducted to analyse the participants' ratings of their perceived sadness (illustrated in figure 3A). Results revealed that ratings of sadness were higher following the mood induction procedure (Mean=21.1, Standard Error=1.6) than at baseline (M=18.8, SE=1.4); $F(1, 46)=4.0$, $p=0.051$. Results also revealed that participants that underwent the negative mood induction reported higher levels of sadness (M=23.5, SE=2) than did those that underwent a positive mood induction (M=16.5, SE=2); $F(1, 46)=6.5$, $p<0.05$. However, these results need to be considered in the light of a significant Group x Time of rating interaction; $F(1, 46)=39.2$, $p<0.001$. Subsequent analyses, using Bonferroni corrected paired and independent t-tests, revealed that participants undergoing positive mood induction reported a significant reduction in their perceived sadness, $t(23)=4.8$, $p<0.001$. Conversely, participants in the negative mood induction condition reported a significant increase in sadness, $t(23)=4.6$, $p<0.001$. Analyses also revealed that although the two groups did not differ in their level of sadness at baseline ($t(46)=0.09$, $p>0.05$), participants in the negative mood induction group reported significantly higher sadness following the mood induction procedure than did participants in the positive mood induction, $t(46)=4.5$, $p<0.001$.

Perceived happiness

A 2 (Group) x 2 (Time of rating) mixed factorial ANOVA was conducted to analyse the participants' ratings of their perceived happiness (illustrated in figure 3B). Results revealed no significant effect of Group and no significant effect of Time of rating; $F(1, 46)=2.3$, $p>0.05$ and $F(1, 46)=2.0$, $p>0.05$ respectively. However, there was a significant Group x Time of rating interaction; $F(1, 46)=65.6$, $p<0.001$. Subsequent analyses, using Bonferroni corrected paired and independent t-tests, revealed that participants in the positive mood induction condition reported a significant increase in happiness from baseline to post mood induction, $t(23)=5.5$, $p<0.001$. Conversely, participants undergoing a negative mood induction reported a significant decrease in their perceived happiness, $t(23)=6.0$, $p<0.001$. Although the two groups did not differ in their level of perceived happiness at baseline ($t(46)=0.9$, $p>0.05$), participants in the positive mood induction group reported significantly higher levels of happiness post mood induction than did individuals who had undergone a negative mood induction, $t(46)=3.7$, $p<0.001$.

Mood repair in the induced negative mood group

Paired t-tests revealed that participants in the negative mood induction group reported significantly higher levels of happiness following the subsequent positive mood induction ($M=90$, $SE=1.9$) than at baseline ($M=77.6$, $SE=1.9$), $t(23)=7.0$, $p<0.001$. Furthermore, following the positive mood induction these individuals reported significantly lower levels of sadness ($M=9.3$, $SE=1.2$) than at baseline ($M=18.8$, SE=5.7), t(23)=5.7, $p<0.001$.

Encoding Phase

Emotion identification times

A 2(group; induced positive mood vs. induced negative mood) x 3 (Type of emotional expression; happiness vs. neutral affect vs. sadness) mixed factorial ANOVA was conducted to analyse the participants emotion identification times (illustrated in figure 4). Results revealed no significant effect of Group, F(1, 46)=2.4, $p>0.05$. There was however a significant main effect of Type of emotional expression; F(2, 92)=84.6, $p<0.001$. Subsequent analysis, using Bonferroni tests, revealed that participants were significantly faster to correctly identify happy expressions (Mean=772ms, Standard Error=25.4) than sad (M=1007ms, SE=33.3) or neutral (M=1037, SE=30.1); both test $p<0.001$. However, these results need to be considered in light of a significant Group x Type of emotional expression interaction; F(2, 92)=9.3, $p<0.001$. In order to investigate this interaction separate one-way repeated measures ANOVA were conducted for each participant group. These analyses revealed that the emotion identification times of the participants that had undergone a positive mood induction differed as a function of the type of emotional expression; F(2, 46)=68.8, $p<0.001$. Subsequent Bonferroni tests revealed that these individuals were significantly faster to identify happy expressions than neutral or sad, both tests $p<0.001$. However, their emotion identification times for sad and neutral expressions did not differ significantly. The emotion identification times of the participants in the negative mood induction group also varied as a function of the type of emotional expression presented, F(2, 46)=27.7, $p<0.001$. Pairwise comparisons, using Bonferroni tests, revealed that these participants were significantly faster to identify happy expressions than sad or neutral, both tests $p<0.001$. Furthermore, these participants were significantly faster to identify sad expressions than neutral, $p<0.05$. Between group comparisons, using Bonferroni corrected independent t-tests, revealed that the emotion identification times of the two groups did not differ for happy and neutral expressions, $t(46)=0.1$, $P>0.05$ and $t(46)=0.9$, $p>0.05$ respectively. However, participants in the negative mood induction group were significantly faster to identify the sad faces than were individuals that undergone a positive mood induction, $t(46)=2.9$, $p<0.01$.

