Threat-Related Attentional Bias in Relation to Anxiety and Depressive Symptoms in the General Population: The Potential Role of Sex Effects

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Threat-Related Attentional Bias in Relation to Anxiety and Depressive Symptoms in the General Population: The Potential Role of Sex Effects

By

Beril Yaffe, M.A.

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

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THE CITY UNIVERSITY OF NEW YORK
Abstract

Threat-Related Attentional Bias in Relation to Anxiety and Depressive Symptoms in the General Population: The Potential Role of Sex Effects

By

Beril Yaffe, M.A.

Advisor: Deborah J. Walder, Ph.D.

Heightened sensitivity to relevant environmental stimuli (attentional bias) has been observed in relation to clinical and non-clinical anxiety and depression symptoms. While depression symptoms are associated with sensitivity to disorder and self-relevant words, hypervigilance to threatening stimuli is observed in relation to anxiety symptoms. Furthermore, attentional bias has been shown to play an important role in the development and maintenance of depressive and anxiety disorders. Accordingly, a large body of literature has examined threat-related attentional bias in relation to symptoms of anxiety and depression. However, several methodological inconsistencies exist across studies, including variability in definitions of threat, lack of consideration of differential aspects of anxiety (physical arousal versus general distress), and the overlooked potential role of sex effects. Therefore, the current study examined the specificity of threat-related attentional bias (for fear, disgust, anger, sadness), using a verbal emotional Stroop task (EST), among individuals from the general population reporting varying degrees of non-clinical symptoms of physical arousal, depression, and general distress (worry). The potential moderating effects of sex in the relationships of threat-related attentional bias with these symptoms were considered. One hundred twenty five (37 men/88 women) undergraduate students were asked to complete a self-report questionnaire of mood and anxiety symptoms and a
computerized EST. In the total sample, symptoms of general distress (worry) alone predicted greater threat-related attentional bias to disgust words. Among women, symptoms of general distress predicted greater engagement with fear and disgust words, whereas physical arousal predicted greater engagement with disgust words alone. Among men, symptoms of physical arousal predicted greater avoidance of disgust words, whereas symptoms of general distress predicted greater avoidance of fear words. Accordingly, disgust and fear may both underlie threat in relation to symptoms of anxiety. Findings of the current study point to the importance of considering the specificity of negative emotions, subtypes of anxiety, and the effects of sex when examining threat-related attentional bias in relation to symptoms of mood and anxiety. Findings hold potential to delineate the specific nature of threat-related attentional bias observed in relation to anxiety symptoms and to inform treatment strategies that target threat bias in anxiety.
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CHAPTER I
INTRODUCTION

Anxiety and depressive disorders are among the most prevalent forms of psychopathology (Williams, Mathews, & MacLeod, 1996). These disorders cause significant economic burden (Kessler, Tat, Demler, & Walters, 2005), impact daily functioning, and largely follow a recurrent or chronic course (Korte, Brown, & Schmidt, 2013). These disorders, in turn, exert an adverse impact on public health as well as individuals who are diagnosed and their caregivers.

Consistent with a dimensional approach to psychopathology (Lebeau et al., 2012), symptoms of anxiety and depression are thought to lie on a continuum ranging from non-clinical to clinical levels (Cuijpers, De Graaf, & Van Dorsselaer, 2004; Flett, Vredenburg, & Krames, 1997; Siddaway, Taylor, & Wood, 2016). From a developmental perspective, individuals from the general population who endorse non-clinical levels of depression and anxiety are shown to be at greater risk for experiencing clinical levels of depression and anxiety (Cuijpers & Smit, 2004; Fergusson et al., 2005; Karsten, Penninx, Verboom, Nolen, & Hartman, 2013; Shankman et al., 2009; Flett, Vredenburg, & Krames, 1997). These findings provide evidence for etiological continuity, which suggests that the presence of non-clinical symptoms pose a subsequent risk for illness (Flett et al., 1997). In addition, significant functional impairment that is similar, though attenuated, compared to those in the clinical range was reported among individuals with non-clinical levels of depression and anxiety (Karsten, Penninx, Verboom, Nolen, & Hartman, 2013). Accordingly, a gradual increase in level of functional impairment in relation to symptoms is observed among individuals endorsing varying levels of symptoms of depression and anxiety, rather than a specific symptom cut off score that would determine presence or absence of
functional impairment (Karsten, Hartman, Ormel, Nolen, & Penninx, 2010; Karsten, Nolen, Penninx, & Hartman, 2011). Collectively, these findings provide evidence for a dimensional/continuity model in conceptualizing depressive and anxiety disorders as opposed to a categorical model.

Consistent with dimensional model of anxiety and depression, recent studies have switched their attention to examining nonclinical populations who endorse varying levels of symptoms of depression and anxiety in an attempt to identify at-risk samples (Fergusson et al., 2005; Gibbs, 1996; Korte et al., 2013). This approach is important given the need to understand the developmental trajectories of illness, manifestations of subclinical symptoms, and their association with risk factors (Korte et al., 2013) to help prevent future illness and inform treatment strategies. Accordingly, examining individuals along the anxiety and depression spectrum can allow for the identification of vulnerability factors that are associated with these disorders (Gibbs, 1996). This approach may also provide an opportunity to develop early intervention strategies that would target vulnerability factors to prevent onset of new incidents (Cuijpers & Smit, 2004; Korte et al., 2013). Early identification of vulnerability markers and at-risk samples is particularly important given that early intervention is shown to prevent future development of full syndrome anxiety and depressive disorders in at-risk samples (Seligman, Schulman, & Derubeis, 1999; Martin, Seligman et al., 2007).

Symptoms of anxiety and depression have been reported in relation to cognitive difficulties in multiple domains of functioning including attention, concentration, executive functions, and memory (see Gotlib & Joormann, 2010; Robinson, Vytal, Cornwell, & Grillon, 2013 for reviews). Attention, in particular, and its interaction with emotional processes have gained increased consideration in the literature, as the interplay between attention and emotion is
thought to be involved in the development and maintenance of depressive and anxiety disorders (Williams et al., 1996).

According to cognitive theories, existing memory representations (schemas) guide individuals to process information in the environment that is consistent with their schemas (Beck & Clark, 1997). In individuals with anxiety, schemas are thought to favor threat (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van IJzendoorn, 2007). This view suggests that anxious individuals prioritize processing of threat-related information (for review see Bar-Haim et al., 2007; Williams et al., 1996). Schemas of depressed individuals, on the other hand, are thought to involve negative themes including loss, separation, failure, worthlessness, and rejection (Gotlib & Joormann, 2010). Consequently, individuals with depression favor information that is related to these themes and interpret ambiguous and neutral stimuli in a way that fits with their schemas (Gotlib & Joormann, 2010). Therefore, biases in attentional processes in the context of emotionally salient information has become a central component of cognitive theories of depression and anxiety (Bar-Haim et al., 2007; Bradley, Mogg, & Lee, 1997; Gotlib & Joormann, 2010; Williams et al., 1996). Accordingly, cognitive models suggest that attentional bias contributes to mechanism of illness, such that life stressors and increased emotional disturbance activate threat and/or negative schemas (Gotlib & Joormann, 2010; Williams et al., 1996). These schemas then generate dysfunctional cognitions and related automatic thoughts allowing certain relevant stimuli in the environment to become more salient, further overestimating the threat or negativity associated with the given stimuli, which in turn leads to enhanced emotional disturbance and negative views (Gotlib & Joormann, 2010; Williams et al., 1996).
Various cognitive theoretical models have been proposed to explain the mechanism in which anxiety impacts threat perception. Some models argue that threat-related material is favored at every level of processing, including early automatic processes such as orienting and encoding, as well as later processes such as elaboration and interpretation (Beck & Clark, 1997). Some models suggest threat-bias mainly occurs in early automatic processes (Ohman, 2005; for review see Cisler & Koster, 2010), while others propose threat-bias is driven primarily by strategic (voluntary) processes (Wells & Matthews, 2014). Regardless of the differences between these models, there is a general consensus that anxious individuals have heightened sensitivity towards threat and display an attentional bias to threat-related information (Bar-Haim et al., 2007).

Contrary to findings in anxiety, in depression, attentional bias is typically observed in the presence of negative self-descriptive information (rather than threat-related information) and particularly in later stages of processing, which allow for extensive elaboration of information to occur (Mogg & Bradley, 2005). These findings suggest that the pattern of attentional bias observed in depression may be explained by difficulty in disengaging from negative material as opposed to facilitated attention, which is the primary mechanism that drives attentional bias in anxiety (Mogg & Bradley, 2005). Difficulty in disengaging, that is observed in depression, is further corroborated by depressed individuals’ tendency to ruminate (Gotlib & Joormann, 2010). Accordingly, findings suggest that depressed individuals exhibit difficulties with removing irrelevant negative information from their working memory, which corresponds to difficulty disengaging from self-relevant negative information, and is shown to be related to proneness to ruminate (Gotlib & Joormann, 2010). These findings fit with the idea that depressed individuals have poorer cognitive control, which interfere with their ability to disengage their attention from
negative information, further increasing unwanted thoughts and rumination (Gotlib & Joormann, 2010). This mechanism is important given that rumination is the most consistently observed thinking style in relation to symptoms of depression; it is also shown to strongly interfere with recovery from depression (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008), as it leads to emotional dysregulation, further exacerbating the symptoms of depression (Gotlib & Joormann, 2010).

To date, a large body of literature has examined attentional bias in relation to symptoms of depression and anxiety both in clinical and nonclinical populations given its relevance to the development and maintenance of symptoms in these disorders (Bar-Haim et al., 2007; Bradley et al., 1997; Williams et al., 1996; Cisler & Koster, 2010; Mogg & Bradley, 2005). The emotional Stroop (EST) task is one measure that is widely used in the literature to study attentional bias in a broad range of psychopathologies including symptoms of depression and anxiety (Bar-Haim et al., 2007; Cisler & Koster, 2010; Williams et al., 1996). The EST requires participants to name the color of the ink in which words are printed as quickly as possible while ignoring the meaning of the words (Williams, Mathews, & MacLeod, 1996). The slower reaction times while naming the ink color of emotional words compared to neutral words was identified as ‘attentional bias,’ where attention is drawn by the emotional content making it more difficult to ignore the meaning (Lang & Davis, 2006; Williams et al., 1996). On the EST, individuals with symptoms of anxiety exhibit an attentional bias to threat-related words (Bar-Haim et al., 2007; Cisler & Koster, 2010; Mogg & Bradley, 2005; Williams et al., 1996), while individuals with symptoms of depression exhibit an attentional bias to self-relevant words, under conditions with longer stimulus presentation durations, which allow for elaborative processing to occur (Mogg & Bradley, 2005). These findings suggest that though attentional bias is observed both in relation to symptoms of
anxiety and depression on the EST, the nature of this bias and the stimuli eliciting it tend to differ.

Several methodological inconsistencies still remain in the attentional bias literature among anxiety and depression, particularly in studies using the EST to examine threat-related attentional bias, which potentially leads to inconclusive findings and gaps in the literature. The first methodological inconsistency pertains to the operational definition of threat, which has been unclear and inconsistent across the field given that the majority of studies used negative emotional stimuli broadly without considering the differential specificity of negative valence (sadness, anger, fear, disgust) or different modalities of stimulus presentation (Bar-Haim et al., 2007; Mogg & Bradley, 2005; Williams, Mathews, & MacLeod, 1996). Second, there has been a lack of consideration of differential aspects of anxiety, namely physical arousal versus general distress, which is important given that the latter captures worry and aspects of depression, while the former captures the physical symptoms of anxiety (Arnaudova et al., 2013). Finally, potential sex effects have been overlooked, even though there are studies that report women compared to men have greater prevalence of anxiety and depressive disorders (McLean & Anderson, 2009), endorse greater nonclinical symptoms of anxiety and depression (Walder, Statucka, Daly, Axen, & Haber, 2012), and exhibit greater attentional bias (Lee et al., 2017; Tan, Ma, Gao, Wu, & Fang, 2011; Tran, Lamplmayr, Pintzinger, & Pfabigan, 2013).

Given the prominent association of attentional bias with symptoms of depression and anxiety, elucidation of the aforementioned methodological inconsistencies is paramount in order to shed light on the gaps in the literature to better understand the nature of this bias. Accordingly, it is important to delineate the specificity of threat-related attentional bias in relation to symptoms of physical arousal (anxiety), worry (general distress), and depression to better
understand the specific emotions that are driving this bias. Consistent with this notion, emerging evidence indicates disgust and fear (as opposed to sadness and anger) correspond to threat in the context of studies using verbal stimuli in the general population (Charash & McKay, 2002; Yaffe & Walder, 2016). Furthermore, consideration of differential aspects of anxiety such as arousal versus general distress (which also captures characteristics of depression, particularly worry and rumination) allows for the examination of the specificity of symptoms associated with threat-related attentional bias. This is important given that, to date, few studies differentiated between physical arousal and general distress (worry) in examining threat-related attentional bias in relation to non-clinical symptoms of anxiety (Sass et al., 2010, 2014). Furthermore, studying the specificity of threat-related attentional bias among individuals in the general population who endorse non-clinical levels of anxiety, depression, and general distress allows for the examination of the specific patterns of threat-related bias as a potential cognitive correlate of these symptoms. Finally, examination of historically overlooked sex differences in the relationship of these non-clinical symptoms with threat-related attention bias may help elucidate potential differential sex effects that may have obfuscated existing findings in the literature.

This review will first discuss the growing evidence in attentional bias in relation to symptoms of anxiety and depression. It will then outline the methodological inconsistencies that are observed in the field, as well as the role of disgust and fear in anxiety and depression. Finally it will touch on the few studies that consider sex effects in the relevant literature.

**Threat-related attention bias in anxiety and depression**

Threat-related attentional bias has been demonstrated across all anxiety disorders including generalized anxiety disorder (for review see Mogg & Bradley, 2005), social phobia (for review see Heinrichs & Hofmann, 2001), post traumatic stress disorder (for review see
Buckley, Blanchard, & Neill, 2000), specific phobia (Rinck, Reinecke, Ellwart, Heuer, & Becker, 2005), and obsessive compulsive disorder (OCD) (Amir, Najmi, & Morrison, 2009). In addition to clinical populations, threat-related attentional bias is also observed in relation to non-clinical levels of anxiety in the general population (for review see Bar-Haim et al., 2007; Fox, Russo, Bowles, & Dutton, 2001; Mogg, Bradley, Miles, & Dixon, 2004; Mogg & Bradley, 1998; Williams et al., 1996). Furthermore, studies also show event related potential (ERP) evidence corresponding to attentional bias to threat-related words among nonclinical populations reporting symptoms of anxiety (Sass et al., 2010, 2014). In fact, in their meta-analysis, Bar-Haim et al. (2007) found comparable effect sizes of threat-related attentional bias among clinically anxious individuals and non-clinical populations with self-reported anxiety. Based on these findings, they concluded that an official clinical cut off is not relevant for threat-related attentional bias, and mild forms of anxiety are sufficient to generate this bias (Bar-Haim et al., 2007). These findings are important, as they further corroborate the etiological continuity between non-clinical and clinical levels of anxiety and provide evidence for examining threat-related attentional bias in non-clinical populations.

