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Attention bias in adults with anorexia nervosa, obsessive-compulsive disorder, and social anxiety disorder

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Abstract

Background—Attention bias to threat (selective attention toward threatening stimuli) has been frequently found in anxiety disorder samples, but its distribution both within and beyond this category is unclear. Attention bias has been studied extensively in social anxiety disorder (SAD) but relatively little in obsessive compulsive disorder (OCD), historically considered an anxiety disorder, or anorexia nervosa (AN), which is often characterized by interpersonal as well as body image/eating fears.

Methods—Medication-free adults with SAD (n=43), OCD (n=50), or AN (n=30), and healthy control volunteers (HC, n=74) were evaluated for attention bias with an established dot probe task presenting images of angry and neutral faces. Additional outcomes included attention bias variability (ABV), which summarizes fluctuation in attention between vigilance and avoidance, and has been reported to have superior reliability. We hypothesized that attention bias would be elevated in SAD and associated with SAD severity.

Results—Attention bias in each disorder did not differ from HC, but within the SAD group attention bias correlated significantly with severity of social avoidance. ABV was significantly

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Contributors

All authors materially participated in the research and/or article preparation, and all authors have approved the final article should be true and included in the disclosure.

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lower in OCD versus HC, and it correlated positively with severity of OCD symptoms within the OCD group.

Conclusions—Findings do not support differences from HC in attention bias to threat faces for SAD, OCD, or AN. Within the SAD sample, the association of attention bias with severity of social avoidance is consistent with evidence that attention bias moderates development of social withdrawal. The association of ABV with OCD diagnosis and severity is novel and deserves further study.

Keywords

attention bias; threat bias; dot probe; social anxiety disorder; obsessive compulsive disorder; anorexia nervosa

Introduction

Biased processing of threatening stimuli has long been hypothesized to play a major role in the development and maintenance of anxiety disorders (Beck and Clark, 1997; Matthews et al, 1997), and modification of attention bias is an active area of treatment development (Kuckertz and Amir, 2015). Recent models and data suggest that anxious individuals both allocate increased attention toward threat and experience difficulty disengaging from threats during the early automatic stages of threat processing, but avoid threat stimuli over longer intervals (Mogg et al., 2004; Cisler and Koster, 2011; Sylvester et al., 2015). Although studies of group differences in attention bias have yielded mixed results, meta-analyses (Bar Haim et al, 2007) demonstrate a significant attention bias toward threat stimuli in persons with anxiety disorders and nonclinical samples with high anxiety, particularly trait anxiety. Attention bias to threat has increasingly been called a common feature of anxiety disorders (Rosso et al., 2015). This study examined whether attention bias occurs across disorders all characterized by high levels of anxiety.

The diagnostic specificity of attention bias to threat, both within anxiety disorders and beyond anxiety disorders, remains unclear. Some anxiety disorders have been relatively little-studied, and studies of depression and other disorders suggest that attention bias to threat may extend beyond anxiety disorders (e.g. Hommer et al, 2015; Matthews et al., 1996). Most studies have been confined to a single disorder, however, limiting ability to compare attention bias across disorders.

Another methodological issue in the mapping of attention bias to psychopathology relates to content specificity of threat stimuli. Many studies have used disorder-congruent threat stimuli, such as trauma-related words in persons with PTSD. In a recent meta-analysis, Pergamin-Hight and colleagues (2015) found that disorder-congruent threat stimuli in general do elicit significantly more attention bias than generic stimuli. A drawback of using disorder-related threat stimuli, however, is that findings are difficult to compare across disorders.

Comparison of attention bias findings across single-disorder studies has also been complicated by the use of different assessment tasks. Most widely accepted is the visual dot

probe task (Macleod et al., 1986), in which a threat stimulus and a neutral stimulus are briefly presented simultaneously, followed by appearance of a probe in place of one of the stimuli. Participants must rapidly identify the location of the probe. Attention bias is evidenced by relatively faster response times to probes that replace the threat stimulus. The dot probe task, however, has been criticized for poor reliability (Schmukle, 2005; Kappenman et al., 2014).