Emotional identification accuracy

A 2 (group) x 3 (Type of emotional expression) mixed factorial ANOVA was conducted to analyse the participants' emotion identification accuracy (illustrated in figure 5). Results of this analysis revealed a significant main effect of Type of emotion; $F(2, 92)=21.2$, $p<0.001$. Subsequent analyses, using Bonferroni tests, revealed that participants made significantly more correct emotion identifications of happy expressions (Mean=96.7%, Standard Error=0.7) than neutral (M=84.2%, SE=2.1) or sad (M=88.3%, SE=3); both tests $p<0.001$. However, the percentage of sad and neutral expressions correctly identified did not differ significantly. Results also revealed a significant main effect of group, such that participants that had undergone a negative mood induction correctly identified significantly more expressions (89.7%, SE=1.2) than did individuals in the positive mood induction group (M=85.6%, SE=1.2); $F(1, 46)=5.9$, $p<0.05$. However, these results need to be considered in the light of a significant Group x Type of emotion; $F(2, 92)=3.7$, $p<0.05$. Investigation of this interaction , using separate one-way repeated measures ANOVA for each group, revealed that percentage of correct emotion identifications made by the participants in the positive mood induction group differed as a function of the type of expression presented, $F(2, 46)=16.5$, $p<0.05$. Subsequent Bonferroni tests revealed that these participants made significantly more correct emotion identifications of happy expressions than sad or neutral expressions, both tests, $p<0.001$. Neutral and sad expressions resulted in similar rate of correct emotion identification in the positive mood group. Results revealed that the percentage of correct emotion identifications made by the participants in the negative mood induction group also varied as a function of the type of expression viewed, $F(2, 46)=6.9$, $p<0.05$. Bonferroni tests revealed that happy expressions resulted in a greater percentage of correct identifications than did neutral or sad; both tests $p<0.001$. However, participants in the negative mood group also correctly identified more of the sad than neutral expressions; $p=0.055$. Between group comparisons, using Bonferroni corrected independent t-tests, revealed that the participants in the two groups correctly identified a similar percentage of happy and neutral expressions correctly; $t(46)=1.2$, $p>0.05$ and $t(46)=0.6$, $p>0.05$ respectively. However, participants in the negative mood group correctly identified significantly more of the sad expressions than did the individuals that had undergone a positive mood induction; $t(46)=2.6$, $p<0.01$.

Recognition Memory Phase

A 2 (Group) x 3 (Type of emotion) mixed factorial ANOVA was conducted to analyse the percentage of faces with each type of emotional expression that were correctly recognised during memory testing by the participants in the two groups (illustrated in figure 6). Results revealed no significant main effects of Group or Type of emotion; $F(1, 46)=1.8$, $p>0.05$ and $F(2, 92)=2.2$, $p>0.05$ respectively. However, there was a significant Group x Type of emotion interaction; $F(2, 92)=8.5$, $p<0.001$. Exploration of this interaction, using separate one-way repeated measures ANOVA for each group, revealed that the percentage of faces correctly recognised at memory testing by the participants in the positive mood group did not differ as a function of the type of emotional expression; $F(2, 46)=1.5$, $p>0.05$. However, the type of emotional expression did exert an influence on the percentage of faces that were recognised by the participants in the negative mood group; $F(2, 46)=8.3$, $p<0.001$. Bonferroni tests revealed that sad expressions resulted in a significantly higher recognition rate than did happy or neutral expressions; $p<0.01$ and $p<0.05$ respectively. Between group comparisons, using Bonferroni corrected independent t-tests, revealed that happy and neutral expressions resulted in similar rates of recognition memory in both positive and negative groups; $t(46)=0.7$, $p>0.05$ and $t(46)=0.8$, $p>0.05$ respectively. However, participants in the negative mood group recognised significantly more of the faces with a sad expression than did the participants in the positive mood group; $t(46)=3.4$, $p<0.01$.