In the same meta-analysis, Bar-Haim et al. (2007) reported an absence of threat-related attentional bias in non-anxious individuals. This finding contradicts prior literature, which, from an evolutionary perspective, suggests that humans have a general tendency to orient to potential threat in the environment (LeDoux, 1995). Accordingly, it is argued that individuals with greater levels of anxiety may show an attentional bias to even mildly threatening stimuli, while non-anxious individuals only show a bias to stimuli with high levels of threat content (Bar-Haim et al., 2007). This argument is, in part, consistent with studies showing that non-anxious individuals tend to direct their attention away from threat-related stimuli (MacLeod, Mathews, & Tata, 1986;
Macleod & Mathews, 1988). Even though most studies in the field examined trait anxiety, few studies looked at the effects of state anxiety in relation to threat-related attentional bias (Bar-Haim et al., 2007). These findings have been generally mixed with some studies showing greater effects of state anxiety among individuals with high trait anxiety compared to those with low trait anxiety (Broadbent & Broadbent, 1988). Other researchers report a positive correlation between state anxiety and threat-related attentional bias among individuals with high trait anxiety, while a negative correlation is reported between state anxiety and threat-related attentional bias among those with low trait anxiety (Egloff & Hock, 2001). In their meta-analysis, Bar Haim et al. (2007) conclude that threat-related attentional bias occurs both in relation to state and trait anxiety. Taken together, even though discrepancies exist in the literature, there appears to be a general consensus that increased threat-related attentional bias is associated with symptoms of anxiety.

The relationship between threat-related attentional bias and anxiety has been demonstrated using various modalities of stimulus presentation (i.e., visual scenes, faces, and words), and across various paradigms, including the EST and the dot probe paradigm (Bar-Haim et al., 2007; Cisler & Koster, 2010; Mogg & Bradley, 1998; Williams et al., 1996). Findings report that the combined effect sizes of studies that used naturalistic stimuli (i.e., faces and visual stimuli) and words are equivalent (Bar-Haim et al., 2007), such that both types of stimuli are comparable in eliciting threat-related attentional bias in relation to symptoms of anxiety. Naturalistic stimuli are most frequently used in dot probe paradigms, while words are commonly used in ESTs (Bar-Haim et al., 2007).

The EST has been frequently used in examining attention allocation to threat-related stimuli (Bar-Haim et al., 2007; Cisler & Koster, 2010; Mogg & Bradley, 1998; Williams et al.,
In the EST, individuals are asked to name the different ink colors in which emotional (i.e. threatening) and neutral word groups are printed. The main idea is that emotional/threat words differentially interfere with color naming compared to neutral words, as they capture greater attentional resources given their emotional content (Bar-Haim et al., 2007; Cisler & Koster, 2010; Egloff & Hock, 2003; Williams et al., 1996). Therefore, greater response times to name the color of threat-related words compared to neutral words is believed to reflect an attentional bias (Bar-Haim et al., 2007; Cisler & Koster, 2010; Egloff & Hock, 2003; Williams et al., 1996). One disadvantage of the EST is its inability to provide information about the time course of the attentional bias; the delayed responding on this task can underlie enhanced attention to threat stimuli as well as an inability to disengage from threatening stimuli (Cisler & Koster, 2010). However, regardless of this limitation, EST has been the most frequently used paradigm in the literature (Cisler & Koster, 2010).

While the exact mechanism involved in threat-related attentional bias is inconclusive, three interrelated domains are believed to play a role, namely the observable components of attentional bias, the mechanisms that mediate these components, and the stage of information processing (for review see Cisler & Koster, 2010). The observable components of attentional bias refer to the mechanisms that underlie threat-related attentional bias. Three components are identified; facilitated attention, difficulty disengaging, and attentional avoidance (Bar-Haim et al., 2007; Cisler & Koster, 2010). Facilitated attention refers to faster detection of threat-related stimuli, which reflects the speed with which attention is drawn to threat-related information (Cisler & Koster, 2010). Difficulty disengaging refers to the degree to which attention is captured by threat-related stimuli and difficulty switching attention away from these stimuli (Cisler & Koster, 2010). Finally, attentional avoidance reflects preferential allocation of attention
away from threatening stimuli (Cisler & Koster, 2010). Taken together, these components are believed to play a role in threat-related attentional bias in anxiety such that facilitated attention to threat occurs at an earlier stage, in response to stimuli with high threat content, whereas difficulty in disengaging and attentional avoidance occur at later stages of processing (Cisler & Koster, 2010).

Mediating mechanisms, which include attentional control, emotion regulation strategies, and neural mechanisms, are thought to mediate the degree to which the observable components of attentional bias occur (Bar-Haim et al., 2007; Cisler & Koster, 2010). Specifically, attentional control is considered to allow individuals to control the allocation of their attentional resources, and those with greater levels of attentional control tend to exhibit less difficulty disengaging from threat-related stimuli (Cisler & Koster, 2010). Similarly, emotional regulation, which refers to an individual’s ability to control the emotions they feel, when they feel them, and how they express them (Gross, 1998) is thought to reflect a strategy to cope with negative and threat-related information, influencing the level of attentional bias an individual exhibits (Cisler & Koster, 2010). Finally, neural mechanisms are considered to be another mediating factor for threat-related attentional bias based on the evidence that amygdala is shown to be highly involved in the processing of fear-related stimuli (Davis & Whalen, 2001; Michael Davis, 2006). Furthermore, increased amygdala activation is reported across multiple studies in response to threat detection (Carlson & Reinke, 2009) and attentional bias to threat (Vuilleumier, 2005). A large body of literature also points to the involvement of the prefrontal cortex in threat-related attentional bias, as it is shown to down-regulate amygdala activity in fear extinction tasks (Myers & Davis, 2007) and in tasks where threat-related stimuli is no longer perceived as threatening after the initial processing stage (Ohman, 2005). Accordingly, neural mechanisms play an
important role along with attentional control and emotional regulation processes in attentional bias to threat. Specifically, attentional control is thought to mediate difficulty disengaging from threat-related stimuli; whereas emotional regulation is thought to mediate attentional avoidance (Cisler & Koster, 2010). With regards to neural mechanisms, amygdala activity is thought to underlie facilitated attention to threat, while prefrontal cortex activity is believed to modulate difficulty disengaging from threat-related stimuli given its role in down-regulating amygdala activity; prefrontal cortex is also involved in emotional regulation and is accordingly believed to play a role in attentional avoidance (Cisler & Koster, 2010).

The final domain that contributes to the mechanism of threat-related attentional bias is the stage of information processing; namely, automatic and strategic, where automatic refers to unconscious processing, whereas strategic refers to processing that is intentional and awareness dependent (Bar-Haim et al., 2007; Cisler & Koster, 2010). Stage of information processing can determine the characteristics of attentional bias, as the timing defines the nature of the bias. For example, threat-related attentional bias is observed in the presence of masked stimuli, where individuals do not consciously perceive threat (Bar-Haim et al., 2007; Mogg et al., 2004; Mogg, Bradley, & Williams, 1995a; Mogg & Bradley, 2002), as well as in tasks where threat-related information is consciously processed (Bar-Haim et al., 2007; Cisler, Bacon, & Williams, 2009). Accordingly, both automatic and strategic processes are involved in threat-related attentional bias.

Taken together, based on the information presented above, multiple factors contribute to threat-related attentional bias. Accordingly, different components of threat bias, the mediating factors, and the different stages of processing should be considered simultaneously to fully understand the mechanism of threat-related attentional bias in anxiety.
Attentional bias has also been widely examined in depression, though the majority of studies fail to show a threat-related attentional bias in relation to symptoms of depression (e.g., Mogg & Bradley, 1998, 2005; Bradley, Mogg, Millar, & White, 1995; Lim & Kim, 2005; Mogg, Bradley, Williams, & Mathews, 1993; Bradley et al., 1997; Mogg, Bradley, & Williams, 1995). In their review, Mogg & Bradley (2005) report a lack of attentional bias in depression among studies using the EST, the dot probe task, naturalistic stimuli (faces, visual scenes), words, as well as subliminal (masked, unconscious) and supraliminal (conscious) presentations. Studies also fail to report a relationship between symptoms of depression and attentional bias to threat-related or negative words among non-clinical individuals (Yovel & Mineka, 2005; Sass et al., 2014). Rather, attentional bias in depression is observed in relation to self-relevant words/information and under circumstances that enable longer stimulus durations (Gotlib, Krasnoperova, Yue Neuber, & Joorman, 2004; Mogg & Bradley, 2005). For example, in one study, depressed individuals showed an attentional bias to self-relevant negative words on an EST (Segal, Gemar, Truchon, & Horowitz, 1995). Another study reported an attentional bias among clinically depressed individuals on an EST when depression-related words were presented for longer durations (1500 milliseconds) (Gotlib & Cane, 1987). Similarly, on a dot probe paradigm, depressed individuals showed an attentional bias to negative words when stimuli were presented for longer than 1000 milliseconds (Donaldson, Lam, & Mathews, 2007). Furthermore, adolescents at-risk for depression exhibited an attentional bias to negative faces under longer stimulus durations compared to adolescents who were not at-risk (Joormann, Talbot, & Gotlib, 2007). Taken together, these findings suggest that an attentional bias to self-relevant words occurs in relation to symptoms of depression, though in line with the aforementioned evidence, individuals with symptoms of depression exhibit this bias when the
stimulus presentation allows for further elaboration of information. Accordingly, the attentional bias observed in depression reflects difficulty disengaging from stimuli after attention is captured by the relevant stimulus, rather than an initial orientation (facilitated attention) to negative stimuli (Gotlib & Joormann, 2010).

One explanation for the pattern of attentional bias observed in relation to symptoms of depression is an excessive degree of internal self-focus (Gotlib & Joormann, 2010; Mogg & Bradley, 2005). Specifically, longer duration of stimulus presentation and self-relevant information required to elicit an attentional bias is consistent with the ruminative processes observed in individuals with symptoms of depression (Mogg & Bradley, 2005). Accordingly, rumination reflects a preoccupation with internally directed negative information, which may prevent these individuals from directing their attention to external threat cues (Mogg & Bradley, 2005). One explanation for the discrepant findings between depression and anxiety may be due to a depression-related motivational deficit (Mogg & Bradley, 2005). A number of cognitive models discuss the difference between the mechanisms that are involved in the threat (valence) evaluation of a given stimuli and those that are involved in allocating resources to perceived threat in order to enable appropriate actions (e.g., Mogg & Bradley, 1998). Accordingly, individuals with anxiety are likely to overestimate threat content of stimuli, which then triggers goal engagement mechanisms, allowing processing resources to be allocated to these stimuli (Mogg & Bradley, 2005). Even though individuals with depression are also likely to overestimate the threat value of stimuli, goal-engagement mechanism may be less responsive and active in response to external stimuli (Mogg & Bradley, 2005). Consequently, their attention is less likely to be drawn to external stimuli, unless external stimuli have high relevance and motivational value to the individual (Mogg & Bradley, 2005). Accordingly, only self-relevant
stimuli (which have high motivational value for depressed individuals), under conditions that allow for elaboration activates goal-engagement mechanisms among individuals with symptoms of depression leading to attentional bias (Mogg & Bradley, 2005).

Examination of threat-related attentional bias among populations with clinical levels of comorbid depression and anxiety yields mixed findings (Bar-Haim et al., 2007; Mogg & Bradley, 2005). For example, in one study individuals with comorbid generalized anxiety disorder and depression failed to show a threat-related attentional bias, while individuals with generalized anxiety alone exhibited a threat bias (Bradley et al., 1995). Similarly, in another study, individuals with anxiety were more likely to direct their gaze to threat-related faces, while those with comorbid anxiety and depression did not display such bias (Mogg, Millar, & Bradley, 2000). Studies failing to report threat-related attentional bias in comorbid populations explain their findings by a mechanism where the inactivated goal engagement processes (motivational deficits) in clinical depression may interfere with the motivational processes required for the threat-related attentional bias to occur in anxiety disorders (Mogg & Bradley, 2005). Few studies, however, report threat-related attentional bias in individuals from the general non-clinical population endorsing high levels of both depressive and anxiety symptoms (Rossignol, Philippot, Crommelinck, & Campanella, 2008; Sass et al., 2014). Consequently, in the general non-clinical population, motivational deficits associated with symptoms of depression may be insufficient to interfere with the motivational processes observed in relation to symptoms of anxiety. Therefore, comorbid anxiety may play a more important role in threat-related attentional bias in the presence of depression in the general population (Sass et al., 2014).

Findings pertaining to comorbid anxiety and depression are important given that the general distress/worry aspect of anxiety is thought, to some degree, to reflect characteristics of
depression such as rumination (Antony, Bieling, Cox, Enns, & Swinson, 1998; Sass et al., 2010, 2014). Even though anxiety is considered to be a multidimensional construct, only a few studies considered two distinct aspects of anxiety, physical arousal (anxious arousal) and general distress (anxious apprehension), in relation to threat-related attentional bias (Sass et al., 2010, 2014). Consideration of these distinct forms of anxiety is important, as they may characterize different anxiety symptom groups that differentially correspond to subtypes of anxiety disorders. For example, there is evidence suggesting that general distress (worry) may correspond to symptoms of generalized anxiety disorder and OCD (Antony et al., 1998; Sass et al., 2014), whereas physical arousal corresponds to somatic symptoms of anxiety such as panic (Antony et al., 1998). Furthermore, general distress is shown to reflect certain characteristics of depression in addition to the worry component of anxiety (Antony et al., 1998). Lack of consideration of these distinct aspects of anxiety in studies using questionnaires conceptualizing anxiety as a unitary construct may have not only erroneously collapsed across unique aspects of anxiety, but also aspects of depression. In turn, this may have contributed to the mixed findings in the relationship of threat-related attentional bias with symptoms of anxiety and depression in the field (Sass et al., 2010, 2014). As a result, future examination of the pattern of association of anxiety (physical arousal) and general distress (generalized anxiety/worry) with threat-related attentional bias is important given that these symptoms differentially correspond to subtypes of anxiety disorders.

Collectively, findings suggest that non-clinical anxiety plays a more prominent role in threat-related attentional bias compared to non-clinical depression in the general population given that threat-related attentional bias in relation to anxiety continues to occur despite comorbid symptoms of depression (Sass et al., 2010, 2014). Taken together, findings point to the importance of considering symptoms of depression and the distinct aspects of anxiety (i.e.,
arousal and worry/general distress), which may differentially reflect characteristics of anxiety and depression.