Price et al (2015) recently reported improved test-retest reliability in SAD using several modified analytic methods, with particularly superior reliability for use of the alternative outcome measure **attention bias variability (ABV)**, a measure of intra-individual trial-to-trial variability in reaction times. ABV reflects the extent to which attention to threat varies over time during a testing session (Iacovello et al., 2014). Whereas assessments of attention bias have historically tended to conceptualize attention bias as a stable trait that can be described by the mean value of reaction times over repeated presentations, ABV captures the extent to which attention to threat stimuli actually fluctuates. The theoretical framework for the ABV's role in attention is not yet well developed, but if ABV is confirmed as a reliable measure associated with clinical features and outcomes, it could complement attention bias in the assessment of attention to threat stimuli and as a target for attention modification therapies (Badura-Brack et al., 2015). ABV outcomes have been reported in only several studies to date, finding ABV to be elevated in PTSD (Iacovello et al., 2014; Naim et al., 2015), but not in SAD relative to healthy subjects (Naim et al., 2015).

This study aimed to investigate the specificity of attention bias across four samples: a prototypical anxiety disorder (social anxiety disorder (SAD), two other psychiatric disorders (anorexia nervosa (AN) and obsessive compulsive disorder (OCD)), and healthy control volunteers (HC). Attention bias was assessed using a visual dot probe paradigm with angry face threat stimuli. SAD was chosen because it is one of the disorders best-established to be associated with biased attention toward threat. A recent meta-analysis of ten studies of individuals with high social anxiety or SAD found a small-to-medium effect size for greater vigilance toward threatening faces (Bantini et al., 2015). Angry faces are particularly salient for SAD, a disorder characterized by fear of negative evaluation, but these emotional face stimuli also have been used as a nonspecific threat across other populations (e.g. Peckham et al., 2016; Salum et al., 2013; Yiend et al., 2015). In other disorders, it has not been shown whether attention bias to threat faces, if present, is a correlate of disorder severity or specifically related to severity of co-occurring social anxiety or trait anxiety.

The two other disorders studied here, OCD and AN, have prominent anxiety symptoms but have been relatively little studied in respect to attention bias to nonspecific threat. In OCD, historically considered an anxiety disorder, attention bias has been reported in some studies using OCD-specific stimuli (e.g., personally relevant threat words and images; Morein-Zamir et al., 2013), but threat faces have not been studied. In AN, often characterized by interpersonal fears in addition to eating and body image fears, two studies found attention bias to angry faces using a Stroop task, but none have utilized the visual dot probe with angry face stimuli (Aspen et al., 2013).

We hypothesized that attention bias to threat faces would be increased in SAD relative to HC participants and associated with social anxiety symptom severity within the SAD group and across the whole sample. We also examined whether attention bias was abnormal in AN and OCD, and whether it was related dimensionally to severity of each respective disorder, to social anxiety symptoms, or to two other features that have been associated with attention bias: depression and trait anxiety (Matthews et al., 1996; Bar Haim et al., 2007). The dot probe task was analyzed for attention bias using both standard methods and novel analytic methods that have been reported to have superior reliability (Price et al., 2015). We explored whether the novel ABV measure differed between groups but did not anticipate differences.

Methods

Study Description

The data reported here come from a study conducted at the New York State Psychiatric Institute/Columbia University Medical Center. Its overall aim was to determine whether well-validated neurobehavioral probes of different neural processes could help explain similarities and differences in phenotype across individuals with AN, OCD, and SAD. This report describes data collected on a dot probe task as a measure of attention bias to threat faces. This investigation was carried out in accordance with the latest version of the Declaration of Helsinki, the Institutional Review Board of New York State Psychiatric Institute approved this study, and participants provided written informed consent after the nature of the procedures had been fully explained.

