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# Lack of an Attention Bias Away From Relatively Negative Faces in Dysphoria Is Not Related to Biased Emotion Identification

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**Eye-tracking-based attention research has consistently shown a lack of a normative attentional bias away from dysphoric face stimuli in depression, characterizing the attention system of non-depressed individuals. However, this more equal attention allocation pattern could also be related to biased emotion identification, namely, an inclination of depressed individuals to attribute negative emotions to non-negative stimuli when processing mood-congruent stimuli. Here, we examined emotion identification as a possible mechanism associated with attention allocation when processing emotional faces in depression. Attention allocation and emotion identification of participants with high (HD; $n = 30$) and low (LD; $n = 30$) levels of depression symptoms were assessed using two corresponding tasks previously shown to yield significant findings in depression, using the same face stimuli (sad, happy, and neutral faces) across both tasks. We examined group differences on each task and possible between-task associations. Results showed that while LD participants dwelled longer on relatively positive faces compared with relatively negative faces on the attention allocation task, HD participants showed no such bias, dwelling equally on both. Trait anxiety did not affect these results. No group differences were noted for emotion identification, and no between-task associations emerged. Present results suggest that depression is characterized by a lack of a general attention bias toward relatively positive faces over relatively negative faces, which is not related to a corresponding bias in emotion identification.**

*Keywords:* depression; attention allocation; attention bias; emotion identification; eye-tracking

COGNITIVE MODELS OF DEPRESSION assert that biased attention to emotional information in one's surroundings contributes to the onset, maintenance, and recurrence of the disorder (for theoretical reviews see Gotlib & Joormann, 2010; LeMoult & Gotlib, 2019). Specifically, two attentional biases have been proposed as playing key roles in depression; the first characterized by prioritizing negative-valence information over positive or neutral information (Dalgleish & Watts, 1990; De Raedt & Koster, 2010; Koster et al., 2011; Peckham et al., 2010), and the second by a lack of a normative attentional preference for positive-valence information (i.e., a lack of a positive or "protective" bias), which is typical of non-depressed individuals (e.g., Bodenschatz et al., 2019; Duque & Vázquez, 2015; Klawohn et al., 2020; Shane & Peterson, 2007). These two biases have been initially established in early attentional studies using first-generation reaction-time (RT)-based tasks (e.g., for a systematic review and meta-analysis see Peckham et al., 2010), with more advanced eye-tracking-based research further elucidating these biases, showing them to manifest mainly in sustained attention (i.e., increased attention maintenance on dysphoric images/sad faces and decreased attention mainte-

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nance on positive images/happy faces), and less so in the early processes of attention orienting or vigilance (for systematic reviews and meta-analyses see Armstrong & Olatunji, 2012; Suslow et al., 2020).

While extant eye-tracking attentional research in depression has greatly advanced our knowledge of attention processes in depression, two main concerns still remain. First, most studies have utilized small stimulus set sizes, ranging from one to a maximum of four stimuli presented at once (e.g., out of 16 studies reviewed by Suslow et al. (2020), 15 used four or less stimuli, with Lazarov et al. (2018) being the only exception; see Procedure below). Examining attention allocation patterns when faced with more complex visual displays of multiple competing emotional stimuli is needed to increase the generalizability of observed attention biases beyond these small set sizes (Ferrari et al., 2016; Lazarov et al., 2016; Lazarov et al., 2018; Lazarov et al., 2019; Mogoaşe et al., 2014; Price et al., 2016; Richards et al., 2014). Second, while improved psychometrics have been noted for eye-tracking-based research of attention (Chong & Meyer, 2020; Sears et al., 2019; Skinner et al., 2018; Waechter et al., 2014; Wermes et al., 2017), research in depression has mostly overlooked the psychometric properties of tasks and measures used (cf. Klawohn et al., 2020; Lazarov et al., 2018; Sanchez et al., 2017), which is essential to inspire confidence in obtained results (Lilienfeld & Strother, 2020; McNally, 2019; Parsons et al., 2019; Skinner et al., 2018; Waechter et al., 2014).

A previous eye-tracking study in depression has tried to address these limitations (Lazarov et al., 2018). Students with high and low levels of depression symptoms, as well as treatment-seeking patients with major depressive disorder (MDD), freely viewed two blocks of 30 face matrices, each comprised of eight sad and eight happy faces (see Figure 1a for an example) presented for 6000 ms. Total dwell time on sad and happy stimuli, respectively (i.e., the accumulative time spent fixating on each predefined area of interest; AOI), was explored. Internal consistency and 1-week test-retest reliability were evaluated. Results showed that while nondepressed participants exhibited an attention allocation pattern favoring happy over sad faces, depressed participants (both students with high levels of depression symptoms and patients with MDD) showed no attentional preference, dwelling more equally on both AOIs. Internal consistency and test-retest reliability for the total dwell time measure were adequate. In a more recent study, 50 patients with a current depressive disorder and 31 never-depressed control participants performed a modified version of the task with two counterbalanced blocks; one contrasting sad and neutral faces (S-N block) and the other contrasting neutral and happy faces (N-H block; see Figure 1b and c for corresponding examples). Results showed that while groups did not differ on attention allocation in the N-H block, control participants dwelled significantly longer on neutral compared to sad faces on the S-N block, a relative attentional bias not evident in depressed participants that dwelled more equally on both AOIs (Klawohn et al., 2020). Again, good-to-excellent internal consistency was found. Taken together, these two studies suggest that the attentional system of nondepressed individuals is biased away from sad stimuli, a bias that is absent in depressed individuals, implicating

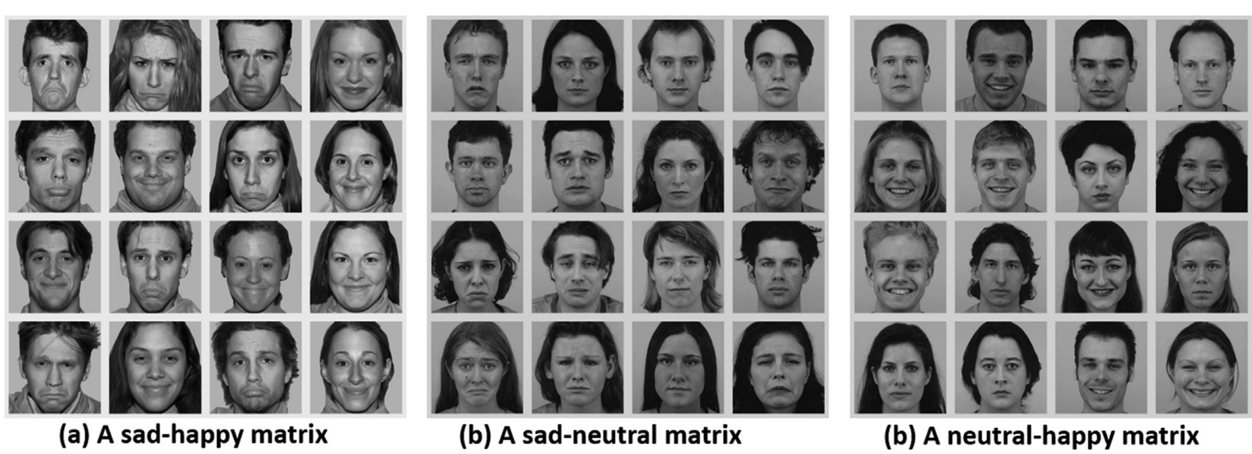


FIGURE 1 An example of a single matrix for (a) the sad-happy block, taken from Lazarov et al. (2018); (b) the sad-neutral block taken from (Klawohn et al., 2020); and (c) the neutral-happy block taken from (Klawohn et al., 2020). In each block each type of emotional faces comprises a separate area of interest (AOI).

negative-related attention allocation as the predominant alteration in the attentional system of depressed individuals (Klawohn et al., 2020).

