ATTENTIONAL BIAS FOR AFFECTIVE STIMULI: EVALUATION OF DISENGAGEMENT IN PERSONS WITH AND WITHOUT SELF-REPORTED GENERALIZED ANXIETY DISORDER

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ABSTRACT

A core feature of GAD, excessive and uncontrollable worry, may be indicative of poor attentional control and difficulty disengaging attention from threatening or emotional information (e.g., Fox, 2004; Mathews, Fox, Yiend, & Calder, 2003; Yiend & Mathews 2001). The current study examined the performance of college students with and without self-reported GAD (*N* = 63) on measures of attentional control and a spatial cueing task designed to assess engagement-disengagement processes from emotionally valenced (aversive, pleasant) and neutral picture stimuli. Attentional control abilities were examined using the Stroop Color-Word Association Test (SCW Test) and Trail-Making Test (TMT). Separate analyses of variance (ANOVAs) demonstrated that GAD participants performed more poorly on the Stroop Color subtest and the TMT: Part B than non-GAD participants. Mixed ANOVAs of response times measured during the spatial cueing task revealed significant main effects for Cue Valence and Cue Validity, as well as several significant interactions of these variables with GAD status. The significant Cue Valence x Cue Validity x GAD status interaction indicated that GAD participants were slower to disengage their attention from aversive stimuli, relative to pleasant or neutral stimuli, than non-GAD participants who did not exhibit this bias. This interaction effect, however, did not remain significant upon covarying for depression. Together, these findings suggest that individuals with GAD evidence poorer attentional control and demonstrate difficulties disengaging from threatening stimuli compared to persons without the disorder. Impairment in these attentional processes may, therefore, contribute to the etiology and maintenance of GAD.

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CHAPTER 1

INTRODUCTION

Generalized anxiety disorder (GAD) is a chronic and disabling disorder characterized by a greater intensity and frequency of worry than is the case for most individuals in the normal population (Borkovec, Alcaine, & Behar, 2004; Dugas, Gagnon, Ladouceur, & Freeston, 1998), and suppression of autonomic reactivity not characteristic of other anxiety disorders (Marten et al., 1994). Worry has been described as an anticipatory cognitive process, consisting primarily of ruminative, verbal linguistic content that allows a person to inhibit excessive emotional responding while he or she analyzes a situation and engages in problem-solving strategies (Borkovec, Ray, & Stöber, 1998; Davey, 1994). The verbal linguistic nature of worry is hypothesized to provide a less vivid and intrusive experience of threatening information than would be produced by more elaborate cognitive processing involving both thoughts and images (Borkovec et al., 1998; Paivio, 1986). This implies some level of cognitive control in that one has the ability to mentally pull back from other demands on his or her attention to evaluate a situation before acting. For persons with GAD, however, their worry appears extreme and seems to fail to serve an adaptive function, evidence of possible impairment in information-processing abilities and limited control over the allocation of their attentional resources (Borkovec et al., 2004). Indeed, individuals with GAD generally judge their worry to be uncontrollable, intrusive, and at times even dangerous (Borkovec et al., 2004; Wells & Carter, 2001), suggestive of attentional biases associated with difficulty disengaging from threatening information once encountered (Fox, 2004; Mathews, Fox, Yiend, & Calder, 2003; Yiend & Mathews 2001).

A meta-analysis of literature in the area of attentional biases suggests that biases toward threat occur in equal magnitude across the anxiety disorders (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007). However, the more chronic nature of attentional biases in persons with GAD compared to high trait anxious individuals and normal controls, indicates possible differences in the mechanisms that comprise and underlie these cognitive processes in GAD. That is, individuals with GAD evidence attentional biases more consistently in many experimental attention tasks and at both automatic (without awareness, intent, control) and conscious (aware, intentional, controllable) processing levels, suggestive of greater difficulties strategically allocating their attention in a functional manner (see MacLeod & Rutherford, 2004; Mathews & MacLeod, 2005; Mogg, Bradley, & Williams, 1995). Research provides support for attentional biases in persons with GAD (see Bar-Haim et al., 2007), but closer examination of specific attention components (e.g., facilitated orientation/engagement, disengagement, attentional avoidance) may elucidate information-processing differences that improve our conceptual understanding of the disorder.

A wide array of experimental paradigms have been used to examine attentional phenomena related to anxiety. Prior to discussing research in this area, it is important to understand how attentional processes may influence biases toward threatening or emotional information. The human attention system is proposed to comprise of attentional shifting, detection/engagement, and disengagement (Eysenck, Derakshan, Santos, & Calvo, 2007; Posner & Peterson, 1990). Attentive processing allows individuals to quickly perceive environmental input and maintain focus on significant stimuli. Not only are the perceptual properties of the scene important during this process, but so are the individual's expectations and interpretations regarding the information they are processing. Information believed to be threatening is thought to be prioritized by the attentional system, which of course, serves an important evolutionary function when adaptively utilized (Eccleston & Crombez, 1999; Öhman & Mineka, 2001). Attentional biases toward threatening information and difficulty disengaging from such information may result in the overburdening of attentional resources, an inability to control allocation of attention toward other relevant environmental stimuli, and enhanced and maintained anxious states. Substantial research has examined attentional biases in persons with GAD and high trait anxious individuals using experimental paradigms such as the emotional Stroop task, the visual probe paradigm, the visual search task, and the spatial cueing task. Each of these experimental tasks assess different observable components of attentional biases, including facilitated orientation/engagement, disengagement, and attentional avoidance. Research utilizing these tasks and the strengths and weaknesses of each in assessing specific components of attention are discussed below.

Emotional Stroop Paradigm

The emotional Stroop task (Mathews & MacLeod, 1985; see Williams, Mathews, & MacLeod, 1996), a variation of the standard Stroop task (Stroop, 1935), has been one of the more widely used paradigms to assess attentional biases in GAD and high trait anxious populations. This task presents participants with a list of emotional or threatening words printed in different colors and asks them to quickly and accurately name the color in which the word is printed while ignoring the meaning of the word. The fundamental premise of the Stroop paradigm is that interference effects (i.e., color-naming delays) are largely caused by the aversive nature of the verbal stimuli. Thus, it is theorized that aversive words will create more cognitive interference as the participant attempts to complete the task. The result would be longer response times in color-naming threat words than neutral or positive words.

Studies utilizing variations of the emotional Stroop task have consistently demonstrated longer response latencies for threatening or emotional words among participants with GAD compared to nonanxious controls (e.g., Becker, Rinck, Magraf, & Roth, 2001; Bradley, Mogg, Millar, & White, 1995; Martin, Williams, & Clark, 1991; Mogg, Bradley, Williams, & Mathews, 1993). Interestingly, individuals with GAD show this bias more consistently than do persons with high trait anxiety. Although attentional biases have been observed in high trait anxious persons during emotional Stroop tasks (e.g., Fox, 1993; Mogg, Bradley, et al., 2000), results are not always consistent and appear more reliable when these individuals are experiencing an additional stressor (e.g., student examinations; MacLeod & Rutherford, 1992). These findings indicate a more constant attentional bias toward threatening or emotional information in persons with GAD, whereas high trait anxious individuals may have the tendency to develop such a bias (Mogg & Bradley, 1998). Possibly, a person with high trait anxiety may develop GAD after experiencing a chronic, repeated pattern of stress.

Important to consider is whether the observed threat bias may be, at least partly, a function of clinically anxious status. One study found that persons with GAD evidenced longer response times to threat words than non-threat words when compared to an equally anxious nonclinical sample (Martin et al., 1991). Accordingly, threat-related attentional biases in individuals with GAD may be the result of some factor(s) associated with being a clinically anxious person, as not all anxious individuals exhibit such a bias.

Research directly comparing persons with GAD and high trait anxious individuals is limited; replicating and extending the results of this study is warranted.

Despite considerable literature on the emotional Stroop task, many have criticized some of the limitations inherent within the Stroop paradigm. For instance, longer response times could be explained by mechanisms other than attentional bias, such as semantic relatedness of stimuli and presentation format (Holle, Neely, & Heimberg, 1997). Longer response latencies could also represent situational cognitive impairments (e.g., distraction) resulting from heightened state anxiety rather than underlying attentional biases toward threatening cues. Moreover, slower color-naming may reflect an attentional avoidance of threat-relevant stimuli rather than attentional orientation toward such stimuli. Although the emotional Stroop task typically aims to tap automatic processes, participants are provided the opportunity for encoding of the stimuli. When participants become consciously aware of the stimuli, they therefore may utilize effortful attentional avoidance strategies (de Ruiter & Bruisschot, 1994). One study utilizing the Stroop paradigm found attentional biases for emotional stimuli in high trait anxious persons with poor attentional control (i.e. cognitive ability to regulate attention allocation and maintain goal-directed activities), whereas this pattern was not observed in individuals with high trait anxiety and good attentional control or low trait anxious individuals (Reinholdt-Dunne, Mogg, & Bradley, 2009). Another interpretation is that slower responding may not be the result of initial engagement of attention but rather difficulty disengaging from the threat once it is detected (Koster, Crombez, Verschuere, & De Houwer, 2004).

Research paradigms manipulating the conditions under which stimuli are presented during the emotional Stroop task have addressed some of the limitations of the standard version of this paradigm (e.g., Bradley et al., 1995; MacLeod & Hagan, 1992; MacLeod & Rutherford, 1992; Mogg et al., 1993). One study compared nonanxious controls to persons with GAD with and without concurrent depression during an emotional Stroop task that incorporated supraliminal and subliminal exposure conditions (Bradley et al., 1995). The subliminal condition allowed for a more accurate assessment of automatic attentional processes as the stimuli were masked to limit participants' awareness of what they had seen. In this condition, anxiety-related, depression-related, positive, and neutral word stimuli were presented briefly (14 ms) on a color background patch and immediately followed by a masking stimulus consisting of a random letter string. The supraliminal condition followed standard emotional Stroop procedures and matched the subliminal condition in all respects except for the use of a masking procedure.

