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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

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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.

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

* Corresponding author. Ghent University, Department of Psychology, Henri Dunantlaan 2, 9000 Gent, Belgium.
E-mail address: ernst.koster@ugent.be (E.H.W. Koster).

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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, Steer, & Brown, 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).