Cognitive models of depression (Beck, 1976; Mathews & MacLeod, 2005), as well as mood congruency depression models (Blanchette & Richards, 2010; Bower, 1981; Mayer et al., 1992), also implicate negative biased interpretations or response biases when processing mood-congruent stimuli, suggesting that depressed individuals are more prone to attribute negative emotions to nonnegative stimuli. Indeed, various studies have shown that depressed individuals tend to evaluate neutral, happy, or ambiguous facial expressions as more sad or less happy compared with healthy individuals, making more sad-prone misclassification errors (Gollan et al., 2008; Leppänen et al., 2004; Van Vleet et al., 2019; for a reviews see Bourke et al., 2010; Foland-Ross & Gotlib, 2012), and to require significantly greater emotional intensity of presented (morphed) happy faces, compared with nondepressed participants, to correctly identify or label them as being of positive valence (e.g., Joormann et al., 2010; Joormann & Gotlib, 2006; LeMoult et al., 2009; Surguladze et al., 2004). From this perspective, one could argue that the relatively equal time depressed participants spend dwelling on the different emotional faces (e.g., sad and neutral faces; Klawohn et al., 2020) is not truly reflective of an equal attention allocation to differently perceived emotional stimuli, but rather is the result of attributing negative emotions to the nonnegative faces, reducing the differentiation between the two face types. Put differently, if one is more prone to attribute negative emotions to nonnegative stimuli, less clearly differentiating between them, then a corresponding "less biased," or more equal, attention allocation pattern is to be expected.

To address this latter possibility experimentally, in the present study participants with high and low levels of depression symptoms completed an attention allocation task and an emotion identification task, using the same face stimuli across both tasks. Attention allocation was assessed via the Matrix task described above, comprised of three different blocks included in the two above-reviewed studies, namely, the S-H block used in Lazarov et al. (2018) and the S-N and N-H blocks used in Klawohn et al. (2020). Emotion identification was assessed using an Emotion Matcher task which examines participants' ability to distinguish pairs of faces (of different individuals) expressing the same or different emotions (Van Vleet et al., 2019). In each trial participants are presented with two faces, each being either sad, happy, or neutral, and are then required to indicate whether they show the same facial expression (e.g., both showing sad expressions), or different expressions (e.g., one showing a sad expression and one a neutral expression). Emotion identification is quantified via accuracy scores (i.e., sum of correct responses). Especially relevant to the aims of the present study, this task has shown accuracy scores to be negatively correlated with depression levels when needing to differentiate sad and neutral faces (S-N pair type; Van Vleet et al., 2019), thereby echoing the performance of depressed participants on the S-N block in the study of Klawohn et al. (2020). In line with the above-reviewed research, we expected that participants with low levels of depression symptoms would dwell longer on neutral faces over sad faces in the S-N block, and on happy faces over sad faces in the S-H block, while participants with high levels of depression symptoms would show less of a bias. We predicted both groups to dwell longer on happy faces relative to neutral faces on the N-H block. We also explored possible associations between attention allocation on the Matrix task and indices of emotion identification on the Emotion Matcher task across the three conditions shared by both tasks (i.e., sad-happy, sad-neutral, and neutral-happy). We reasoned that if a nonbiased attention allocation pattern is indeed related to a corresponding deficiency in emotion identification, then a decreased ability to differentiate emotional faces on a specific pair type on the Emotion Matcher should be associated with a less biased attention allocation pattern (more equally dwelling on both AOIs) when viewing the same emotional contrast on the Matrix task.

## Methods

### PARTICIPANTS

Three hundred and thirty-seven first-year students were screened using the Patient Health Questionnaire-9 (PHQ-9; Kroenke et al., 2001) at the beginning of the academic year. Students scoring at top and bottom of the PHQ-9 distribution were then contacted over the phone and offered to participate in the study for course credit. Student scoring at the top of the PHQ-9 distribution comprised the high dysphoric (HD) group, contingent on having a cutoff score of 10 as an inclusion criterion. This score was chosen as it is considered the clinical cutoff for a diagnostic status of moderate depression (Kroenke et al., 2001), with adequate balance between sensitivity and specificity when used as an MDD diagnostic tool (Manea et al., 2012). Thus, this cutoff score enabled as the enrollment of participants that most closely resemble the clinical population of interest. Only those scoring above the cutoff score also on the day of their participation, held several weeks following the initial screening, were deemed eligible for the study. The low dysphoric (LD) group consisted of those who scored at the bottom of the sampling pool, reflecting minimal depression. Potential participants scoring above 9 on their participation day were excluded. The final sample included 60 participants (*M*age = 23.12 years, *SD* = 1.62, range = 20–27 years; 12 men; all white): Thirty in the HD group (*M*age = 23.00 years, *SD* = 1.44, range = 20–26 years; 6 men) and 30 in the LD group (*M*age = 23.25 years, *SD* = 1.82, range = 20–27 years; 6 men). Two LD participants were excluded from analyses due to technical difficulties related to the eye-tracking apparatus during their session (i.e., no data were recorded) resulting in a group of 28 LD participants (for a total of 58 study participants). All participants provided informed consent and received course credit for participation.

The study protocol was approved by the Research Ethics Council of Tel Aviv University and participants provided written informed consent. We only invited participants with normal or corrected-to normal vision, excluding usage of multi-focal eyewear to prevent eye-tracking calibration difficulties.

### MEASURES

#### *Depression*

Depression levels were measured using the PHQ-9 (Kroenke et al., 2001), a 9-item self-report questionnaire evaluating symptoms of MDD based on the criteria of the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 2013). Each single item corresponds to one of the nine symptoms of depression, rated in relation to the previous two weeks. Responses range from “Not at all” (0) to “Nearly every day” (3). Item scores are summed for a total score ranging from 0 to 27. The PHQ-9 has good validity, test–retest reliability, and internal consistency (Kroenke et al., 2001). Cronbach’s alpha in the present sample was 0.89.

#### *Trait Anxiety*

Trait anxiety was measured using the Trait subscale of the State Trait Anxiety Inventory (STAI-T; Spielberger et al., 1983). The STAI-T consists of 20 items relating to general anxious moods, each rated on a 4-point scale ranging from “not at all” (1) to “very much” (4). Item scores are summed for a total score ranging from 20 to 80. The STAI-Trait subscale has good internal consistency (ranging from .86 to .92) and high test–retest stability (ranging from .73 to .86), and acceptable convergent and discriminant validity (Spielberger et al., 1983; Speilberger & Vagg, 1984). Cronbach’s alpha of the STAI-T in the current sample was .95.

- **The attention allocation task (i.e., the Matrix task)**

Attention allocation was assessed using a well-established free-viewing task with adequate psychometric properties in different psychopathologies (Abend et al., 2021; Chong & Meyer, 2020; Klawohn et al., 2020; Lazarov et al., 2016; Lazarov et al., 2017; Lazarov, Suarez-Jimenez, et al., 2021), including depression (Klawohn et al., 2020; Lazarov et al., 2018), adapted for the current study. The task was designed and executed using the Experiment Builder software (version 2.1.140; SR Research Ltd., Mississauga, Ontario, Canada).

The Matrix task comprised of three separate blocks, each focusing on a different emotional contrast, identical to those used in the previous studies implementing this task in depression (Klawohn et al., 2020; Lazarov et al., 2018). Specifically, one block consisted of sad and happy facial expressions (the S-H block), one of sad and neutral expressions (the S-N block), and one of neutral and happy expressions (the N-H block). Blocks were delivered in a counterbalanced manner across participants in each group. For the S-H block, color photographs of eight males and eight female actors, each contributing a sad and a happy facial expression, were taken from the NimStim Stimulus Set (Tottenham et al., 2009). For each of the S-N and N-H blocks, color photographs of eight male and eight female actors, each contributing an emotional (sad, happy) and a neutral facial expression, were taken from the Karolinska Directed Emotional Faces database (KDEF; Lundqvist et al., 1998). Overall, different actors appeared in each of the three blocks. Blocks consisted of 30 different 4-by-4 face matrices. Each individual face extended 225-by-225 pixels, including a 10-pixel white margin frame, for an overall size of 900-by-900 pixels (see Figure 1 for a matrix example of each block). Each single face appeared randomly at any position on the matrix while ensuring that: (a) each actor appeared only once in a matrix; (b) each matrix contained eight male and eight female faces; and (c) half the faces were of each emotional contrast, a ratio that was also kept for the four inner faces of the matrix. Each single facial expression had the same appearance prevalence within the block, that is, each facial expression appeared exactly 15 times per block.

Each trial began with a centrally presented fixation-cross mandating a 1-second fixation for the next display to appear. Then the matrix appeared for 6 seconds, followed by a 2-second inter-trial-interval. Participants were instructed to look freely at the matrix until it disappeared. A 2-minute break was introduced between blocks to reduce fatigue. Each block was preceded by a 5-point eye-tracking calibration and a 5-point validation procedure. The task/block did not ensue unless a visual deviation below 0.5° was achieved for each point on both the X and Y axes.