Persons with GAD without concurrent depression demonstrated slower color naming responses for negative words versus neutral words when compared to persons with GAD and concurrent depression and nonanxious controls. This effect was evident in both the supraliminal and subliminal conditions, indicating attentional biases toward negative stimuli occurred at an automatic and conscious processing level. The pattern held despite the fact that an "awareness check" confirmed that words presented in the subliminal condition were, in fact, processed at a subliminal level (i.e., participants were unable to surpass chance levels of correct identification of already-seen words).

The findings also indicate that such attentional biases may be specific to anxiety-related psychopathology, as the performance decrements were not observed in persons with GAD and concurrent depression. Depression may have a suppressive effect on attentional biases, which is consistent with research finding a lack of bias toward negative words or faces in depressed individuals (e.g., MacLeod, Mathews, & Tata, 1986; Mogg, Millar, et al., 2000). Interestingly, attentional biases were not only observed in response to threat-relevant words, but to negative words in general (e.g., sadness, worthlessness), suggesting that the attentional biases may be nonspecific for negative information. Other research utilizing the emotional Stroop task in persons with GAD has also shown attentional biases not only for negative words but for emotional stimuli in general (e.g., Becker et al., 2001; Martin et al., 1991).

Visual Probe Paradigm

Experimental tasks, such as the visual probe paradigm, have been used to address some of the limitations raised by the Stroop task (e.g., MacLeod et al., 1986; Mogg, Mathews, & Eysenck, 1992). In the visual probe task, two stimuli (threatening and non-threatening) are simultaneously presented on each trial and a neutral probe (e.g., dot, letter) then replaces a target stimulus. Participants are required to press a key as quickly as possible when they detect the presentation of the neutral probe. Faster detection of the probes that replace threat-laden (vs. non-threatening) stimuli is interpreted as reflecting greater attention for threat. That is, threat bias facilitates attention orientation, and this response pattern would be expected for someone demonstrating an attentional bias toward threat-relevant information. During the visual probe tasks, stimuli and probes are typically presented in pairs in very quick succession; the lag-time between the stimulus and probe, termed stimulus onset asynchrony (SOA), is usually set between 500 and 1000 ms (see Bar-Haim et al., 2007; Mogg & Bradley, 2005).

Numerous studies utilizing the visual probe task have shown that individuals with GAD respond more rapidly than nonanxious controls to probes presented in the previous location of threatening word stimuli (e.g., Bradley, Mogg, & Millar, 2000; MacLeod et al., 1986; Mogg et al., 1995). Similar effects have been observed in persons with high trait anxiety as well (e.g., Mogg, Bradley, & Hallowell, 1994; Salemink, et al. 2007). Visual probe tasks employing pictorial stimuli (e.g., angry, fearful, neutral faces) have also revealed comparable results among persons with GAD (Bradley, Mogg, White, Groom, & de Bono, 1999) and individuals with high trait anxiety (Bradley et al., 2000; Fox, 2002; Koster et al., 2004). Related is some evidence indicating that nonanxious controls exhibit a reverse pattern in visual probe tasks, responding more slowly to probes presented in the spatial location of threatening words. Such findings suggest that nonanxious individuals may effortfully divert their attention away from threatening stimuli (MacLeod et al., 1986). This particular pattern, however, has not always been uniformly demonstrated and, thus, should be considered cautiously.

Consistent with findings from the emotional Stroop literature, attentional biases observed in persons with GAD during visual probe tasks are not as reliably exhibited in high trait anxious individuals. For instance, MacLeod and Mathews (1988) found that persons with high trait anxiety, when compared to low trait anxious individuals, only evidenced attentional biases when threat-relevant words were presented in the context of a salient environmental stressor. Together, these data provide support for the assertion of a more consistent and chronic pattern of attentional biases in individuals with GAD than high trait anxious persons.

The visual probe task is not without its own limitations. Modifications to the original task have made it difficult to determine what attentional processes are being measured from one study to another. For instance, one form of the task requires participants not only to detect the probe but then differentiate between two types of probes (e.g., an arrow pointing left versus right), and it is unclear if the same attentional phenomena is being measured in this version. Another modified version of the task compares responding on threatening trials with a neutral baseline trial to attempt to parse out facilitated orientation versus disengagement difficulties (Koster et al., 2004), whereas the influence of slowed disengagement is not measured in the original task even though it likely influences responding. Similar to the emotional Stroop task, some methodological problems have also been pointed out with respect to parsing out automatic versus conscious and strategic responses (MacLeod & Rutherford, 2004). Although the visual probe paradigm is often used to assess automatic attentional biases, the typical SOA in these studies is between 500 and 1000 ms (Mogg & Bradley, 2005). Some theorize that conscious processes begin to influence responding around 500 ms, and shorter SOAs (e.g., 100-250 ms) are necessary to assess more automatic processes and limit the influence of conscious attentional control (Beck & Clark, 1997; MacLeod & Rutherford, 2004).

Utilization of masked presentation of stimuli in the visual probe paradigm has been helpful in addressing some of these limitations (e.g., Mathews, Ridgeway, & Williamson, 1996; Mogg et al., 1995). Studies using such methodology have demonstrated, for instance, that persons with GAD respond faster to negative words in the subliminal condition compared to individuals with depression and normal controls (Mogg et al., 1995). This particular finding suggests that persons with GAD evidence automatic attentional biases toward negative information. Also of note, individuals in the depressed group showed increased vigilance for anxiety-relevant words only in the supraliminal condition. Therefore, it appears that persons with GAD are sensitive to attentional bias at both an automatic level and when strategic attentional control can be utilized. Depressed individuals, on the other hand, may not be automatically responsive to threat words but appear to process them on the supraliminal level. This later proposition could indicate that depressed persons are either less sensitive to threat words or that conscious responding is secondary to some other depressive process (e.g., rumination).

Visual probe tasks incorporating measures of eye gaze during the presentation of emotional stimuli offer another complementary assessment of attentional biases, with a more precise measure of attention orientation. One study investigated biases toward emotional face stimuli (i.e., threatening, happy, sad, and neutral) in persons with GAD and depressive disorder by monitoring the direction and latency of initial eye movements in response to the presentation of facial stimuli (Mogg, Bradley, et al., 2000). GAD participants were more likely to initially orient to threat faces than neutral faces compared to participants with depressive disorder and normal controls, and they did so more quickly. These findings suggest a facilitated orientation bias toward threatening stimuli among persons with GAD.

Overall, the research shows that individuals with GAD evidence attentional biases toward threatening information specifically and possibly emotional information in general. Data from diverse experimental paradigms, including the emotional Stroop and visual probe tasks, indicate that attentional differences exist between persons with GAD and high trait anxious, depressed, and non-anxious individuals. Further, findings from the unmasked presentation literature show that individuals with GAD evidence an impairment in cognitive control processes. When participants are given the opportunity to apply attentional control strategies during unmasked presentations of threatening stimuli, persons with GAD seem unable to effectively allocate their attention during the task, and attentional biases toward threatening or emotional stimuli are maintained (Bradley et al., 1995; Mathews & MacLeod, 1985). High trait anxious individuals, on the other hand, exhibit a decrease in attentional biases toward threatening information during unmasked compared to masked presentations (MacLeod & Hagan, 1992; MacLeod & Rutherford, 1992; Mogg, Bradley, et al., 2000). These findings support the assertion that persons with GAD demonstrate more consistent automatic and conscious attentional biases, and may be more susceptible to chronically heightened threat interference that decreases adaptive allocation of attention and ability to maintain task-focus.

Nevertheless, it is unclear whether limitations in control of attention allocation are associated with enhanced facilitation toward threatening or emotional stimuli and/or an inability to disengage from such stimuli once it has been noticed (Eysenck et al., 2007). Difficulty disengaging from threat-relevant information may lead to enhanced emotional distress and trigger and maintain an excessive and uncontrollable worry episode (Fox, Russo, Bowles, & Dutton, 2001; Georgiou et al., 2005). Although research using GAD samples is lacking in this area, Derryberry and Reed (2002) found high trait anxious individuals with poor attentional control, as measured by a self-report questionnaire, evidenced greater difficulty disengaging from threatening stimuli than high trait anxious persons with good attentional control. It is difficult to make claims about ability to disengage from stimuli based on findings from the emotional Stroop and visual probe paradigms, however, because these tasks do not allow for adequate assessment of the process of disengagement. To better understand attentional components of facilitated engagement and slowed disengagement, the visual search task (e.g., Öhman, Flykt, & Lundqvist, 2000; Rinck, Becker, Kellermann, & Roth, 2003) and emotional spatial cueing task (e.g., Fox, Russo, & Dutton, 2002; Mathews et al., 2003; Yiend & Mathews, 2001) have been used to provide a more direct assessment of these processes.