Participants

Adults aged 18–50 years with a principal diagnosis of SAD, OCD, or AN, and HC were recruited via media notices and referrals from health professionals. Diagnoses were made by a psychiatrist and confirmed by a trained rater (MD or PhD) using the Structured Clinical Interview for DSM-IV (First and Spitzer, 1996). HC had no lifetime Axis I psychiatric disorders. AN participants could have comorbid OCD or SAD of lesser severity, due to the common co-occurrence of AN with these disorders (Hudson et al., 2007). Other current comorbid Axis I disorders, except for specific phobias or tic disorders, were exclusionary. Individuals with AN were inpatients with a body mass index (BMI) between 16.0 kg/m²–18.5 kg/m² at the start of study procedures (to minimize effects of extreme starvation on performance). Participants were free of psychiatric medication for at least four weeks (six weeks for fluoxetine), with the exception of one participant who took one dose of lorazepam two weeks prior to testing.

Additional exclusion criteria included: lifetime psychotic disorder, bipolar disorder, mental retardation, attention deficit hyperactivity disorder, or primary hoarding; use of medication affecting the central nervous system; inability to refrain from caffeine for four hours prior to study without withdrawal symptoms; habitual tobacco use (more than five cigarettes per day or inability to refrain from smoking for 24 hours prior to study without withdrawal symptoms); medical or neurological problems that could interfere with study performance or interpretation; and active suicidal ideation. Women who were pregnant, nursing, postmenopausal, or using hormonal methods of birth control were excluded. All but three

AN participants were amenorrheic. To reduce potential confounds of hormonal status, menstruating women were tested in the first week of their cycle.

Clinical Assessment

All participants completed the same battery of clinical assessments. Clinical measures assessed severity of each index disorder and depression, and other features previously associated with attention bias. Clinician-administered measures were given by a PhD-level psychologist. SAD severity was assessed with the clinician-administered Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987), which assesses fear and avoidance in social and performance situations, yielding a total score, and fear and avoidance subscale scores. OCD severity was assessed with the clinician-administered Yale-Brown Obsessive Compulsive Scale (Y-BOCS; Goodman et al., 1989a), which includes subscales for obsessions and of compulsions. The Y-BOCS and the LSAS have strong psychometric properties (Goodman et al., 1989a,b; Heimberg, et al, 1999). Eating disorder symptoms were assessed with the Eating Disorder Examination Questionnaire (EDE-Q; Cooper and Fairburn, 1987), a self-report measure with subscales related to restraint, eating concern, shape concern, and weight concern.

Other self-report measures were the Quick Inventory of Depressive Symptomatology (QIDS; Rush et al., 2003) to assess severity of depression, and the State Trait Anxiety Inventory – Trait Anxiety Scale (STAI-Trait; Spielberger et al., 1983). State anxiety and especially trait anxiety have been associated with increased attention bias to threat (Bar Haim et al., 2007). The EDE-Q, STAI, and QIDS have good psychometric properties (Cooper et al., 1989; Rush et al., 2003; Spielberger et al., 1983). IQ was estimated with the North American Adult Reading Test (NAART; Blair and Spreen, 1989).

Dot Probe Task and Data Processing

The dot probe task was obtained from the Tel Aviv University - National Institute of Mental Health Attention Bias Measurement Toolbox (<http://people.socsci.tau.ac.il/mu/anxietytrauma/research/>), designed to foster standardized attention bias measurements for an international database. In each trial of this computerized task, the participant was presented with a fixation cross (500ms), followed by a pair of face pictures of the same individual, one angry and one neutral, or both neutral, presented one above the other (500ms), followed by a small visual probe arrow in the location vacated by one of the face pictures (until response, see Figure 1). Face stimuli were photographs of 20 individuals (10 male, 10 female). Nineteen were taken from the NimStim stimulus set (Tottenham, et al., 2009), and one from the Matsumoto and Ekman set (Matsumoto & Ekman, 1989). All faces were placed on a background as in the Matsumoto and Ekman set. Two pictures of each individual, showing angry and neutral expressions, were used. The photographs were positioned equidistant (14mm) from the fixation cross, with the top photograph 20mm from the top edge of the screen. Each face photograph subtends 45mm in width and 34 mm in height.