**Methodological inconsistencies in definitions of “threat”**

From an evolutionary perspective, stimuli that are relevant to survival, especially in the context of acute danger receive heightened attention in order to guide appropriate actions (Vuilleumier, 2005). While threat-related attentional bias is examined extensively in the literature, the lack of content specificity in defining threat and the modality of threat-related stimuli utilized (e.g., visual, face, verbal) resulted in methodological inconsistencies across studies. The majority of studies examining threat-related attentional bias grouped negative stimuli without utilizing a systematic approach in defining the specific emotions that may underlie threat (Van Hooff, Devue, Vieweg, & Theeuwes, 2013). The fact that threatening stimuli are seemingly negative does not necessarily indicate that all negative stimuli are threatening (Van Hooff et al., 2013). In terms of basic emotions, fear is conceptualized as occurring in response to situations posing immediate threat (Woody & Teachman, 2000). Furthermore, fear is shown to activate the sympathetic nervous system (the fight or flight response), which facilitates the appropriate behaviors in order to prevent or reduce danger in threatening situations (Woody & Teachman, 2000). Accordingly, given the close associations between fear and threat, most studies examining threat-related attentional bias almost exclusively focused on fear as the threat-related emotion (Krusemark & Li, 2011) without considering other negative emotions that may differentially underlie threat.

Definitions of threat also potentially vary as a function of modality of stimulus presentation (e.g., facial expressions, visual scenes, words). Threat is defined relatively clearly in the context of facial stimuli; specifically, angry and fearful facial expressions are identified as
threat-related (Davis et al., 2011), whereas literature has been mixed in the context of visual stimuli. For example, in the International Affective Picture Systems (IAPS) (Lang, Bradley, & Cuthbert, 1997), a widely used database for visual emotional stimuli (Davis & Whalen, 2001; Mckenna & Sharma, 1995), the majority of IAPS scenes reflect a combination of negative emotions (e.g., fear, disgust, anger, sadness) rather than single discrete emotions (Libkuman, Otani, Kern, Viger, & Novak, 2007; Mikels et al., 2005). Moreover, the visual images classified as ‘threat’ often reflect physical injuries, mutilations, and burn victims that may elicit disgust rather than (or in addition to) fear (Libkuman et al., 2007; Mikels et al., 2005; van Hooff et al., 2013). A recent study using IAPS pictures reported that threatening pictures (depicting fear) and disgust-related pictures elicited similar responses at the neuronal level as measured by the electroencephalogram (EEG) (Wheaton et al., 2013). They concluded that disgust related stimuli were prioritized at least as much as other threatening stimuli by the viewer, which provide evidence that disgust communicates important information relevant for survival (e.g., infection) (Wheaton et al., 2013). Furthermore, Van Hooff et al. (2013) examined the ability to disengage from fear and disgust related visual scenes among normal controls; findings demonstrated that individuals experienced lower accuracy and greater reaction times when they detected targets following images associated with disgust compared to images associated with fear. These findings point to the possibility that disgust may be more involved in difficulty disengaging compared to fear. Another study using a verbal EST, demonstrated greater reaction times in naming the ink color of disgust words compared to neutral words; whereas, similar differences in reaction times were not observed when color naming of fear words was compared to neutral words (Charash & McKay, 2002). In line with the above findings, in a study utilizing a rapid serial visual processing paradigm, participants had greater difficulty identifying probes following
target words with disgust content compared to target words with fear content (Cisler, Olatunji, Lohr, & Williams, 2009). Accordingly, disgust has recently begun to receive attention as a threat-related emotion given that it is conceptualized in the context of “food rejection and threat of oral incorporation” (Woody & Teachman, 2000). Disgust is posited to serve self-protective functions, as it motivates withdrawal from unpleasant stimuli (Woody & Teachman, 2000). Therefore, disgust (and fear) can be characterized as defensive responses (Woody & Teachman, 2000). Accordingly, while recent studies began to examine disgust in relation to threat, research examining disgust in the context of attentional bias (using verbal stimuli) remains in an incipient stage.

Given the inconsistent definitions of threat in the field, our recent work investigated the specificity of threat related attentional bias by examining specific negative emotion subcategories (fear, disgust, anger, sadness), using a verbal EST in the general population, and in relation to non-clinical self-reported symptoms of schizotypy (Yaffe & Walder, 2016). Our findings demonstrated a greater attentional bias for fear compared to anger verbal stimuli, and a comparable attentional bias between fear and disgust verbal stimuli in the general population. Furthermore, we reported a positive association between positive schizotypy and attentional bias to disgust among individuals who self-reported high levels of schizotypal traits. Our findings partially fit with prior evidence suggesting that disgust and fear may be prominent negative emotions underlying threat (when using verbal stimuli) (Charash & McKay, 2002). Furthermore, our findings argue that disgust may be particularly salient to threat-related attentional bias observed in non-clinical positive schizotypy, as well as serve as a potential cognitive correlate for positive schizotypy (Yaffe & Walder, 2016). Elucidation of the specificity of negative emotion subcategories underlying ‘threat-related’ attentional bias in relation to non-clinical
anxiety and depressive symptoms in the general population is important, as it may allow for a clearer definition of threat (using verbal stimuli) to be applied in the field.

**Disgust, fear, and threat in depression and anxiety**

The involvement of fear in anxiety disorders is well documented in the literature (Cisler, Olatunji, & Lohr, 2009). Fear is defined as a defensive reaction, which occurs in response to potential threat in the environment (Rosen & Schulkin, 1998). Fear activates the sympathetic nervous system (i.e., fight or flight response), which motivates appropriate behaviors (i.e., escape, avoidance) to reduce potential threat (Woody & Teachman, 2000). Given that anxiety is viewed as an exaggerated fear response, anxiety disorders are primarily considered to be associated with fear (Rosen & Schulkin, 1998). From a cognitive perspective, the relationship between excessive fear and anxiety disorders is explained by a mechanism wherein chronic hypervigilance in response to perceived threat interferes with the completion of ongoing daily tasks, leading to the development of pathological levels of anxiety (Rosen & Schulkin, 1998).

Recent evidence suggests that disgust too may be involved in anxiety disorders (Woody & Teachman, 2000). Disgust is posited to be a defensive response given that it serves a protective function against illness, disease, and contamination (Davey, 2011; Marzillier & Davey, 2004; Rozin & Fallon, 1987). Additionally, disgust is thought to be involved in guiding behavior in interpersonal and social settings, as it is elicited by socially and culturally rejected attitudes and behaviors (Davey, 2011).

Fear and disgust are both shown to be present in appraisals of danger in the context of threat of bodily harm (Woody & Teachman, 2000). For example, a panic attack can evoke fear when the individual believes that the symptoms are indicative of a health-related issue, whereas seeing an open wound can elicit disgust (Woody & Teachman, 2000). Likewise, fear and disgust
are thought to be involved in the context of social threat (Woody & Teachman, 2000). For instance, social situations may be avoided due to fear of rejection or negative evaluation, while disgust-related appraisals can lead to shame in a situation where an individual with social anxiety sweats in public and views self as the source of disgust (Woody & Teachman, 2000). Finally, disgust (Olatunji, Cisler, Mckay, & Phillips, 2010; Rozin & Fallon, 1987) and fear (Woody & Teachman, 2000; Davey, 2011) both evoke avoidance, a tendency that is consistently observed in anxiety disorders (Davey, 2011). Based on this evidence, disgust along with fear is thought to be involved in anxiety disorders given that it also plays a role in guiding anxiety-related behaviors.

There is strong evidence pointing to disgust’s involvement in anxiety disorders that involve fear of contamination such as obsessive compulsive disorder (OCD), blood injection injury phobia, and small animal phobias (Davey, 2011; Cisler, Olatunji, & Lohr, 2009; Olatunji et al., 2010). One explanation for the robust associations between disgust and the aforementioned anxiety disorders is that disgust eliciting themes or “disgust elicitors” (e.g., germs, insects) are significant characteristics of these disorders (Davey, 2011). For example, disgust sensitivity is found to be associated with fear of small animals, such as small rodents, reptiles, amphibians, and insects, which are most commonly (and universally) feared animals in small animal phobias (Arrindel, Pickersgill, Merckelbach, Ardon, & Cornet, 1991; Davey, 1994; Mulkens, Jong, & Merckelbach, 1996; Davey, 1994; Mulkens, Jong, & Merckelbach, 1996). In blood injection injury phobia, studies show that individuals exhibit more facial expressions of disgust (Davey, 2011) and a greater sensitivity to disgust (Page, 1994); the vasovagal syncope associated with fainting in blood injection injury phobia is also reported to have the same psychological and physiological processes that underlie disgust (Page, 1994). Furthermore, disgust is thought to play an important role in contamination fear associated with OCD, such that disgust is found to
be a better predictor of washing in contamination fear when compared to fear, anxiety, or depression (Mancini, Gragnani, & Olimpio, 2001; Olatunji, Williams, Lohr, & Sawchuk, 2005). Moreover, disgust sensitivity is found to be associated with avoidance of contamination-related stimuli (Deacon & Olatunji, 2007; Tsao & Mckay, 2004). Accordingly, OCD, blood injection injury phobia, and small animal phobias are all triggered by disgust eliciting environmental stimuli such as small animals (e.g., insects, rodents), blood and mutilations (e.g., amputated hands), and contamination agents (e.g., diarrhea, vomit) (Davey, 2011). Even though blood, injury, mutilation, and contamination agents are clearly related to disease avoidance, the relationship between small animals and disease avoidance is not as clear (Davey, 2011). Therefore, a few explanations are proposed; first small animals are historically associated with spread of disease or the contamination of food; second, some animals resemble disgust-eliciting stimuli such as mucus (e.g., slimy animals); and third some animals are thought to be superstitiously associated with disease (e.g., spider bites being infectious) (Davey, 2011). Taken together, evidence points to the involvement of disgust in blood injection injury phobia, small animal phobias, and OCD given that disgust eliciting stimuli are core components of these disorders.

The fact that disgust and the aforementioned disorders (i.e., OCD, blood injection injury phobia, small animal phobias) are associated with similar environmental triggers does not necessarily indicate that disgust is a vulnerability factor or cause of these disorders (Davey, 2011). Therefore, it is posited that disgust may be involved in the formation of clinical levels of contamination fear (Davey, 2011). Accordingly, evidence suggests that disgust induction elicited distress levels in individuals with low contamination fear similar to that of individuals with high contamination fear, when they were exposed to stimuli with high contagion characteristics
Similarly, when the effects of disgust provocation manipulation was compared between individuals with OCD and healthy participants, disgust induction impacted the immunological factors that are uniquely associated with OCD in individuals who were diagnosed with it, but not among healthy controls (Fluitman, Denys, Heiknen, & Westenberg, 2010). These findings suggest that disgust experiences can have a causal effect on biological factors associated with OCD (Fluitman et al., 2010). Another approach suggests that disgust sensitivity may be a vulnerability factor for anxiety disorders, enabling the formation of fear and anxiety in response to the disgust elicitors related to small animal phobias, blood injection injury phobia, and OCD (Davey, 2011). This interaction between disgust and fear/anxiety is explained by a mechanism where feelings of disgust in response to an elicitor (e.g., contamination agents) motivates disease-avoidance goals leading to distress, which in turn promotes feelings of fear and anxiety (Davey, 2011). Accordingly, greater reinforcement of the relationship between disgust and avoidance goals facilitates increased distress and anxiety reactions in response to the disgust elicitors, further supporting disgust’s involvement in this process (Davey, 2011). These findings suggest that disgust may indeed contribute to the disease process, beyond its role as an emotion associated with the disorder specific environmental triggers.

Though scarce, accumulating evidence suggests disgust may also be related to other anxiety disorders such as generalized anxiety disorder (Olatunji, Tart, Ciesielski, McGrath, & Smits, 2011), separation anxiety (Muris, Merckelbach, Schmidt, & Tierney, 1999), agoraphobia (Muris, Merckelbach, Nederkoorn, & Rassin, 2000), hypochondrias (Davey & Bond, 2006), and health anxiety (Davey & Bond, 2006). The observed associations between disgust and the aforementioned disorders are interesting given that disgust elicitors are not necessarily
characteristics of these disorders (Davey, 2011). Though theoretical in nature, two potential mechanisms mediating the relationship between disgust and other anxiety related psychopathologies have been suggested (Davey, 2011). The first approach posits that disgust is associated with self-disgust and guilt in the context of other anxiety disorders (Davey, 2011). Evidence for this comes from studies demonstrating a relationship between disgust and shame (Miller & Tangney, 1994). Accordingly, it is argued that shame is involved in social phobia, where the self is the object of shame (Woody & Teachman, 2000). Furthermore, it is suggested that having multiple anxious psychopathologies may lead to self-disgust and shame, which can explain the relationship between disgust-irrelevant anxiety disorders and disgust (Davey, 2011). An alternative view suggests that disgust generates a threat-interpretation bias (Davey, 2011). Evidence for this comes from studies where ambiguous material are interpreted as threatening following disgust inductions, which in turn maintains the anxious process (Davey, Leathers-Smith, & Davey, 2011). For example, one study found that individuals were more likely to interpret ambiguous words as threatening after disgust induction, compared to happy, neutral, or anxiety mood inductions (Davey, Bickerstaffe, & Macdonald, 2006). According to these findings, Davey et al. (2006) concluded that disgust has a causal effect on interpretation biases, impacting anxiety-related disorders given that the threat-interpretation bias maintains the anxious state. Similarly, another study demonstrated a threat-interpretation bias on a homophone spelling task following disgust mood inductions (Leathers-Smith & Davey, 2011), further supporting disgust’s potential causal role in anxious psychopathology (Leathers-Smith & Davey, 2011). Taken together, emerging literature suggests that disgust may play an important causal role in anxiety disorders, wherein disgust elicitors are not the core components.
Contrary to anxiety disorders, the involvement of fear in depressive disorders has been inconclusive. There is extensive evidence suggesting that individuals with depressive disorders tend to display a negative (sad) bias in emotion recognition tasks (Surguladze et al., 2010; Bouhuys, Geerts, & Gordijn, 1999; Gotlib et al., 2004; Gur et al., 1992; Surguladze et al., 2005; Fu et al., 2004; Kan, Mimura, Kamijima, & Kawamura, 2004). However, only a few studies examined the specific role of fear in relation to depressive symptoms. Furthermore, the majority of these studies examined emotion processing using facial expressions. For instance, adolescents with major depressive disorder exhibited increased brain activation in the prefrontal cortex in response to fearful faces compared to healthy controls (Diler et al., 2013). Similarly, patients with major depressive disorder demonstrated differential patterns of brain activation in response to facial expressions of fear compared to healthy controls (Surguladze et al., 2010). Another study showed an increased left amygdala activation in response to fearful faces among depressed individuals compared to healthy controls, pointing to a potential fear bias (Sheline et al., 2001). In contrast, one study showed no differences in identifying fearful facial stimuli between individuals reporting depressive symptoms and those who were not in the general population (Maniglio et al., 2014). Other studies also failed to show a specific fear bias among individuals with depression when using subliminal and supraliminal facial stimuli presentations (Sprengelmeyer et al., 2011; Almeida, Versace, Hassel, Kupfer, & Phillips, 2010; Lawrence et al., 2004). While some studies report differential processing of fearful facial expressions in individuals with depression, findings have been rather inconclusive thus far and are thought to reflect a general negative bias (Surguladze et al., 2010).