Visual Search Paradigm

In the visual search task, a modification of the odd-one-out search task (Hansen & Hansen, 1988), participants are asked to search for a target stimulus among a matrix of distracter stimuli. Some trials include a neutral target stimulus among emotional or threatening stimuli (i.e., distracter stimuli) or vice versa. The matrix may also contain a neutral target stimulus among neutral distracters. Different reaction times when exposed to the various combinations of target and distracter stimuli can then be compared, allowing for measurement of enhanced facilitation of attention toward emotional or threatening stimuli and increased distraction by such stimuli. An initial orientation bias (enhanced facilitation) is interpreted from faster response times to detect an emotional or threatening target stimulus than a neutral target stimulus among neutral distracter stimuli. Difficulty disengaging from threatening or emotional stimuli is considered to have occurred when slower responding is observed in identifying a neutral target stimulus among emotional or threatening distracter stimuli, compared to response times to detect a neutral target stimulus among neutral distracter stimuli. Taken together, these patterns of response times indicate a “pop-out” effect of threatening or emotional target stimuli and stronger distraction by such stimuli.

Research utilizing the visual search task demonstrates that ability to disengage from threatening or emotional stimuli may be an important component of attentional biases. For instance, high trait anxious individuals have shown difficulty in attentional disengagement compared to nonanxious controls when threatening facial stimuli are used as distracters (Byrne & Eysenck, 1995). Rinck and colleagues (2003) examined attentional biases in persons with GAD, speech phobia (SP), and nonanxious controls, using a visual search task with all combinations of GAD-related, SP-related, positive, and neutral target words among distracter stimuli consisting of these same categories. GAD participants showed slowed responding to target words among matrices of GAD-related distracters, indicating more difficulty disengaging from the GAD-related distracter stimuli compared to other categories of distracters (i.e., SP-related, positive, neutral distracters). SP participants and nonanxious controls did not exhibit this bias in any of the matrix combinations. Interestingly, an initial orientation bias (faster detection) was not observed when GAD-related words were used as targets for individuals with GAD and SP-related words were used as targets for persons with SP.

Taken together, these findings suggest that slowed disengagement rather than an initial orientation bias may be a more influential component of attentional biases, at least in individuals with GAD. Nevertheless, research using the visual search task is limited, making it difficult to generalize findings. Ability to assess whether observed attentional biases are the result of faster detection or difficulties disengaging from threat is also limited in this task (Fox et al., 2001; Koster et al., 2004), and the simultaneous presentation of emotional and neutral stimuli make it difficult to isolate attentional biases.

Emotional Spatial Cueing Paradigm

The emotional spatial cueing paradigm addresses the limitations of the previously discussed paradigms and is designed to distinguish between delays resulting from either faster engagement (i.e., facilitated orientation) or difficulty disengaging from a threatening or emotional stimulus. This task, a variation of Posner's (1980) spatial cueing paradigm, consists of a cue (e.g., positive, threatening, neutral word or pictorial stimulus) appearing in one of two locations on a computer screen, and upon the offset of the cue, a target is presented (e.g., dot probe). The target appears either in the same location where the cue appeared ("valid" trial) or on the opposite side of the computer screen ("invalid" trial). This allows for a measure of disengagement from the cued location on invalid trials. During this task, the cue and target are presented in the same location on the majority of trials, so as to ensure a build-up of the participant's expectation that the target will appear in the cued location.

As might be expected, response rates are typically faster on validly-cued trials than on invalidly-cued trials. It is asserted that this task requires participants to first allocate attention to the cue (a reflexive process), and when the target appears in the invalid location, participants need to shift their attention via disengagement from the cued location to the uncued location (Fox et al., 2001; 2002). Then, participants need to re-engage attention to the target. Slower response rates on invalidly-cued trials are believed to be a consequence of having difficulty disengaging attention from the cued location. For instance, if an emotional word cue is presented on one side of the screen, a person's attention may be oriented toward that word cue. Ability to disengage from that word cue (shift attention to the other side of the screen) will be determined in part by how salient the word is to the individual. A person more sensitive to threat words, for example, will demonstrate a longer delay in shifting attention from the word cue to the target. Different reaction times can then be compared across positive, neutral, or threat-relevant word cues. The spatial cueing task can, therefore, be utilized to determine if underlying attentional biases in anxious populations are associated with an inability to disengage attention once threatening stimuli have been detected. The entire process (orientation to a cue, disengagement from the cue, and re-engagement to the target) happens within milliseconds of the initial presentation of the cue.

An important phenomenon observed in the spatial cueing paradigm literature is "inhibition of return" (IOR). IOR refers to a process in which attention is inhibited from returning to an area previously searched (Klein, 2000; Posner & Cohen, 1984), and slowed attentional disengagement is theorized to be reflected in reduced IOR (Fox et al., 2002). The IOR effect is typically observed when longer cue-target SOAs are used (e.g., > 300 ms; Koster, Crombez, Vershuere, Van Damme, & Wiersema, 2006; Koster, Verschuere, Crombez, & Van Damme, 2005; Mogg, Bradley, Miles, & Dixon, 2004; Pérez-Dueñas, Acosta, Lupiáñez, 2009), likely the result of increased time to consciously process stimuli and engage attentional control strategies. This reverses the typical pattern of faster responding to validly-cued than invalidly-cued trials, as individuals are more inclined to favor targets appearing in locations not already scanned, resulting in shorter response times on invalid trials. In highly anxious persons, one might expect slowed disengagement from threatening or emotional stimuli, which could be deduced from a reduced or non-existent IOR effect for such stimuli compared to neutral stimuli. Although, if there is an increased IOR effect for threatening or emotional stimuli, that may indicate the highly anxious individuals were successful in engaging in attentional avoidance of those stimuli.

The spatial cueing paradigm has been adapted to study attentional biases toward emotionally valenced stimuli in anxious populations (e.g., Derryberry & Reed, 2002; Fox et al. 2001; Fox et al., 2002; Koster et al., 2006, Mathews et al., 2003; Yiend & Mathews, 2001; Waters, Nitz, Craske, & Johnson, 2007). Nevertheless, this procedure is relatively new with limited research testing hypotheses specifically relevant to GAD. One study used the spatial cueing paradigm to examine the influence of trait worry and induced state worry on attentional disengagement using angry, happy, and neutral schematic face cues (Verkuil, Brosschot, Putman, & Thayer, 2009). A cue-target SOA of 960 ms was used. Overall, participants responded faster on the invalidly-cued trials compared to the validly-cued trials, indicating an IOR effect. Persons with high trait worry *and* high trait anxiety evidenced reduced IOR for angry faces, suggesting greater difficulty disengaging from angry face cues than happy and neutral face cues. When trait anxiety was held constant, both trait worry and state worry were correlated with increased IOR for neutral face cues, indicating that worry may bias attention allocation away from neutral stimuli to more emotional or threatening stimuli. Further research with this population is needed to confirm these results.

Additional research using the spatial cueing paradigm has been conducted in high trait and state anxious individuals and revealed slowed disengagement from emotionally valenced stimuli in these populations (see Bar-Haim et al. 2007; Cisler & Koster, 2010). Fox and colleagues (2002; Experiment 1) examined responses of persons with high and low trait anxiety using angry, happy, and neutral schematic face cues and a cue-target SOA of 300 ms. In this task, high trait anxious individuals evidenced longer response latencies than persons with low trait anxiety when angry cues preceded the invalidly-cued target (i.e., dot probe), and this effect was not observed on valid trials. Angry face cues, therefore, did not induce faster localization of targets appearing in the cued location as would be suggested by an engagement account of attentional bias (i.e., facilitated orientation toward threatening stimuli). Rather, the angry face cues slowed down localization of targets in the uncued location, supporting the disengagement account of attentional bias (i.e., inability to disengage from threatening stimuli once detected). Interestingly, high trait anxious participants also took longer to disengage from happy facial expressions relative to neutral expressions on invalidly-cued trials, indicating a possible attentional bias toward emotional information in general. Differences in response times across the angry, happy, and neutral face cues were not observed for low trait anxious participants. Slowed disengagement from angry facial stimuli among persons with high trait anxiety has been observed using comparable paradigms with SOAs of 300 and 700 ms as well (Fox, Mathews, Calder, & Yiend, 2007). Further, variations of the spatial cueing task using threat-related, neutral, and positive word stimuli have demonstrated similar results in high and low *state* anxious individuals (Fox et al., 2001).

In Experiment 2 (Fox et al., 2002), the SOA was increased from 300 ms to 960 ms to determine if IOR would be less with angry face cues compared to happy or neutral face cues in high trait anxious individuals, suggesting slowed attentional disengagement. Participants with high and low trait anxiety showed overall faster responding on invalidly-cued trials than validly-cued trials (i.e., IOR effect). There was a reduced IOR effect for angry face cues for all participants, indicating high and low trait anxious individuals had more difficulty disengaging from angry cues compared to happy and neutral face cues. Fox and colleagues hypothesize that a shorter cue-target SOA might have identified differences between the anxiety groups in disengagement processes.

Spatial cueing paradigms utilizing non-face pictorial cues have demonstrated comparable results to those using word and facial cues. Yiend and Mathews (2001), Experiments 2 and 3, examined whether high and low trait anxious individuals would show attentional biases toward threat pictures compared to neutral pictures. Picture cues were taken from the International Affective Picture System (IAPS; Center for the Study of Emotion and Attention, 1999). In this task, high trait anxious participants evidenced slower response times than low trait anxious participants on invalidly-cued trials when probes were preceded by a threatening cue, indicating slowed disengagement on these trials. Individuals with high trait anxiety also exhibited longer overall response latencies when presented with highly threatening pictures cues. This effect was revealed at a cue-target SOA of 500 ms; however, the pattern changed when the SOA was increased to 2000 ms. With the longer SOA, high and low trait anxious participants showed faster responding on invalidly-cued compared to validly-cued trials, suggestive of IOR. Comparable to the results of Fox and colleagues (2002; Experiment 2), a reduced IOR effect for threatening picture cues was observed, but there were no significant differences between high and low trait anxious individuals at the longer SOA.