*Apparatus*. Eye-tracking data were collected and recorded using the remote head-free high-speed EyeLink Portable-Duo apparatus and the Experiment Builder software (SR-research, Ottawa, Ontario, Canada). Participants were seated approximately 700 mm away from the screen. Real-time monocular eye-tracking data were recorded continuously throughout the task at 500 Hz, with a 1920 × 1080-pixel display resolution.

*Eye-tracking measures*. Eye-tracking data were processed using EyeLink Data Viewer software, version 3.1.246 (SR-research, Ottawa, Ontario, Canada). Fixations were defined as at least 100 ms of stable fixation within 1-degree visual angle. For each presented matrix we defined two AOIs, one for each emotional contrast. Specifically, sad and happy AOIs for the S-H block, sad and neutral AOIs for the S-N block, and neutral and happy AOIs for the N-H block. *Total dwell time* per AOI was calculated by aggregating dwell time on each AOI across the 30 matrices of the block. For correlational analyses with measures of the Emotion Matcher task (see Data Analysis) we first calculated for each block a measure of attention allocation proportion by computing percent dwell time (DT%) of the relatively negative AOI in each block (i.e., the sad AOI in the S-H block, the sad AOI in the S-N block, and the neutral AOI in the N-H block) out of the total dwell time on both AOIs in the respected block (Lazarov et al., 2016, 2018, 2017; Lazarov, Suarez-Jimenez, et al., 2021). Next, to reflect the extent to which this attention allocation measure deviated from unbiased attention allocation (equally dwelling on both AOIs; 50%), we computed a *deviation score* by computing the difference from 0.5 in absolute value. Internal consistency for total dwell time on relatively negative faces, total dwell time on relatively positive faces, and the percentage of total dwell time on relatively negative faces (out of total dwell time spent on both types of faces) were acceptable, with Cronbach's alphas of .75, .93, and .87, respectively.

- **The emotion identification task (i.e., the Emotion Matcher task)**

Assessment of emotion identification followed closely the original procedure of the Emotion Matcher task (Van Vleet et al., 2019), using the same face stimuli from the Matrix task. We adapted the original task using a web based application developed specifically for this study in JavaScript on top of Node.js (14.16.0), designed in "Visual Studio Code (Microsoft Ltd)".

As in the original study, the task included 48 trials in total. Each trial began with a centered fixation cross of 500 ms, followed by the presentation of two faces, each showing a neutral, happy, or sad expression, for additional 750 ms. Following the presentation of the face pair, participants were asked to indicate whether the two faces displayed the same emotion, by pressing a corresponding "yes" button, or two different emotions, by pressing a corresponding "no" button. Response buttons remained on the screen until a response was made (they were disabled during faces presentation). Next, an inter-trial-interval of 1750 ms was introduced.

Each face pair presented in each trial belonged to one of the following 6 potential pair options: sad-happy, sad-neutral, neutral-happy, sad-sad, neutral-neutral, and happy-happy. Each of these 6 pair options appeared in 8 trials out of the 48 trials of the task. The order of trials was randomized per participant such that different participants received different trial orders. As in total 32 sad faces, 32 happy faces, and 32 neutral faces were used in the matrix task, and as the Emotion Matcher necessitates 96 single faces (two faces per trial, 48 trials), each single face from the Matrix task appeared once in the emotion matcher task, while ensuring that none of the pairs included two faces of the same actor. Single faces were 282-by-282 pixels in size.

*Measures*. Emotion identification was assessed based on accuracy scores (Van Vleet et al., 2019). Specifically, for each of the 6 pair types we totaled participants' number of correct responses, with the total score reflecting emotional differentiation. As each pair type was assessed in 8 trials, scores ranged from 0 to 8 per pair type, and 0 to 48 in total, with higher scores indicating better emotional differentiation. In line with the original study of Van Vleet et al. (2019), we also explored the time elapsing from the presentation of the two faces to the button press (i.e., reaction time) as possibly indicating difficulty in differentiating the emotional expressions of the presented faces. Specifically, for each of the 6 pair types we averaged participants' reaction times across the 8 relevant trials.

### PROCEDURE

Participants were tested individually in a small and quiet room at the university. After signing informed consent, they completed the two tasks. Task order was counterbalanced across participants within each group to eliminate task order effects—specifically, within each group half of the participants completed the Matrix task first followed by the Emotion Matcher task, while for the other half task order was reversed (i.e., the Emotion Matcher first, followed by the Matrix task). A 10-minute break was introduced between tasks.

Prior to the Matrix task participants were seated in front of the eye-tracking monitor and told that during this task they would be presented with different matrices of faces, appearing one after the other. They were also informed that before the appearance of each matrix a fixation cross will appear at the center of the screen, on which they should fixate their gaze to make the matrix itself appear. They were then presented with a demonstration of this contingency. Participants were asked to look freely at each matrix in any way they chose until it disappeared.

Prior to the Emotion Matcher task participants were told that during this task they would be presented with two faces, one next to the other, for a brief duration, and that each face would be either a sad, happy, or neutral face. They were also informed that their task is to indicate whether the two presented faces were of the same emotion or of two different emotions by pressing on two corresponding computer keys (i.e., the "yes" and "no" buttons), and were asked to respond as accurately and quickly as possible. Following this general explanation, participants completed two practice trials, one with two faces of the same emotion (i.e., a "yes" trial) and one of two different emotions (i.e., a "no" trial), using faces not included in any of the tasks, and were given feedback as to their performance on each trial. Following the practice trials, the actual task began as described above, during which no feedback was given.

Following the completion of both tasks, participants filled out the PHQ-9 and STAI-T questionnaires. All participants were then thanked for participation and debriefed.

### DATA ANALYSIS

As the present study aimed to explore emotion identification as a possible underlying factor associated with group differences in attention allocation, we powered our study to detect a group-by-AOI interaction on the Matrix task using a 2-tailed $\alpha = .05$, with 0.90 power, and an effect size of $\eta_p^2 = .11$, an effect size estimate derived from previous studies using the same task in depression (Klawohn et al., 2020; Lazarov et al., 2018). This resulted in a required sample of 56 participants, for a minimum of 28 participants per group. We decided to recruit a minimum of 30 participants per group as a precaution. Power analysis was performed using G*Power 3.1.9.4 (Faul et al., 2007).

Independent sample t-tests compared between groups on age, PHQ-9 and STAI-T scores, and chi-square tests compared groups on gender ratio. For the Matrix task, we examined group differences on total dwell time by performing a two-by-three-by-two mixed-model ANOVA with group (HD, LD) as a between-subjects factor, and block (S-H, S-N, N-H) and AOI (relatively negative, relatively positive; per block) as within-subject factors. In line with previous studies using the Matrix task (Lazarov et al., 2016; Lazarov, Basel, et al., 2021; Lazarov et al., 2018; Lazarov, Suarez-Jimenez, et al., 2021), reliability was assessed for the three variants of the total dwell time measure—namely, dwell time on each AOI and the percentage of dwell time on the relatively negative AOI out of total dwell time on both AOIs (% dwell time). Internal consistency was examined using *Cronbach's alpha* while treating each trial (i.e., each matrix) as a single item. For the Emotion Matcher task, we examined group differences on accuracy scores and RTs by performing a two-by-six mixed-model ANOVA with group (HD, LD) as a between-subjects factor, and pair type (S-H, S-N, N-H, S-S, N-N, H-H) as a within-subject factor. As our analysis indicated group differences on trait anxiety, we performed analysis of covariance (ANCOVA) for significant findings entering STAI-T scores as a covariate to the above described analyses. Finally, to explore possible associations between performance on the two tasks, we computed Pearson correlation coefficients between the attention allocation deviation score and accuracy scores.

Statistical analyses were conducted using SPSS (IBM; version 27.0) and were 2-sided, using $\alpha$ of 0.05. Effect sizes are reported using $\eta_p^2$ values for ANOVAs and *Cohen's d* for mean comparisons. Bonferroni correction was applied to multiple comparisons.