Disgust was rather overlooked in the depression literature until recently, even though it may potentially play an important role in depressive disorders (Surguladze et al., 2010). Facial
expressions of disgust is shown to express social rejection (Marzillier & Davey, 2004; Rozin, Lowery, & Ebert, 1994); therefore, disgust is thought to be involved in depression given that depressed individuals are highly sensitive to social rejection (Surguladze et al., 2010). This argument is supported by studies demonstrating enhanced recognition (accuracy) of disgust-related facial stimuli among previously depressed individuals who underwent tryptophan depletion compared to normal controls (Hayward, Goodwin, Cowen, & Harmer, 2005; Merens, Booji, Haffmans, & Van der Does, 2008). Studies also report deficits in disgust recognition when using facial stimuli as an index of disgust sensitivity among individuals with depression (Sprengelmeyer et al., 2011; Tranter et al., 2009). In addition to a sensitivity to external cues of disgust, disgust is also thought to be involved in the context of self-disgust in depression (Surguladze et al., 2010). Specifically, shame and guilt, which are typically experienced in depression are thought to be rooted in disgust (Power & Tarsia, 2007). This is further supported by findings showing that individuals with depression endorsed greater experiences of disgust compared to healthy controls (Power & Tarsia, 2007). Disgust sensitivity was also found to be associated with self-reported symptoms of depression in the general population (Olatunji, Unoka, Beran, David, & Armstrong, 2009). Furthermore, one study reported that self-disgust mediated the association between dysfunctional cognitions and depressive symptoms (Overton, Markland, Taggart, Bagshaw, & Simpson, 2008). Overall, these findings demonstrate that disgust, which was previously an overlooked emotion, may contribute to the symptoms of depression.

Imaging evidence depicts that insula is highly involved in disgust processing (Hennenlotter et al., 2004; Phillips et al., 1997; Sprengelmeyer et al., 2011). Accordingly, patients with major depressive disorder demonstrated differential patterns of activation in anatomical structures associated with disgust processing, namely left insula, left-orbitofrontal
gyrus, left and right middle/inferior temporal gyri compared to healthy controls in response to facial expressions of disgust (Surguladze et al., 2010). Deficits in recognizing facial expressions of disgust, reductions in the insular gray matter, and correlations between impaired disgust recognition and volumetric reduction within the anterior insula were identified in individuals with major depressive disorder (Sprengelmeyer et al., 2011). These findings are consistent with others reporting volume reductions in insular cortex among currently depressed and remitted depressed participants (Takahashi et al., 2010) and individuals with first depressive episode (Peng et al., 2011), as well as those reporting decreased regional homogeneity in insula among individuals at risk for depression (Liu et al., 2010). Overall, findings suggest that insula may be particularly involved in major depressive disorder, and given its implications in disgust perception, it may potentially be leading to the observed deficits in disgust recognition among this population (Sprengelmeyer et al., 2011).

Taken together, there is extensive evidence pointing to the differential involvement of fear and disgust in anxiety and depressive disorders. Therefore, examination of fear and disgust in threat-related attentional bias in relation to these symptoms in the non-clinical range holds potential given that fear and disgust may be differentially associated with threat in the context of anxiety and depression.

**Relevant sex differences**

Literature shows that women have increased risk of developing anxiety disorders compared to men (Bruce et al., 2005; McLean & Anderson, 2009). Specifically, women are more likely to experience generalized anxiety disorder (GAD), panic disorder, agoraphobia (Kessler et al., 1994), posttraumatic stress disorder (PTSD) (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995), and phobias (Lindal & Stefansson, 1993). Sex differences in anxiety disorders are thought
to be accounted by multiple factors (McLean & Anderson, 2009). For example, women exhibit
greater negative affectivity and trait anxiety, which have greater heritability among women
compared to men; this, in part, is thought to be influenced by environmental factors and gender
socialization given that these environmental factors counteract anxious tendencies among men
whereas support anxious tendencies among women (for review see McLean & Anderson, 2009).

Similarly, women are also at greater risk of developing depressive disorders (for review
see Piccinelli & Wilkinson, 2000). Various factors are thought to contribute to the prominent sex
differences in depression, including women’s greater likelihood of having adverse experiences,
depression, and anxiety in childhood, women’s sociocultural roles such as role limitation, role
overload, and competing social roles, as well as women’s tendency to utilize more ruminative
coping strategies (Piccinelli & Wilkinson, 2000).

In line with the aforementioned findings, women also report greater levels of anxiety on
self-report measures in the general population (Costa, Terracciano, & Mccrae, 2001; Egloff &
Schmukle, 2004; Feingold, 1994). Furthermore, women exhibit greater anxiety scores both on
explicit (e.g., conscious) and implicit (e.g., automatic, non-conscious) measures, demonstrating
that sex differences in anxiety is not an outcome of response bias (Egloff & Schmukle, 2004).
Moreover, women compared to men in the general population are also shown to report greater
levels of depression that is more chronic in nature and lasting for longer periods (Nolen-
Hoeksema, Morrow, & Fredrickson, 1993). Taken together, there is clear evidence pointing to
robust sex differences in symptoms of depression and anxiety both in clinical and non-clinical
populations.

Women appear to be more sensitive and responsive to environmental threat (Lee et al.,
2017; Mcclure, 2000; Pintzinger, Pfabigan, Tran, Kryspin-exner, & Lamm, 2016; Sass et al.,
2010; Tan et al., 2011; Tran et al., 2013). For example, women are reported to be better at labeling others’ emotions based on external cues such as facial expressions (Mcclure, 2000; Montagne, Kessels, Frigerio, Haan, & Perrett, 2005) and auditory stimuli (Collignon et al., 2010). Women also display a stronger startle responses and skin conductance to threatening images, suggesting that they are more responsive to threat compared to men (McMain, Guimond, Strengier, Cardish, & Links, 2012). Furthermore, women are reported to overestimate the danger associated with stimuli (Mcclure, 2000).

Emerging evidence also demonstrate sex differences in experiences of fear and disgust (Woody & Teachman, 2000). Accordingly, a number of studies show women experience greater levels of fear (Arrindell, Mulkins, Kok, & Vollenbroek, 1999; Davey, 1994; McLean & Anderson, 2009) and disgust (Haidt, McCauley, & Rozin, 1994; Woody & Teachman, 2000).

Sex differences in threat-sensitivity is further supported by important neuroanatomical evidence pointing to sex differences in emotion processing (Cahill, 2006). For example, in his review, Cahill (2006) reported differential patterns of amygdala activation between males and females. This is relevant given that amygdala is an anatomical structure that is highly involved in emotion (threat) processing (Cahill, 2006). Furthermore, sex differences in lateralization and connectivity of insula, a structure strongly associated with disgust perception, was also reported (Kann, Manza, Leung, & Li, 2016). These findings suggest that sex specific neural connectivity in insula may potentially underlie the observed sex differences in threat perception. In addition, an extensive meta-analysis reported greater cortical lateralization among men and greater brainstem activation among women during emotion processing (Wager, Phan, Liberzon, & Taylor, 2003). Finally, Mcclure et al. (2004) demonstrated selective activation of the orbitofrontal cortex and the amygdala when processing unambiguous threatening facial stimuli.
among women, whereas this was not observed in men. Taken together, findings suggest that
women display a greater sensitivity to threat compared to men, which is supported by studies
reporting sex differences in neural processing of emotional stimuli.

Even though there are robust sex differences in attentional bias, only a few recent studies
considered sex differences in examining threat-related attentional bias (Lee et al., 2017;
Pintzinger et al., 2016; Sass et al., 2010a; Tan et al., 2011; Tran et al., 2013). This is important
given that literature suggests women may preferentially process threat, while men process
pleasing stimuli. Accordingly studies examining emotion processing found that healthy women
exhibited greater activation in the primary and secondary visual cortices in response to
unpleasant (negative) stimuli (Lang et al., 1998), whereas men showed greater extrastriate
activation to pleasant stimuli (Lang et al., 1998; Sabatinelli, Fiasch, Bradley, Fitzsimmons, &
Lang, 2004). Furthermore, one study showed that women rated unpleasant stimuli more
unpleasant, whereas men rated pleasant stimuli (e.g., erotica) as more pleasant (Bradley et al.,
2001). Accordingly, men who report high levels of trait anxiety in the general population tended
to avoid subliminally presented fearful faces, while women showed an attentional bias towards
them (Tan et al., 2011). Similarly, women reporting high levels of anxiety showed an attentional
bias towards angry faces, while men with high levels of anxiety showed a bias towards happy
faces (Tran et al., 2013). Based on these findings, attentional avoidance observed in men may
have adaptive value by allowing individuals to complete ongoing tasks and could be useful in
regulating mood (Tan et al., 2011). These findings are also consistent with studies demonstrating
women’s tendency to display greater sensitivity to threat and likelihood of having anxiety
disorders (Tan et al., 2011; McLean & Anderson, 2009). However, not every study supports
women’s tendency to attend to threat and men’s tendency to avoid threat. For example in a study
examining ERPs in threat processing, women with high levels of anxiety showed greater processing of emotional stimuli at early stages compared to men, and non-anxious men demonstrated an attentional bias to threat at an early stage while women showed preferential processing of threat at later stages (Sass et al., 2010). These findings are consistent with others demonstrating greater attentional bias in response to fearful faces among women compared to men only in early stages of processing (Lee et al., 2017).

Taken together, literature examining sex differences in threat-related attentional bias is in a nascent stage. Accordingly, more research needs to be conducted to better understand the specific pattern of threat bias among women and men. Nevertheless, there is emerging evidence pointing to the importance of considering sex effects in the field.

**Summary**

Anxiety and depressive disorders are among the most prevalent forms of psychopathology (Kessler et al., 2005; Williams et al., 1996). Despite differences in illness presentation, evidence suggests a mutual heightened sensitivity to, and excessive concern with, relevant stimuli across depressive and anxiety disorders (Bar-Haim et al., 2007; Cisler & Koster, 2010; Mogg & Bradley, 2005; Williams et al., 1996). Hypervigilance and sensitivity to threatening stimuli in the environment are consistently associated with anxiety symptoms (Bar-Haim et al., 2007; Cisler & Koster, 2010; Williams et al., 1996). By comparison, attentional biases for personal losses and rumination are associated with depressive symptoms (Nolen-Hoeksema et al., 1993; Gotlib & Joormann, 2010; Mogg & Bradley, 2005). Taken together, research suggests that attentional bias plays a major role in the formation and maintenance of symptoms of depression and anxiety (Bar-Haim et al., 2007; Cisler & Koster, 2010; Williams et al., 1996). Specifically, heightened emotional disturbance allows certain stimuli to become more
salient, leading to an overestimation of danger/negativity associated with these stimuli, further enhancing the existing emotional disturbance (Gotlib & Joormann, 2010; Williams et al., 1996). Accordingly, individuals with symptoms of anxiety are shown to exhibit an attentional bias towards threat-related stimuli (Bar-Haim et al., 2007; Cisler & Koster, 2010), while individuals with depression exhibit an attentional bias to self-relevant depressive stimuli, under longer stimulus presentation durations allowing for elaborative processes (Mogg & Bradley, 2005). Given that threat-related attentional bias is strongly implicated in anxiety and depressive disorders, it is important to delineate the specificity of threat-related attentional bias in relation to these symptoms, to better understand the characteristics of this bias.

Consistent with the involvement of threat across anxiety and mood disorders, emerging evidence indicates disgust and fear (as opposed to other negative emotions) correspond to threat in the context of verbal stimuli (Charash & McKay, 2002; Yaffe & Walder, 2016). Furthermore, consideration of differential aspects of anxiety such as arousal versus general distress (which also captures characteristics of depression) will allow for the examination of the specificity of symptoms associated with threat-related attentional bias. This is important given that, to date, few studies differentiated between physical arousal and general distress (worry) in examining threat-related attentional bias in relation to non-clinical symptoms of anxiety (Sass et al., 2010, 2014). Furthermore, studying the specificity of threat-related attentional bias among individuals in the general population who endorse non-clinical levels of anxiety, depression, and general distress will allow for the examination of the specific patterns of threat-related bias as a potential cognitive correlate of these symptoms. Finally, anxiety and depressive disorders are marked by robust sex differences (Piccinelli & Wilkinson, 2000; McLean & Anderson, 2009) with women demonstrating greater likelihood of developing anxiety and depressive disorders. Similarly,
when examined in the general population, females (compared to males) endorse greater levels of anxiety and report more severe and longer periods of depressed mood than males (Costa, Terracciano, & McCrae, 2001; Egloff & Schmukle, 2004; Feingold, 1994; Nolen-Hoeksema et al., 1993; Piccinelli & Wilkinson, 2000). Sex differences are also demonstrated in the emotion processing literature in neuroimaging (Cahill, 2006) and behavioral studies (Sass et al., 2010), and in the context of threat-related attentional bias (Tan et al., 2011), whereby men and women demonstrate differential patterns of threat-related attentional bias (Sass et al., 2010; Tan et al., 2011; Lee et al., 2017). Examination of historically overlooked sex differences in the relationship of these non-clinical symptoms with threat-related attentional bias will help elucidate potential differential sex effects that may have obfuscated and contributed to variability in existing findings in the literature.

**Specific Aims and Hypotheses**

**Aim 1:** To examine the specificity of threat-related attentional bias in relation to non-clinical symptoms of anxiety, depression, and general distress in the general population.

**Hypothesis 1:** We hypothesize that symptoms of anxiety and general distress will both account for a significant proportion of variability in attentional bias for fear and disgust verbal stimuli (but not for sadness and anger verbal stimuli). By contrast, depressive symptoms are not expected to significantly contribute to variability in attentional bias for any negative emotion subcategory (fear, disgust, anger, sadness). This is based on evidence that fear and disgust are more strongly associated with threat than other negative emotions (anger, sadness) when using verbal stimuli (Charash & McKay, 2002; Yaffe & Walder, 2016), and threat-related attentional bias is consistently observed in relation to anxiety (Bar-Haim et al., 2007; Cisler & Koster, 2010). Furthermore, general distress, which captures the worry aspect of anxiety (and, to a lesser
extent, aspects of depression) has been demonstrated to resemble symptoms of generalized anxiety disorder (Arnaudova et al., 2013), which is associated with threat-related attentional bias (Bar-Haim et al., 2007). Therefore, we expect threat-related attentional bias will be associated with non-clinical symptoms of general distress. We do not expect threat-related attentional bias to be significantly related to depressive symptoms, based on evidence that attentional bias tends to be related to symptoms of depression primarily when utilizing self-relevant depression related (not general threat related) words, and tasks involving longer duration of stimulus exposure than that used in ESTs (Mogg & Bradley, 2005).

**Aim 2:** To examine sex differences in symptoms of anxiety, depression, general distress, and threat-related attentional bias.

**Hypothesis 2:** We expect females (compared to males) will report greater 1) symptoms of anxiety, depression, and general distress and 2) threat-related attentional bias (independent of symptoms). This is based on well-established greater anxiety and depressive non-clinical symptoms (Egloff & Schmukle, 2004) and higher prevalence of anxiety and depression among females (McLean & Anderson, 2009). Also, threat-related attentional bias is greater in females with subclinical anxiety (Sass et al., 2010; Tan et al., 2011; Lee et al., 2017).

