Attentional modulation by reward and punishment cues in relation to depressive symptoms

Ana Maria Brailean, Ernst H.W. Koster*, Kristof Hoorelbeke, & Rudi De Raedt

Ghent University, Belgium

Running head: ATTENTION IN DYSPHORIA

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* Corresponding Author:

Ernst Koster

Ghent University

Department of Psychology

Henri Dunantlaan 2

9000 Gent

Belgium

E-mail: ernst.koster@ugent.be

Abstract

Background and Objectives: Research indicates that individuals at-risk for depression are characterized by high sensitivity to loss and reduced sensitivity to reward. Moreover, it has been shown that attentional bias plays an important role in depression vulnerability. The current study aimed to examine the interplay between these risk factors for depression by examining the development of attentional bias toward reward and loss signals in dysphoric participants (individuals with elevated levels of depressive symptoms).

Methods: Shapes were conditioned to reward and loss and subsequently presented in a dot probe task in a sample of dysphoric and nondysphoric participants.

Results: Nondysphoric individuals oriented towards reward-related signals whereas dysphoric individuals failed to develop a reward-related attentional bias. This attentional effect was observed in the absence of group differences in motivational factors. No group differences were found for attentional bias for loss-related signals, despite the fact that dysphoric individuals performed worse in response to losing.

Limitations: The current sample is not clinical thus generalization to clinical depression is not warranted.

Conclusions: We argue that impaired early attentional processing of rewards are an important cognitive risk factor for anhedonic symptoms in persons with dysphoria.

Keywords: depression; attention; dysphoria; cognitive risk; reward; anhedonia

Major Depressive Disorder (MDD) is a debilitating and recurrent condition that leads to major suffering and high societal costs (Kessler & Wang, 2009; Vittengl, Clark, Dunn, & Jarrett, 2007). Understanding mechanisms associated with the etiology and maintenance of depression is imperative for the development of effective treatment programs. Extensive research indicates that reduced sensitivity to reward and heightened sensitivity to loss are key characteristics of depression (Eshel & Roiser, 2010). Independently from that, processing biases (prioritizing negative information over positive information) are also considered vulnerability factors for the development of depression (Gotlib & Joormann, 2010). Although these research lines have emerged independently, these processes could influence each other. Therefore, the present study provides an exploratory integration of these possible pathways to depression. We introduce these pathways separately to then argue for an integrative investigation. We present a new paradigm to investigate the relation between reward and loss sensitivity and attentional bias.

Reward and loss sensitivity. A key characteristic of depression is reduced approach-related positive affect. This deficit manifests itself in anhedonic symptoms and reduced reward responsiveness (e.g., Deldin, Keller, Gergen, & Miller, 2001). Anhedonia, diminished pleasure and interest in rewarding activities, has a prevalence rate of 37% among individuals with MDD (Pelizza & Ferrari, 2009). Moreover, in non-clinical populations it precedes depression onset (Dryman & Eaton, 1991) and predicts poor treatment response 12 months later (Spijker, Bijl, de Graaf, & Nolen, 2001). Interestingly, studies indicate that depressed individuals fail to develop response bias to rewards: reduced hedonic capacity prevents depressed individuals from learning the reinforcing value of rewards, leading to reduced reward seeking behavior (Pizzagalli, Jahn, & O'Shea., 2005).

On the other hand, there seems to be strong reactivity to punishment-, criticism- and loss-related cues in depression. Indeed, research indicates that negative feedback impairs task performance in both currently and remitted depressed individuals and the level of impairment correlates with symptom severity (Elliott, Sahakian, Herrod, Robbins, & Paykel, 1997). One possible interpretation is that depressed people are hypersensitive to negative feedback (Eshel & Roiser, 2010) as such feedback may activate negative beliefs acquired through previous experiences (Beck, Rush, Shaw, & Emery, 1979).

Although sensitivity to punishment and heightened negative affect in general are not specific for depression (e.g., Clark & Watson, 1991), the combination of heightened negative affect and reduced responding to positive stimuli is specific for depression, as described in the well-validated (e.g., Brown, Chorpita, & Barlow, 1998; Joiner, 1996) Tripartite Model of anxiety and depression (Clark & Watson, 1991). The difference in sensitivity to reward versus loss presumably reflects reduced approach motivation and enhanced avoidance motivation in depression. As proposed by Gray (1987; 1990), appetitive/approach motivation (Behavioral Activation System; BAS) activates behavior in response to signals of reward and non-punishment, while aversive motivation (Behavioral Inhibition System; BIS) inhibits behavior in response to signals of punishment and non-reward. Indeed, lower BAS levels and higher BIS levels have been reported to play an important role in depressive complaints (e.g., Kasch, Rottenberg, Arnow, & Gotlib, 2002).

Attentional bias. Cognitive theories of depression (Beck, 1967) propose that processing biases - at the level of attention, memory and interpretation - play a major role in the etiology and maintenance of depression. Recent research suggests that under certain conditions (e.g., negative self-relevant information, longer presentation durations) depressed individuals display an attentional bias (AB; De Raedt & Koster, 2010; Gotlib & Joormann, 2010). A recent meta-analysis has shown that depressed people have an AB for negative information as well as a reduced AB towards positive information (Peckham, McHugh, & Otto, 2010). Studies show that AB for negative information plays an important role in depression (De Raedt & Koster, 2010). Moreover, AB towards positive information is observed in non-depressed individuals but absent in (remitted) depressed patients (McCabe, Gotlib, & Martin, 2000) and dysphoric participants (Koster, De Raedt, Goeleven, Franck, & Crombez, 2005; McCabe & Toman, 2000).