Table 1
Demographic and Clinical Characteristics of the Two Groups

| | LD group ($n = 28$) | | HD group ($n = 30$) | |
|---|---|---|---|---|
| Measure | *M* | *SD* | *M* | *SD* |
| PHQ-9 | 4.04[a] | 2.25 | 14.86[b] | 3.53 |
| STAI-Trait | 35.89[a] | 6.73 | 56.3[b] | 9.58 |
| Age | 23.25[a] | 1.82 | 23.00[a] | 1.44 |
| Gender ratio (M:W) | 6:22[a] | – | 6:24[a] | – |
| Race (% White) | 100 | – | 100 | – |

*Note.* Different superscripts signify differences between groups at $p < .001$. Same superscripts signify differences between groups at $p > .56$. LD, low dysphoric; HD, high dysphoric; PHQ-9, Patient Health Questionnaire-9; STAI-Trait, State-Trait Anxiety Inventory-Trait subscale.

## Results

### DATA AVAILABILITY

The data that support the findings of this study are openly available in Open Science Foundation (OSF) at https://osf.io/qvuhj/?view_only = 781e544 04d834ed9a327d8e4cf42f253.

### DEMOGRAPHIC AND CLINICAL CHARACTERISTICS

Demographic and clinical characteristics are described in Table 1. As expected, significant group differences emerged for PHQ-9 depression scores, $t(56) = 13.82$, $p < .001$, *Cohen's* $d = 3.66$, and STAI-T trait anxiety scores, $t(56) = 9.32$, $p < .001$, *Cohen's* $d = 2.46$. No group differences were noted for age, $t(56) = .58$, $p = .56$, or gender ratio, $\chi^2(1) = .02$, $p = .89$.

### EXPERIMENTAL TASKS

On the Matrix task, the omnibus Group × Block × AOI interaction was not significant, $F(1, 56) = .50$, $p = .82$. However, a significant Group × AOI emerged, $F(1, 56) = 9.57$, $p = .003$, $\eta_p^2 = .15$, indicating differential dwell time patterns of the two groups for the two AOIs across blocks. We therefore collapsed across the three blocks for the remaining analyses by computing a total dwell time for a *relatively negative* AOI (aggregating total dwell time on sad faces in the S-H block, sad faces in the S-N block, and neutral faces in the N-H block) and for a *relatively positive* AOI (aggregating total dwell time on happy faces in the S-H block, neutral faces in the S-N block, and happy faces in the N-H block; see Figure 2[2]). Follow-up simple effects analyses showed that the LD group spent significantly more time fixating on the relatively positive AOI ($M_{seconds} = 231.71$, $SD = 24.86$), compared with the relatively negative AOI ($M_{seconds} = 204.86$, $SD = 21.20$), $t(27) = 3.25$, $p = .003$, *Cohen's* $d = 1.16$, reflecting an attention allocation pattern favoring relatively positive over relatively negative stimuli. Conversely, the HD group dwelled more equally on the relatively positive AOI ($M_{seconds} = 210.38$, $SD = 22.63$) and the relatively negative AOI ($M_{seconds} = 211.37$, $SD = 15.13$), $t(29) = 0.25$, $p = .81$, reflecting a relative equal attention allocation pattern. The group-by-AOI interaction effect remained significant after entering STAI-T trait anxiety scores as a covariate, $F(1,55) = 8.68$, $p = .005$, $\eta_p^2 = .14$.

In the Emotion Matcher task a non-significant Group × Pair type interaction was noted for accuracy scores, $F(1, 56) = .01$, $p = .91$, as well as a nonsignificant main effect of group, $F(1, 56) = 1.01$, $p = .32$, indicating similar performance patterns of the two groups across all pair types (see Figure 3). Repeating this analysis after redefining Pair type to include only the three pair types with contrasting emotions (i.e., the S-H, S-N, and N-H pair types) did not change the patterns of results, namely, $F(1, 56) = .01$, $p = .97$, for Group × Pair type interaction, and $F(1, 56) = .26$, $p = .61$, for the main effect of group. No significant correlations emerged between deviation scores on the Matrix task and accuracy scores on the Emotion Matcher task for any of the shared condition (i.e., the S-H, S-N, and N-H conditions), across participants and within groups, with observed correlation coefficients ranging from $r = .03$ (for the S-N condition within the LD group) to r = .30 (for the N-H condition in the LD group), all *p*'s > .16. This was also true after collapsing across blocks in the Matrix task (i.e., computing deviation score for the relative negative AOI) and across pair type in the Emotion Matcher (computing a total accuracy score for all 6 pair types as well as for only the three pair types of contrasting emotions), with correlation coefficients ranging from $r = .003$ (for the three pair types across participants) to $r = .19$ (for the six pair

[2] See Supplementary Material Figure S1 for data broken by block (S-H, S-N, N-H)

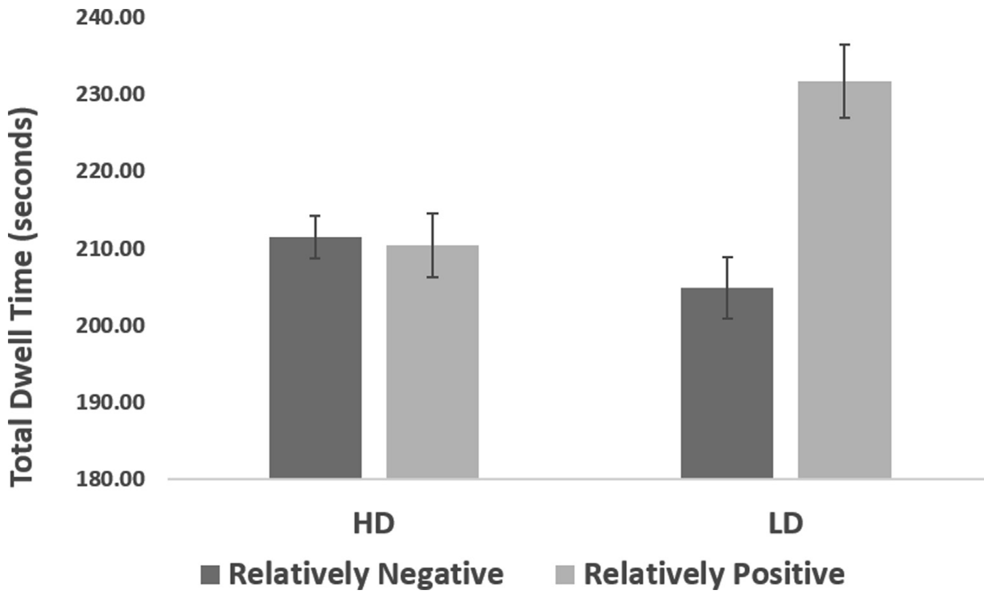


**FIGURE 2** Total dwell time (in seconds) by Area of interest (AOI) and Group. Higher values indicate higher mean dwell time. Error bars denote standard error of the mean. *Note*. HD, high dysphoric; LD, low dysphoric.

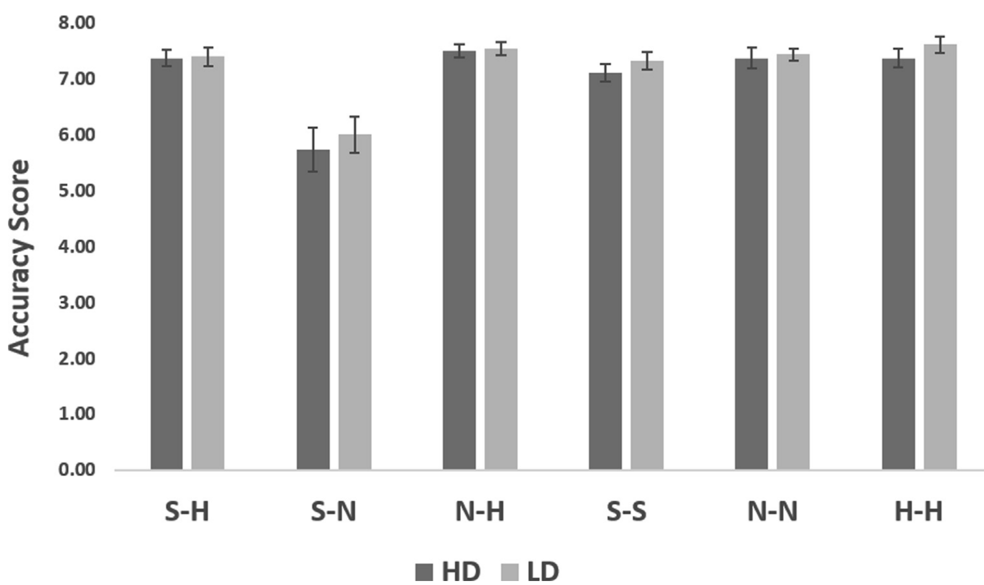


**FIGURE 3** Accuracy scores by Pair type and Group. Higher values indicate higher accuracy scores. Error bars denote standard error of the mean. *Note*. HD, high dysphoric; LD, low dysphoric.