**Aim 3** To examine potential moderating effects of sex in the association of threat-related attentional bias with symptoms of anxiety, depression, and general distress.

**Hypothesis 3:** We expect sex will moderate the relationship of anxiety (e.g., arousal) and general distress (e.g., worry) symptoms (not depressive symptoms alone) with threat-related attentional bias for fear and disgust (not sadness and anger). The strength of the relationships of anxiety and general distress symptoms with attentional bias for fear and disgust will be greater for females than males, given females demonstrate heightened hypervigilance to threat (McLean
& Anderson, 2009) and greater difficulty disengaging from threat-related stimuli (Tan et al., 2011; Lee et al., 2017).
CHAPTER II

METHOD

Participants

Participants were 125 (88 female / 37 male) English-speaking students, ages 18-35 years (Mean age = 20.61 years, SD = 3.26), recruited from Brooklyn College of The City University of New York (CUNY) Introduction to Psychology human subjects pool. Participants received course credit as compensation. The sample size was based on sample sizes (~120) used in similar studies (Hock & Egloff, 2001; Smith & Waterman, 2005). A power analysis using GPower (effect size $R^2 = .13$, $\alpha = .05$, number of tested predictors = 3, and total number of predictors = 7) (Erdfelder, Faul, & Buchner, 1996) yielded sufficient power ($1-\beta = 0.95$) in the current study with a sample size of 125 subjects. The uneven distribution of participants by sex is consistent with evidence demonstrating that females are more likely to enroll in psychology coursework than males (Harton & Lyons, 2015). For demographic characteristics of the current study, see Table 1.

Table 1. Demographic Characteristics

<table>
<thead>
<tr>
<th>N</th>
<th>125</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age [Mean (SD)]</td>
<td>20.61 (3.26)</td>
</tr>
<tr>
<td><strong>Sex n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>37 (29.6)</td>
</tr>
<tr>
<td>Female</td>
<td>88 (70.4)</td>
</tr>
<tr>
<td><strong>Handedness n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>115 (92%)</td>
</tr>
<tr>
<td>Left</td>
<td>10 (8%)</td>
</tr>
<tr>
<td><strong>Ethnicity n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>White/Caucasian</td>
<td>58 (46.4)</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td>Count (%)</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Black/African-American</td>
<td>16 (12.8)</td>
</tr>
<tr>
<td>Spanish, Hispanic, or Latino</td>
<td>18 (14.4)</td>
</tr>
<tr>
<td>Native Hawaiian or Pacific Islander</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Asian</td>
<td>33 (26.4)</td>
</tr>
<tr>
<td>Other</td>
<td>17 (13.6)</td>
</tr>
</tbody>
</table>

**Education n (%)**

- Some college, technical, trade, or vocational school: 109 (87.2%)
- Associate’s Degree: 9 (7.2%)
- Bachelor’s Degree: 7 (5.6%)

**Yearly Household Income n (%)**

- Under $10,000: 5 (4.0%)
- $10,000-$24,999: 26 (20.8%)
- $25,000-$39,999: 24 (19.2%)
- $40,000-$69,999: 29 (23.2%)
- $70,000-$100,000: 25 (20.0%)
- Over $100,000: 12 (9.6%)

**Procedure**

The study protocol received Human Subjects Institutional Review Board (IRB) approval in accordance with Brooklyn College/CUNY IRB policies. Participants volunteered and registered for the study via the CUNY Sona System. They arrived to the lab at Brooklyn College at their scheduled appointment time. Written informed consent was obtained from each participant prior to participation. Demographic information such as socioeconomic status (SES),...
age, and education were collected through a brief demographic interview. All participants were asked to complete a self-report questionnaire of mood symptoms, as well as a computerized EST in the context of a broader battery of measures not included in the current study. All data collection was completed in a laboratory setting at Brooklyn College. Upon study completion, participants were debriefed and received a list of readily accessible mental health resources. The portion of the overarching protocol relevant to the current study lasted approximately 1 hour.

Materials

**Self-Report Measures**

*Depression Anxiety Stress Scales (DASS)* (Lovibond & Lovibond, 1995). The DASS is a 42-item self-report measure yielding depression (DASS-D), anxiety (DASS-A) and stress (DASS-S) subscale scores. The DASS exhibits strong internal consistency for Depression (α coefficient = 0.97), Anxiety (α coefficient = 0.92), and Stress (α coefficient = 0.95) subscales (Antony et al., 1998). Participants reported feelings present over the past week, and items were rated on a scale ranging from 0 (not at all) to 3 (very much). The DASS-D measures unique characteristics of depression such as low positive affect, sadness, worthlessness, loss of self-esteem and incentive, as well as a sense of hopelessness (Brown, Chorpita, Korotitsch, & Barlow, 1997; Lovibond & Lovibond, 1995; Szabó, 2011). The DASS-A measures features unique to anxiety such as somatic arousal, physiological hyperarousal, subjective awareness of anxious affect, and escape or avoidance tendencies (Brown et al., 1997; Lovibond & Lovibond, 1995; Szabó, 2011). The DASS-S reflects tension, irritability, worry, and a tendency to overreact to stressful events (Brown et al., 1997; Lovibond & Lovibond, 1995; Szabó, 2011). It is related to general negative affect and is thought to most closely resemble attributes of generalized anxiety disorder in both clinical (Brown et al., 1997) and nonclinical (Szabó, 2011) populations.
DASS-S is thought to capture aspects of both anxiety and depression (Brown et al., 1997), though it is more closely associated with anxiety than depression (Lovibond & Lovibond, 1995). Furthermore, the DASS-S is thought to measure persistent anxiety and tension and is thought to overlap in factor loadings with the DASS-A, suggesting a natural continuity between DASS-S and DASS-A scales. Nevertheless, DASS-S scale is thought to reflect a distinct set of symptoms, differentiating it from DASS-A and DASS-D (Lovibond & Lovibond, 1995). For the current study, the DASS-S was conceptualized as ‘general distress’.

*Chapman Infrequency Scale (CIS)* (Chapman & Chapman, 1986). The CIS measures infrequent responding in order to detect individuals with “fake-bad” response patterns (Kwapil, Barrantes-Vidal, & Silvia, 2008); or an invalid response pattern. An abbreviated version of the CIS was used to identify random and invalid responses (Cohen, Matthews, Najolia, & Brown, 2010). As done in prior research (Kwapil et al., 2008; Yaffe & Walder, 2016), CIS items were randomly embedded within a self-report measure in the overarching battery; namely, in our study, within the schizotypal personality questionnaire. Participants who endorsed two or more of the three CIS items were excluded from data analyses. None of the current study participants satisfied this exclusion criterion.

**Cognitive-Affective Task**

*Emotional Stroop Task (EST)*. The description of the EST in this subsection is taken verbatim from our recent paper (Yaffe & Walder, 2016) given the same task was used in the current study. A novel adaptation of the EST was developed and administered based on prior studies (Mohanty et al., 2005, 2008). The current EST version was aimed at capturing attentional bias elicited by negative emotions. All four universal negative emotion subcategories (fear,
disgust, anger, and sadness) (Levenson, 2003) were examined in order to delineate differential attentional bias effects as a function of negative emotion specificity.

Word stimuli for inclusion in the current EST were selected from the Affective Norms for English Words (ANEW) (Bradley & Lang, 1999), a widely used database providing established norms for valence rating, arousal rating, and frequency in the English language. Bradley and Lang (1999) provide norms for negative, positive, and neutral valence ratings for each ANEW word. These valence ratings were not sufficient for our study, given we aimed to examine subcategories of negative valence (disgust, fear, anger, and sadness), rather than negative valence in general. Therefore, we used Stevenson, Mikels, & James's (2007) established norms, which provide a mean negative valence rating for each of four discrete negative emotions (sadness, anger, disgust, and fear) for each ANEW word. Thus, each ANEW word has four valence ratings. Stevenson et al. (2007) used these valence ratings to group words into negative emotion subcategories. Specifically, to assign a word to a subcategory, the mean of one subcategory rating had to be one standard deviation greater than the mean ratings for the remaining three subcategories (Stevenson et al., 2007). This relatively stringent method rendered few words in each subcategory. Thus, Stevenson et al. (2007) suggested an alternative method using confidence intervals (CIs). Although not applied to ANEW words, this method was utilized by Mikels et al. (2005) to categorize International Affective Picture System (IAPS) stimuli into distinct emotion subcategories.

The current study adapted Stevenson et al.’s (2007) negative subcategory valence ratings and applied Mikels et al.’s (2005) method to the raw ANEW data, to categorize the negatively valenced words into four discrete negative emotion subcategories. Specifically, we constructed a 90 % (CI) around the mean of each valence rating (sadness, anger, disgust, and fear) for each
ANEW word, and placed them into subcategories based on overlap of CIs (for more details see Mikels et al., 2005). We selected 32 words for each negative emotion subcategory (sadness, anger, fear, disgust) based on word length, frequency in English language, and arousal rating. Word categories (neutral, sadness, anger, fear, disgust) were comparable in word length (three to nine letters, M = 6, SD = 0.3), frequency in language, and arousal ratings. On average, word categories significantly differed from each other in valence, which was imperative to the main goals of the current study.

Word stimuli included 128 neutral words (four blocks of neutral words; labeled Neutral 1 through Neutral 4, each with 32 words) and 128 negative words (four blocks of negative words; each with 32 sadness, 32 angry, 32 fear, and 32 disgust words). Two neutral words were included as buffers at the beginning of each block and excluded from all analyses. Participants were seated at a 50 cm distance from a computer screen.

Instructions appeared on the screen, followed by a practice run of 16 neutral words. Each word appeared one at a time, horizontally in the middle of the screen (in either red, green, yellow or blue color). Words were in Arial font style and 1” font size. Each word was presented only once, in red, green, yellow, or blue. Colors were represented equally and in random order across words. For each block, following a 500 millisecond central fixation cross, words were each presented for 1000 milliseconds on the computer screen. Word presentation was followed by a blank screen, which persisted until the participant responded; then the next word appeared. As part of the response, participants were instructed to identify (as quickly and accurately as possible) the ink color of negative and neutral words while ignoring word meaning. Participants responded by pressing the corresponding color-coded key on a keyboard. Two keyboards were used to counterbalance order of color-pair button positions on the keyboard (across subjects).
Accuracy (total number correct) and reaction time (RT; in milliseconds) were both recorded by the computer software, Psychopy (Peirce, 2009).

Block presentation (neutral, sadness, anger, fear, disgust) was used to evoke emotional bias (Bar-Haim et al., 2007). To control for order effects, eight orders of task administration were generated using partial counterbalancing. Accordingly, each condition appeared only once in any order. Half of the participants started with a neutral condition; the other half started with an emotional condition. With each administration, a neutral condition followed an emotional condition, to control for carryover effects (Figure 1).

Figure 1. Order of Administration

<table>
<thead>
<tr>
<th>#</th>
<th>Order</th>
<th>Neut 1</th>
<th>Fear</th>
<th>Neut 2</th>
<th>Anger</th>
<th>Neut 3</th>
<th>Sad</th>
<th>Neut 4</th>
<th>Disg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Practice</td>
<td>Neut 1</td>
<td>Fear</td>
<td>Neut 2</td>
<td>Anger</td>
<td>Neut 3</td>
<td>Sad</td>
<td>Neut 4</td>
<td>Disg</td>
</tr>
<tr>
<td>2</td>
<td>Practice</td>
<td>Fear</td>
<td>Neut 2</td>
<td>Anger</td>
<td>Neut 3</td>
<td>Sad</td>
<td>Neut 4</td>
<td>Disg</td>
<td>Neut 1</td>
</tr>
<tr>
<td>3</td>
<td>Practice</td>
<td>Neut 2</td>
<td>Anger</td>
<td>Neut 3</td>
<td>Sad</td>
<td>Neut 4</td>
<td>Disg</td>
<td>Neut 1</td>
<td>Fear</td>
</tr>
<tr>
<td>4</td>
<td>Practice</td>
<td>Anger</td>
<td>Neut 3</td>
<td>Sad</td>
<td>Neut 4</td>
<td>Disg</td>
<td>Neut 1</td>
<td>Fear</td>
<td>Neut 2</td>
</tr>
<tr>
<td>5</td>
<td>Practice</td>
<td>Neut 3</td>
<td>Sad</td>
<td>Neut 4</td>
<td>Disg</td>
<td>Neut 1</td>
<td>Fear</td>
<td>Neut 2</td>
<td>Anger</td>
</tr>
<tr>
<td>6</td>
<td>Practice</td>
<td>Sad</td>
<td>Neut 4</td>
<td>Disg</td>
<td>Neut 1</td>
<td>Fear</td>
<td>Neut 2</td>
<td>Anger</td>
<td>Neut 3</td>
</tr>
<tr>
<td>7</td>
<td>Practice</td>
<td>Neut 4</td>
<td>Disg</td>
<td>Neut 1</td>
<td>Fear</td>
<td>Neut 2</td>
<td>Anger</td>
<td>Neut 3</td>
<td>Sad</td>
</tr>
<tr>
<td>8</td>
<td>Practice</td>
<td>Disg</td>
<td>Neut 1</td>
<td>Fear</td>
<td>Neut 2</td>
<td>Anger</td>
<td>Neut 3</td>
<td>Sad</td>
<td>Neut 4</td>
</tr>
</tbody>
</table>

Statistical Analyses

*Stroop Indices.* The description for Stroop indices was taken from our recent paper (Yaffe & Walder, 2016) given the same Stroop indices were used in the current study. A Stroop neutral index, labeled Total Neutral RT, was derived by averaging RTs across three neutral blocks: Neutral 1, Neutral 2 and Neutral 3. Neutral 4 was excluded from the current analyses given it elicited a significantly greater RT compared to the other neutral blocks [$F(3,117) = 8.23, p < 0.001$]. This preserved homogeneity across neutral stimuli, towards deriving the aforementioned uniform neutral index. The neutral blocks were used to calculate attentional bias indices.
Four Stroop attentional bias indices were derived by subtracting Total Neutral RT from each of the four negative emotion RT indices (Fear RT, Anger RT, Sad RT, Disgust RT). This yielded Fear, Anger, Sad and Disgust attentional bias indices. This method for calculating attentional bias indices is consistent with other studies in the field (Egloff & Hock, 2001, 2003; Mohanty et al., 2008; Smith & Waterman, 2005; Van Strien & Van Kampen, 2009).

**Validity.** To minimize the likelihood of random or careless response patterns, the accuracy of response to the CIS items were examined.

**Order Effects.** A 5x8 factorial ANOVA was conducted in order to test for order effects for each of the 5 emotional Stroop indices (Total Neutral RT, Anger RT, Sad RT, Disgust RT, Fear RT) across the 8 orders of administration.

**Accuracy.** Number of correct trials was calculated across 4 emotional Stroop indices [(Anger NC; M = 31.1, SE = .11), (Fear NC; M = 30.4, SE = .18), (Sad NC; M = 31.1, SE = .12), (Disgust NC; M = 31.1, SE = .11)]. Accuracy rates were consistent with other studies in the literature (Mohanty et al., 2008).