Participants were read instructions to respond as quickly as possible, without compromising accuracy, by pressing a key corresponding to the direction in which the probe pointed. Response was followed by an inter-trial interval (500ms) of a white rectangle on the black

background. Each subject completed 120 trials (80 angry-neutral and 40 neutral-neutral presentations). Angry-face location, probe location, probe type, and identity of the face were counterbalanced. If the participant achieved less than 70% accuracy on the first 10 trials, the program displayed a warning and the experiment was aborted. The participant was then rebriefed, and data collection was re-initiated.

For primary analyses of attention bias to threat, data was processed as previously described (Roy et al., 2008). Response times (RTs) from the angry-neutral trials were analyzed. To maintain data integrity, trials were excluded for an incorrect response or if they were response time outliers. Outlier trials were defined by an RT that was extremely short ($<150\text{ms}$) or long ($>2000\text{ms}$), indicating possible failure to follow task instructions, or trials in which the RT was >2.5 SDs outside of the participant's mean for each condition (angry or neutral face) (O'Toole and Dennis, 2012). Attention bias score was calculated as the mean difference between RT to probes replacing neutral faces and RT to probes replacing angry faces. Greater attention bias to threat is indicated by briefer mean RT to angry faces relative to neutral faces, resulting in greater attention bias score. Sensitivity analyses of attention bias scores were performed using two methods that were recently reported to yield increased test-retest reliability (Price et al., 2015): 1) analysis of only those trials with the probe appearing in place of the bottom image (reducing variance related to spatial influences), and 2) rescaling response time outlier trials (rather than excluding them) by reassigning values to the nearest value within the valid (nonoutlying) distribution.

An alternative outcome measure, attention bias variability (ABV), has recently been described by others (Iacovelli et al., 2014; Naim et al., 2015; Price et al., 2015) and was also computed here. For analyses of ABV, dot probe task data for each individual were analyzed as previously described (Naim et al., 2015), using a moving average algorithm to compute attention bias scores for each successive 10-trial block throughout an individual's session. Attention bias scores were first calculated for the blocks containing trials 1–10, 2–11, 3–12, etc. The standard deviation of these successive bias scores was then calculated, as a measure of variation in attention bias for the session as a whole. This index of variation was then divided by the participant's mean response time in the session, to control for any associations between mean and variance. Greater ABV reflects greater within-individual variability of attention bias to threat, normalized to the individual's task performance (Iacovelli et al., 2014).

Statistical Analysis

To test for group differences in demographic and clinical measures, one-way analysis of variance (ANOVA) was used for continuous measures and Fisher's Exact Test for categorical variables. One-way ANOVAs were also used to assess differences between groups in RT (attention bias to threat) and ABV. Preplanned pairwise contrasts compared means for each diagnostic group with HC. Because the AN group differed markedly in sex and race/ethnicity, comparisons of AN with HC groups controlled for group differences in sex and race/ethnicity. Sensitivity analyses comparing AN females to HC females and AN white females to HC white females did not change significance of findings, and are reported in the Supplementary Material. Within each group, one sample t-tests were used to

determine if mean attention bias differed significantly from zero. Statistical significance was defined as $p < .05$. Effect sizes (Cohen's d) for group differences were calculated by dividing the differences in mean RT or mean ABV by the respective standard deviation in the overall sample.

Spearman correlations were used to estimate associations of RT and ABV, respectively, with dimensional measures within each disorder group and across the full sample. Additionally, multiple regressions were performed with attention bias and ABV as the outcomes, including as predictors all clinical variables found to be significantly different between diagnostic groups. Analyses were performed using SAS version 9.3.

Results

Clinical features

Of 217 participants (55 OCD, 30 AN, 53 SAD, and 79 HC) accepted into the parent study, 8 (5 SAD, 2 OCD, 1 HC) were excluded from analyses because participant did not return after consenting or did not complete dot probe task, 3 (1 SAD, 2 HC) due to toxicology screen positive for drug of abuse, 7 (3 SAD, 3 OCD, 1 HC) due to being found to meet an exclusion criterion during participation, and 2 (1 SAD, 1 HC) due to technical problems with task. The final sample included 197 participants (50 OCD, 30 AN, 43 SAD, and 74 HC) who completed the dot probe task with analyzable data.

