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Research paper

Free viewing of sad and happy faces in depression: A potential target for attention bias modification

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ABSTRACT

Background: Identification of reliable targets for therapeutic interventions is essential for developing evidence-based therapies. Attention biases toward negative-valenced information and lack of protective positive bias toward positive-valenced stimuli have been implicated in depression. However, extant research has typically used tasks with narrow stimuli arrays and unknown or poor psychometric properties. Here, we recorded eye-tracking data of depressed and non-depressed participants during a free viewing task to address these limitations.

Methods: Patients with major depressive disorder (MDD; $n = 20$) and undergraduate students with high ($n = 23$) and low ($n = 20$) levels of depression freely viewed 60 different face-based matrices for six seconds each. Each matrix included eight sad and eight happy facial expressions. Gaze patterns on sad and happy areas of interest (AOIs) were explored. Internal consistency for the entire sample and one-week test-retest reliability in the student sub-sample were assessed.

Results: Compared to undergraduates with low levels of depression, patients with MDD and students with high levels of depression dwelled significantly longer on sad faces. Results also showed a significantly longer dwell time on the happy AOI relative to the sad AOI only in the low depression group. The two depressed groups dwelled equally on the two AOIs. The task demonstrated high internal consistency and acceptable one-week test-retest reliability.

Limitations: Only sad and happy facial expressions were used. Relative small sample size.

Conclusion: Relative to non-depressed participants, depressed participants showed prolonged dwelling on sad faces and lack of bias toward happy faces. These biases present viable targets for gaze-contingent attention bias modification therapy.

1. Introduction

Cognitive models relate attention biases to depression (Beck, 1967, 1976; Clark et al., 1999; Teasdale, 1988), whereby the attention system of depressed individuals, unlike in non-depressed individuals, prioritizes negative-valence over positive and neutral information (Dalgleish and Watts, 1990; De Raedt and Koster, 2010; Koster et al., 2011; Peckham et al., 2010). In addition, some models suggest that depressed individuals also fail to demonstrate a positivity bias observed in non-depressed individuals (Alloy and Abramson, 1979, 1988; Matthews and Antes, 1992).

Research using reaction-time (RT) to quantify attention processes in MDD finds some evidence of attention bias toward negative information (Gotlib and Joormann, 2010; Peckham et al., 2010), with such biases, when revealed, typically emerging only when employing long (>1,000 ms) stimulus exposure durations (De Raedt and Koster, 2010; Gotlib and Joormann, 2010; Peckham et al., 2010). Some RT-based attentional research has also demonstrated a lack of a "protective bias" in depression. That is, depressed individuals typically lack an attentional preference for positive over negative information, which characterizes non-depressed individuals (Gotlib et al., 1988; Matthews and Antes, 1992; Mccabe and Gotlib, 1995; Peckham et al., 2010; Shane and Peterson, 2007). However, concerns about poor psychometric properties (i.e., internal consistency and test-retest reliability) of RT-based

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attention bias indices have lead research to employ alternative eye-tracking measures of attention, which were shown to be more reliable compared with RT measures (Skinner et al., 2017; Waechter et al., 2014). A meta-analysis of free-viewing eye-tracking studies concluded that depression involves reduced gaze maintenance on positive stimuli and increased gaze maintenance on negative-valence stimuli (Armstrong and Olatunji, 2012), with two more recent studies showing similar results in clinically diagnosed MDD patients (Duque and Vazquez, 2015; Lu et al., 2017). Other eye-tracking-based paradigms have reported similar results. For example, research using the attentional engagement-disengagement task, designed specifically to examine volitional disengagement of attention, has showed that depressed participants take longer to disengage sad faces and shift gaze towards neutral faces when explicitly prompted to do so (Sanchez et al., 2017; Sanchez et al., 2013).

Despite these coherent and promising findings, extant eye-tracking research has two main limitations. First, research has exclusively used stimulus sets with four or fewer items, limiting generalizability. Stronger, more generalizable results may arise via studies using more complex visual displays, thus extending extant findings in the field (Ferrari et al., 2016; Lazarov et al., 2016; Mogoase et al., 2014; Price et al., 2016; Richards et al., 2014). Second, no eye-tracking study to date has examined the test-retest reliability of attention bias indices in depression, with only one previous study reporting on acceptable internal consistency (Sanchez et al., 2017). In research on anxiety, Lazarov et al. (2016) addressed these two limitations, using a free viewing eye-tracking task, serving also as unique targets for a novel treatment (Lazarov et al., 2017). Given the high co-morbidity between anxiety and depression, the current study extends work on biased gaze patterns in anxiety to quantify a reliable indicator of attention biases in major depressive disorder (MDD). We recorded eye-tracking data while participants freely viewed visual displays comprised of happy and sad faces (16 faces per display), presented for 6 s each. We measured the gaze patterns of three groups of participants: undergraduate students with high or low levels of depressive symptoms, and a group of clinically diagnosed treatment-seeking patients with MDD. Internal consistency and one-week test-retest reliability were evaluated. Based on previous findings, we expected that relative to non-depressed participants, depressed participants would dwell longer on sad faces and shorter on happy faces.