**Hypothesis 1.** Pearson’s bivariate and Spearman correlations were conducted to assess for possible demographic covariates. Multiple regression analyses using enter method were conducted to assess the extent to which each DASS scale (DASS-A, DASS-D, DASS-S) accounted for variability in threat-related attentional bias for words in each of four negative emotion subcategories (fear, disgust, anger, sadness). Independent variables were DASS-A, DASS-D, and DASS-S. Dependent variables were the four attentional bias indices (for fear, anger, sadness, disgust). DASS-D was entered in the first block given depressive symptoms were not expected to account for a significant proportion of variability in threat-related attentional bias. DASS-A and DASS-S were entered into the second block, in order to examine the unique
respective contributions of anxiety (physical arousal) and general distress (worry) in threat-related attentional bias. Analyses were repeated separately for each of the four dependent variables. Alpha level for significance was set at .05, and tests were two-tailed.

**Hypothesis 2.** A MANOVA was conducted to examine sex differences (male versus female) on each of the DASS scales (DASS-A, DASS-D, DASS-S). Independent variable was sex and dependent variables were the DASS scales (DASS-A, DASS-D, DASS-S). A MANOVA was conducted to examine sex differences (male versus female) on the attentional bias indices using words from each negative emotion subcategory (fear, disgust, anger, sadness). Given that no sex differences were found for DASS-A, DASS-D, and DASS-S, they were not included in the analyses as covariates. The independent variable was sex and dependent variables were the four attentional bias indices (for fear, disgust, anger, sadness). Alpha level for significance was set at .05, and tests were two-tailed.

**Hypothesis 3.** Multiple Regression analyses were used to examine whether the relationship of anxiety (physical arousal), depression, and general distress (worry) symptoms (DASS-A, DASS-D, DASS-S) with threat-related attentional bias for each negative emotion subcategory (fear, disgust, anger, sadness) was moderated by sex. Independent variables were DASS-A, DASS-S, and DASS-D. Dependent variables were the four attentional bias indices (for fear, disgust, anger, sadness). We did not expect to see moderating effects of sex for depression, though DASS-D was still entered into the model in order to confirm null findings. Alpha level for significance was set at .05, and tests were two-tailed.

DASS-D, DASS-A, DASS-S, sex, as well as the interaction terms of sex with each DASS-A, DASS-S, and DASS-D were entered into the same block in order to examine interaction effects (i.e., sex x anxiety; sex x general distress; sex x depression). This multiple
Supplementary Analyses. We believed the uneven distribution of sex (88 female / 37 male) may have restricted power to detect statistical significant in analyses examining sex as a moderator. Therefore, we repeated multiple regression analyses separately by sex to examine the relative contribution of depression, general distress, and anxiety symptoms to attentional bias indices (for fear, anger, sadness, disgust) among males and females, independently. Accordingly, we used a split file by sex and conducted multiple regression analyses using enter method. Independent variables were DASS-A, DASS-D, and DASS-S. Dependent variables were the four attentional bias indices (for fear, anger, sadness, disgust). DASS-D was entered in the first block given depressive symptoms were not expected to account for a significant proportion of variability in threat-related attentional bias. DASS-A and DASS-S were entered into the second block, in order to examine the unique respective contributions of anxiety and general distress in threat-related attentional bias. Analyses were repeated separately for each of the four dependent variables.
CHAPTER III

RESULTS

Assessment of Validity

In order to minimize the likelihood of including participants who responded in a random, careless, or invalid manner, responses on the Chapman Infrequency Scale (CIS; Chapman & Chapman, 1983) were examined. All of the participants answered the three embedded items in the expected direction; therefore, none of the participants were excluded due to questionable validity.

Assessment for Normality

In order to assess for normality of distribution of scores, histograms, skewness, and kurtosis values were examined for all variables. For skewness and kurtosis, statistics were divided by their corresponding standard error, and a variable was determined to approximate normality if this value was $\leq 1.95$. According to these criteria, the following variables did not meet the assumptions of normality: DASS-D, DASS-S, DASS-A, Fear, Sad, and Disgust. Outliers were identified using $\pm 3$ standard deviations from the mean. A total of 9 outliers were identified (Fear, n = 3; Disgust, n = 4; Sad, n = 2), and removing these outliers rendered Fear, Disgust, and Sad normally distributed. Therefore, all analyses were conducted excluding the outliers on respective analyses to ensure that these variables met the assumptions for normality. There were no outliers on DASS-D, DASS-S, or DASS-A. Therefore, Box-Cox transformations were performed on these three variables. DASS-D, DASS-S, and DASS-A all met assumption
of normality following transformation; thus, the transformed variables were used in respective analyses.

**Covariates**

Pearson’s bivariate and Spearman correlations revealed no significant associations of demographic variables (income, age, education) with any of the independent or dependent variables. Therefore, no covariates were adjusted for in analyses.

**Order Effects**

A 5x8 factorial analysis of variance (ANOVA) revealed no significant differences in RTs elicited by specific emotions (Fear RT, Anger RT, Sad RT, Disgust RT) across 8 orders of administrations, deeming the counterbalancing successful. There were no significant order effects.

**Associations Among Depression, Anxiety, and General Distress Symptoms**

Table 2. Pearson Correlations Examining Associations Among Depression, Anxiety, and Stress Symptoms

<table>
<thead>
<tr>
<th></th>
<th>DASS-D</th>
<th>DASS-S</th>
</tr>
</thead>
<tbody>
<tr>
<td>DASS-S</td>
<td>.760**</td>
<td></td>
</tr>
<tr>
<td>DASS-A</td>
<td>.681**</td>
<td>.731**</td>
</tr>
</tbody>
</table>

*Note. N = 124. Findings marked with * were significant at p ≤ .05 and findings marked with ** were significant at p ≤ .01; two-tailed. DASS-A: Depression Anxiety Stress Scale – Anxiety symptoms; DASS-D: Depression Anxiety Stress Scale – Depressive symptoms; DASS-S: Depression Anxiety Stress Scale – General Distress symptoms*

**Relative Contributions of Depression, Anxiety, and General Distress Symptoms to Attentional Bias Indices**

Hierarchical multiple regression analyses were conducted using enter method to examine the relative contribution of depression, general distress, and anxiety symptoms to attentional bias
indices (disgust, fear, anger, sadness). As seen in Table 3, symptoms of general distress (DASS-S) added unique variance to attentional bias to disgust above and beyond depression (DASS-D) at a trend level, with higher general distress scores being associated with longer attentional bias to disgust. No other findings were significant.

Table 3. Multiple Regression Examining Relative Contributions of Depression, Anxiety, and General Distress Symptoms to Attentional Bias Indices

<table>
<thead>
<tr>
<th></th>
<th>Disgust</th>
<th>Fear</th>
<th>Anger</th>
<th>Sad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1:</td>
<td>$R^2 = .02$</td>
<td>$R^2 = .02$</td>
<td>$R^2 = .01$</td>
<td>$R^2 = .004$</td>
</tr>
<tr>
<td>DASS-D</td>
<td>$F(1, 118) = 2.27$</td>
<td>$F(1, 119) = 1.94$</td>
<td>$F(1, 122) = 1.418$</td>
<td>$F(1, 120) = .475$</td>
</tr>
<tr>
<td></td>
<td>$p = .14$</td>
<td>$p = .17$</td>
<td>$p = .24$</td>
<td>$p = .49$</td>
</tr>
<tr>
<td>Block 2:</td>
<td>$R^2_{change} = .04$</td>
<td>$R^2_{change} = .01$</td>
<td>$R^2_{change} = .02$</td>
<td>$R^2_{change} = .02$</td>
</tr>
<tr>
<td>DASS-S</td>
<td>$F(3, 118) = 2.40$</td>
<td>$F(3, 119) = 1.091$</td>
<td>$F(3, 122) = 1.43$</td>
<td>$F(3, 120) = .747$</td>
</tr>
<tr>
<td>DASS-A</td>
<td>$p = .07$</td>
<td>$p = .36$</td>
<td>$p = .24$</td>
<td>$p = .53$</td>
</tr>
</tbody>
</table>

Relative Contributions of Specific Variables

<table>
<thead>
<tr>
<th></th>
<th>DASS-D</th>
<th>DASS-S</th>
<th>DASS-A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$</td>
<td>$t$</td>
<td>$p$</td>
</tr>
<tr>
<td>DASS-D</td>
<td>.138</td>
<td>1.506</td>
<td>.135</td>
</tr>
<tr>
<td>DASS-S</td>
<td>.340</td>
<td>2.180</td>
<td>.031 *</td>
</tr>
<tr>
<td>DASS-A</td>
<td>-.179</td>
<td>-1.285</td>
<td>.201</td>
</tr>
</tbody>
</table>

*Note. Disgust, n = 119; Fear, n = 120; Anger, n = 123; Sad, n = 121. Findings marked with * were significant at $p \leq .05$ and findings marked with ** were significant at $p \leq .01$; two-tailed. DASS-A: Depression Anxiety Stress Scale – Anxiety symptoms; DASS-D: Depression Anxiety Stress Scale – Depressive symptoms; DASS-S: Depression Anxiety Stress Scale – General Distress symptoms; Disgust: Attentional bias to disgust words; Fear: Attentional bias to fear words; Anger: Attentional bias to anger words; Sad: Attentional bias to sad words.

Additional regression analyses conducted to examine the relative contribution of the interaction of symptoms (physical arousal, general distress, and depression) were not significant.¹

Sex Differences in Symptoms of Depression, Anxiety, General Distress and Attentional Bias Indices
Two multivariate ANOVAs (MANOVAs) were conducted to examine sex differences: (1) in DASS symptom scales; and (2) attentional bias indices. Although men and women did not differ in symptom ratings (see Table 4), men exhibited greater attentional bias to fear words than women (see Table 5). No other findings were significant.

Table 4. Multiple Analysis of Variance (MANOVA) Examining Sex Differences Across Depression, Anxiety, and General Distress Symptoms

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>F</th>
<th>p</th>
<th>Partial $\eta^2$</th>
<th>Male M(SD)</th>
<th>Female M(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASS-D</td>
<td>1,121</td>
<td>.457</td>
<td>.500</td>
<td>.004</td>
<td>7.78 (7.56)</td>
<td>7.24 (7.87)</td>
</tr>
<tr>
<td>DASS-S</td>
<td>1,121</td>
<td>1.119</td>
<td>.292</td>
<td>.009</td>
<td>11.58 (7.73)</td>
<td>13.56 (8.92)</td>
</tr>
<tr>
<td>DASS-A</td>
<td>1,121</td>
<td>.000</td>
<td>.996</td>
<td>.000</td>
<td>7.64 (5.79)</td>
<td>7.79 (6.11)</td>
</tr>
</tbody>
</table>

Note. Males, n = 35; Females, n = 87. Findings marked with * were significant at $p \leq 0.05$ and findings marked with ** were significant at $p \leq 0.01$; two-tailed. DASS-A: Depression Anxiety Stress Scale – Anxiety symptoms; DASS-D: Depression Anxiety Stress Scale – Depressive symptoms; DASS-S: Depression Anxiety Stress Scale – General Distress symptoms.

Table 5. Multiple Analysis of Variance (MANOVA) Examining Sex Differences Across Attentional Bias Indices

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>F</th>
<th>p</th>
<th>Partial $\eta^2$</th>
<th>Male M(SD)</th>
<th>Female M(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disgust</td>
<td>1,113</td>
<td>1.000</td>
<td>.320</td>
<td>.009</td>
<td>.024 (.049)</td>
<td>.013 (.058)</td>
</tr>
<tr>
<td><strong>Fear</strong></td>
<td>1,113</td>
<td>7.895</td>
<td>.006**</td>
<td>.065</td>
<td>.060 (.082)</td>
<td>.023 (.054)</td>
</tr>
<tr>
<td>Anger</td>
<td>1,113</td>
<td>.147</td>
<td>.702</td>
<td>.001</td>
<td>.007 (.051)</td>
<td>.011 (.053)</td>
</tr>
<tr>
<td>Sadness</td>
<td>1,113</td>
<td>.087</td>
<td>.768</td>
<td>.001</td>
<td>.042 (.071)</td>
<td>.038 (.066)</td>
</tr>
</tbody>
</table>

Note. Males, n = 30; Females, n = 85. Findings marked with * were significant at $p \leq 0.05$ and findings marked with ** were significant at $p \leq 0.01$; two-tailed. Disgust: Attentional bias to disgust words; Fear: Attentional bias to fear words; Anger: Attentional bias to anger words; Sad: Attentional bias to sad words.

**Moderating Effects of Sex in the Associations of Symptoms with Attentional Bias Indices**

Table 6. Multiple Regression Analyses Examining the Moderating Effects of Sex in the Relationships of Symptoms of Depression, Anxiety, and General distress with Attentional Bias
Diss satisfaction with DASS-A: Depression Anxiety Stress Scale – Anxiety symptoms; DASS-D: Depression Anxiety Stress Scale – Depressive symptoms; DASS-S: Depression Anxiety Stress Scale – General Distress symptoms; Disgust: Attentional bias to disgust words; Fear: Attentional bias to fear words; Anger: Attentional bias to anger words; Sad: Attentional bias to sad words.

Multiple Regression analyses were conducted using enter method to examine whether the relationships of anxiety, general distress, and depression symptoms with attentional bias indices (for fear, disgust, anger, sadness) were moderated by sex. As seen in Table 6, the interaction of sex and anxiety added significant unique variance to attentional bias to disgust, where greater anxiety symptoms were associated with lower attentional bias to disgust words among men, whereas greater anxiety levels were associated with greater attentional bias to disgust words among women (Figure 2). As seen in Table 6, the interaction of sex and general distress
symptoms added significant unique variance to attentional bias to fear, where greater general
distress symptoms were associated with lower attentional bias to fear words among men, while
greater general distress symptoms were associated with greater attentional bias to fear words
among women (Figure 3). No other findings were significant.

Figure 2. Moderating Effect of Sex in the Relationship of Anxiety Symptoms with Attentional
Bias to Disgust
Figure 3. Moderating Effect of Sex in the Relationship of General Distress Symptoms with Attentional Bias to Fear

Relative Contributions of Depression, Anxiety, and General Distress Symptoms to Attentional Bias Indices by Sex

The uneven distribution of sex (males n = 36, females n = 88) may have restricted power to detect statistical significance in analyses examining sex as a moderator. Thus, multiple regression analyses were repeated separately by sex to examine the relative contribution of depression, general distress, and anxiety symptoms to attentional bias indices (for disgust, fear, anger, sadness) among men and women, independently.