types in the HD group), all $p$'s > .62. As accuracy scores were relatively high in both groups (see Figure 3), insufficient inter-individual variability may have limited our ability to detect possible associations with attention allocation on the Matrix task. Hence, we also explored Reaction Time (RT; the time elapsing from the presentation of the two faces to the button press) as possibly indicating difficulty in differentiating the emotional expressions of the presented faces. Similar to accuracy scores, a nonsignificant Group × Pair type interaction, $F(1, 56) = .63$, $p = .43$, emerged (see Figure 4), also when redefining Pair type as including only those with contrasting emotions, $F(1, 56) = .001$, $p = .97$. Exploring associations with deviation scores on the Matrix task also revealed no significant correlations. For the shared conditions, across participants and within groups, observed correlation coefficients ranged from $r = -.003$ (for the S-N condition within the HD group) to $r = -.32$ (for the S-H condition in the LD group), all $p$'s > .27. This was also true after collapsing across

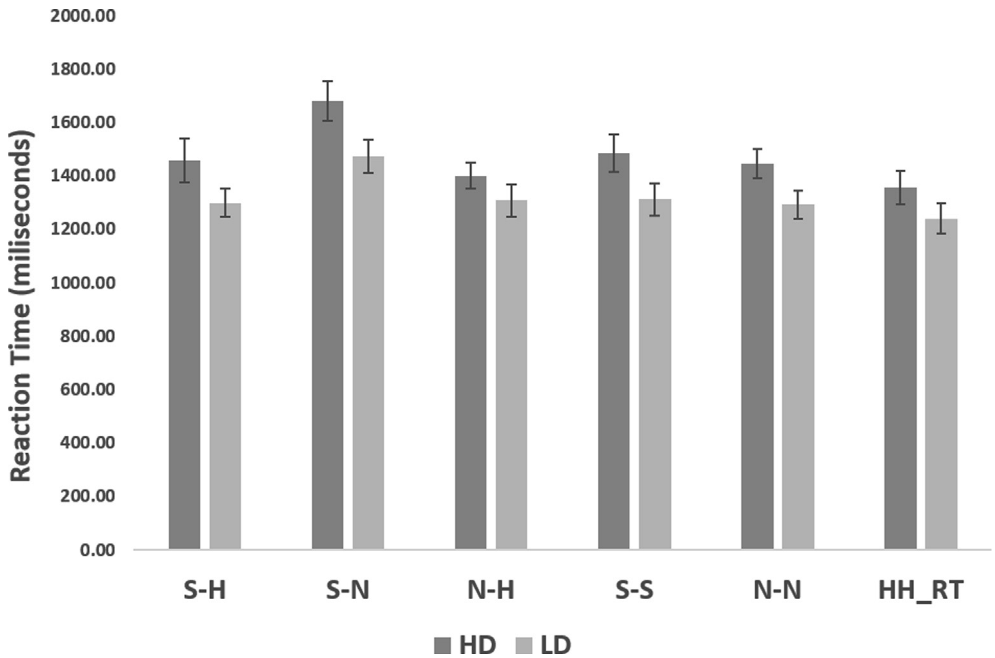


FIGURE 4 Reaction time by Pair type and Group. Higher values indicate longer reaction times. Error bars denote standard error of the mean. *Note*. HD, high dysphoric; LD, low dysphoric.

blocks and across pair type (computing an average RT for all 6 pair types and for the three contrasting emotions pair types). Here correlation coefficients ranged from $r = .05$ (for the six pair types in the HD group) to $r = -.13$ (for the six pair types in the LD group), all $p$'s > .76.

## Discussion

The present study examined emotion identification as a possible mechanism associated with attention allocation to face stimuli in depression. Performance of participants with high and low levels of depression symptoms was compared on two tasks previously yielding significant results in depression (Klawohn et al., 2020; Lazarov et al., 2018; Van Vleet et al., 2019) – an attention allocation task (i.e., the Matrix task) and an emotion identification task (i.e., the Emotion Matcher task) – incorporating the same stimuli across both tasks. Performance on these two tasks was then correlated to examine possible associations between them. Results showed that while participants with low levels of depression symptoms spent more time fixating on relatively positive faces compared with relatively negative faces, participants with high levels of depression symptoms dwelled equally on both. No group differences were noted for emotion identification accuracy scores, and no associations emerged between performance indices on the two tasks.

The equal attention allocation of HD participants on the Matrix task, or lack of a normative bias away from negative cues characterizing LD participants, is in line with previous research in depression using the same paradigm (Klawohn et al., 2020; Lazarov et al., 2018), as well as other tasks and measures (Duque & Vázquez, 2015; Gotlib et al., 1988; Lu et al., 2017; McCabe & Gotlib, 1995; McCabe, Gotlib, & Martin, 2000). It is also in accordance with research on the attentional aspects of well-being showing well-being to be associated with increased attention allocation to positive stimuli among healthy participants (Blanco & Vazquez, 2021; Sanchez & Vazquez, 2014). Interestingly, as each presented matrix comprised the same number of faces of each type (a 50% ratio), this equal distribution of attention shown by participants with high depression symptoms mirrors the actual division of information in their environment, reflecting a more "accurate" or "realistic" attention allocation pattern.

The present study did not find evidence for performance differences between the three used blocks, suggesting a general bias toward *relatively* positive stimuli over *relatively* negative stimuli in healthy individuals. This results pattern suggesting a general bias (or lack of) across different emotional contrasts is in line with previous studies using different versions of the Matrix task in which different emotional blocks were incorporated (Abend et al., 2021; Lazarov, Suarez-Jimenez, et al., 2021). Current and previous findings may suggest that it is less the valence of a specific stimulus that affects attention allocation, but rather its relative valence in relation to co-presented stimuli, that is, it is the less negative/-more positive cue to which healthy individuals allocate more of their attention. Using a neutral face as an example, it may be considered relatively negative when presented with a happy face, but relatively positive when presented with a sad face. This suggested perspective of face valence as relative, rather than absolute, is in line with classic theories of emotion perception which assert that the judgment of the valence of a specific facial expression is not determined exclusively by its physical features, but is also dependent on the context in which it is presented, namely, how it compares with other co-presented facial expressions (Brosch et al., 2010; Russell & Fehr, 1987).

The Emotion Matcher task yielded no significant findings on any of the examined pair types, suggesting no group differences on emotion identification. These findings are in contrast with a previous study using the same task that showed discrimination accuracy to be inversely correlated with depression scores on the S-N pair type, such that as severity of depression increased, accuracy decreased (Van Vleet et al., 2019). Two main methodological differences may explain this divergence in results. First, while here we recruited participants with high and low levels of depression symptoms based on an established cutoff score, the sample used in the original study was a relatively small convenience sample of nonselected participants that provided self-reported levels of depression symptoms as part of their participation, with depression scores not being used as an inclusion/exclusion criterion. Second, unlike the original study in which the entire study procedure (i.e., questionnaires and tasks) was delivered remotely on a mobile device, here the task was delivered in more controlled laboratory setting. Several concerns regarding the data quality of online psychological-related research have been raised, which may also apply here. These include, among others, sample biases reducing generalizability, less control and monitoring over the data-collection setting lowering reliability, and participant dropout (Hewson, 2003; Kraut et al., 2004).

No between-task associations emerged for any of the shared conditions, across participants and within groups, nor did they emerge after collapsing across blocks and pair types, which is not surprising given the lack of group differences on the Emotion Matcher task. Thus, taken together, current findings suggest that the equal attention allocation of HD participants to relatively negative and relatively positive faces is not related to a corresponding deficiency in accurately identifying the emotion of the relatively positive face, which would have led to corresponding difficulties in differentiating the two. Put differently, depressed individuals allocated an equal amount of attention to two well-differentiated emotional cues. This suggestion is in line with several explanations of depression-related biases in attention allocation that assume intact emotional identification, such as conceptualizing increased dwell time on dysphoric stimuli as the attentional manifestation of rumination (Donaldson et al., 2007; Koster et al., 2011; Sanchez-Lopez et al., 2019; Sanchez & Vazquez et al., 2013) or as a more mood congruent attention allocation pattern (Bradley et al., 1997; Koster et al., 2010), and referring to attention allocation patterns of depressed individuals as reflecting a an attention allocation pattern that mirrors the actual division of presented stimuli (Lazarov et al., 2018; Matthews & Antes, 1992).