Attentional bias and Motivation. Theory suggests that approach-avoidance motivation systems and attention have bidirectional links (e.g., Carver & Scheier, 1998; Mogg & Bradley, 1998). On the one hand, attention is oriented to motivationally relevant information (Gray, 1987). On the other hand, AB could maintain hedonic deficits by preventing changes in approach and avoidance learning. Derryberry and Reed (1994) showed that attention is biased toward gain-related cues in individuals with high approach motivation, as well as toward loss-related cues in individuals with high avoidance motivation. Moreover, Hickey, Chelazzi, and Theeuwes (2010) found that individuals are more likely to orient attention toward stimuli that have been paired with reward. Yet, to our knowledge, motivational states have not been linked to AB in relation to depression. If attention is controlled by positive and negative motivational systems and if depressed individuals show reduced approach and enhanced avoidance motivation, then depressed individuals should selectively attend to loss versus reward signals.

Current study. We examined the relation between approach-avoidance motivation and AB in a dysphoric sample. To this aim we used a conditioning procedure during which neutral stimuli (shapes) were paired to monetary rewards and losses in order to increase their salience. The conditioned stimuli can be regarded as goal-relevant as participants aimed to maximize gains and minimize losses. Therefore, we will refer to this task as the “goal task”. Subsequently, conditioned stimuli were presented as cues in a dot probe task (MacLeod, Mathews, & Tata, 1986) to test whether, in the absence of ongoing conditioning, attentional resources were preferentially captured by reward and/or loss signals versus neutral stimuli.

Lastly, we presented participants with a combined task with alternated trials of the goal and dot probe task in order to test the influence of ongoing reward/loss conditioning on attentional processing. Assuming that the motivational strength of goal pursuit orients attention (cf. Vogt, De Houwer, & Crombez, 2011), we expected dysphoric participants to show selective attention toward loss versus neutral cues, as well as reduced attention to reward versus neutral cues. Note that this latter task is more complicated and less well validated than the standard dot probe task, which led to the decision to also include a dot probe task without conditioning. Moreover, we explored the relationship between goal engagement, AB, and self-reported measures of anhedonia and punishment/reward sensitivity. Here, we expected a significant correlation between the level of goal engagement and AB, both of these processes potentially being related to anhedonia and reward- and punishment sensitivity.

Method

Participants

Fifty-four undergraduates were recruited for the study. They participated in exchange for money. We included only participants high and low in dysphoria where the dysphoric group had a score of at least 14 on the BDI-II during a first large screening *and* a second administration during the experiment. Note that, from the original 54 participants, 4 participants did not exhibit the appropriate contingency learning on the goal task during the reward condition, compared to 5 participants in the loss condition. Based on error rates and outlier analysis, an additional 8 participants were excluded from data analysis for the reward condition, compared to 6 participants in the loss condition, leaving a final sample size of 42 participants in the reward condition and 43 participants in the loss condition.

Apparatus and Materials

Apparatus

The tasks were programmed using the INQUISIT Millisecond software package and ran on a S710 Dell computer with a 72 Hz, 17-inch color monitor.

Self-report measures

Depressive symptoms. Participants filled in the Dutch version of the Beck Depression Inventory (BDI-II; Beck et al., 1996; Van der Does, 2002), a widely used 21-item self-report scale that indexes the severity of depressive symptoms over the past 2 weeks. As the second session took place one week after the first session, we asked participants to report their symptoms over the previous week at the second session. Previous research has reported good psychometric properties for this instrument (Beck et al., 1996).

Anhedonia. The Snaith–Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995) is a 14-item instrument used to measure anhedonia in normal and clinical samples and has adequate internal consistency and test–retest reliability (Dutch version: Franken, Rassin & Muris, 2007).

Behavioral Inhibition and Behavioral Activation. The Behavioral Inhibition and Behavioral Activation System Scales (BIS/BAS; Carver & White, 1994) is a 76-item instrument. Factor analysis identified a single scale to assess BIS features, and three subscales that assess different aspects of BAS functioning: Reward Responsiveness (BAS-RR), Drive (BAS-D) and Fun Seeking (BAS-FS).

Overview of design

Figure 1 presents the study design and tasks, presented in the following order: goal task, dot probe task, combined task. Tasks were presented in two phases: a phase without conditioning to examine reaction times at baseline, followed by a conditioning phase where cues were paired with monetary gains or losses. The goal task as well as goal trials of the combined task were used for conditioning. Figure 2 depicts the conditioning procedure and explains how feedback was provided. The dot probe task and dot probe trials of the combined task were used to asses AB. We describe the tasks below, for the baseline phase and for the conditioning phase. Pilot testing indicated that mixing reward and loss cues in a single conditioning phase reduced learning. Therefore, we separated conditioning to reward and punishment into two test sessions that were a week apart (in counterbalanced order).

Baseline phase

Goal task. Stimuli were presented against a black background. A trial in the goal task started with the appearance of a black-framed shape inside a white square (5 cm high x 6 cm wide) in the middle of the screen for 100 ms, followed by a red question mark. Participants had to distinguish whether the black-framed shape presented in each trial was a circle or a triangle (loss condition), and a circle or a rectangle (reward condition), by pressing corresponding keys on a keyboard with the index and middle finger of their left hand. A trial ended once a response was made or when 1500 ms had elapsed. Trials with reaction times slower than 1500 ms were recorded as errors. The inter-trial interval (ITI) was 700 ms. The goal task consisted of 12 practice and 36 test trials.