Table 7. Multiple Regression Analyses Examining Relative Contributions of Depression, Anxiety, and General Distress Symptoms to Attentional Bias Indices Among Males Alone

<table>
<thead>
<tr>
<th>Block 1:</th>
<th>Disgust</th>
<th>Fear</th>
<th>Anger</th>
<th>Sad</th>
</tr>
</thead>
<tbody>
<tr>
<td>DASS-D</td>
<td>$R^2 = .01$</td>
<td>$R^2 = .07$</td>
<td>$R^2 = .00$</td>
<td>$R^2 = .00$</td>
</tr>
<tr>
<td>$F(1, 32) = .160, p = .69$</td>
<td>$F(1, 33) = 2.44, p = .13$</td>
<td>$F(1, 35) = .119, p = .73$</td>
<td>$F(1, 34) = .014, p = .91$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Block 2:</th>
<th>$R^2 = .25$</th>
<th>$R^2 = .19$</th>
<th>$R^2 = .02$</th>
<th>$R^2 = .15$</th>
</tr>
</thead>
<tbody>
<tr>
<td>DASS-S</td>
<td>$F(3, 32) = 3.23, F(3, 33) = 2.28, F(3, 35) = .177, F(3, 34) = 1.81,$</td>
<td>$F(3, 33) = .19$</td>
<td>$F(3, 35) = .02$</td>
<td>$F(3, 34) = .15$</td>
</tr>
</tbody>
</table>
Relative Contributions of Specific Variables

<table>
<thead>
<tr>
<th></th>
<th>DASS-A</th>
<th></th>
<th>DASS-D</th>
<th></th>
<th>DASS-S</th>
<th></th>
<th>DASS-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>β</td>
<td>.815</td>
<td></td>
<td>-2.988</td>
<td></td>
<td>.301</td>
<td></td>
<td>-.400</td>
</tr>
<tr>
<td>t</td>
<td>-1.563</td>
<td></td>
<td>-.243</td>
<td></td>
<td>.336</td>
<td></td>
<td>.692</td>
</tr>
<tr>
<td>p</td>
<td>.04</td>
<td></td>
<td>.10</td>
<td></td>
<td>.91</td>
<td></td>
<td>.17</td>
</tr>
</tbody>
</table>

Note. Disgust, n = 33; Fear, n = 34; Anger, n = 36; Sad, n = 35. Findings marked with * were significant at $p \leq .05$ and findings marked with ** were significant at $p \leq .01$; two-tailed. DASS-A: Depression Anxiety Stress Scale – Anxiety symptoms; DASS-D: Depression Anxiety Stress Scale – Depressive symptoms; DASS-S: Depression Anxiety Stress Scale – General Distress symptoms; Disgust: Attentional bias to disgust words; Fear: Attentional bias to fear words; Anger: Attentional bias to anger words; Sad: Attentional bias to sad words.

As seen in Table 7, among men, symptoms of anxiety added significant unique variance to attentional bias to disgust words above and beyond depression, as such greater symptoms of anxiety were associated with lower attentional bias to disgust words. No other findings were significant.

Table 8. Multiple Regression Analyses Examining Relative Contributions of Depression, Anxiety, and General Distress Symptoms to Attentional Bias Indices Among Females Alone

<table>
<thead>
<tr>
<th></th>
<th>Disgust</th>
<th>Fear</th>
<th>Anger</th>
<th>Sad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1:</td>
<td>$R^2 = .02$</td>
<td>$R^2 = .01$</td>
<td>$R^2 = .03$</td>
<td>$R^2 = .01$</td>
</tr>
<tr>
<td>DASS-D</td>
<td>$F(1, 85) = 2.01$, $p = .16$</td>
<td>$F(1, 85) = .677$, $p = .41$</td>
<td>$F(1, 86) = 2.75$, $p = .10$</td>
<td>$F(1, 85) = .830$, $p = .37$</td>
</tr>
<tr>
<td>Block 2:</td>
<td>$R^2 = .10$</td>
<td>$R^2 = .03$</td>
<td>$R^2 = .07$</td>
<td>$R^2 = .02$</td>
</tr>
<tr>
<td>DASS-S</td>
<td>$F(3, 85) = 3.14$, $p = .03^*$</td>
<td>$F(3, 85) = .942$, $p = .42$</td>
<td>$F(3, 86) = 1.93$, $p = .13$</td>
<td>$F(3, 85) = .482$, $p = .70$</td>
</tr>
</tbody>
</table>

Note. Disgust, n = 86; Fear, n = 86; Anger, n = 87; Sad, n = 86. Findings marked with * were significant at $p \leq .05$ and findings marked with ** were significant at $p \leq .01$; two-tailed. DASS-
A: Depression Anxiety Stress Scale – Anxiety symptoms; DASS-D: Depression Anxiety Stress Scale – Depressive symptoms; DASS-S: Depression Anxiety Stress Scale – General Distress symptoms; Disgust: Attentional bias to disgust words; Fear: Attentional bias to fear words; Anger: Attentional bias to anger words; Sad: Attentional bias to sad words.

As seen in Table 8, among women, symptoms of general distress added significant unique variance to attentional bias to disgust words above and beyond depression, as such greater levels of general distress were associated with greater attentional bias to disgust words. No other findings were significant.
CHAPTER IV

DISCUSSION

The current study aimed to examine the specificity of threat-related attentional bias across negative emotion subcategories (i.e., fear, disgust, sadness, anger) in relation to symptoms of depression and subtypes of anxiety (i.e., physical arousal and general distress) with the consideration of potential sex effects. One goal was to confirm a differential pattern of attentional bias by symptom type. Specifically, we expected presence of threat-related attentional bias in relation to symptoms of anxiety (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van IJzendoorn, 2007; Cisler & Koster, 2010) and absence of threat-related attentional bias in relation to symptoms of depression (Mogg & Bradley, 2005). The second goal was to extend our and others’ prior findings (Charash & McKay, 2002; Yaffe & Walder, 2016) to show disgust and fear (not sad and anger) verbal stimuli underlie threat-related attentional bias in anxiety. Third, we aimed to demonstrate differential patterns of attentional bias among men versus women, with women displaying a greater bias compared to men (Lee et al., 2017; Sass et al., 2010; Tan, Ma, Gao, Wu, & Fang, 2011; Tran, Lamplmayr, Pintzinger, & Pfabigan, 2013).

As hypothesized, symptoms of depression were not significantly associated with threat-related attentional bias. This is consistent with prior evidence suggesting that an attentional bias to threat is not observed in relation to symptoms of depression when using ESTs with short stimulus presentation durations (Mogg & Bradley, 2005). Accordingly, though not directly tested, our findings fit with the established evidence suggesting that self-relevant words, under longer stimulus presentation durations, which allow for further elaborative processing, may be required to elicit an attentional bias in relation to symptoms of depression (Gotlib & Joormann, 2010; Mogg & Bradley, 2005).
Partially consistent with hypotheses, there was a trend level association of general distress (but not physical arousal) with attentional bias to disgust (but not to fear) words, with greater general distress symptoms associated with greater attentional bias to disgust words in the total sample. Consistent with expectations, symptoms of anxiety and general distress were not associated with attentional bias to non-threat (sad and anger) words. These findings suggest disgust may more strongly underlie threat in relation to non-clinical symptoms of anxiety, particularly those that pertain to general distress (worry). This is consistent with our prior findings, as we demonstrated an attentional bias to disgust words among individuals with non-clinical levels of positive schizotypal traits (Yaffe & Walder, 2016). We concluded that disgust may be particularly salient to threat-related attentional bias observed in non-clinical positive schizotypy (Yaffe & Walder, 2016). Similarly, given that we observed an attentional bias to disgust (but not to fear) words in relation to symptoms of general distress (but not physical arousal), we conclude that disgust may also be particularly salient to threat-related attentional bias in non-clinical levels of anxiety, especially worry. Furthermore, general distress (worry) and physical arousal are not mutually exclusive and are thought to occur at varying degrees across anxiety disorders (Sass et al., 2010). Accordingly, our findings argue that the general distress (worry) aspect of anxiety may be more prominent than the physical arousal aspect of anxiety in driving the threat-related attentional bias observed in non-clinical levels of anxiety. This finding, however, is not fully consistent with prior studies (Sass et al., 2010, 2014), which demonstrated an attentional bias using ERPs to arousing and non-pleasant words both among individuals with non-clinical levels of anxious apprehension (i.e., general distress) and anxious arousal (i.e., physical arousal). Nevertheless, the current study had a number of methodological differences compared to prior studies. First, the Sass et al. (2010, 2014) findings were demonstrated using
ERP data, whereas the current study only used behavioral data. Second, Sass et al. (2010) reported an early attentional bias to arousing words among individuals with anxious apprehension (general distress), and an even earlier attentional bias among individuals with anxious arousal (physical arousal). Our study did not replicate this finding in the total sample, though such patterns emerged when considering sex effects. The absence of significant findings in the total sample was likely attributable to underlying sex effects, rather than methodological factors such as limited sensitivity of the RT indices of the EST in capturing the level of early attentional bias observed in Sass et al.’s (2010) study. Nonetheless, incorporation of ERP measures (which is superior to behavioral data for measuring temporality of cognitive phenomena) in future research may be beneficial for capturing a potential early attentional bias in relation to symptoms of physical arousal.

Contrary to our second hypothesis, there were no significant sex differences in symptoms of depression and subtypes of anxiety, including general distress and physical arousal. These findings are in contrast with prior evidence demonstrating women have a greater likelihood of developing anxiety (McLean & Anderson, 2009) and depressive disorders (Piccinelli & Wilkinson, 2000) and report greater levels of non-clinical anxiety (Costa et al., 2001; Egloff & Schmukle, 2004; Feingold, 1994) and depression (Nolen-Hoeksema et al., 1993) symptoms on self-report measures. This discrepancy between prior literature and the present findings is likely due to the uneven distribution of sex in the current sample, which may have reduced the power to detect statistical significance.

Consistent with expectations, there were no sex differences in attentional bias to angry and sad words, given that they were not considered to be threat-related in the current study. Partially consistent with hypotheses, sex differences were observed in attentional bias to fear (but
not to disgust) words. However, males (compared to females) exhibited a greater attentional bias to fear, which contradicted the directional hypothesis. Even though our findings are inconsistent with prior literature demonstrating a greater attentional bias to threat among females compared to males in the general population, prior studies observed this directional effect in relation to symptoms of anxiety, suggesting that anxiety may have modulated the sex differences in attentional bias to threat. (Tan, Ma, Gao, Wu, & Fang, 2011; Lee et al., 2017; Pintzinger, Pfabigan, Tran, Kryspin-exner, & Lamm, 2016; Sass et al., 2010; Tran, Lamplmayr, Pintzinger, & Pfabigan, 2013). This is further supported by evidence demonstrating an attentional bias to threat (compared to pleasant) words at early stages of processing among non-anxious men (Sass et al., 2010). Our discrepant findings can also be explained by prior evidence showing that men compared to women are more likely to show an attentional bias to words with direct (physical) aggression on a verbal EST (Smith & Waterman, 2005). This is important given that the majority of fear words utilized in the current study involved direct physical threat (e.g., weapon, python, shotgun, knife, bullet, pistol), which may have captured aspects of direct aggression rather than/or in addition to threat (Smith & Waterman, 2005).

Consistent with the third hypothesis, sex did not moderate the relationship of any of the symptoms (i.e., depression, physical arousal, general distress) with attentional bias to non-threat words (i.e., anger, sadness). Partially consistent with hypotheses, however, sex moderated the relationships of physical arousal symptoms (not general distress) with attentional bias to disgust and general distress (not physical arousal) symptoms with attentional bias to fear, though in a manner other than expected. Sex was expected to moderate the magnitude of the relationship, whereas we found sex moderated the direction of these relationships. Specifically, greater anxiety (physical arousal) predicted lower attentional bias to disgust words among men, whereas
greater anxiety (physical arousal) predicted greater attentional bias to disgust words among women. Furthermore, general distress (worry) predicted lower attentional bias to fear words among men, whereas general distress (worry) predicted greater attentional bias to fear words among women. Given the uneven distribution of the sample by sex, we also examined the relative contribution of symptoms (depression, general distress, physical arousal) to attentional bias to disgust and fear words separately among men and women alone. Findings revealed, among women alone, general distress symptoms were associated with attentional bias to disgust words, such that greater symptoms of general distress predicted greater attentional bias to disgust words. In contrast, among men alone, physical arousal symptoms were associated with attentional bias to disgust, such that greater symptoms of physical arousal predicted lower attentional bias to disgust words. Taken together, these findings suggest that among men, physical arousal symptoms drive threat-related attentional bias to disgust words, whereas general distress symptoms drive threat-related attentional bias to fear words. However, among women general distress appears to drive attentional bias to both fear and disgust words, whereas physical arousal symptoms appear to drive attentional bias to disgust alone. Accordingly, our findings suggest that symptoms of physical arousal may be particularly salient to attentional bias to disgust words among both men and women, whereas general distress may be particularly salient to attentional bias to fear words among men alone. Among women alone, general distress may be salient to attentional bias to both disgust and fear words, arguing that symptoms of worry (general distress) may be nonspecific in its association with general threat. Furthermore, among women, greater levels of anxiety were associated with an attentional bias toward threat-related (disgust and fear) verbal stimuli. In contrast, among men greater levels of anxiety were associated with an attentional bias away from threat-related (disgust and fear) verbal stimuli.
These findings provide evidence for a reversed pattern of threat-related attentional bias in relation to symptoms of anxiety across men and women. This was partly consistent with the study hypothesis given that we expected the relationship between symptoms of anxiety and attentional bias to threat to be similar though lesser in magnitude among men compared to women. Furthermore, findings suggest that both fear and disgust may underlie threat in the relationship of anxiety symptoms and threat-related attentional bias.

The current pattern of sex differences in threat-related attentional bias in relation to anxiety are supported by ERP evidence demonstrating that women (compared to men) with symptoms of anxious arousal (physical arousal) exhibited greater attentional bias to threatening words (Sass et al., 2010). Furthermore, anxious women displayed a bias towards threatening (angry) faces, whereas men displayed a bias towards happy faces (Tran et al., 2013). Finally, a recent study using the general population demonstrated an attentional bias towards threatening (fearful) faces among high trait anxious women, whereas there was an attentional bias away from threatening (fearful) faces among high trait anxious men (Tan et al., 2011). This sexually differentiated pattern of findings suggests that anxious men may use threat-avoidance strategies more frequently than women, which allow them to complete ongoing tasks while also effectively regulating their mood (Tan et al., 2011). These strategies are thought to be adaptive in nature, as they prevent negative information from interfering with the task at hand, leading to more effective coping mechanisms (Tan et al., 2011). In contrast, greater engagement with threatening stimuli is thought to reflect ruminative processes (Tan et al., 2011; Piccinelli & Wilkinson, 2000). Accordingly, findings of the current study fit with literature suggesting that women are more prone to utilizing ruminative coping strategies, leading to an overestimation of potential threat, which, in turn, creates greater disturbance and increases the likelihood of developing
anxiety disorders among women compared to men (McLean & Anderson, 2009; Piccinelli & Wilkinson, 2000). Taken together, the aforementioned studies recently (Tan, Ma, Gao, Wu, & Fang, 2011; Lee et al., 2017; Pintzinger, Pfabigan, Tran, Kryspin-exner, & Lamm, 2016; Sass et al., 2010; Tran, Lamplmayr, Pintzinger, & Pfabigan, 2013) began considering sex differences in threat-related attentional bias and found sexually differentiated patterns of threat-related attentional bias. Recent findings, together with the current study findings, highlight the importance of considering sex effects when examining the relationship of anxiety with threat-related attentional bias. The reverse pattern of bias observed among men compared to women may have implications for differential utilization of coping strategies across men and women.