Specific phobia was comorbid in 13 participants (four OCD, six AN, and three SAD) and tic disorder in six (four OCD and two AN). Additionally, in the AN group four participants had comorbid OCD and eight had SAD. Analyses were re-run two ways: 1) excluding any participants with comorbid specific phobia or tic disorders; and 2) excluding AN participants with comorbid OCD or SAD. The general pattern of results did not change, so all participants with analyzable data are included in results presented below.

Demographic and clinical features are shown in Table 1. Groups did not differ in age, estimated IQ, or years of education, but differed in sex and race/ethnicity due to the AN group being predominantly composed of white women. Excluding the AN participants, diagnostic groups did not differ in sex or race/ethnicity. Diagnostic groups differed on symptom severity of index disorder as expected. Mean level of social anxiety was moderate to severe in the SAD group, and the AN group also had a mean level of social anxiety severity within the clinical range (Mennin et al., 2002). AN participants also reported the highest levels of trait anxiety and depression (all $p < .001$ for comparisons with each of the other groups).

Attention bias and attention bias variability

Rates of exclusion of dot probe trials (due to outlier values or incorrect response), were 3.1% for HC, 2.2% for SAD, 1.8% for OCD, and 2.9% for AN; only the OCD group's rate was significantly lower than the HC group rate ($t=2.35$, $df=193$, $p = .02$). This was primarily because the OCD group's rate of trials excluded due to incorrect response was significantly lower than the HC group's ($t=2.55$, $df=193$, $p = .01$); there were no group differences in rate

of trials excluded for outlier values. Attention bias scores and ABV were not significantly associated with age, sex, or race (all $p > .12$).

Mean attention bias scores (RT) of each diagnostic group did not differ from the HC group (see Table 2). Within each group, RT did not differ from 0 (i.e. no significant bias, all $p > .17$). Limiting the SAD analyses to the subgroup with LSAS total scores >60 ($n = 34$), indicative of the generalized subtype of SAD (Mennin et al., 2002), did not change the pattern or significance of these findings. A sensitivity analysis that reanalyzed these data for attention bias as described in the Methods (i.e. following the recommendations of Price et al. 2015) did not yield meaningfully different results (see Supplementary Materials for details). Exclusion of outliers ($n=3$) with attention bias scores > 3 SD from the mean did not change significance of any findings.

Within the SAD group, RT was significantly correlated with greater severity of social avoidance ($r_s = .31$, $p = .045$) but was not significantly correlated with social fear ($r_s = .10$, $p = .53$) or overall severity of SAD ($r_s = .25$, $p = .12$). Within OCD and AN groups, RT was not correlated with severity of either index disorder (both $p > .20$). Across all participants, RT was not significantly correlated with severity of social anxiety disorder symptoms, trait anxiety, or depression (all $p > .12$). Additionally, in a multiple regression simultaneously including predictors of gender, race, LSAS, YBOCS, EDE, QIDS, and STAI (i.e. the variables found to be significantly different across diagnostic group), we found none of these variables to be significantly associated with threat bias (all $p > 0.13$) nor with threat bias variability (all $p > 0.11$).

In the analyses of dot probe outcome for attention bias variability (ABV), the only group differing from HC was the OCD group, with decreased ABV ($p = .037$, see Table 2). Within the OCD group there was a trend for ABV and OCD severity (YBOCS total) to be positively correlated ($r_s = .27$, $p = .06$). The SAD group had the same mean and SD values for ABV as the OCD group, but findings were not statistically significant in the smaller SAD sample. Within the SAD group ABV was not correlated with severity of SAD, social fear, or social avoidance (all $p > .54$). Within the AN group ABV was correlated negatively with severity of eating disorder symptoms on the EDE-Q ($r_s = -.46$, $p = .010$). Across all participants, ABV was not correlated with severity of social anxiety, trait anxiety, or depression (all $p > .27$). Scatterplots of attention bias and ABV values for each subject by group in shown in Figures 2 and 3. All ABV scores were within 3 SD of the mean.