Dot probe task. Trials started with a fixation cross in the middle of the screen for 500 ms. Along with the fixation cross, two white placeholders (5 cm high x 6 cm wide) were presented above and below the fixation cross. The middle of each of these placeholders was 4.6 cm from fixation. Cues and probes were presented within the placeholders. The two shapes, introduced in the goal task, appeared for 250 ms. Immediately after cue-offset, a probe (black square, 0.5 cm x 0.5 cm) appeared. Responses required locating the probe by pressing corresponding keys on a keyboard with the index and middle finger of the right hand. A trial ended after a response was registered or 1500 ms had elapsed. Trials with reaction times slower than 1500 ms were recorded as errors. The ITI was 300 ms. The baseline dot probe task consisted of 12 practice and 36 test trials.

Combined task. This task comprised alternating trials of the dot probe task and the goal task described above. We included 12 dual practice and 24 dual test trials.

Conditioning phase

Tasks in the conditioning phase were similar to baseline versions with exception of several modifications, detailed below.

Goal task. In the reward condition, one shape uniquely predicted reward (CS+) while the other one was neutral (CS-). Similarly, in the loss condition, one shape predicted loss of points (CS+) while the other shape was neutral (CS-). Which shape functioned as the CS+ or CS- was counterbalanced across participants.

Feedback delivery was adjusted based on mean individual reaction times to the shapes at baseline. To enhance learning, in the reward condition, CS+ was followed by a pleasant sound and points gained when participants answered correctly and at least 20 milliseconds faster than their baseline performance. Feedback was displayed on the screen for 500 ms ("+5"). Whenever an incorrect and/or slow answer was given, CS+ was not followed by reward. In the loss condition, loss was delivered whenever participants answered incorrectly and/or their reaction times were not at least 20 milliseconds faster than at baseline. Feedback was displayed on the screen for 500 ms ("-5") while a brief white noise was played. No losses were delivered for correct and fast responses.

The conditioning phase during the goal task consisted of 64 trials distributed in 4 blocks in which stimuli were distributed equally and randomly. At the end of each block participants received feedback about their score.

Dot probe task. Directly after conditioning, reward, loss and neutral cues, were presented in a dot probe task to test AB toward reward versus neutral signals (reward condition), respectively toward loss versus neutral signals (loss condition). Each cue was presented randomly at the upper or lower cue location. Each cue predicted the target location correctly on half of the trials. The dot probe task consisted of 40 test trials.

Combined task. The combined task comprised alternating trials of the dot probe task and the goal task described above. For the goal trials only, CS+ reward and CS+ loss were predictive of points gain/loss. On both goal trials and dot probe trials, participants received an “Error” feedback after incorrect responses. The conditioning combined task consisted of 64 dual trials distributed in 4 different blocks. At the end of each block participants received feedback about the amount of points won/lost.

Manipulation check. To examine whether participants learned the contingency between the shapes and reward or loss, after the goal and combined task participants indicated whether each of the shapes was associated with loss, reward, or neither loss nor reward clicking “yes” or “no” respectively. Participants were also asked to report on a 10-point scale the extent to which they experienced joy when winning points or sadness when losing points, as well as the extent to which they thought that the amount of points lost/won depended on their responses.

Procedure

Participants were informed that the study would consist of two 30-minute sessions over a one week interval. Depending on the session, they were told that the goal of the study was to maximize the number of points won (reward condition) or to minimize the number of points lost (loss condition) and that this could be achieved by answering fast and correctly during the goal task. They were told that the number of points won/lost would convert into money at the end of the experiment. In the reward condition participants were told that their base payment would be 4 euro but that they could earn up to 6 euro if they answered correctly and fast. More precisely, a participant would win 5 points/cents on a goal trial in the conditioning phase if the response was correct and at least 20 ms faster than the average speed in the baseline phase of the goal task. Each 5 points won converted into 5 cents. In the loss condition, the rules were the same, only that they were told that they would start with 6 euro and could drop down to 4 euro depending on their speed and number of correct answers. Hereafter, participants signed the informed consent and the self-report measures.

Next, participants completed the experimental tasks. They were told that the baseline phase was meant to familiarize them with the different tasks and that no points would be won/lost during this phase. In the conditioning phase participants were informed that they would start to win/lose points and were reminded that they could increase gains/reduce losses by answering fast and correctly. They were told that one of the shapes was a predictor of reward/loss while the other shape was neutral and that they would receive feedback indicating the number of points won/lost. This was followed by the dot probe task. Then the combined task was administered where they could again win/lose points. At the end of the second session participants were paid and debriefed.

Results

Group Characteristics

Descriptive information about the dysphoric and nondysphoric group can be found in Table 1. A Chi-square test showed that gender was equally distributed in the two groups, χ^2 (1, N = 54) = 1.02, p = .31. The groups did not significantly differ with regard to age, t(52) = 1.68, p = .77.

Manipulation Check

We examined the efficacy of the conditioning procedure. The reward and loss conditioning procedure was effective as most participants learnt the cue-reward/loss contingency. Four participants in the reward condition (dysphoric: N = 3; nondysphoric: N =

1) and five participants in the loss condition (dysphoric: $N = 2$; nondysphoric: $N = 3$) showed incorrect contingency learning and were excluded from final data analysis.

In the reward condition, at the end of the goal task, dysphoric participants were less confident that their gains were related to their reaction times than nondysphoric participants, $t(40) = 1.98$, $p = .05$, $d = .61$ (see Table 3 for means), but this effect was no longer significant at the end of the combined task, $t(40) < 1$. Neither after the goal task nor after the combined task were there any significant group differences in the level of joy participants reported as a result of winning points (*t*s < 1.4).

In the loss condition, no significant group differences were found with regard to the extent to which the amount of losses was considered to be based on participants' responses (*t*s < 1.3). There were no significant group differences in the level of sadness (as a result of losing points) after the tasks (*t*s < 1.3).