In a similar study designed by Koster and colleagues (2006), persons with high and low trait anxiety engaged in a spatial cueing task with neutral, mildly, and highly threatening IAPS pictures. High trait anxious participants showed greater attentional engagement and impaired disengagement from highly threatening pictures compared to low trait anxious participants at a cue-target SOA of 100 ms. Interestingly, at 200 and 500 ms SOAs, participants with high trait anxiety demonstrated faster reaction times on invalidly-cued than validly-cued trials following a threatening picture, indicating the IOR effect and possible attentional avoidance of threatening cues. The IOR effect observed at 200 ms contrasts with previous research demonstrating this effect only at longer intervals (e.g., Koster et al. 2005; Koster et al., 2006; Mogg et al., 2004).

Waters and colleagues (2007) used a spatial cueing paradigm comparable to Yiend and Mathews (2001) but added pleasant picture cues to elucidate whether slower attentional disengagement among anxious individuals was specific to aversive stimuli or related to emotional stimuli in general. Notably, females with high trait anxiety exhibited greater difficulty disengaging from threatening stimuli than neutral and pleasant stimuli compared to low trait anxious females, whereas no differences were found in males with high or low trait anxiety. Sample sizes were small (< 15 per group); however, and these results have not been replicated. Similar to Koster and colleagues (2006), but contrary to Yiend and Mathews (2001), participants evidenced slower responding on validly-cued trials compared to invalidly-cued trials (i.e., IOR effect) using a 500 ms SOA.

Overall, findings from the spatial cueing task literature indicate that a possible factor in the maintenance of anxiety disorders is difficulty disengaging from threatening information. Of course, this does not mean the hypothesis that anxiety is associated with biased attention orientation to threat-related stimuli has been disproved, but rather that the ability to disengage may be a significant component of attentional biases as well. Although results are somewhat mixed, research to date demonstrates differential patterns of attentional disengagement between high and low trait anxious individuals at shorter cue-target SOAs and possible attentional avoidance in both groups at longer SOAs. Differential responding observed at specific cue-target SOAs may be indicative of information processing occurring at automatic or strategic processing levels, or a combination of both, at certain stimuli presentation lengths. For instance, strategic attentional control abilities may begin to influence automatic biases for threatening or emotional stimuli, possibly resulting in increased attentional avoidance, although it is unclear at what exact cue-target SOA this occurs. More research examining these time scale variations in the spatial cueing paradigm might clarify how differences in early and later stages of information processing influence attentional biases among individuals with high and low anxiety.

Future research using the spatial cueing paradigm should also more closely examine disengagement processes in populations with different levels of state and trait worry and anxiety. As previously stated, it appears attentional biases may involve an interaction between state and trait anxiety, given high trait anxious individuals inconsistently show biases toward threat unless under an additional stressor (e.g., MacLeod & Mathews, 1988; Mogg et al., 1994). Utilizing the spatial cueing paradigm, Fox and colleagues (2001, 2002) demonstrated that high trait and high state anxious persons evidence similar patterns of slowed disengagement from threatening information. Interacting effects of high trait worry and high trait anxiety also seem to influence attentional biases for threatening stimuli in the spatial cueing task (Verkuil et al., 2009). Research in this area is relatively new; however, and future investigations should examine whether findings replicate and generalize to populations with different levels of state and trait worry and anxiety, as well as to populations with clinical psychopathologies such as GAD.

Examining how individuals with GAD respond during the spatial cueing task is of particular interest, given difficulty disengaging from threatening or emotional information may contribute to the perseverative and uncontrollable nature of worry central to the disorder. This process would result in the overburdening of attentional resources, an inability to adaptively allocate attention toward other relevant environmental stimuli, and serve to maintain and enhance distress in persons with GAD. Additionally, given depressed individuals exhibit different patterns of responding during attention tasks than anxious persons (e.g., MacLeod et al., 1986; Mogg, Bradley, et al., 2000), and rumination in depression appears to be a similar process to worry in GAD, persons with GAD may show different attentional bias patterns than high trait anxious individuals or persons with other anxiety disorders. Research utilizing the spatial cueing task with GAD populations should also examine cue-target SOAs at which attentional control begins to influence responding (e.g., > 300), as individuals with GAD are hypothesized to experience difficulty with strategic control of attentional processes (e.g., adaptive allocation of attention resources; Borkovec et al., 2004). Generalizing findings from the spatial cueing task literature to persons with GAD may prove an informative next step in better understanding the specific mechanisms underlying the disorder.

Researchers utilizing the spatial cueing paradigm have begun incorporating pictorial stimuli in an attempt to enhance the salience and generalizability of this experimental task (Waters et al., 2007; Yiend & Mathews, 2001), given the majority of studies examining attentional biases to date have utilized word or schematic face stimuli. The salience of realistic pictorial stimuli compared to word stimuli may be particularly relevant for persons with GAD, given threatening images are theorized to be more distressing for these individuals and avoided using the less threatening verbal linguistic process of worry (e.g., Borkovec et al., 1998). Further, although word and schematic face stimuli have been shown to elicit attentional biases, such stimuli may not always evoke sufficient arousal as they may not match real-life dangers perceived by anxious individuals. Realistic pictorial stimuli may provide a better representation of these perceived threats. The processing of objects and pictures compared to words is also thought to more strongly relate to affective information processing (Glaser & Glaser, 1989) at a more vivid and elaborate level (Borkovec et al., 1998; Paivio, 1986). Indeed, research has demonstrated that affective pictures interfere with performance during attention tasks more than affective words (De Houwer & Hermans, 1994, Experiment 1). Images may therefore prove more salient and elicit greater arousal in individuals with GAD than word stimuli.

Use of images such as those that make up the IAPS pictures, shown to evoke distinctive physiological and subjective reactions (Lang, Bradley, & Cuthbert, 1999), offers variety in subject matter and emotional valence of stimuli for the spatial cueing task. However, when using realistic pictorial stimuli, the difficulty in matching perceptual characteristics (e.g., size, color, detail) of the images across experimental conditions should be considered. Matching perceptual characteristics is important because small variations may affect reaction times. Some of the pictures may also be more relevant to participants based on prior exposure to certain stimuli or environmental situations, an important confounding factor to consider. Nevertheless, the realistic nature and emotional valence variation of IAPS pictures may allow for a more comprehensive assessment of attentional biases in persons with GAD, including whether the biases are specific to threat or emotional information in general. Research in this area is fairly limited and results are conflicting (e.g., Mathews & Klug, 1993; Martin et al., 1991); although, individuals with GAD have indeed evidenced a bias toward positive stimuli as well as threatening stimuli (Becker et al., 2001; Martin et al., 1991). Utilizing the spatial cueing task, with IAPS picture stimuli, may help clarity the nature of attentional biases in persons with GAD.

Summary of Present Study

The overall goal of the present study was to better understand the attentional processes in persons with and without self-reported GAD. The core feature of GAD, perseverative and uncontrollable worry, suggests possible impairment in information-processing abilities and limited control over adaptive allocation of attentional resources in this population (Borkovec et al., 2004). Specifically, persons with GAD may have attentional biases associated with an inability to disengage from threatening or emotional information (Fox, 2004), enhancing and maintaining their worry and anxious states.

The emotional spatial cueing task offers a paradigm for assessing disengagement in the attentional process when individuals are presented with stimuli of different emotional valences (e.g., aversive, pleasant, neutral). Studies utilizing this task have shown that high trait anxious persons exhibit greater difficulty disengaging from emotionally valenced stimuli compared to low trait anxious individuals or non-anxious controls (e.g., Derryberry & Reed, 2002; Fox et al., 2002; Waters et al., 2007; Yiend & Mathews, 2001). However, to date, there is limited research using this paradigm to examine attentional processes in persons with GAD, who may have particular difficulty disengaging from emotional stimuli as indicated by their pathological worry. Research using the emotional Stroop and visual probe paradigms has already demonstrated attentional biases in persons with GAD associated with facilitated orientation *toward* threatening and emotional information, at an automatic and conscious processing level (e.g., Becker et al., 2001; Bradley et al., 1995; Bradley et al., 1999; Mogg et al., 1995). The spatial cueing paradigm allows for determination of whether attentional processes in these individuals are further influenced by difficulties disengaging *from* such stimuli. In the current study, the spatial cueing task was used to examine attentional biases at a conscious processing level (i.e., 500 ms SOA), to assess these biases when strategic control of attentional allocation can be utilized. The emotional valence of stimuli presented during this task allowed for examination of whether biases in persons with GAD were specific to threat-relevant stimuli or related to emotional stimuli in general. Improved understanding of attentional biases in this population may illuminate the role they play in the phenomenology of GAD.

Attentional control abilities in persons with and without self-reported GAD were first assessed using neutral cognitive tasks: the original Stroop Color-Word Association Test (SCW Test) and the Trail-Making Test (TMT). Separate analyses of variance (ANOVAs) examined differences in attentional control between individuals in the GAD and non-GAD groups. For the SCW Test, mean response scores (amount of task completed within the time limit) were the dependent variables assessed. For the TMT, the dependent variables were mean response times on the task.

Attentional biases associated with engagement and disengagement were then measured in the emotional spatial cueing paradigm using picture cues differing in valence. A 2 (GAD status: GAD and non-GAD) x 3 (Cue Valence: neutral, pleasant, aversive) x 2 (Cue Validity: valid and invalid) factorial design was conducted. Mean response times on the spatial cueing task were the primary dependent variables assessed and were calculated for each participant as a function of each factor in the design. That is, separate mean response times were calculated for validly-cued versus invalidly-cued trials and for each cue valence condition (neutral, pleasant, aversive), as well as for each combination of these dimensions.