Discussion

Attention bias to threat faces, as assessed in this study by a dot probe task, was not significantly associated with categorical diagnosis of SAD, OCD, or AN. The non-replication of prior findings of an association with SAD is consistent with meta-analytic evidence for only small to moderate effect size (Bantini et al, 2016) and variability across SAD studies. Sensitivity analyses of threat bias, using alternative methods that had been found more reliable in a prior SAD study, did not yield a consistent pattern of greater group differences.

A dimensional association of attention bias with SAD was partially supported here by the significant correlation of attention bias with severity of social avoidance (though not with severity of social fear or overall severity of SAD) within the SAD group. The association of attention bias with social avoidance in the SAD group is consistent with a series of studies showing that attention bias moderates the development of social withdrawal behavior. Specifically, children with a behaviorally inhibited temperament, characterized by a heightened sensitivity to novelty, social withdrawal, and anxious behaviors, are particularly likely to go on to develop SAD (Clauss and Blackford, 2012). Among children with behavioral inhibition, attention bias to threat moderates associations with concurrent social withdrawal behavior (Cole et al., 2016) and with later development of social withdrawal in childhood or adolescence (Perez-Edgar et al., 2010, 2011). Greater threat bias might predispose to avoidance behavior, and avoidance behavior might in turn serve to maintain threat bias by limiting opportunities for exposure that might attenuate bias. Over the whole sample in this study, attention bias was not significantly associated with dimensional measures of social anxiety disorder symptoms, trait anxiety, or depression, suggesting that the previously demonstrated relationships of attention bias to these dimensions may be restricted to certain populations.

The negative outcome for attention bias in AN differs from two prior studies that reported attention bias to angry faces using a Stroop task (Aspen et al., 2013), but it is consistent with a study using the dot probe task with social threat word stimuli (Dipl-psych et al., 2014). Relative to the dot probe, the Stroop task has been noted to have disadvantages, including that delays in response to threat stimuli may be due to increased attention as well as general delays in response to threat (Algom et al., 2004), and inability to assess allocation of spatial attention (MacLeod et al., 1986). The negative finding for attention bias in OCD represents the first using threat faces with a dot probe task in this disorder. If confirmed it would support the case for the distinctiveness of OCD, which often involves emotions of disgust or shame, from fear-centered anxiety disorders (Stein et al., 2010). Preliminary data in OCD patients have suggested promise for treatment with attention bias modification away from disgust stimuli (Riemann et al., 2013).

ABV was significantly decreased in the OCD group here, indicating a greater trial-to-trial consistency in their relative attention to angry versus neutral faces. In combination with the finding that the OCD group had significantly fewer dot probe trials excluded for outlier response times and incorrect responses, this may suggest that both of these findings to some extent reflect greater task effort on the part of participants with OCD, rather than specific differences in threat processing. Within the OCD group, however, ABV was positively correlated with OCD severity. Greater levels of OCD severity have been associated in some studies with greater neuropsychological impairment of performance and executive functions (Abramovitch et al., 2011), which could contribute to the greater variability in reaction times seen here. In contrast, greater severity of AN was associated with lower ABV although mean ABV did not differ in AN compared to HC. ABV has not been previously assessed in OCD or AN, and these first reports differences in OCD, and divergent associations with disorder severity require replication.

The SAD and OCD groups had the same lower mean ABV relative to the HC group, but this difference was not statistically significant in the smaller SAD sample. It remains unclear, therefore, whether this reflects no true difference between SAD and HC groups, or insufficient power to detect such a decrease in this study. A finding of no difference in ABV for the SAD group relative to HC would replicate the prior report of ABV in SAD (Naim et al., 2015). In that study mean ABV in SAD patients (n=91) was identical to the mean values in high trait anxiety (n=21) and normative (n=70) samples of students, as well as in healthy combat-exposed US Army soldiers (n=81), but ABV was increased in PTSD subjects (n=69). Whereas the SAD sample in this study was unmedicated, medication status for the SAD group in Naim et al. (2015) was not specified. One other study has also reported threat-related ABV to be elevated in PTSD, relative to trauma-exposed non-PTSD and HC groups (Iacovelli et al., 2014). Both of these studies reported significant positive correlations of ABV with PTSD severity. On this basis, elevated ABV has been proposed as a cognitive marker for PTSD, and it has been hypothesized that trauma-induced response patterns of excessive attention to threat, coupled with attentional avoidance that temporarily relieves anxiety, contribute to increased ABV (Naim et al., 2015). Similar conflicts, however, have been shown to exist in other anxiety conditions (Mogg et al., 2004; Cisler and Koster, 2011; Sylvester et al., 2015). Further study is needed to clarify the scope and meaning of differences in ABV across PTSD and other disorders.