Overall, consistent with the literature, the current study shows evidence for the presence of a threat-related attentional bias in relation to symptoms of anxiety, and the absence of it in relation to depression (Bar-Haim et al., 2007; Cisler & Koster, 2010; Mogg & Bradley, 2005). Furthermore, anxiety subtypes (general distress and physical arousal) differentially contribute to threat-related attentional bias to disgust and fear words such that, among men, physical arousal is associated with threat bias to disgust alone, and general distress is associated with attentional bias to fear alone, whereas among women, general distress is associated with threat bias to both disgust and fear, whereas physical arousal is associated with threat bias to disgust alone. These findings suggest that both among men and women symptoms of physical arousal may be particularly related to attentional bias to disgust words. However, among men, fear words, which potentially reflect direct physical threat (aggression), may be particularly salient to general distress symptoms, whereas among women, the differentiation of threat (direct aggression) may not be as relevant, and threat (fear and disgust), in general, may be particularly salient to general distress. The sexually differentiated associations of subtypes of anxiety symptoms with subtypes
of threat-related words (fear and disgust) are novel given that previous studies did not examine the relationship of differential aspects of anxiety symptoms (physical arousal versus general distress) with specific negative emotion categories corresponding to threat, with consideration of sex effects. Finally, the current findings provide evidence for prominent sex differences in threat-related attentional bias in relation to symptoms of anxiety, wherein women with greater symptoms of anxiety direct their attention towards threat stimuli, whereas men with greater symptoms of anxiety avoid threat stimuli.

**Study Implications**

Cumulatively, the current study findings have implications for informing future studies examining threat-related attentional bias in relation to symptoms. First, findings point to the importance of considering the specificity of emotions that are associated with threat. This is based on the findings that disgust (rather than fear) appeared to underlie threat (in verbal stimuli) in relation to symptoms of anxiety in the total sample, whereas fear and disgust appeared to differentially underlie threat (in verbal stimuli) when examined in relation to anxiety symptoms across men and women. This is relevant given that most studies to date utilized fear stimuli and overlooked the potential role of disgust when studying threat-related attentional bias, which potentially limited their ability to capture important effects related to disgust and may have more strongly captured effects of aggression (physical threat). Second, findings demonstrate the importance of considering depression and subtypes of anxiety (general distress and physical arousal), as these symptoms were differentially associated with threat-related attentional bias. This is further supported by evidence suggesting that general distress corresponds to symptoms of generalized anxiety disorder (worry) (Antony et al., 1998; Arnaudova et al., 2013), whereas physical arousal corresponds to somatic symptoms of anxiety such as panic (Antony et al.,
Lack of consideration of these distinct aspects of anxiety in studies conceptualizing anxiety as a unitary construct may have contributed to mixed prior findings in the field regarding the relationship of threat-related attentional bias with symptoms of anxiety and depression.

Finally, the current study demonstrated an opposite pattern of relationship between anxiety symptoms and threat-related attentional bias among men and women, highlighting the importance of examining sex effects when studying threat related attentional bias in relation to symptoms. Taken together, future consideration of such methodological inconsistencies in the field will allow for a clearer examination of threat-related attentional bias in relation to symptoms of anxiety and mood. This is important given that threat-related attentional bias is thought to be a core component of anxiety disorders such that it contributes to the development and maintenance of symptoms of anxiety (Cisler & Koster, 2010; Williams, Mathews, & MacLeod, 1996). Accordingly, it is important to provide a clearer identification of threat-related attentional bias, especially among non-clinical samples given that it is consistently observed in relation to a range of non-clinical and clinical anxiety symptoms. This suggests that threat-related attentional bias may be an early cognitive marker of anxiety disorders. Furthermore, understanding the exact pattern of this bias among men versus women may allow for the development of sex-specific appropriate treatment strategies (e.g., attention bias modification treatment; see next paragraph) to target this bias among non-clinical and at-risk samples to prevent future illness.

Findings of the current study may also inform strategies for treating anxiety. For example, attention bias modification recently emerged as a potential training-based treatment (in both clinical and non-clinical samples), rooted in the idea that cognitive tasks demonstrating specific attention biases in anxiety can be altered to manipulate attention biases and reduce
anxiety in both clinical and non-clinical populations (Bar-Haim, 2010). While research examining the effectiveness of attention bias modification in clinical and non-clinical populations with anxiety is in incipient stages, initial findings are promising, especially when considered in combination with cognitive behavioral therapy (Bar-Haim, 2010). One important issue in attention bias modification pertains to the selection of threat-related stimuli used in the training process (Bar-Haim, 2010). The majority of studies selected words that are relevant to the specific anxiety disorder being treated (Bar-Haim, 2010). However, this method can be problematic for certain disorders such as generalized anxiety disorder, which present with large variability in the types of concerns experienced by individuals, requiring the selection of personalized stimuli tailored for each individual. Given that this introduces a tradeoff in the ease of delivery and feasibility of the treatment, standardized procedures in identifying the specific emotions that underlie threat in anxiety disorders would be important. To this end, the current study provides early evidence pointing to the saliency of disgust-related verbal stimuli across symptoms of anxiety, as well as the sexually differentiated associations of fear and disgust with symptoms of anxiety. Future studies are needed to extend these findings and establish disgust’s role (along with fear) in threat in relation to anxiety. This may help elucidate the suitability of disgust-related words along with fear-related words for successful use in attention bias modification treatments.

Finally, sexually differentiated patterns of association of anxiety symptoms with threat bias observed in the current study suggest different symptoms may contribute to threat bias among men versus women. Delineation of these sex-specific associations may allow for the development of effective treatment strategies that are specifically tailored for men and women. Furthermore, in the context of findings demonstrating a relationship between anxiety and
women’s tendency to attend to threat, whereas men’s tendency to avoid threat, future research may examine the role of sex in the efficacy of attention bias modification treatment for symptoms of anxiety. Specifically, even though men’s tendency to avoid threatening stimuli is argued to serve an adaptive function in the literature (McLean & Anderson, 2009), it would be important to explore whether such avoidance, though adaptive in the initial stages of processing, would play a role in the maintenance of the anxious process, further exacerbating the symptoms of anxiety in the long run among men. Accordingly, conducting longitudinal studies that particularly examine the contribution of avoidance to the exacerbation of symptoms in the general population endorsing non-clinical anxiety symptoms may help us better understand the role of avoidance as a coping strategy, especially among men. Taken together, evidence suggesting attention bias modification is a potential treatment strategy for anxiety highlights the need to understand the specificity of threat-related attentional bias, which in turn can help improve the efficacy of this treatment strategy across various anxiety disorders among men and women.

**Study Limitations**

The current study had a number of limitations. First, the words for each emotion category (sad, anger, fear, disgust) were selected from the ANEW database (Bradley & Lang, 1999), using the categorization of words under emotion domains, created by Stevenson et al. (2007). Stevenson et al. (2007) used a rather stringent method in categorizing words under distinct emotion domains in order to limit selecting words that reflect more than one specific negative emotion. Therefore, their method yielded very few words in each of the distinct emotion domains (sad, angry, fear and disgust), given that most words in the database reflected a combination of negative emotions, therefore not being purely associated with one specific emotion. Thus, the
current study used a more lenient approach that was successfully used by (Mikels et al. 2005) in selecting visual stimuli in selecting words in order to ascertain enough words in each specific emotion category (sad, fear, anger, disgust). This approach was advantageous, as it allowed greater number of stimuli in each specific emotion domain to ensure statistical power. The methodology used in the current study yielded greater number of words in each specific emotion category; however it also may have permitted selecting words associated with various distinct emotions along with the dominant emotion of the word. Accordingly, this method of categorization may have decreased our ability to capture words that purely belong to one of the four negative emotion subcategories. For example, the majority of fear words utilized in our study appeared to capture physical threat, which is reported to reflect direct aggression (Smith & Waterman, 2005). This suggests fear words used in our study may have incorrectly captured aggression instead of or in addition to fear. Accordingly, this may explain our lack of threat-related attentional bias findings in response to fear words in the total sample, despite the fact that fear is consistently associated with threat in the field (Krusemark & Li, 2011).

The second limitation also related to the method of word selection (Yaffe & Walder, 2016). Consistent with our goal of examining the pure effects of valence, words were selected to match on arousal level across negative emotion subcategories to control for arousal effects, as arousal is shown to generate attentional bias independent of valence (Sass et al., 2010). The disadvantage of this approach was that it may have reduced the unique variability across distinct emotion subcategories given that arousal levels naturally vary across negative emotions. This may have contributed to the lack of attentional bias findings in response to fear words in the total sample, given that it may have attenuated the unique characteristics of fear.
The third limitation was the uneven distribution of sex in our sample, which may have limited our ability to fully examine the moderating effects of sex, as it may have restricted statistical power to detect significance. Furthermore, the sample contained more than twice the number of women than men, which may have obfuscated potential sex effects, such that findings in the general sample may have reflected findings observed among women. This was particularly apparent regarding the contribution of general distress to threat-related attentional bias to disgust words in the general sample, given that the finding observed in the general population was an attenuation of the finding observed among women.

The final limitation of the study pertained to the generalizability of findings given that the sample was restricted to undergraduate students. Accordingly, inferences about other non-clinical samples (with different demographic characteristics) should be made with caution.

**Conclusion**

Overall, the current study in a non-clinical sample corroborated prior findings in clinical and non-clinical samples demonstrating a threat-related attentional bias in relation to symptoms of anxiety (Bar-Haim et al., 2007; Cisler & Koster, 2010; Williams, Mathews, & MacLeod, 1996) and absence of it in relation to symptoms of depression (Mogg & Bradley, 2005). Given the current findings were demonstrated in a non-clinical sample, this study corroborates the notion that threat-related attentional bias may present a vulnerability marker of anxiety disorders (Bar-Haim et al., 2007; Williams et al., 1996). Second, threat-related attentional bias was exclusively observed in response to disgust words in the total sample, which provide evidence for considering disgust as a threat-related emotion in the context of symptoms of anxiety. These findings support our (Yaffe & Walder, 2016) and others’ (Charash & McKay, 2002) prior work and provide a step towards establishing disgust’s role as a threat-related emotion in the context
of verbal stimuli. Third, only general distress and not physical arousal was associated with an attentional bias to threat (disgust) words in the general sample, suggesting that the general distress aspect of anxiety, which taps into worry, may be more strongly associated with threat-related attentional bias in anxiety. However, this finding should be interpreted with caution given that it was likely influenced by the uneven distribution of sex (88 women, 37 men). Thus, findings in the total sample more likely captured female-specific patterns. Men (compared to women) demonstrated an opposite pattern of findings, which likely explains the attenuated female-specific finding in the total sample. Finally, the results of the current study yielded a number of sex effects. Men compared to women showed a greater attentional bias to fear words. Given that the majority of fear words used in the current study potentially reflected direct (physical) aggression, these findings fit with men’s greater sensitivity to direct aggression (Smith & Waterman, 2005). Moreover, different subtypes of anxiety appeared to underlie threat-related attentional bias in a manner that was sexually differentiated. Specifically, among women, general distress contributed to the attentional bias (engagement) to threat (fear and disgust), and physical arousal symptoms contributed to the attentional bias to disgust alone, whereas among men, physical arousal contributed to the bias (away from threat) to disgust words, and general distress contributed to the bias (away from threat) to fear words, alone. These findings suggest that fear and disgust may have captured differential aspects of threat (i.e., physical threat/and general threat), and different constellation of anxiety symptoms may predict attentional bias to fear and disgust across men and women. Finally, there was a sexually differentiated pattern of threat-related attentional bias such that women directed their attention towards threat, whereas men directed their attention away from (avoid) threat. These findings fit with recent evidence demonstrating that women compared to men exhibit a greater difficulty disengaging from threat-
related stimuli (Lee et al., 2017; Tan et al., 2011; Tran et al., 2013), which is thought to reflect greater utilization of ruminative coping strategies (e.g., worry) among women, leading to increased incidence of anxiety disorders (McLean & Anderson, 2009). This argument also corroborates the contribution of general distress to attentional bias to both fear and disgust words among women in the current study, given that general distress particularly taps into worry and rumination, which are frequently observed among women. (McLean & Anderson, 2009; Tan et al., 2011). The specific contribution of physical arousal to attentional bias to disgust among men and women, and general distress to attentional bias to fear alone among men was an interesting finding given that this effect suggests differential involvement of anxiety symptoms with specific emotion subcategories (fear and disgust) among men and women. For example, these findings may suggest that symptoms of worry may be particularly salient to physical threat/aggression (potentially captured by fear words in the current study) among men, whereas symptoms of worry may be nonspecific in its association with threat among women. Given this novel finding, more research needs to be conducted to delineate the differential associations of anxiety and attentional bias to aggression and general threat among men and women. Furthermore, future research aimed at delineating the specificity of mechanisms underlying the sexually differentiated patterns of associations of anxiety symptoms with threat-related attentional bias are needed. Future studies replicating the current findings across various modalities of stimulus presentation and pinpointing the constellation of symptoms that are potentially driving threat bias by examining the specificity of threat among men and women would also be beneficial.

The current study took a novel approach by differentially examining the specificity of negative emotion subcategories (using verbal stimuli) that underlie threat-related attentional bias, specifically in relation to non-clinical symptoms of anxiety, depression, and general distress in
the general population, with consideration of sex effects. Findings corroborated the importance of examining the specificity of emotions underlying threat given that disgust (along with fear) was particularly salient to symptoms of anxiety in the context of threat. The current study also demonstrated the importance of examining subtypes of anxiety as well as depression, given that these symptoms were differentially associated with threat-related attentional bias in a sexually-differentiated manner. Finally, examination of sex is crucial, as men and women show reversed patterns of threat-related attentional bias (attending vs. avoiding). Findings have implications for identifying the specificity (or patterns) of threat-related attentional bias across clinical and non-clinical anxiety given that it may be a cognitive marker of illness. Development of successful strategies that target this bias among non-clinical populations hold potential to contribute to illness prevention. Findings hold potential for informing emerging treatment strategies in anxiety, namely the attention bias modification treatment, which manipulates attention biases to reduce anxiety in both clinical and non-clinical populations (Bar-Haim, 2010).
Multiple regression analyses were conducted by entering DASS-D, DASS-A, DASS-S, and the interactions of DASS-A x DASS-S, DASS-A x DASS-D, DASS-S x DASS-A, and DASS-A x DASS-S x DASS-D to examine the differential contribution of symptoms on outcome measures, namely attentional bias indices for fear, disgust, anger, and sad words. Independent and dependent variables were standardized prior to the regression analyses. These analyses were repeated separately among men and women. However given that the overall ANOVAs for these models were not significant (p > .10), findings were not reported in the results section.
## APPENDIX

<table>
<thead>
<tr>
<th>Neutral 1</th>
<th>Neutral 2</th>
<th>Neutral 3</th>
<th>Neutral 4</th>
<th>Sad</th>
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<th>Anger</th>
<th>Disgust</th>
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