Table 1. Characteristics of the participants in the dysphoric and non-dysphoric groups (Standard deviations are presented in parentheses).

	Dysphoric (n = 25)	**Non-dysphoric (n = 20)**
Age	20.2 (1.3)	21.4 (4.4)
Sex ratio	7 males, 18 females	8 males, 12 females
Depression (BDI)**	16.8 (4.3)	4.2 (1.5)
Trait Anxiety (STAI)**	44.9 (11.4)	31.4 (7.3)
Trait Anxiety (STAI)**	50.1 (12.1)	33.9 (8.4)
Digit Symbol Substitution Task	36.7 (6.0)	38.3 (7.9)
Digit Span Task*	14.5 (2.9)	16.3 (3.2)

*** p=0.053 ** Significant difference at the p<0.001 level**

Table 2. Characteristics of the participants in the positive and negative mood induction groups (Standard deviations are presented in parentheses).

	Positive Mood Induction (n = 24)	**Negative Mood Induction (n = 24)**
Age	20.7 (1.4)	21.1 (1.2)
Sex ratio	17 female, 7 male	17 female, 7 male
Depression (BDI)	4.4 (2.3)	5.2 (2.1)
State Anxiety (STAI)	35.8 (8.3)	35.8 (6.7)
Trait Anxiety (STAI)	40.0 (8.9)	42.3 (7.2)
Digit Symbol Substitution Task	41.3 (6.4)	42.8 (16.3)
Digit Span	13.7 (4.1)	13.6 (2.6)

BDI=Beck Depression Inventory; STAI-State=State Trait Anxiety Inventory – State anxiety subscale; STAI-Trait=State Trait Anxiety Inventory – trait anxiety subscale.