Findings of attention bias toward threat in anxious individuals have led in recent years to the testing of a variety of attention bias modification treatments of anxiety disorders, with only mixed results (Heeren et al., 2015). Our findings suggest that a diagnosis of SAD, OCD, or AN alone is not an adequate clinical predictor of attention bias, so membership in these diagnostic groups may be an inefficient way to identify persons who would benefit from attention bias modification. Within-diagnosis heterogeneity must be taken into account. The clinical implications of our findings of low mean ABV in OCD and possibly in SAD are unclear. In PTSD, which has been associated with high ABV, a recent report found efficacy for an attention control training treatment that aims to balance attention to threat and neutral stimuli, rather than to counteract a bias (Badura-Brack, et al., 2015). Future work should clarify whether low ABV reflects a problematic attentional rigidity whose modification by a similar balancing approach might be beneficial, or an adaptive compensatory mechanism that should not be modified.

This study has several methodological strengths. Specifically, the SAD sample was the largest reported to date to be assessed for attention bias using a dot probe task. This was the first study in AN and OCD to use a dot probe task with emotional face stimuli to assess attention bias and ABV. Samples were well-defined by structured interviews, low in comorbidity, and all participants were free of psychiatric medication. All menstruating women were tested within the first week of their menstrual cycle to control for hormonal effects. The study utilized an established dot probe task that was conducted and analyzed using identical methods across the three psychiatric disorders and HC. The participants performed the task as expected, with few outlier trials excluded.

Limitations include the AN sample's relatively small size, demographic distinctiveness, and inclusion of 12 subjects with comorbid SAD and OCD. For group contrasts, the sample sizes

yielded 80% power to detect effects sizes between 0.51 and 0.61, depending on the group. As mentioned above, the dot probe task has been criticized for its limited reliability, and recent findings suggest that the 500ms exposure duration used in this study and common to many attention bias dot probe studies may be too long to optimally capture vigilance effects in SAD (Bantini et al., 2016). Also, although use of the dot probe as a sole task to assess attention bias has been common in prior studies, it may capture only one aspect of attention bias. Combination of the dot probe task with potentially complementary assessments, such as eye tracking, may yield a more complete picture of differences in attentional processes (Cisler and Koster, 2010; Sigurjónsdóttir et al., 2015). The use of threat faces as a probe may have lacked salience for subjects with OCD and AN, and this study did not address whether attention biases exist for disorder-congruent stimuli in these groups.

The absence of a significant association of attention bias with SAD and with overall severity of SAD, in a sample of greater than 40 SAD participants and a larger HC comparison group, provides more evidence that attention bias to threat, as measured by this dot probe task, has low predictive power for this diagnosis. Previous associations of trait anxiety with attention bias were also not supported, consistent with relatively low strength of these associations. Findings here and in the literature as a whole suggest that reifying attention bias as a major factor in “fear circuitry disorders” such as SAD is premature. Further task development is needed to enhance reliability and validity of attention bias assessments, and deployment of standardized tasks across multiple sites and samples, an aim of the Tel Aviv University - National Institute of Mental Health Attention Bias Measurement Toolbox utilized in this study, will facilitate mapping of the generalizability of findings.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Sequence of Events in a Single Dot-probe Attention Task Trial.