"Cue validity effect" is a term used frequently in the spatial cueing paradigm literature, and it is important to understand how it relates to response time. The cue validity effect refers to the relative difference between response times on invalidly-cued versus validly-cued trials. This provides a better measure of the individual's ability to disengage from a cue than a single response time. Some studies calculate the cue validity effect directly, using a formula such as: Cue Validity Effect = response time invalid cue – response time valid cue (Posner & Cohen, 1984). When calculated directly, a positive cue validity value indicates that participants are responding faster on validly-cued than invalidly-cued trials, suggesting there was maintained attention to the preceding cue. A negative cue validity value shows that participants responded faster on invalidly-cued than validly-cued trials, indicating that attention shifted from the cued location and that the return of attention to that location was inhibited (IOR effect; Fox et al., 2001). In the current study, response time on invalidly-cued versus validly-cued trials was included as a within-subject factor (repeated measure) for the primary mixed ANOVA. The cue validity effect was calculated directly for some follow-up analyses of significant interactions to better understand simple effects. This approach has been used in previous research (e.g., Fox et al., 2001, 2007; Waters et al., 2007; Verkuil et al., 2009), and the conceptual interpretation of the cue validity effect is the same in both calculations.

Hypotheses

1. **Attentional Control**

Participants with self-reported GAD were hypothesized to exhibit poorer attentional control abilities compared to non-GAD participants, as measured by lower response scores (less task completion within the time limit) on the SCW Test and longer response times on the TMT: Part B, a measure of ability to divide attention and cognitive flexibility. No differences were hypothesized between groups for the TMT: Part A, a measure of basic visual scanning and numeric sequencing.

2. **Attentional Biases Associated with Engagement-Disengagement**

For the emotional spatial cueing paradigm, analyses were hypothesized to identify several general differences (main effects), including (a) slower overall response times for the GAD versus non-GAD group, (b) faster response times for validly-cued versus invalidly cued trials, and (c) slower overall response times for aversive cues than for pleasant or neutral cues. Several specific hypotheses were then proposed to examine the interaction of these core factors. Based on past research with high trait anxious individuals (e.g., Fox et al., 2001; Waters et al., 2007; Yiend & Mathews, 2001), the following three hypotheses were advanced:

(d) Mean response times were expected to be slower for the GAD group than the non-GAD group during aversive cue trials compared to response times for pleasant and neutral cue trials. Furthermore, response times among GAD participants were expected to be slower than response times for non-GAD participants for pleasant cue trials, as persons with GAD are also hypothesized to evidence slower responses to emotionally arousing stimuli (even if pleasant). No differences were hypothesized in response times to neutral stimuli.

(e) Cue validity effects (response times on invalidly-cued relative to validly-cued trials) were expected to be larger on aversive cue trials than on pleasant cue trials, and larger on pleasant cue trials than on neutral cue trials. Likewise, cue validity effects were hypothesized to be larger on aversive cue trials than on neutral cue trials. The difference in magnitude of the cue validity effect was expected to be more influenced by longer response times on invalidly-cued trials, indicating slowed disengagement, rather than shorter response times on validly-cued trials, suggestive of faster engagement/initial localization of cues.

(f) A third hypothesis built off the first two. The interaction between cue validity effects and cue valence described in hypothesis (e) was expected to be significantly stronger for GAD than non-GAD participants. That is, the GAD group, compared to the non-GAD group, was hypothesized to show greater difficulties disengaging their attention from aversive and pleasant stimuli, as indicated by larger cue validity effects for these valences.

CHAPTER 2

METHOD

The study investigated how attentional biases, specifically ability to disengage from emotionally valenced stimuli, differed among students with and without self-reported GAD. Study participants completed the following in the specified order: 1) several self-report questionnaires assessing anxiety and mood symptoms, 2) the SCW Test and TMT, and 3) the emotional spatial cueing task, utilizing aversive, pleasant, and neutral pictorial stimuli. Upon completion of the study, participants were debriefed, provided with referrals to local treatment facilities should they chose to seek psychological services, and received 1 unit of academic credit or monetary compensation ($10).

Participants

Ninety eight undergraduate students enrolled in an introductory psychology course at Temple University completed the study. Participants were selected and assigned to groups based on their screening scores on the *Generalized Anxiety Disorder Questionnaire for DSM-IV* (GAD-Q-IV; Newman et al., 2002). The dimensional scoring system of the GAD-Q-IV was used to establish self-reported GAD and non-GAD groups.

Participants were selected using a double-gated screening procedure. Persons scoring a 5.7 or above were initially recruited for the GAD group and those with a score of 3 or below were recruited for the non-GAD group. The 5.7 cut-off score was used to identify GAD participants as it provides optimal balance between diagnostic specificity (89%) and sensitivity (83%) when screening for individuals meeting DSM-IV criteria for GAD (Newman et al., 2002). The median GAD-Q-IV score of this sample was 5. Given the difficulty categorizing individuals scoring close to the median into discrete groups, only individuals scoring in the top (7.67 or above) and bottom (2.33 or below) 35% of the distribution of scores on the GAD-Q-IV were chosen for the GAD and non-GAD groups. This sub-sample was selected to maintain an adequate sample size while creating sufficient separation between participant groups (GAD: n = 31; non-GAD: n = 32). All remaining analyses are presented for the final sample of 63 participants. These groups will be referred to as the GAD group and non-GAD group henceforth.

Sample Size Considerations

A power analysis, using guidelines suggested by Cohen (1998), was conducted to determine the number of participants needed to detect effects for the study's primary hypotheses using a repeated-measures ANOVA. Similar analyses in the literature have produced large effect sizes for interaction effects and planned comparisons (e.g., Fox et al., 2001; Waters et al., 2007). A large effect size (f = .40), power of .80, and α = .05 were deemed appropriate for the proposed study. Main effects (GAD status; Cue Validity; Cue Valence) and two-way interactions (GAD x Cue Validity) required a total sample size of 38 (3.17 per cell). Two-way interactions with Cue Valence (GAD x Cue Valence; Cue Validity x Cue Valence) and our highest order three-way interaction (GAD x Cue Valence x Cue Validity) required a total sample size of 60 (5 per cell). To ensure sufficient power, data on 31 GAD and 32 non-GAD participants were analyzed.

Measures

Self-Report Measures

Demographics. All participants provided general information regarding their age, gender, ethnicity, educational level, occupation, and household income.

Generalized Anxiety Disorder Questionnaire for DSM-IV (GAD-Q-IV; Newman et al., 2002). The GAD-Q-IV is a self-report measure assessing DSM-IV (American Psychiatric Association [APA], 1994) criteria for GAD. The GAD-Q-IV consists of: (a) five Yes/No questions assessing the occurrence of excessive and uncontrollable worry (e.g., "Do you find it difficult to control the worry once it starts?"); (b) a list of the most frequent topics of worry; (c) a checklist of the six somatic symptoms related to GAD (e.g., muscle tension, irritability); and (d) two items assessing the level of interference and distress resulting from worry and physical symptoms, rated on a 9-point scale of 0 = *None* to 8 = *Very Severe*. The GAD-Q-IV can be scored via a criterion-based (straightforward sum of item responses) or dimensional scoring system (weighted scoring system for individual items). The dimensional scoring system has been recommended (Newman et al., 2002), as it generates a score that best matches the DSM-IV diagnostic threshold for the GAD diagnosis and provides an overall index of the severity of GAD. Further, using a 5.7 cut-off score, the dimensional scoring system demonstrates improved diagnostic specificity and sensitivity (89% and 83%, respectively) over the criterion-based scoring system (96% and 67%, respectively) when screening for individuals meeting diagnostic criteria for GAD. The GAD-Q-IV also evidences good diagnostic agreement with a clinician-administered semi-structured diagnostic interview, the Anxiety Disorders Interview Schedule (ADIS-IV; Brown, DiNardo, & Barlow, 1994). Agreement between the GAD-Q-IV and the ADIS-IV (kappa = .67) found by Newman and colleagues (2002) is comparable to that reported for two independently administered ADIS-IV interviews (kappa = .65; Brown, DiNardo, Lehman, & Campbell, 2001). Correlations between the GAD-Q-IV and measures of worry, social anxiety, and post-traumatic stress disorder symptoms support the convergent and discriminant validity of the measure (Newman et al., 2002). Adequate test-retest reliability (kappa = .64) over a 2-week period was also shown using the GAD-Q-IV dimensional score (Newman et al., 2002).

For the present study, the dimensional scoring system for the GAD-Q-IV was used to examine the presence and severity of self-reported generalized anxiety symptoms in the study sample. To create a dimensional total score: (a) the five Yes/No questions are coded as 1 for yes and 0 for no; (b) 1 point is given for each item on the list of worry topics, up to 6, and this total is divided by 3; (c) 1 point is given for each item on the list of somatic symptoms, up to 6, and this total is divided by 3; and (d) for the interference and distress questions, the number circled on the 9-point scale is taken, and each number is divided by 4 and then added together. Using this system, scores can range from 0-13, with scores above 5.7 indicating clinically significant symptoms of GAD. To create discrete "symptomatic" groups for the current study, however, only individuals scoring 7.67 or above on the GAD-Q-IV were included in the GAD sample and persons scoring 2.33 or below were included in the non-GAD sample (see "Participants" section). The coefficient α in the current sample was .93.

Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990). The PSWQ consists of 16 items rated on a 1-5 scale and assesses the extent to which worry is excessive, uncontrollable, and pervasive. A total score is calculated by summing the items (noting the 5 items that are reverse-scored). The PSWQ has good internal consistency (α = .91; Meyer et al., 1990) and has been shown to discriminate individuals with GAD, other anxiety disorders, and community controls (Brown, Antony, & Barlow, 1992). Correlations between the PSWQ and measures of anxiety, depression, and emotional control have also supported the convergent and discriminant validity of the measure (Brown et al., 1992). The PSWQ has correlated positively with worry as measured by the Worry Domains Questionnaire (WDQ; Tallis, Eysenck, & Mathews, 1991) and correlated with the dimensional scoring of the GAD-Q-IV (r = .71; Rodebaugh, Holaway, & Heimberg, 2008). The measure is also sensitive to change across 6-week and 12-week treatment interventions for GAD (Borkovec & Costello, 1993). Good predictive validity of the PSWQ has been evidenced through its ability to predict worry duration in individuals diagnosed with GAD (r = .42) and in healthy participants (r = .59; Dupuy, Beaudoin, Rheaume, Ladouceur, & Dugas, 2001). Good test-retest reliability (r = .74 - .92) across time frames as long as 2-10 weeks in undergraduate samples (Meyer et al., 1990; Molina & Borkovec, 1994; Stöber, 1998) has also been demonstrated. The PSWQ was included to provide a fuller description of worry characteristics in the study participants. The coefficient α in the current sample was .97.

Beck Depression Inventory – II (BDI-II; Beck, Steer, Ball, & Ranieri, 1996). The BDI-II is a 21-item self-report instrument intended to assess the existence and severity of symptoms of depression as listed in the DSM-IV (APA, 1994). Each of the 21 items corresponding to a symptom of depression is summed to give a single score for the BDI-II. There is a four-point scale for each item ranging from 0 to 3. On two items (16 and 18) there are seven options to indicate either an increase or decrease of appetite and sleep, although the items are still scored 0-3. Cut score guidelines for the BDI-II are given with the recommendation that thresholds be adjusted based on the characteristics of the sample and the purpose for use of the BDI-II. A total score of 0-13 is considered to represent minimal levels of dysphoria, 14-19 is mild, 20-28 is moderate, and 29-63 is severe (Beck et al., 1996). This measure has been used extensively and has demonstrated good internal consistency among college students (α = .93) and psychiatric outpatients (α = .92). A high correlation has been shown between the BDI-1A and the BDI-II (r = .93), and high test-retest reliability (r = .93) over a one-week period in a psychiatric outpatient population has also been reported (Beck et al., 1996). The BDI-II was used to examine differences in the presence and severity of depressive symptoms across study participants and, in a *post hoc* analysis, to examine whether hypothesized findings would remain robust when covarying for depressive symptoms. The coefficient α in the current sample was .95.

Emotional Intensity Scale (EIS; Bachorowski & Braaten, 1994). The EIS consists of 30 items rated on a 1-5 scale designed to assess the typical intensity with which an individual experiences positive and negative emotions across various situations (e.g., at a fun party, seeing a sad movie, having an embarrassing experience). The total score is calculated by summing the items (noting that 9 items are reversed-scored). The EIS has exhibited good internal consistency (α = .90) and temporal stability (r = .83) over a 9-week period (Bachorowski & Braaten, 1994). Bachorowski and Braaten (1994) also found the EIS to be positively correlated (r = .48, p < .01) with the Affect Intensity Measure (Larsen & Diener, 1987), used to assess trait affect intensity, supporting the construct validity of the EIS. The EIS was included to examine differences in the level of intensity with which study participants experience emotions. The coefficient α in the current sample was .90.

Clinician-Administered Measures

The Stroop Color-Word Association Test (SCW Test; Stroop, 1935). The SCW Test is a clinician-administered measure of selective attention, response inhibition, and controlled cognitive processes. The Golden Stroop format (Golden, 1978) was used for the present study and consists of three subtests, each with a 45-second time limit, and each presented on an 8½ in x 11 in page with 100 items presented in five columns of 20 items each. The three subtests were administered in the following order: Stroop Word (SW), Stroop Color (SC), and Stroop Color-Word (SCW). In the SW subtest, participants are asked to read a series of color words (e.g., "green", "red", "blue") printed in black ink. The SW provides an indicator of simple attention and reading ability. During the SC subtest, participants name the colors of a series of "x"s that are printed in green, red, or blue ink. The SC establishes the tendency to respond to color, and the subtest is believed to require a more conscious effort to identify the hue and then select the corresponding lexical information to name the hue, than the more automatic response and reduced lexical retrieval demands involved in seeing and naming a color word in the SW subtest. In the SCW subtest, participants are asked to name the color of ink in which each word is printed while suppressing the probable dominant response of reading the incongruent color name (e.g., the word "blue" printed in green ink). The SCW subtest positively correlates with another measure of response inhibition, the second half of the Test of Variable of Attention (TOVA: Greenberg & Waldman, 1993), suggesting construct validity (Cox et al., 1997). All three subtests have also demonstrated good test-retest reliability ($r > .80$; Connor, Franzen, & Sharp, 1988; Graf, Uttl, & Tuokko, 1995). The SCW Test was administered in the present study as a measure of cognitive control abilities, specifically selective attention and response inhibition. Scoring is based on the total number of items read or named correctly within a 45-sec interval. SCW Test age-corrected raw scores (SCW-Raw), SCW age-corrected T-scores (SCW-T), and the number of SCW errors (SCW-Err) were calculated for the present study based on normative data published in the Stroop Test manual (Trenerry, Crosson, DeBoe, & Leber, 1989).

Trail-Making Test (TMT; Army Individual Test Battery, 1944). The TMT is a test of visual scanning, numeric sequencing, divided attention, and cognitive flexibility. It consists of two stimulus sheets (Part A and Part B) on 8 ½ in x 11 in paper. Part A features circles containing ascending numbers from 1 to 25. Participants are asked to begin at the circle containing the number "1" and to draw lines to consecutively connect the numbered circles until they reach the final circle with the number "25". Part A provides a measure of visual scanning, numeric sequencing, and visual-motor speed. Part B consists of a combination of letters (A to L) and numbers (1 to 13). Participants are again asked to begin at the circle containing the number "1" and to connect ascending numbers and letters in an alternating pattern. Part B provides an indicator of cognitive flexibility and ability to divide attention. The TMT positively correlates ($r = .50$, $p < .05$) with the Visual Search and Attention Test, another measure of attention (VSAT; O'Donnell, MacGregor, Dabrowski, Oestreicher, & Romero, 1994; Trenerry, Crosson, DeBoe, & Leber, 1990), and positively correlates ($r = .59$, $p < .01$) with the Wisconsin Card Sorting Test - *percent perseverative errors,* a measure of cognitive flexibility (WCST; Heaton, Chelune, Talley, Kay, & Curtiss, 1993; Kortte, Horner, & Windham, 2002). Additionally, the TMT has demonstrated good test-retest reliability ($r = 0.89$) over a 9-month time interval (Dikmen, Heaton, Grant, & Temkin, 1999). The TMT was used in the current study as a measure of sustained and divided attention and general cognitive flexibility.

Apparatus and Materials

International Affective Picture System (IAPS; Center for the Study of Emotion and Attention, 1999; Lang et al., 1999). The IAPS consists of 768 standardized color photographs that can be presented as digitized images on a computer screen or as projected slides. IAPS images are rated on dimensions of affective valence (ranging from pleasant to unpleasant) and subjective arousal (ranging from calm to excited). The pictures used in the current study ranged from pleasant (e.g., scenes of couples, nature), to neutral (e.g., furniture, household appliances), to unpleasant (e.g., physical attacks, mutilated bodies). The IAPS images have been shown to effectively elicit subjective and physiological arousal in normal and clinical populations (Bradley, Cuthbert, & Lang, 1990, 1991; Vrana, Spence, & Lang, 1988).

IAPS pictures are typically rated on a 0 – 9 point scale for each dimension indicating perceived affective pleasantness and subjective arousal. Ratings are scored such that 9 represents a high score on each dimension (i.e., high pleasure, high arousal) and 1 represents a low score (i.e., low pleasure, low arousal). The IAPS images used for the current study were selected on the basis of normative affective valence and arousal ratings (Lang et al., 1999). Aversive and pleasant images that differ in affective valence ratings but were similar in subjective arousal level were used, given arousal level and perceived pleasantness of an image can influence the processing of affective picture stimuli (Cuthbert, Bradley, & Lang, 1996; Vogt, De Houwer, Koster, Van Damme, & Crombez, 2008). In the present study, an omnibus ANOVA demonstrated significant overall differences among the three cue valences (i.e., aversive, pleasant, neutral) in both perceived valence, $F(2, 141) = 4233.30$, $p < .001$, and arousal, $F(2, 141) = 727.41$, $p < .001$. Tukey HSD *post hoc* analyses indicated that aversive images ($M = 2.48$, $SD = 0.28$) were rated significantly different in perceived valence from both pleasant ($M = 7.45$, $SD = 0.34$) and neutral ($M = 5.02$, $SD = 0.13$) images (both *p*'s < .001). Pleasant and neutral images also differed on perceived valence, $p < .001$. Tukey HSD *post hoc* analyses also showed that aversive images ($M = 6.07$, $SD = 0.39$) were not rated significantly different in arousal than pleasant images ($M = 6.02$, $SD = 0.59$), *p* = ns. However, neutral images ($M = 2.81$, $SD = 0.43$) did differ significantly in arousal from both aversive and pleasant images, $p < .001$, consistent with expectations.