Reaction Time (RT) Data

Data preparation

For both goal trials and dot probe trials we excluded practice trials and error trials. Participants who had an error rate over 25% during any of the tasks in either the reward condition or the loss condition were excluded (the *N* varies per task). Error rates for our final sample are presented in Table 4. From the dot probe trials we also excluded trials with RTs < 150 ms (anticipatory responding) or > 3 SDs above the individual means. Furthermore, we also excluded participants with mean RTs of > 3 SD above group mean in the reward condition (dysphoric: $N = 1$; nondysphoric: $N = 1$) or the loss condition (dysphoric: $N = 1$; nondysphoric: $N = 0$).

Attention bias (AB) scores were calculated by subtracting RTs on congruent trials (when the probe replaces the reward-relevant stimulus) from RTs on incongruent trials (when the probe replaces the neutral stimulus). A positive AB reflects attentional vigilance while a negative AB reflects attentional avoidance.

Reward conditioning. For the goal task, the 2 x 2 x 2 ANOVA with Time (baseline; conditioning) and CS type (CS+; CS-) as within-subjects factors and Group (dysphoric; nondysphoric) as between-subjects factor on mean RTs revealed a marginally significant main effect of CS type, $F(1, 40) = 3.51$, $p = .06$, $\eta^2 = .08$, with RTs being shorter on CS+ trials (M = 322 ms), compared to CS- trials (M = 331 ms). There were no main effects of Time, $F(1, 40) = 1.71$, $p = .19$, $\eta^2 = .04$, and Group, $F(1, 40) < 1$, *ns*. However, the Time x CS type interaction was significant, $F(1, 40) = 8.42$, $p = .01$, $\eta^2 = .17$, indicating faster changes in RTs on reward trials (baseline: M = 331 ms; conditioning: M = 314 ms) compared with neutral trials (baseline: M = 330 ms; conditioning: M = 333 ms). All other interactions were not significant (all Fs < 1.3; see Table 4). This suggests that groups did not differ in responding to reward.

For the combined task, the 2 x 2 x 2 ANOVA revealed significant main effects of Time, $F(1, 40) = 65.19$, $p < .001$, $\eta^2 = .62$, with faster RTs on conditioning trials (M = 386 ms), compared to baseline trials (M = 481 ms), as well as CS type, $F(1, 40) = 13.55$, $p = .001$, $\eta^2 = .25$, reflecting faster RTs on reward trials (M = 418 ms) than neutral trials (M = 449 ms). We found a marginally significant Time x Group interaction, $F(1, 40) = 3.34$, $p = .07$, $\eta^2 = .07$, indicating that nondysphoric participants became faster (baseline: M = 496 ms; conditioning: M = 379 ms) than dysphoric participants (baseline: M = 446 ms; conditioning: M = 392 ms). The Time x CS type interaction was also significant, $F(1,40) = 8.96$, $p = .005$, $\eta^2 = .18$, indicating that participants became faster over time on reward trials (baseline: M =

479 ms; conditioning: *M* = 357 ms), compared to neutral trials (baseline: *M* = 483 ms; conditioning: *M* = 414 ms). All other effects were not significant (All *F*s < 1.6; see Table 4).

Points won. The groups did not differ in the number of points won during the goal task, *t*(40) = 1.08, *p* = .28, *d* = .34, but only in the number of points won during the combined task, *t*(40) = 3.02, *p* = .004, *d* = .93 (Table 3), where nondysphoric participants won more points.

Attentional bias to reward. For the dot probe task, we ran a 2 x 2 ANOVA with Time (baseline; conditioning) and Group (dysphoric; nondysphoric) on AB to reward. This revealed main effects of Time, *F*(1, 40) = 4.25, *p* = .04, η^2 = .09, indicating a larger AB in the conditioning phase (*M* = 11 ms) compared to the baseline phase (*M* = 1 ms) and Group, *F*(1, 40) = 4.53, *p* = .03, η^2 = .10: nondysphoric participants had a higher AB score (*M* = 14 ms) than dysphoric participants (*M* = -1 ms). These main effects were qualified by a marginally significant Time x Group interaction, *F*(1, 40) = 3.60, *p* = .06, η^2 = .08, reflecting an increase in AB to reward in the nondysphoric group as compared to the dysphoric group (Table 6). Follow-up paired samples *t*-test showed that the conditioning procedure led to a significant modulation of attention in the nondysphoric group, *t*(20) = 3.26, *p* = .004, *d* = .70, whereas this was not the case in the dysphoric group, *t*(20) < 1. Independent samples *t*-tests indicated no significant baseline group difference in AB to reward, *t*(40) < 1, but a significant group difference in attentional bias to reward following conditioning, *t*(40) = 2.88, *p* = .007, *d* = .87.

We did not find any significant correlations between AB to reward in the dot probe task and either behavioral (points won) or self-report measures of reward sensitivity (BAS subscales) in either groups (all *r*s < .37). However, we found that indices of AB to reward in the dot probe task correlated with perceived ability to control outcomes during the goal task in the dysphoric group (*r* = .56, *p* = .007), and with levels of joy reported after the goal task in the nondysphoric group (*r* = .56, *p* = .008).

For the combined task, the ANOVA with Time (baseline; conditioning) as within-subject factor and Group (dysphoric; nondysphoric) as between-subjects factor on AB to reward showed no significant effects (all Fs < 1; Table 6).