Figure 2.
Scatterplot of Attention Bias (ms) and Mean Attention Bias by Diagnosis

Figure 3. Scatterplot of Attention Bias Variability and Mean Attention Bias Variability by Diagnosis

Table 1

Demographics and Clinical Characteristics

	HC n=74 Mean (SD)	OCD n=50 Mean (SD)	AN n=30 Mean (SD)	SAD n=43 Mean (SD)	p ^{a,b}
Age	28.9 (7.6)	29.2 (5.9)	26.9 (7.5)	29.9 (7.5)	0.37
Sex (n, % Female)	38 (51%)	25 (50%)	29 (97%)	23 (53%)	<.001
Race/Ethnicity (n, %)					0.004
Non-Hispanic White	42 (57%)	25 (50%)	29 (97%)	17 (39%)	
Hispanic White	11 (15%)	8 (16%)	1 (3%)	10 (23%)	
Asian	5 (7%)	4 (8%)	0	5 (12%)	
Black	15 (20%)	12 (24%)	0	7 (16%)	
Other	1 (1%)	1 (2%)	0	4 (9%)	
Years of Education	15.7 (2.1)	15.4 (2.0)	14.8 (2.0)	15.7 (2.0)	0.23
Estimated IQ (NAART)	110.4 (9.1)	109.6 (8.5)	109.2 (8.5)	110.4 (7.7)	0.89
LSAS					
-Total	11.5 (8.0)	24.2 (16.7)	54.1 (26.1)	76.4 (19.8)	<.001
-Fear Subtotal	6.9 (4.2)	13.6 (9.4)	29.3 (13.6)	38.8 (9.3)	<.001
-Avoidance Subtotal	4.6 (4.4)	10.6 (7.9)	24.8 (13.2)	37.6 (11.5)	<.001
Y-BOCS – Total	0.3 (1.0)	25.1 (3.4)	11.4 (11.2)	3.2 (5.9)	<.001
EDE-Q – Global	0.5 (0.6)	1.0 (1.0)	3.6 (1.5)	0.9 (0.9)	<.001
QIDS – Total	2.3 (1.9)	5.7 (4.3)	12.9 (4.4)	5.6 (3.6)	<.001
STAI – Trait	31.4 (5.2)	43.4 (10.6)	54.9 (9.1)	48.2 (8.4)	<.001

Note. HC=Healthy Control Group, AN=Anorexia Nervosa Group, OCD=Obsessive Compulsive Disorder Group, SAD=Social Anxiety Disorder Group, NAART=North American Adult Reading Task, EDE-Q=Eating Disorder Examination Questionnaire, LSAS=Liebowitz Social Anxiety Scale, QIDS=Quick Inventory of Depressive Symptomatology, STAI=State Trait Anxiety Inventory, Y-BOCS=Yale-Brown Obsessive Compulsive Scale

^a p-value for ANOVA (Age, Education, Estimated IQ, LSAS, Y-BOCS, EDE-Q, QIDS, STAI) and Fisher's exact test (sex, race/ethnicity) for any group differences.

^b p-values for group differences excluding AN, who are all white females, are $p=0.96$ for sex, and $p=0.37$ for race/ethnicity.

Table 2

Attention Bias and Attention Bias Variability, by Group.

	Attention Bias (ms)			Attention Bias Variability		
	Comparisons to HC			Comparisons to HC		
	Mean (SD)	<i>t</i>	<i>p</i>	ES	Mean (SD)	<i>t</i> <i>p</i> ES
HC <i>n</i> =74	0.4 (21.6)	--	--	--	0.09 (0.03)	-- -- --
SAD <i>n</i> =43	3.3 (19.2)	0.70	.48	0.14	0.07 (0.04)	-1.68 .10 -0.32
OCD <i>n</i> =50	6.6 (19.4)	1.57	.12	0.29	0.07 (0.04)	-2.10 .037 -0.38
AN <i>n</i> =30	2.0 (25.4)	0.34	.73	0.08	0.09 (0.03)	0.30 .76 0.06

HC = Healthy Control

SAD=Social Anxiety Disorder

OCD= Obsessive Compulsive Disorder

AN= Anorexia Nervosa

ES = Effect size (Cohen's *d*)