Procedure

Part 1. Undergraduate students enrolled in an introductory psychology course at Temple University completed an online set of research questionnaires using the Sona Systems® interface. Prior to completing the questionnaires (which included the GAD-Q-IV), participants were presented with a consent form and required to either accept or decline participation before proceeding. Completion of the questionnaire packet took approximately 2 hours, and students received 2 research credits toward a course requirement. An alternative method of screening potential participants involved setting up a separate study on the Sona Systems® interface that allowed interested persons to complete the GAD-Q-IV and a small set of other questionnaires not related to this study, separately from the larger set of questionnaires. Again, participants were presented with a consent form and required to either accept or decline participation before proceeding to the questionnaires. Completion of Part 1 of this study through this alternative mechanism took approximately 20 minutes, and students received 0.5 research credits toward a course requirement.

Potential participants who completed the GAD-Q-IV were placed into groups based on their GAD-Q-IV total scores as described above. They were then informed of their eligibility via email and, if interested in participating, were instructed to select an available time on Sona Systems® for the experimental task in Part 2.

Part 2. Participants were instructed to come to the Adult Anxiety Clinic of Temple University (AACT) on their scheduled day, and each participant was run individually through the experimental task in Part 2. Upon arrival at the laboratory, participants were escorted to the waiting area, wherein they received an introduction to this phase of the study and were asked to complete a consent form describing study procedures. The experimenter answered any questions about the consent form or study procedures prior to beginning the experimental task. Participants were then asked to complete several questionnaires pertaining to their mood and anxiety, including the GAD-Q-IV, PSWQ, EIS, and BDI-II, and were informed completion of the questionnaires would take approximately 15 minutes. They were left alone for this portion of the study.

Once the questionnaires were completed, participants were escorted to another room and seated at a desk to complete the SCW Test followed by the TMT. Participants were instructed that they would be completing several paper-and-pencil tasks prior to beginning the computer task. They were reminded before each task that they would be timed and to complete the tasks as quickly and as accurately as possible. The experimenter stated that she would observe the participant's performance on the SCW

Test and the TMT, and the participant would be notified of any errors made during the tasks so they could correct these errors before proceeding. Upon completion of the SCW Test, which included the Stroop Word (SW), Stroop Color (SC), and Stroop Color-Word (SCW) subtests, and completion of the TMT: Part A and B, participants were escorted to another room for the emotional spatial cueing computer task.

The computer task was programmed using Presentation Software v0.76 Build 11.30.03 (Neurobehavioral Systems, Inc.) and presented on a Dell Optiplex computer with a 17" 75 Hz CRT color monitor. Participants were seated 50 cm from the computer monitor for the duration of the task. The IAPS pictures (aversive, pleasant, neutral) were used as the cues in the experiment. They were presented in color and sized to 300 by 225 pixels (subtending 7.03° x 9.39°). Participants were informed that a series of pictures would be displayed on the computer screen and that each picture should be viewed in its entirety while on the screen. Participants were then instructed to respond to the white arrowhead probe (2 pixels wide, subtending 1.53° x 1.53°) that appeared after the offset of the picture cue presentation. The arrowhead probe was presented at the lower half of the visual space previously occupied by the picture cue or on the opposite side of the computer screen. Participants were instructed to left click or right click the computer mouse in correspondence with the direction of the arrowhead, as quickly and as accurately as possible, once the arrowhead was detected (e.g., right click mouse if the arrowhead pointed right). The computer mouse was positioned on the desk central to the computer screen. Participants were also told to direct their attention to the white fixation cross (1 pixel wide, subtending 1.53° x 1.53°) in the center of the screen when no picture cue or arrowhead probe was being presented. The cue-probe onset asynchrony (SOA) was 500 ms and the inter-trial interval was 1,000 ms. Each trial sequence proceeded as follows: 1) The fixation cross was presented for 1,000 ms in the center of the computer screen, 2) the picture cue was presented for 500 ms on either the right or the left side of the fixation cross, and then 3) on "probed" trials the arrowhead probe was presented immediately following the picture cue until the participant responded (or after 2,000 ms), and on "non-probed" trials, no arrowhead probe was presented following the picture cue.

The experimental task consisted of 144 trials, with an equal number of aversive, pleasant, and neutral picture cues presented (i.e., 32 each) during the validly and invalidly-cued trials. On 75% of the probed trials, the arrowhead probe followed in the same location as the picture cue ("validly-cued trial"), and on the remainder trials, the arrowhead probe appeared on the opposite side to the picture cue ("invalidly-cued trial"). The greater percent of validly-cued compared to invalidly-cued trials was intended to ensure an increase in the participant's expectation of the probe appearing in the picture cue location, allowing for measurement of disengagement from this location on invalidly-cued trials. The 75% valid to 25% invalid ratio was balanced across the picture cue valences (neutral, pleasant, aversive). There were an additional 48 non-probed trials to prevent participants from developing a response set. Picture cues were also equally balanced between appearing on the left or right side of the computer screen for each of the picture cue valences. Further, the direction of the arrowhead probe (right, left) was balanced on both the validly-cued and invalidly-cued trials. Picture cue valence, side (left, right), cue validity (valid, invalid), probe (probed, non-probed trials), and direction of the arrowhead probe (right, left) appeared in random order. Prior to beginning the experimental task, participants completed 10 practice trials. Participants were then informed they would be observed through the one-way mirror in the computer room while they finished the experimental task, to help ensure participants maintained attention on the task (e.g., kept eyes on the computer screen). The experimenter then ensured all of the participant's questions regarding the experimental procedures were answered, reminded the participant to respond as quickly and as accurately as possible, and then left the room once the computer task began. This portion of the study took approximately 45 minutes to complete.

At the end of the experiment, participants were debriefed by the experimenter and received either course credit or monetary compensation ($10). Study participants were provided with referrals to local treatment facilities should they choose to seek psychological services.

CHAPTER 3

RESULTS

Preliminary Analyses

Prior to testing the study's hypotheses, normality, skewness, and kurtosis were examined for all variables. Distributional properties for all self-report measures and response times on the SCW Test, TMT, and spatial cueing task reasonably approximated a normal distribution. Outliers (2 *SD*s above or below the mean) were identified in the response scores on the SCW Test ($n = 2$; 1 from non-GAD group, 1 from GAD group) and response times on the TMT: Part A and B ($n = 4$; 3 from non-GAD group, 1 from GAD group). Data from these outliers were excluded in analyses using the SCW Test and TMT.

Demographic variables for the GAD and non-GAD groups were examined (see Table 1). Participants in the GAD and non-GAD groups did not significantly differ with respect to age, $t(61) = -0.24$, p = ns, gender, $\chi^2(N = 63, df = 1) = 2.89$, p = ns, or ethnicity, $\chi^2(N = 63, df = 1) = 1.07$, p = ns. Due to the low number of minorities in the sample, Hispanic/Latino, African-American/African, Asian-American/Asian, and "other" participants were collapsed into a single minority group for the Chi Square analysis to satisfy the assumption of expected frequencies.

Means and standard deviations for all self-report measures of psychological and emotional constructs are presented in Table 2. As expected, the GAD and non-GAD groups differed significantly on the GAD-Q-IV, PSWQ, and EIS. GAD participants reported higher levels of generalized anxiety, $t(61) = -29.49$, $p < .001$, trait worry, $t(61) = -15.13$, $p < .001$, and experienced emotional intensity, $t(61) = -2.60$, $p < .01$. The GAD group also reported higher levels of depressive symptoms on the BDI-II, $t(61) = -7.91$, $p < .01$, than the non-GAD group.

Table 1
Participant Demographic Characteristics

Variable	GAD Group (*n* = 31)	Non-GAD Group (*n* = 32)
Mean Age (years)	20.42 (*SD* = 3.89)	20.22 (*SD* = 2.59)
Gender:		
Female	22	16
Male	9	16
Ethnicity:		
European-American/Caucasian	24(77.4%)	21(65.6%)
Hispanic/Latino	2(6.5%)	1(3.1%)
African-American/African	1(3.2%)	8(25%)
Asian-American/Asian	3(9.7%)	2(6.3%)
Mixed Ethnic Background	0	0
Other	1(3.2%)	0

Note: GAD = self-reported generalized anxiety disorder.

Table 2
Means and Standard Deviations for Self-Report Measures of Psychological and Emotional Constructs

	GAD Group (*n* = 31)		Non-GAD Group (*n* = 32)	
Measures	*M*	*SD*	*M*	*SD*
GAD-Q-IV	10.22	1.49	1.48	0.74
PSWQ	67.00	9.18	32.28	9.04
BDI-II	22.65	11.78	4.56	3.60
EIS	119.39	23.19	94.47	9.96

Note: GAD-Q-IV = Generalized Anxiety Disorder Questionnaire for DSM-IV; PSWQ = Penn State Worry Questionnaire; BDI-II = Beck Depression Inventory – II; EIS = Emotional Intensity Scale.

Correlational analyses were used to examine the relationships among self-report measures (see Table 3). As expected, there was a high correlation between self-reported GAD and worry, between GAD and experienced emotional intensity, and between worry and experienced emotional intensity. These measures were also positively correlated with depressive symptoms, as measured by the BDI-II. Of note, correlations including the GAD-Q-IV should be interpreted with caution, due to the selection of scores at the extreme ends of the distribution for the study sample. Correlations were calculated separately for the high and low GAD-Q-IV sample; however, and observed correlations were similar at both ends of the distribution.