Loss conditioning. For the goal task, the 2 x 2 x 2 ANOVA with Time, CS type and Group factors on mean RTs revealed a significant main effect of Time, $F(1, 41) = 10.30$, $p = .003$, $\eta^2 = .20$. RTs were significantly faster in the conditioning phase (*M* = 330 ms) compared to the baseline phase (*M* = 347 ms). The main effect of CS type was significant, $F(1, 41) = 8.20$, $p = .007$, $\eta^2 = .16$, with RTs being shorter on loss (*M* = 332 ms) than on neutral trials (*M* = 345 ms). The Time x Group interaction was significant, $F(1, 41) = 7.16$, $p = .01$, $\eta^2 = .14$, indicating that nondysphoric participants became significantly faster over time (baseline: *M* = 361 ms; conditioning: *M* = 329 ms) than dysphoric participants (baseline: *M* = 333 ms; conditioning: *M* = 331 ms). All other effects were not significant (all *F*s < 1; see Table 5).

For goal trials of the combined task, the 2 x 2 x 2 ANOVA revealed a significant main effect of Time, $F(1, 41) = 69.01$, $p < .001$, $\eta^2 = .62$, with shorter RTs during the conditioning phase (*M* = 399 ms), compared with baseline phase (*M* = 508 ms). The main effect of CS type was significant, $F(1, 41) = 16.49$, $p < .001$, $\eta^2 = .28$, reflecting faster RTs on loss trials (*M* = 437 ms) than on neutral trials (*M* = 470 ms). There was a significant Time x Group interaction, $F(1, 41) = 8.53$, $p = .008$, $\eta^2 = .17$, indicating that nondysphoric participants became significantly faster over time (baseline: *M* = 514 ms; conditioning: *M* = 367 ms) than dysphoric participants (baseline: *M* = 502 ms; conditioning: *M* = 431 ms). The Time x CS type interaction was also significant, $F(1, 41) = 6.77$, $p = .01$, $\eta^2 = .14$, showing that participants became significantly faster on loss trials (baseline: *M* = 502 ms; conditioning: *M*

= 371 ms) than on neutral trials (baseline: M = 514 ms; conditioning: M = 426 ms). None of the other effects were significant (all Fs < 1).

Points lost. Dysphoric participants lost more points than nondysphoric participants. This effect was observed in the goal task, $t(41) = 1.95$, $p = .05$, $d = .60$, as well as the combined task, $t(41) = 2.47$, $p = .01$, $d = .76$.

Attentional bias to loss. An ANOVA with Time and Group as factors was performed on AB scores in the dot probe task. We found no significant main effects (Fs < 1). The Time x Group interaction was marginally significant, $F(1, 41) = 3.10$, $p = .08$, $\eta^2 = .07$ (Table 7). A follow-up paired samples t-test showed no significant modulation of attention to loss in either nondysphoric, $t(21) = 1.03$, $p = .31$, $d = .31$, or dysphoric individuals, $t(20) = 1.51$, $p = .14$, $d = .22$. Independent samples t-tests showed no significant group differences in AB at baseline, $t(41) < 1$, and after conditioning, $t(41) < 1$. AB to loss only correlated significantly with BAS Drive scores in the nondysphoric group ($r = .49$, $p = .02$; all other rs < .36).

The 2 x 2 ANOVA with Time and Group on AB scores in the dot probe trials of the combined task revealed no significant main or interaction effects (Fs < 1).

Discussion

Previous research has reported hyposensitive responses to reward as well as maladaptive responses to loss in depressed individuals (Eshel & Roiser, 2010), but the attentional processing of reward and loss was not examined. The main aim of this study was to investigate whether there is a distinct pattern of attentive processing of loss and reward in dysphoric versus nondysphoric participants. We expected that dysphoric participants would preferentially attend to loss-related information while also failing to orient attention towards reward-related information. We investigated attentional processing following conditioning and during conditioning. Our findings in the reward condition indicate that dysphoric participants failed to develop AB to reward and that this was not related to deficient approach motivation. Our findings in the loss condition suggest that both dysphoric and nondysphoric individuals do not show preferential attentional processing of loss-related information. However, dysphoric individuals do show reduced performance in the loss condition, reflected in a higher number of points lost compared with nondysphoric individuals. We will separately discuss these findings.

In the reward condition, results show that dysphoric individuals fail to develop an AB for reward following conditioning. Interestingly, the groups did not significantly differ in the number of points won during conditioning in the goal task which suggests that the failure to develop an attentional bias to reward in dysphoric individuals is not indicative of a motivational deficit. In nondysphoric individuals, attention was clearly modulated by reward which is in line with previous research showing that stimuli associated with reward capture attention (Hickey et al., 2010). Although means indicated a similar pattern of data in the combined task, the effects in this task were not significant due to much higher standard deviations. It is likely that the complexity of the combined task increased RTs, making it more difficult to find AB. Given this latter finding we mainly base our conclusions about AB on the "standard" dot probe task.

AB for reward cues was not correlated with the amount of points won and they were also not correlated with self-report measures of approach/avoidance motivation (BAS/BIS). Moreover, in line with findings by Sherdell, Waugh, and Gotlib (2012), our finding that both groups showed similar levels of self-reported joy following monetary gains, argues against a deficit in consummatory liking. Interestingly, our finding that dysphoric participants with higher levels of perceived ability to control reward outcomes showed an enhanced attentional bias for reward is in line with findings by Karademas, Kafetsios, and Sideridis (2007), indicating that individuals with high self-efficacy showed enhanced processing of well-being-related stimuli.

As for the loss condition, we found no significant group differences in attentional processing of loss signals. These findings are at odds with predictions of cognitive theories proposing that dysphoric individuals should preferentially attend to loss-related information (Beck, 1967). However, our results are in line with existing literature arguing that dysphoric individuals do not show selective attentional engagement with negative stimuli, but rather show a difficulty in disengaging attention from negative stimuli once they became the focus of attention (De Raedt & Koster, 2010). As we used short durations of stimulus exposure (250 ms), our task was only suitable to test attentional engagement with loss stimuli, which may explain our failure to find an attentional bias for loss-related stimuli. Future studies should investigate the attentional processing of loss signals in depression using longer stimulus durations.