2. Methods

2.1. Participants

Participants in this study belonged to three groups: undergraduate students with high levels of depressive symptoms, undergraduate students with low levels of depressive symptoms, and treatment-seeking patients with clinically diagnosed MDD. The clinical group consisted of 20 treatment-seeking patients diagnosed with MDD (7 females, mean age = 40.28 years, *SD* = 10.40, range = 23–58). Primary and co-morbid diagnoses were ascertained using the Mini-International Neuropsychiatric Interview (see below, M.I.N.I; Sheehan et al., 1998) administered by a clinical psychologist trained to 85% reliability criterion with a senior experienced psychologist. MDD diagnosis was further ascertained using the clinician-rated Montgomery–Asberg Depression Rating Scale (MADRS; (Montgomery and Asberg, 1979)). A cutoff score of 18 or higher was used as an inclusion criterion, reflecting moderate to severe depression (Mittmann et al., 1997; Snaith et al., 1986). Exclusion criteria for the MDD group were: a) age not between 18 and 60 years; b) present or past psychotic episode; c) co-morbid Tic disorder or Tourette's syndrome; d) any neurologic condition (e.g., epilepsy, brain injury); e) being in psychotherapy of any kind; and f) any change in medication occurring in the three months prior to participation in the study. Of the 20 participants with MDD included in the study, two also met criteria for dysthymia, 11 for generalized anxiety disorder (GAD), two for panic disorder (PD), one for obsessive-compulsive disorder (OCD), and five for social anxiety disorder (SAD). While not an exclusionary criterion, none of the patients were on any medication.

Two hundred and forty-two undergraduate students were screened for depressive symptoms using the Patient Health Questionnaire-9 (PHQ-9; (Kroenke et al., 2001)). Students with PHQ-9 score ≥ 10 constituted the high depression (HD) group (n = 23, 18 females, mean age = 23.87 years, *SD* = 1.98, range = 21–28). A PHQ-9 score of 10 is considered the clinical cutoff for a diagnostic status of moderate depression (Kroenke et al., 2001). Using this cutoff score enabled the enrollment of participants that most closely resemble the clinical population of interest. The low depression (LD) group consisted of students with PHQ-9 score ≤ 4 (n = 20, 15 females, Mean age = 23.60 years, *SD* = 1.67, range = 20–27), reflecting minimal depression using this scale. All student participants received course credit for participation.

The local Institutional Review Board approved the study and participants provided written informed consent. To avoid eye-tracking calibration difficulties we only invited participants who had normal or corrected-to-normal vision, also excluding use of multi-focal eyewear. None of the participants had prior experience with eye-tracking procedures.

2.2. Measures

2.2.1. Depression

Self-reported levels of depression were assessed using the PHQ-9 (Kroenke et al., 2001). The PHQ-9 is a 9-item self-report questionnaire evaluating symptoms of major depressive disorder according to the criteria of the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; (American Psychiatric Association, 1994)). Each PHQ-9 item corresponds to one of the nine DSM-IV symptoms of depression, rated in relation to the previous two weeks. The PHQ-9 has good validity, test-retest reliability, and internal consistency (Kroenke et al., 2001). Cronbach's α in the current sample was 0.88.

Clinician evaluated levels of depression were measured using the Structured Interview Guide for the MADRS (SIGMA (Williams and Kobak, 2008). The MADRS consists of 10-items assessing levels of depression symptoms during the past week, with each item rated on a scale of 0 (no evidence of symptom) to 6 (pervasive evidence). The MADRS has high inter-rater reliability and convergent validity (Montgomery and Asberg, 1979). Cronbach's α in the current sample was 0.70.

2.2.2. Primary and co-morbid diagnoses

Primary and co-morbid diagnoses in the clinical MDD group were assessed in individual clinical interviews using the MINI (Sheehan et al., 1998), a structured diagnostic interview for DSM-IV and ICD-10 psychiatric disorders (Lecrubier et al., 1997; Sheehan et al., 1997).

2.3. The eye-tracking task

Gaze patterns were assessed using an established eye-tracking task (Lazarov et al., 2016; Lazarov et al., 2017) adapted for depression, using a remote high-speed eye-tracker (SensoMotoric Instruments (SMI), Inc., Teltow, Germany). The task was designed and executed using the innate Experiment Center software provided by SMI.

Color photographs of 16 males and 16 female actors, each contributing a sad and a happy facial expression, were taken from the NimStim Stimulus Set (Tottenham et al., 2009). We assembled 60 different 4-by-4 matrices, each containing eight sad and eight happy facial expressions. Each individual face extended 225-by-225 pixels, including a 10-pixel white margin on every edge, for an overall size of 900-by-900 pixels (Fig. 1). Each single face appeared randomly at any position on the matrix while ensuring the following: a) each actor