Notwithstanding the above-stated conclusion, it should be noted that emotion identification was assessed here using the same face stimuli used in the Matrix task (i.e., the KDEF and NimStim datasets)—face stimuli of clear valence and strong intensity. While using the same face stimuli across both tasks enabled us to explore our main hypothesis, it may have, at the same time, precluded us from finding group differences in emotion identification which may only arise when participants are presented with more ambiguous or vague emotional facial expressions. Indeed, some studies have shown that depressed individuals perform fairly well when needing to identify or label clear face stimuli of high emotion intensity, but struggle when presented with less intensive face stimuli (Joormann et al., 2010; Joormann & Gotlib, 2006; LeMoult et al., 2009; Surguladze et al., 2004). Thus, using more ambiguous or less intense face stimuli on the Emotion Matcher task may have yielded group differences on emotion identification. While in the present study emotion identification was not related to attention allocation, this may be the case only when using this type of stimuli. Future research could attempt and use less intense face stimuli across both tasks to explore this possibility.

This study has several limitations. First, participants were individuals with high and low levels of depression symptoms, not clinically diagnosed for depression. Still, we used a PHQ-9 cutoff score of 10, assessed twice to verify score stability, as an inclusion criterion, a score that is considered a reliable cutoff for moderate depression (Kroenke et al., 2001), also demonstrating an adequate balance between sensitivity and specificity (Manea et al., 2012). In addition, the two tasks used here have each shown relevant results in depression using nonclinical samples, similar to the one used in the present study (Lazarov et al., 2018; Van Vleet et al., 2019). Still, future studies should replicate the present one among patients with clinically diagnosed MDD. Second, the present study included a homogeneous sample of White Hebrew-speaking Israeli participants, limiting the generalizability of obtained results. Future research should replicate the present study across different cultures/nationalities to address this limitation. Relatedly, as most face stimuli were chosen from the KDEF database, only White actors were used in the task, which may have different effects on the attention allocation of White and Black participants (Dickter & Bartholow, 2007). While in the present study all participants were White, future research should rectify this shortcoming by using more racially diverse face stimuli such as those included in the NimStim set of facial expressions (Tottenham et al., 2009). Third, in light of the study's main goal, we powered our study to detect group differences on the Matrix task, which may have precluded our ability to detect group differences on the Emotion Matcher task. Future research employing a larger sample size or basing power analysis on the Emotion Matcher task could address this limitation. Fourth, in line with the previous studies that used the Matrix and the Emotion Matcher tasks in depression, we also chose to include sad, happy, and neutral facial expressions, thereby limiting emergent findings to these specific emotions and possible emotional contrasts. Future research using the Matrix task should incorporate additional emotional expressions (e.g., anger, disgust, fear) and possible emotional contrasts (e.g., anger-neutral, disgust-happy, fear-happy and more) to explore the specificity of the suggested lack of a general bias toward *relatively* positive stimuli over *relatively* negative stimuli in depression to the emotions used here. Similarly, the task in its current version could be used in other psychopathologies to determine the specificity of observed findings to depression.

From a clinical perspective, current findings may have some implications for extant procedures of attention bias modification therapy (ABMT) for depression, designed to divert participants' attention away from dysphoric stimuli, as most have yielded inconsistent results (for reviews see Cristea et al., 2015; Hallion & Ruscio, 2011; Jones & Sharpe, 2017). Specifically, current findings encourage the use of different emotional contrasts during ABMT training for depression (e.g., using sad vs happy, sad vs neutral, and neutral vs happy contrasts), rather than focusing on a specific emotional contrast (e.g., contrasting only sad vs happy faces) as done in most ABMT procedures. This may in turn increase the near-transfer generalization effects of training which are necessary for the clinical efficacy of ABMT (Hertel & Mathews, 2011). Interestingly, this suggestion is in line with a recent ABMT trial in depression that compared gaze-contingent music reward therapy (GC-MRT), designed to divert patients' gaze toward positive over sad stimuli, to a control condition of gaze-noncontingent music, which showed that while GC-MRT produced a greater reduction in dwell-time on sad faces, compared to the control condition, both groups showed similar depression levels at posttreatment. Importantly, this lack of group difference in symptom reduction was attributed to the failure of the effects of GCMRT to generalize to novel faces not shown during treatment (Shamai-Leshem et al., 2020). Based on present results, future research could explore the generalization effects of a similar GC-MRT procedure whilst using multiple types of contrasting emotional faces during training, and possibly the ensuing therapeutic value of such a procedure.

## Conflict of Interest Statement

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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## References

Abend, R., Bajaj, M. A., Matsumoto, C., Yetter, M., Harrewijn, A., Cardinale, E. M., Kircanski, K., et al. (2021). Converging multi-modal evidence for implicit threat-related bias in pediatric anxiety disorders. *Journal of Abnormal Child Psychology, 49*, 227–240. https://doi.org/10.1007/s10802-020-00712-w.

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). American Psychiatric Publishing.

Armstrong, T., & Olatunji, B. O. (2012). Eye tracking of attention in the affective disorders: A meta-analytic review and synthesis. *Clinical Psychology Review, 32*(8), 704–723. https://doi.org/10.1016/j.cpr.2012.09.004.

Beck, A. T. (1976). *Cognitive therapy and the emotional disorders*. International Universities Press.

Blanchette, I., & Richards, A. (2010). The influence of affect on higher level cognition: A review of research on interpretation, judgement, decision making and reasoning. *Cognition & Emotion, 24*(4), 561–595. https://doi.org/10.1080/02699930903132496.

Blanco, I., & Vazquez, C. (2021). Integrative well-being leads our attentional system: An eye-tracking study. *Journal of Happiness Studies, 22*, 787–801. https://doi.org/10.1007/s10902-020-00251-7.

Bodenschatz, C. M., Skopinceva, M., Ruß, T., & Suslow, T. (2019). Attentional bias and childhood maltreatment in clinical depression-an eye-tracking study. *Journal of Psychiatric Research, 112*, 83–88. https://doi.org/10.1016/j.jpsychires.2019.02.025.

Bourke, C., Douglas, K., & Porter, R. (2010). Processing of facial emotion expression in major depression: A review. *Australian & New Zealand Journal of Psychiatry, 44*(8), 681–696. https://doi.org/10.3109/00048674.2010.496359.

Bower, G. H. (1981). Mood and Memory. *American Psychologist, 36*(2), 129–148. https://doi.org/10.1037/0003-066X.36.2.129.

Bradley, B. P., Mogg, K., & Lee, S. C. (1997). Attentional biases for negative information in induced and naturally occurring dysphoria. *Behaviour Research and Therapy, 35*(10), 911–927. https://doi.org/10.1016/S0005-7967(97)00053-3.

Brosch, T., Pourtois, G., & Sander, D. (2010). The perception and categorisation of emotional stimuli: A review. *Cognition and Emotion, 24*(3), 377–400. https://doi.org/10.1080/02699930902975754.

Chong, L. J., & Meyer, A. (2020). Psychometric properties of threat-related attentional bias in young children using eye-tracking. *Developmental Psychobiology, 00*, 1–12. https://doi.org/10.1002/dev.22053.

Cristea, I. A., Kok, R. N., & Cuijpers, P. (2015). Efficacy of cognitive bias modification interventions in anxiety and depression: Meta-analysis. *The British Journal of Psychiatry, 206*(1), 7–16. https://doi.org/10.1192/bjp.bp.114.146761.

Dalgleish, T., & Watts, F. N. (1990). Biases of attention and memory in disorders of anxiety and depression. *Clinical Psychology Review, 10*(5), 589–604. https://doi.org/10.1016/0272-7358(90)90098-U.

De Raedt, R., & Koster, E. H. (2010). Understanding vulnerability for depression from a cognitive neuroscience perspective: A reappraisal of attentional factors and a new conceptual framework. *Cognitive, Affective, & Behavioral Neuroscience, 10*(1), 50–70. https://doi.org/10.3758/CABN.10.1.50.