The finding that the groups differed in the amount of points lost in the combined task could not be explained by group differences in experienced importance of a fast response in order to avoid loss, nor by sadness when losing points. A potential explanation for the group differences is that failure feedback hampered performance in dysphorics in a high demanding task. Another issue concerning the amount of points won/lost, is the finding that both groups performed better on the combined task than on the goal task. This might be an artifact of our experimental procedure. During our experiment, participants had more experience with the trials used in both tasks by the time the combined task was administered, possibly allowing them to respond faster to the trials of the combined task due to more extensive practice. Also, the individualized standards for winning/losing points were based on the mean baseline RTs for both tasks separately. When the more complex combined task was administered for the first time, participants might have responded slower than on the trials of the goal task, allowing them to prevent loss more easily.

In sum, the observed pattern of data is mainly informative about the development of a reward-related attentional bias in relation to positive reinforcement. Despite similar levels of task engagement and reinforcement, dysphoric individuals failed to develop a reward-related attentional bias whereas nondysphoric did show such a bias. This finding has a number of interesting implications. First, this finding is consistent with the frequently observed absence of a positivity bias in persons struggling with dysphoria or depression (Peckham et al., 2010). Moreover, the finding is in line with the observation that, in the absence of immediate rewards, depressed individuals are less effective in using the past reinforcement history to guide current decision-making (Gradin et al., 2011). It could be that such deficits are due to low-level failures to deploy attention towards potentially reinforcing information in the environment. Indeed, such deficits may be at the heart of the absence of a positive bias and further downstream modulation of cognition and behavior in function of reward.

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Table 1

Group Characteristics as a function of condition

	Group					
	Dysphoric (Reward: *n* = 21; Loss: *n* = *22*)			Nondysphoric (Reward: *n* = 21; Loss: *n* = 21)		
	M	*SD*	*Observed range*	*M*	*SD*	*Observed range*
Reward condition						
BDI-II-NL (depr.)						
Session 1***	21.05	7.22	14 – 35	4.57	3.85	0 – 11
Session 2***	20.52	6.87	14 – 34	4.38	4.19	0 – 14
SHAPS (anhedonia)	23.24	7.15	14 – 38	21.81	8.53	14 – 54
BIS (inhibition)*	23.43	2.75	16 – 27	20.57	4.50	7 – 25
BAS(activation)						
Drive	11.76	2.21	6 – 16	12.62	2.06	8 – 16
Fun Seeking	11.00	2.61	6 – 15	11.14	1.71	8 – 14
Reward Resp.	17.14	2.39	12 – 20	18.00	1.48	15 – 20
Loss condition						
BDI-II-NL (depr.)						
Session 1***	19.86	6.74	14 – 35	4.71	3.89	0 – 11
Session 2***	19.82	6.84	14 – 34	4.48	4.15	0 – 14
SHAPS (anhedonia)	22.77	6.25	14 – 38	23.48	11.17	14 – 55
BIS (inhibition)*	23.32	2.73	16 – 27	20.57	4.53	7 – 25
BAS(activation)						
Drive	11.82	2.17	6 – 16	12.24	2.00	8 – 15
Fun Seeking	11.18	2.65	6 – 15	11.29	1.85	8 – 15
Reward Resp.	17.09	2.35	12 – 20	19.57	6.43	15 – 47

Note: based on Mann-Whitney U, * = $p < .05$, ** = $p < .01$, and *** = $p < .001$ between the dysphoric and nondysphoric group

Table 2

Percentage of erroneous responses as a function of condition, time, group and task

		Group			
		Dysphoric (*n* = 21)		Nondysphoric (*n* = 21)	
Condition	Task	*M*	*SD*	*M*	*SD*
Reward condition					
Baseline	Goal task	6.34	4.74	4.89	3.81
	Dot probe task	5.42	6.11	4.23	3.58
	Combined task	8.33	6.03	5.35	5.12
Conditioning	Goal task	7.21	5.35	6.25	3.24
	Dot probe task	4.76	4.10	4.28	3.63
	Combined task	8.11	5.14	5.20	3.57
		Dysphoric (*n* = 22)		Nondysphoric (*n* = 21)	
Loss condition					
Baseline	Goal task	7.44	5.44	4.89	4.80
	Dot probe task	3.40	3.63	2.24	2.72
	Combined task***	7.76	4.50	2.57	3.60
Conditioning	Goal task	7.81	5.05	7.81	4.81
	Dot probe task	3.63	3.51	4.40	4.02
	Combined task	6.67	5.70	5.13	3.42

Note: based on Mann-Whitney U, * = $p < .05$, ** = $p < .01$, and *** = $p < .001$ between the dysphoric and nondysphoric group

Table 3

Points won/lost and UCS characteristics in the reward/loss condition as a function of group and task

		Group			
		Dysphoric (*n* = 21)		Nondysphoric (*n* = 21)	
Condition	Measure	*M*	*SD*	*M*	*SD*
Reward condition					
Goal task	Points won	77.38 (48%)	31.04	86.90 (54%)	25.42
	Speed – win*	6.52	2.35	7.90	2.14
	Joy – win	7.28	1.52	7.90	1.37
Combined task	Points won**	52.14 (65%)	16.16	64.52 (81%)	9.47
	Speed – win	7.47	2.08	7.33	2.17
	Joy – win	7.23	1.75	7.90	1.26
		Dysphoric (*n* = 22)		Nondysphoric (*n* = 21)	
Loss condition					
Goal task	Points lost*	74.77 (47%)	25.18	57.14 (36%)	33.52
	Speed – lose	6.81	3.04	7.90	2.52
	Sadness – lose	5.36	2.25	6.28	2.53
Combined task	Points lost*	22.72 (28%)	14.28	13.09 (16%)	10.89
	Speed – lose	7.18	2.66	7.61	2.41
	Sadness – lose	5.50	1.99	5.85	2.61