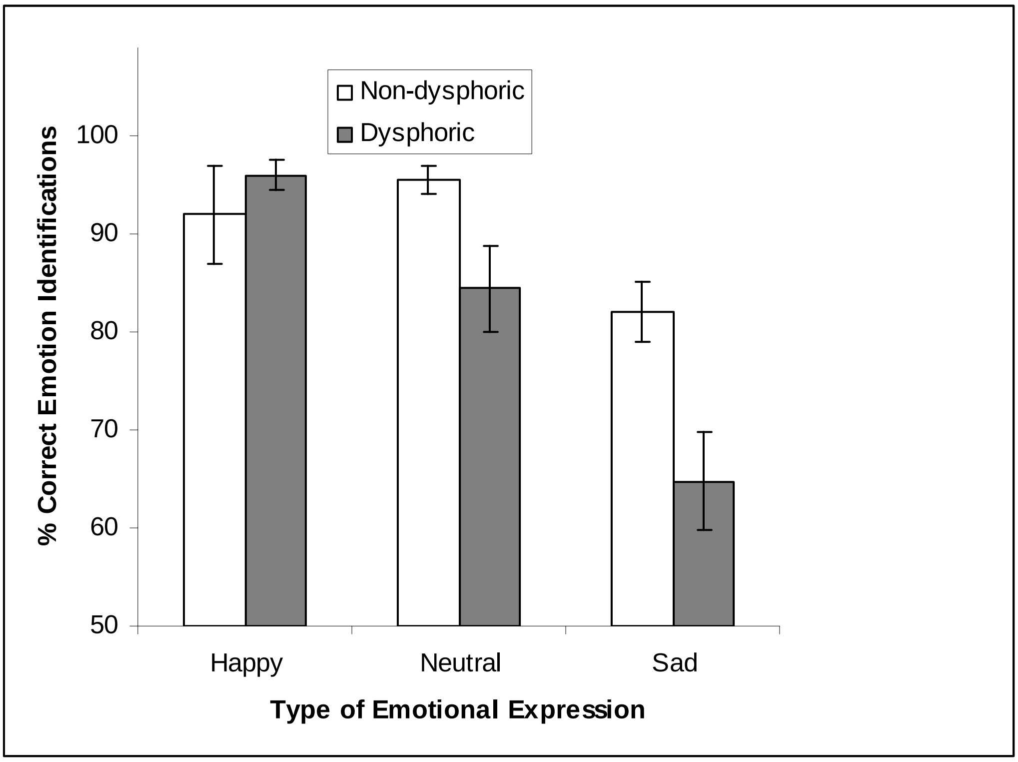


Figure 1. Percentage of each type of emotional expressions correctly identified by dysphoric and non-dysphoric participants (error bars show ± 1 standard error of the mean).

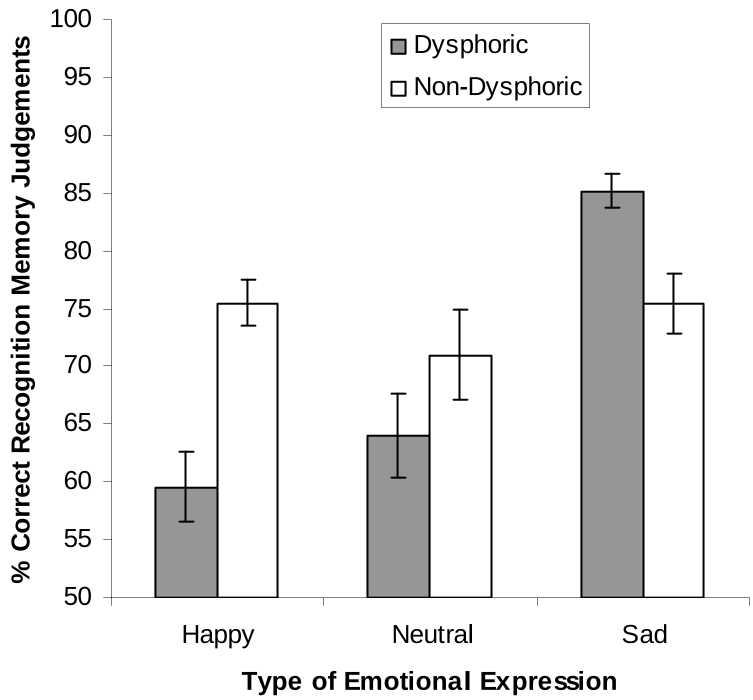
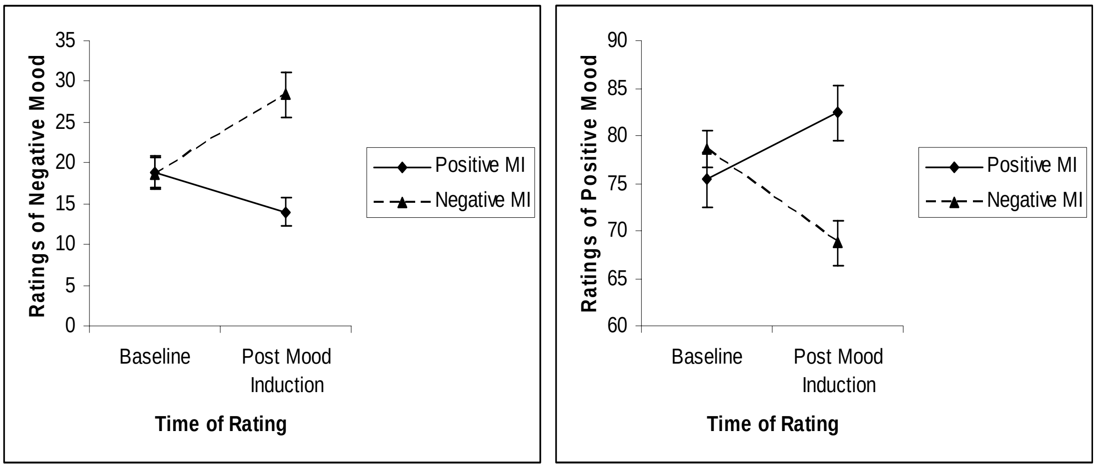


Figure 2. Percentage correct recognitions made by the participants as a function of type of emotional expression (error bars show ± 1 standard error of the mean).