Dickter, C. L., & Bartholow, B. D. (2007). Racial ingroup and outgroup attention biases revealed by event-related brain potentials. *Social Cognitive and Affective Neuroscience, 2*(3), 189–198. https://doi.org/10.1093/scan/nsm012.

Donaldson, C., Lam, D., & Mathews, A. (2007). Rumination and attention in major depression. *Behaviour Research and Therapy, 45*(11), 2664–2678. https://doi.org/10.1016/j.brat.2007.07.002.

Duque, A., & Vázquez, C. (2015). Double attention bias for positive and negative emotional faces in clinical depression: Evidence from an eye-tracking study. *Journal of Behavior Therapy and Experimental Psychiatry, 46*, 107–114. https://doi.org/10.1016/j.jbtep.2014.09.005.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191. https://doi.org/10.3758/BF03193146.

Ferrari, G. R., Möbius, M., van Opdorp, A., Becker, E. S., & Rinck, M. (2016). Can't look away: An eye-tracking based attentional disengagement training for depression. *Cognitive Therapy and Research, 40*(5), 672–686. https://doi.org/10.1007/s10608-016-9766-0.

Foland-Ross, L. C., & Gotlib, I. H. (2012). Cognitive and neural aspects of information processing in major depressive disorder: An integrative perspective. *Frontiers in Psychology, 3*, 489. https://doi.org/10.3389/fpsyg.2012.00489.

Gollan, J. K., Pane, H. T., McCloskey, M. S., & Coccaro, E. F. (2008). Identifying differences in biased affective information processing in major depression. *Psychiatry Research, 159*(1–2), 18–24. https://doi.org/10.1016/j.psychres.2007.06.011.

Gotlib, I. H., & Joormann, J. (2010). Cognition and depression: Current status and future directions. *Annual Review of Clinical Psychology, 6*, 285–312. https://doi.org/10.1146/annurev.clinpsy.121208.131305.

Gotlib, I. H., McLachlan, A. L., & Katz, A. N. (1988). Biases in visual attention in depressed and nondepressed individuals. *Cognition & Emotion, 2*(3), 185–200. https://doi.org/10.1080/02699938808410923.

Hallion, L. S., & Ruscio, A. M. (2011). A meta-analysis of the effect of cognitive bias modification on anxiety and depression. *Psychological Bulletin, 137*(6), 940–958. https://doi.org/10.1037/a0024355.

Hertel, P. T., & Mathews, A. (2011). Cognitive bias modification: Past perspectives, current findings, and future applications. *Perspectives on Psychological Science, 6*(6), 521–536. https://doi.org/10.1177/1745691611421205.

Hewson, C. (2003). Conducting research on the internet. *Psychologist, 16*(6), 290–293.

Jones, E. B., & Sharpe, L. (2017). Cognitive bias modification: A review of meta-analyses. *Journal of Affective Disorders, 223*, 175–183. https://doi.org/10.1016/j.jad.2017.07.034.

Joormann, J., & Gotlib, I. H. (2006). Is this happiness I see? Biases in the identification of emotional facial expressions in depression and social phobia. *Journal of Abnormal Psychology, 115*, 705–714. https://doi.org/10.1037/0021-843x.115.4.705.

Joormann, J., Gilbert, K., & Gotlib, I. H. (2010). Emotion identification in girls at high risk for depression. *Journal of Child Psychology and Psychiatry, 51*, 575–582. https://doi.org/10.1111/j.1469-7610.2009.02175.x.

Klawohn, J., Bruchnak, A., Burani, K., Meyer, A., Lazarov, A., Bar-Haim, Y., & Hajcak, G. (2020). Aberrant attentional bias to sad faces in depression and the role of stressful life events: Evidence from an eye-tracking paradigm. *Behaviour Research and Therapy, 135*. https://doi.org/10.1016/j.brat.2020.103762 103762.

Koster, E. H., De Lissnyder, E., Derakshan, N., & De Raedt, R. (2011). Understanding depressive rumination from a cognitive science perspective: The impaired disengagement hypothesis. *Clinical Psychology Review, 31*(1), 138–145. https://doi.org/10.1016/j.cpr.2010.08.005.

Koster, E. H., De Raedt, R., Leyman, L., & De Lissnyder, E. (2010). Mood-congruent attention and memory bias in dysphoria: Exploring the coherence among information-processing biases. *Behaviour Research and Therapy, 48*(3), 219–225. https://doi.org/10.1016/j.brat.2009.11.004.

Kraut, R., Olson, J., Banaji, M., Bruckman, A., Cohen, J., & Couper, M. (2004). Psychological research online: Report of Board of Scientific Affairs' Advisory Group on the Conduct of Research on the Internet. *American Psychologist, 59*(2), 105–117. https://doi.org/10.1037/0003-066X.59.2.105.

Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine, 16*(9), 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x.

Lazarov, A., Abend, R., & Bar-Haim, Y. (2016). Social anxiety is related to increased dwell time on socially threatening faces. *Journal of Affective Disorders, 193*, 282–288. https://doi.org/10.1016/j.jad.2016.01.007.

Lazarov, A., Basel, D., Dolan, S., Dillon, D. G., Pizzagalli, D. A., & Schneier, F. R. (2021). Increased attention allocation to socially threatening faces in social anxiety disorder: A replication study. *Journal of Affective Disorders, 290*, 169–177. https://doi.org/10.1016/j.jad.2021.04.063.

Lazarov, A., Ben-Zion, Z., Shamai, D., Pine, D. S., & Bar-Haim, Y. (2018). Free viewing of sad and happy faces in depression: A potential target for attention bias modification. *Journal of Affective Disorders, 238*, 94–100. https://doi.org/10.1016/j.jad.2018.05.047.

Lazarov, A., Pine, D. S., & Bar-Haim, Y. (2017). Gaze-contingent music reward therapy for social anxiety disorder: A randomized controlled trial. *American Journal of Psychiatry, 174*(7), 649–656. https://doi.org/10.1176/appi.ajp.2016.16080894.

Lazarov, A., Segal, A., & Bar-Haim, Y. (2018). Cognitive training and technology in the treatment of children and adolescents. In T. H. Ollendick, S. W. White, & B. A. White (Eds.), *The Oxford handbook of clinical child and adolescent psychology*. Oxford University Press. Oxford University Press.

Lazarov, A., Suarez-Jimenez, B., Tamman, A., Falzon, L., Zhu, X., Edmondson, D. E., & Neria, Y. (2019). Attention to threat in posttraumatic stress disorder as indexed by eye-tracking indices: A systematic review. *Psychological Medicine, 49*(5), 705–726. https://doi.org/10.1017/S0033291718002313.

Lazarov, A., Suarez-Jimenez, B., Zhu, X., Pine, D. S., Bar-Haim, Y., & Neria, Y. (2021). Attention allocation in posttraumatic stress disorder: An eye-tracking study. *Psychological Medicine*, 1–10. https://doi.org/10.1017/S0033291721000581.

LeMoult, J., & Gotlib, I. H. (2019). Depression: A cognitive perspective. *Clinical Psychology Review, 69*, 51–66. https://doi.org/10.1016/j.cpr.2018.06.008.

LeMoult, J., Joormann, J., Sherdell, L., Wright, Y., & Gotlib, I. H. (2009). Identification of emotional facial expressions following recovery from depression. *Journal of Abnormal Psychology, 118*, 828–833. https://doi.org/10.1037/a0016944.

Leppänen, J. M., Milders, M., Bell, J. S., Terriere, E., & Hietanen, J. K. (2004). Depression biases the recognition of emotionally neutral faces. *Psychiatry Research, 128*(2), 123–133. https://doi.org/10.1016/j.psychres.2004.05.020.

Lilienfeld, S. O., & Strother, A. N. (2020). Psychological measurement and the replication crisis: Four sacred cows. *Canadian Psychology/Psychologie canadienne, 61*(4), 281–288. https://doi.org/10.1037/cap0000236.

Lu, S., Xu, J., Li, M., Xue, J., Lu, X., Feng, L., Fu, B., Wang, G., Zhong, N., & Hu, B. (2017). Attentional bias scores in patients with depression and effects of age: A controlled, eye-tracking study. *Journal of International Medical Research, 45*(5), 1518–1527. https://doi.org/10.1177/0300060517708920.