Note: based on Mann-Whitney U, * = $p < .05$, ** = $p < .01$, and *** = $p < .001$ between the dysphoric and nondysphoric group

Table 4

Mean reaction times and standard deviations for the reward condition as a function of task, group, time and CS type

		Group			
		Dysphoric (*n* = 21)		Nondysphoric (*n* = 21)	
Condition	CS type	*M*	*SD*	*M*	*SD*
Goal task					
Baseline	Neutral	325	43	334	48
	Reward	324	59	338	46
Conditioning	Neutral	332	41	334	44
	Reward	315	49	313	44
Combined task					
Baseline	Neutral	471	128	496	91
	Reward	462	110	497	126
Conditioning	Neutral	412	91	416	65
	Reward	372	102	342	54

Note: based on Independent Samples *t*-tests, * = $p < .05$, ** = $p < .01$, and *** = $p < .001$ between the dysphoric and nondysphoric group

Table 5

Mean reaction times and standard deviations for the loss condition as a function of task, group, time and CS type

		Group			
		Dysphoric (*n* = 22)		Nondysphoric (*n* = 21)	
Condition	CS type	*M*	*SD*	*M*	*SD*
Goal task					
Baseline	Neutral	338	44	367	59
	Loss	329	39	355	67
Conditioning	Neutral	335	40	339	45
	Loss	326	51	319	44
Combined task					
Baseline	Neutral	507	115	522	158
	Loss	497	162	507	140
Conditioning	Neutral*	458	116	395	81
	Loss*	404	121	339	72

Note: based on Independent Samples *t*-tests, * = $p < .05$, ** = $p < .01$, and *** = $p < .001$ between the dysphoric and nondysphoric group

Table 6

Mean attentional biases and standard deviations (in ms) for the reward condition as a function of task, group and time

		Group			
		Dysphoric (*n* = 21)		Nondysphoric (*n* = 21)	
Task	Time	*M*	*SD*	*M*	*SD*
Dot probe task	Baseline	-2	36	4	20
	Conditioning**	-1	21	23	33
Combined task	Baseline	8	55	5	50
	Conditioning	6	29	19	40

Note: based on Independent Samples *t*-tests, * = $p < .05$, ** = $p < .01$, and *** = $p < .001$ between the dysphoric and nondysphoric group

Table 7

Mean attentional biases and standard deviations (in ms) for the loss condition as a function of task, group and time

		Group			
		Dysphoric (*n* = 22)		Nondysphoric (*n* = 21)	
Task	Time	*M*	*SD*	*M*	*SD*
Dot probe task	Baseline	2	32	-5	26
	Conditioning	-5	31	3	26
Combined task	Baseline	1	60	5	49
	Conditioning	-2	29	8	33

Note: based on Independent Samples *t*-tests, * = $p < .05$, ** = $p < .01$, and *** = $p < .001$ between the dysphoric and nondysphoric group