(A) **(B)**

Figure 3. Mean Visual Analogue Scale (VAS) ratings of sadness (A) and happiness (B) reported by the participants at baseline and post mood induction (error bars shown ± one standard error of the mean).

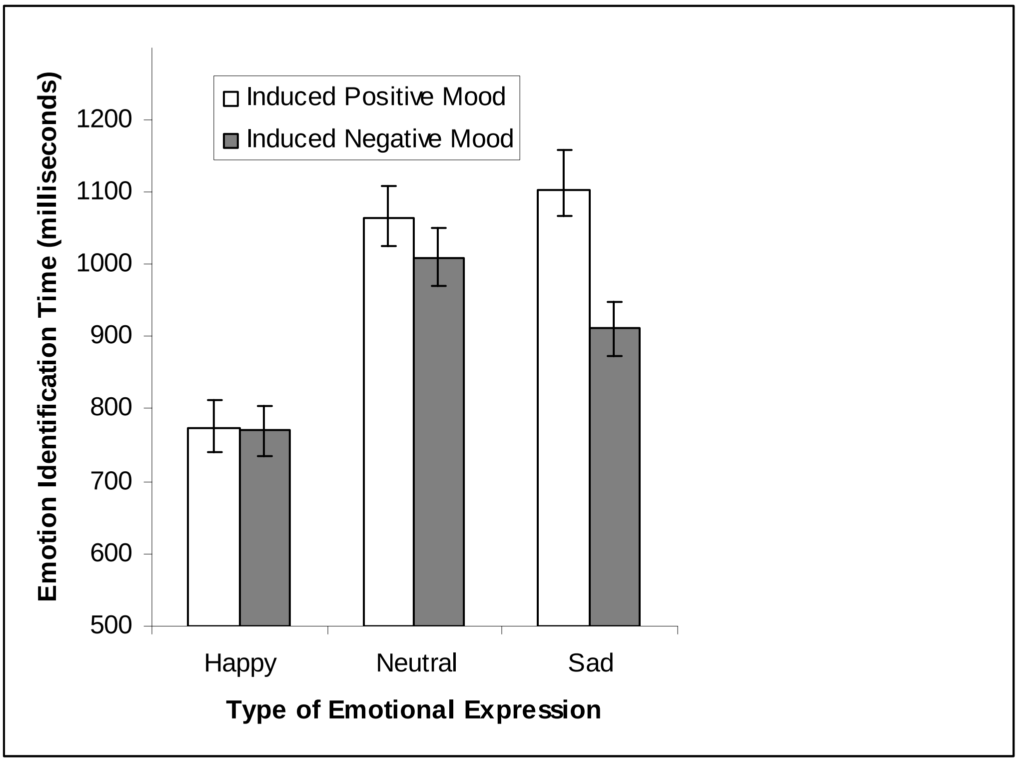


Figure 4. Mean time (in milliseconds) taken by the participants to correctly identify the different types of emotional expressions (error bars show ± one standard error of the mean).