Lundqvist, D., Flykt, A., & Öhman, A. (1998). *The Karolinska Directed Emotional Faces – KDEF*. CD ROM from Department of Clinical Neuroscience, Psychology Section, Karolinska Institutet, ISBN 91-630-7164-9.

Manea, L., Gilbody, S., & McMillan, D. (2012). Optimal cut-off score for diagnosing depression with the Patient Health Questionnaire (PHQ-9): A meta-analysis. *Canadian Medical Association Journal, 184*(3), E191–E196. https://doi.org/10.1503/cmaj.110829.

Mathews, A., & MacLeod, C. (2005). Cognitive vulnerability to emotional disorders. *Annual Review of Clinical Psychology, 1*, 167–195. https://doi.org/10.1146/annurev.clinpsy.1.102803.143916.

Matthews, G. R., & Antes, J. R. (1992). Visual attention and depression: Cognitive biases in the eye fixations of the dysphoric and the nondepressed. *Cognitive Therapy and Research, 16*(3), 359–371. https://doi.org/10.1007/BF01183287.

Mayer, J. D., Gaschke, Y. N., Braverman, D. L., & Evans, T. W. (1992). Mood-congruent judgment is a general effect. *Journal of Personality and Social Psychology, 63*(1), 119–132. https://doi.org/10.1037/0022-3514.63.1.119.

McCabe, S. B., & Gotlib, I. H. (1995). Selective attention and clinical depression: Performance on a deployment-of-attention task. *Journal of Abnormal Psychology, 104*(1), 241–245. https://doi.org/10.1037/0021-843X.104.1.241.

McCabe, S. B., Gotlib, I. H., & Martin, R. A. (2000). Cognitive vulnerability for depression: Deployment of attention as a function of history of depression and current mood state. *Cognitive Therapy and Research, 24*(4), 427–444. https://doi.org/10.1023/A:1005579719849.

McNally, R. J. (2019). Attentional bias for threat: Crisis or opportunity? *Clinical Psychology Review, 69*, 4–13. https://doi.org/10.1016/j.cpr.2018.05.005.

Mogoaşe, C., David, D., & Koster, E. H. (2014). Clinical efficacy of attentional bias modification procedures: An updated meta-analysis. *Journal of Clinical Psychology, 70*(12), 1133–1157. https://doi.org/10.1002/jclp.22081.

Parsons, S., Kruijt, A. W., & Fox, E. (2019). Psychological science needs a standard practice of reporting the reliability of cognitive-behavioral measurements. *Advances in Methods and Practices in Psychological Science, 2*(4), 378–395. https://doi.org/10.1177/2515245919879695.

Peckham, A. D., McHugh, R. K., & Otto, M. W. (2010). A meta-analysis of the magnitude of biased attention in depression. *Depression and Anxiety, 27*(12), 1135–1142. https://doi.org/10.1002/da.20755.

Price, R. B., Greven, I. M., Siegle, G. J., Koster, E. H., & De Raedt, R. (2016). A novel attention training paradigm based on operant conditioning of eye gaze: Preliminary findings. *Emotion, 16*(1), 110–116. https://doi.org/10.1037/emo0000093.

Richards, H. J., Benson, V., Donnelly, N., & Hadwin, J. A. (2014). Exploring the function of selective attention and hypervigilance for threat in anxiety. *Clinical Psychology Review, 34*(1), 1–13. https://doi.org/10.1016/j.cpr.2013.10.006.

Russell, J. A., & Fehr, B. (1987). Relativity in the perception of emotion in facial expressions. *Journal of Experimental Psychology: General, 116*(3), 223–237. https://doi.org/10.1037/0096-3445.116.3.223.

Sanchez-Lopez, A., Koster, E. H., Van Put, J., & De Raedt, R. (2019). Attentional disengagement from emotional information predicts future depression via changes in ruminative brooding: A five-month longitudinal eye-tracking study. *Behaviour Research and Therapy, 118*, 30–42. https://doi.org/10.1016/j.brat.2019.03.013.

Sanchez, A., Romero, N., & De Raedt, R. (2017). Depression-related difficulties disengaging from negative faces are associated with sustained attention to negative feedback during social evaluation and predict stress recovery. *PloS One, 12*(3). https://doi.org/10.1371/journal.pone.0175040 e0175040.

Sanchez, A., & Vazquez, C. (2014). Looking at the eyes of happiness: Positive emotions mediate the influence of life satisfaction on attention to happy faces. *The Journal of Positive Psychology, 9*(5), 435–448. https://doi.org/10.1080/17439760.2014.910827.

Sanchez, A., Vazquez, C., Marker, C., LeMoult, J., & Joormann, J. (2013). Attentional disengagement predicts stress recovery in depression: An eye-tracking study. *Journal of Abnormal Psychology, 122*(2), 303–313. https://doi.org/10.1037/a0031529.

Sears, C., Quigley, L., Fernandez, A., Newman, K., & Dobson, K. (2019). The reliability of attentional biases for emotional images measured using a free-viewing eye-tracking paradigm. *Behavior Research Methods, 51*(6), 2748–2760. https://doi.org/10.3758/s13428-018-1147-z.

Shamai-Leshem, D., Lazarov, A., Pine, D. S., & Bar-Haim, Y. (2020). A randomized controlled trial of gaze-contingent music reward therapy for major depressive disorder. *Depression and Anxiety, 38*(2), 134–145. https://doi.org/10.1002/da.23089.

Shane, M. S., & Peterson, J. B. (2007). An evaluation of early and late stage attentional processing of positive and negative information in dysphoria. *Cognition and Emotion, 21*(4), 789–815. https://doi.org/10.1080/02699930600843197.

Skinner, I. W., Hübscher, M., Moseley, G. L., Lee, H., Wand, B. M., Traeger, A. C., Gustin, S. M., & McAuley, J. H. (2018). The reliability of eyetracking to assess attentional bias to threatening words in healthy individuals. *Behavior Research Methods, 50*(5), 1778–1792. https://doi.org/10.3758/s13428-017-0946-y.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the state-trait anxiety inventory*. Consulting Psychologists Press.

Speilberger, C. D., & Vagg, P. R. (1984). Psychometric properties of the STAI: A reply to Ramanaiah, Franzen, and Schill. *Journal of Personality Assessment, 48*(1), 95–97. https://doi.org/10.1207/s15327752jpa4801_16.

Surguladze, S. A., Young, A. W., Senior, C., Brébion, G., Travis, M. J., & Phillips, M. L. (2004). Recognition accuracy and response bias to happy and sad facial expressions in patients with major depression. *Neuropsychology, 18*(2), 212–218. https://doi.org/10.1037/0894-4105.18.2.212.

Suslow, T., Hußlack, A., Kersting, A., & Bodenschatz, C. M. (2020). Attentional biases to emotional information in clinical depression: A systematic and meta-analytic review of eye tracking findings. *Journal of Affective Disorders, 274*, 632–642. https://doi.org/10.1016/j.jad.2020.05.140.

Tottenham, N., Tanaka, J. W., Leon, A. C., McCarry, T., Nurse, M., Hare, T. A., Marcus, D. J., Westerlund, A., Casey, B. J., & Nelson, C. (2009). The NimStim set of facial expressions: Judgments from untrained research participants. *Psychiatry Research, 168*(3), 242–249. https://doi.org/10.1016/j.psychres.2008.05.006.

Van Vleet, T., Stark-Inbar, A., Merzenich, M. M., Jordan, J. T., Wallace, D. L., Lee, M. B., Dawes, H. E., Chang, E. F., & Nahum, M. (2019). Biases in processing of mood-congruent facial expressions in depression. *Psychiatry Research, 275*, 143–148. https://doi.org/10.1016/j.psychres.2019.02.076.

Waechter, S., Nelson, A. L., Wright, C., Hyatt, A., & Oakman, J. (2014). Measuring attentional bias to threat: Reliability of dot probe and eye movement indices. *Cognitive Therapy and Research, 38*(3), 313–333. https://doi.org/10.1007/s10608-013-9588-2.

Wermes, R., Lincoln, T. M., & Helbig-Lang, S. (2017). How well can we measure visual attention? Psychometric properties of manual response times and first fixation latencies in a visual search paradigm. *Cognitive Therapy and Research, 41*(4), 588–599. https://doi.org/10.1007/s10608-016-9830-9.

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