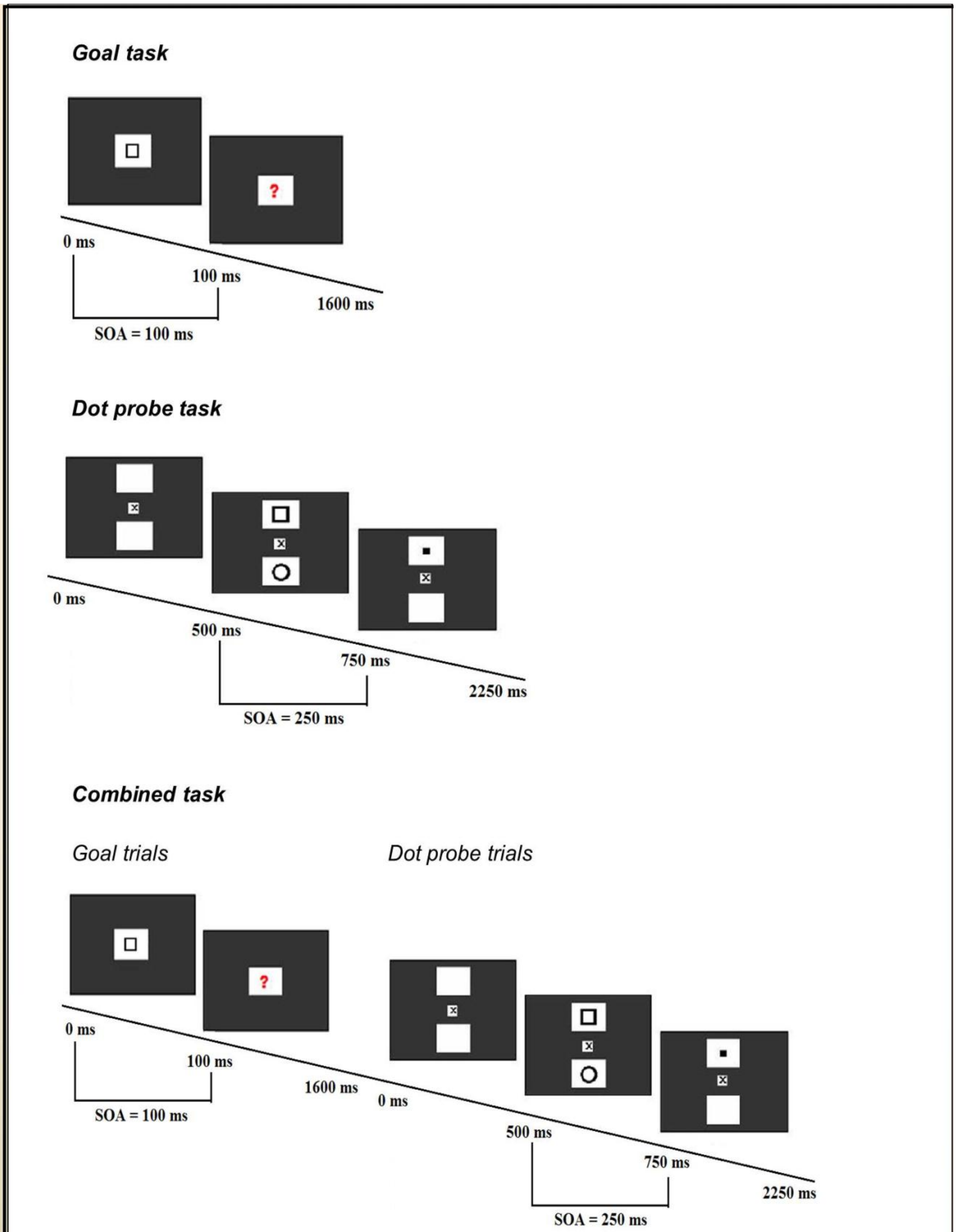

Figure 1. Schematic diagram for the different tasks. On goal trials, after presentation of the black-framed shape, followed by the question mark, participants selected which kind of shape had been presented by pressing either the “Q” or “S”. For the dot probe trials, after presentation of the two black-framed shapes inside the white squares, participants indicated the location of the dot probe by pressing either “4” or “5”.

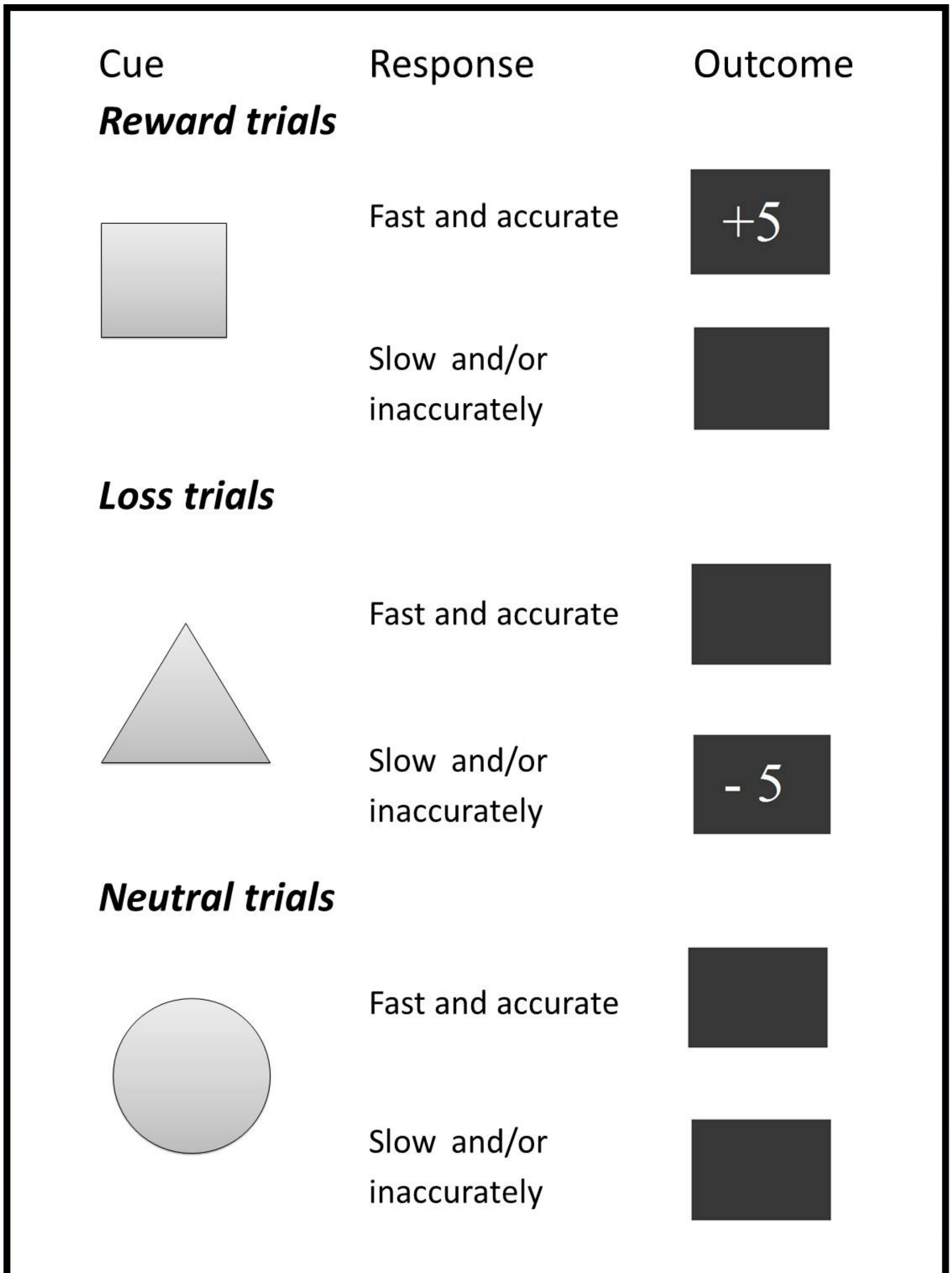

Figure 2. Schematic diagram for the different types of feedback that participants received on goal trials during conditioning. The assignment of cue shapes to different trial types was counterbalanced across participants.