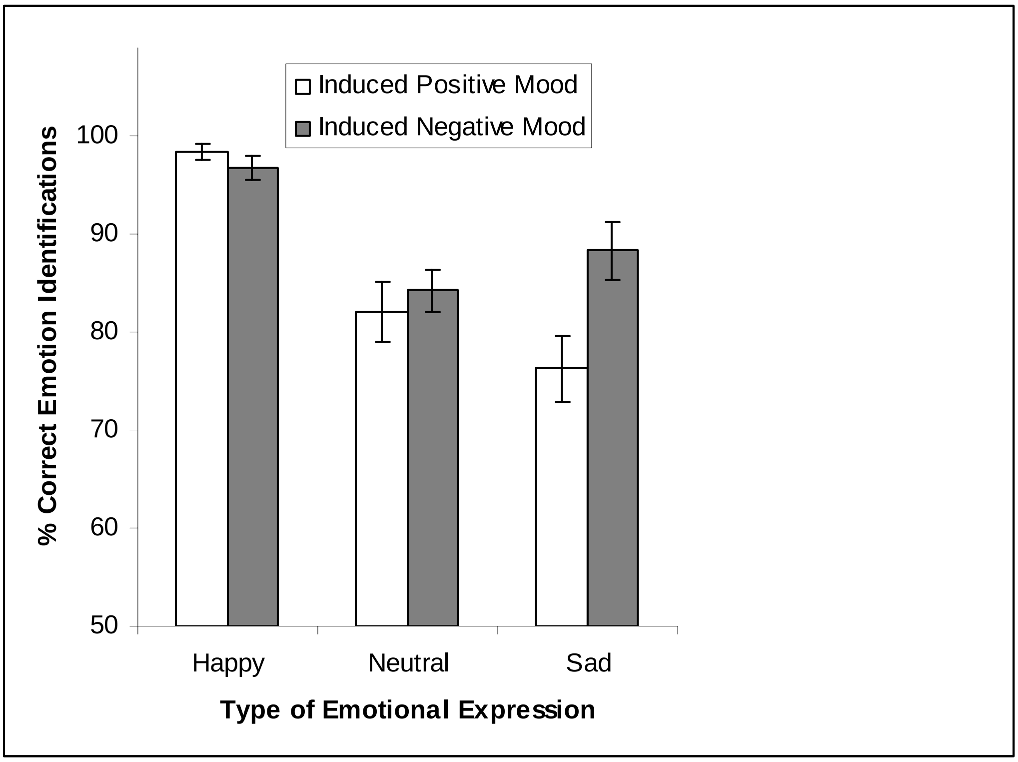


Figure 5. Percentage correct identifications of each type of emotional expression as a function of participant group (error bars show ± standard error of the mean).

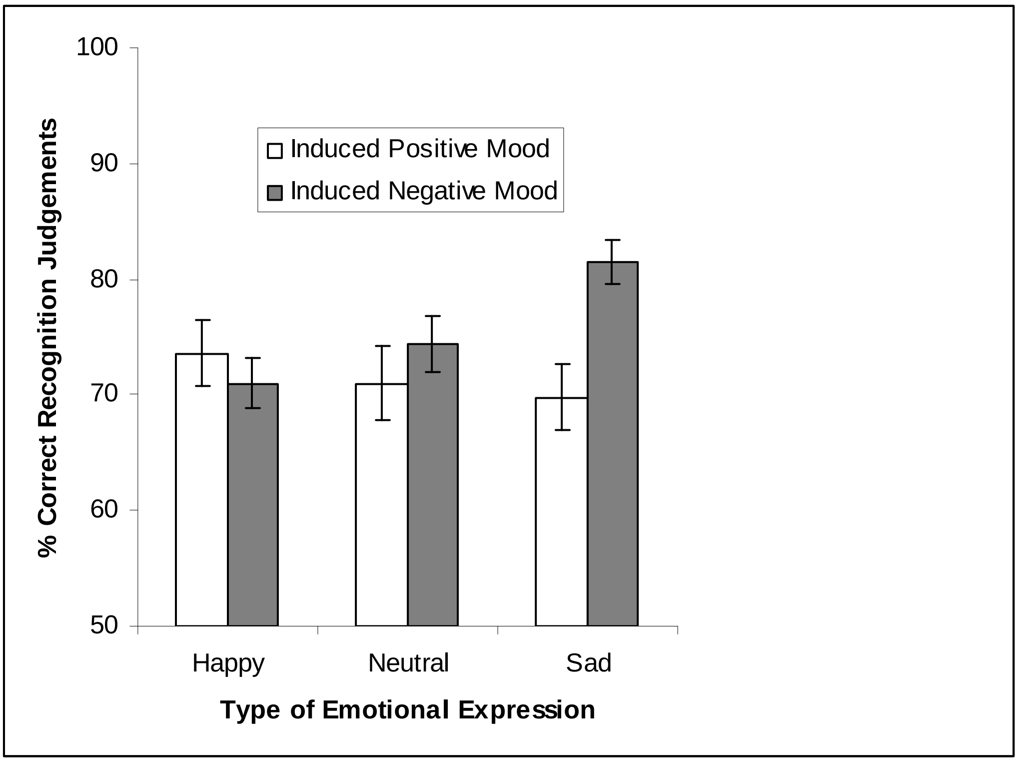


Figure 6. Percentage of correct recognition memory judgements from each participant group as a function of the different types of emotional expression (error bars show ± standard error of the mean).