Table 3
Intercorrelations among Self-Report Measures of Psychological and Emotional Constructs

	GAD-Q-IV	PSWQ	BDI-II	EIS
GAD-Q-IV	-	.94**	.81**	.40**
PSWQ		-	.73**	.44**
BDI-II			-	.41**
EIS				-

Note: *p < .05; **p < .01; GAD-Q-IV = Generalized Anxiety Disorder Questionnaire for DSM-IV; PSWQ = Penn State Worry Questionnaire; BDI-II = Beck Depression Inventory – II; EIS = Emotional Intensity Scale.

Correlation analyses among mean response scores on the SCW Test and mean response times on the TMT and spatial cueing task were also examined (see Table 4). Mean response times on the spatial cueing trials (i.e., aversive-invalid, aversive-valid, pleasant-invalid, pleasant-valid, neutral-invalid, neutral-valid) were negatively associated

Table 4

Intercorrelations among Attention Measures

	Aver-InV	Aver-V	Ple-InV	Ple-V	Neu-InV	Neu-V	TMT-A	TMT-B	SW-R	SW-T	SC-R	SC-T	SCW-R	SCW-T
Aver-InV	-	.77**	.77**	.78**	.83**	.83**	.21	.22	-.40**	-.43**	-.45**	-.47**	-.27*	-.27*
Aver-V		-	.81**	.89**	.84**	.89**	.15	.29*	-.46**	-.49**	-.39**	-.43**	-.31*	-.33*
Ple-InV			-	.77**	.82**	.79**	.08	.12	-.46**	-.47**	-.34**	-.36**	-.31*	-.31*
Ple-V				-	.81**	.87**	.18	.29*	-.43**	-.48**	-.37**	-.41**	-.29*	-.33*
Neu-InV					-	.84**	.08	.22	-.39**	-.42**	-.35**	-.38**	-.24	-.26*
Neu-V						-	.12	.24	-.33*	-.37**	-.38**	-.42**	-.32*	-.34**
TMT-A							-	.42**	-.14	-.17	-.31*	-.32*	-.12	-.14
TMT-B								-	-.23	-.25	-.52**	-.54**	-.39**	-.39**
SW-R									-	.98**	.56**	.55**	.50**	.48**
SW-T										-	.54**	.55**	.49**	.51**
SC-R											-	.99**	.70**	.65**
SC-T												-	.71**	.68**
SCW-R													-	.98**
SCW-T														-

Note: **p* < .05; ***p* < .01; Aver-InV = invalidly-cued aversive trial mean response time; Aver-V = validly-cued aversive trial mean response time; Ple-InV = invalidly-cued pleasant trial mean response time; Ple-V = validly-cued pleasant trial mean response time; Neu-InV = invalidly-cued neutral trial mean response time; Neu-V = validly-cued neutral trial mean response time; TMT-A = Trail-Making Test: Part A total score; TMT-B = Trail-Making Test: Part B total score; SW-R = Stroop-Word raw score; SW-T = Stroop-Word T-score; SC-R = Stroop-Color raw score; SC-T = Stroop-Color T-score ; SCW-R = Stroop-ColorWord raw score; SCW-T = Stroop-ColorWord T-score.

with the SCW Test mean response scores, except for the neutral-invalid trial, which was not significantly correlated with the SCW Raw subtest response score. Most of the spatial cueing task mean response times were not correlated with the TMT: Part A and B mean response times, but the aversive-valid and pleasant-valid trials were positively correlated with the TMT: Part B mean response time. The TMT: Part A mean response time was also not correlated with most mean response scores on the SCW Test, but it was negatively correlated with the SC Raw subtest and T response scores. The TMT: Part B mean response time, however, was negatively correlated with most response scores on the SCW Test, except for the SW Raw subtest and T response scores.

Primary Statistical Analyses

SCW Test and TMT

The GAD group was hypothesized to exhibit less ability to selectively attend to stimuli, inhibit dominant responding, and control cognitive processes as measured by slower responding on the SCW Test. See Table 5 for SCW subtest means and standard deviations. Separate ANOVAs were calculated, with diagnostic group (GAD, non-GAD) as the independent variable, for each subtest in the SCW Test (SW, SC, SCW Raw and T scores). The GAD group showed significantly slower response scores than the non-GAD group on the SC subtest (see Table 6). No other significant differences were found between groups on the SCW Test.

GAD participants were also hypothesized to exhibit less ability to divide attention and less cognitive flexibility, as measured by longer response times on the TMT: Part B (see Table 5). An ANOVA was calculated with diagnostic group (GAD, non-GAD) as the independent variable and revealed significantly longer response times for the GAD than non-GAD participants on the TMT: Part B (see Table 6). No differences were hypothesized between groups for basic visual scanning and numeric sequencing, as measured by the TMT: Part A, and no significant differences were observed.

Table 5

Means and Standard Deviations for Stroop Test and Trail-Making Test

	GAD Group (*n* = 30)		Non-GAD Group (*n* = 31)	
Measure	*M*	*SD*	*M*	*SD*
SW-R	103.30	13.02	106.26	14.11
SW-T	48.87	8.91	51.13	10.29
SW-E	0.40	0.77	0.71	1.24
SC-R	73.70	10.91	79.94	11.88
SC-T	45.07	8.87	50.48	9.95
SC-E	1.17	1.23	1.29	1.58
SCW-R	48.47	7.61	50.16	10.09
SCW-T	52.57	7.36	54.26	9.69
SCW-E	1.47	2.39	1.61	1.26
	GAD Group (*n* = 30)		Non-GAD Group (*n* = 29)	
Measure	*M*	*SD*	*M*	*SD*
TMT-A	27.23	6.82	24.55	9.76
TMT-B	61.17	14.29	51.00	13.89

Note: SW-R = Stroop-Word raw score; SW-T = Stroop-Word T-score; SW-E = Stroop-Word error score; SC-R = Stroop-Color raw score; SC-T = Stroop-Color T-score ; SC-E = Stroop-Color error score; SCW-R = Stroop-ColorWord raw score; SCW-T = Stroop-ColorWord T-score; SCW-E = Stroop-Color Word error score; TMT-A = Trail-Making Test: Part A total score; TMT-B = Trail-Making Test: Part B total score.

Table 6

Analysis of Variance: GAD vs. Non-GAD on Stroop Test and Trail-Making Test

	Full Sample (*N* = 61)			
Measure	*F*	df	*p*	η_p^2
SW-R	0.72	1, 59	.39	0.01
SW-T	0.84	1, 59	.36	0.01
SC-R	4.55	1, 59	.04	0.07
SC-T	5.03	1, 59	.03	0.08
SCW-R	0.55	1, 59	.46	0.01
SCW-T	0.59	1, 59	.45	0.01
	Full Sample (*N* = 59)			
Measure	*F*	df	*p*	η_p^2
TMT-A	1.51	1, 57	.23	0.03
TMT-B	7.67	1, 57	.01	0.12

Note: SW-R = Stroop-Word raw score; SW-T = Stroop-Word T-score; SC-R = Stroop-Color raw score; SC-T = Stroop-Color T-score; SCW-R = Stroop-ColorWord raw score; SCW-T = Stroop-ColorWord T-score; TMT-A = Trail-Making Test: Part A total score; TMT-B = Trail-Making Test: Part B total score.

Emotional Spatial Cueing Task

All spatial cueing task trials in which participants made errors (e.g., clicking wrong side of the mouse following presentation of the arrowhead probe) and response times of 2,000 milliseconds or greater were excluded from data analyses, consistent with guidelines followed in similar studies (e.g., Waters et al., 2007; Yiend & Mathews, 2001). Of all the spatial cueing task trials, 1.63% (i.e., 110 of 6,768) were excluded from the analyses. A comparable number of trials were excluded from GAD and non-GAD groups (57 and 53, respectively).

Analyses were hypothesized to identify several main effects, including (a) slower overall response times for GAD versus non-GAD groups, (b) faster response times for validly-cued than invalidly-cued trials, and (c) slower overall response times for aversive cues than for pleasant or neutral cues. Several specific interactions were also hypothesized, including: (d) slower mean response times for GAD compared to non-GAD participants during aversive cue trials than pleasant and neutral cue trials, and slower response times for pleasant cue trials among GAD participants; (e) larger cue validity effects (response times on invalidly-cued relative to validly-cued trials) on aversive cue trials than on pleasant cue trials, and on pleasant cue trials than on neutral cue trials. Cue validity effects were also expected to be larger on aversive cue trials than on neutral cue trials; and (f) the interaction between cue validity effects and cue valence described in hypothesis (e) was expected to be significantly stronger for the GAD group compared to the non-GAD group. Specifically, GAD participants were expected to demonstrate greater difficulties disengaging their attention from aversive and pleasant stimuli, as indicated by larger cue validity effects for these valences compared to non-GAD participants.

To formally test for main and interaction effects across all variables, a 2 (GAD status: GAD and non-GAD) x 3 (Cue Valence: neutral, pleasant, aversive) x 2 (Cue Validity: valid and invalid) mixed ANOVA was conducted. GAD status was the between-subjects factor, whereas Cue Valence and Cue Validity were within-subjects factors. Participant’s mean response times on the spatial cueing task (see Table 7) were the dependent variables. Results of the mixed ANOVA revealed several significant main effects (see Table 8). First, there was a main effect of Cue Valence on participant response times. Planned simple contrasts revealed longer response times for aversive than for neutral cues, $F(1, 60) = 11.95$, $p < .001$, $\eta_p^2 = .16$. A non-significant planned contrast was observed when comparing response times for pleasant to neutral cues. There was also a main effect of Cue Validity on participant response times, indicating longer response times for validly-cued than invalidly-cued trials. Although not statistically significant, a trend toward a main effect for GAD status was also observed ($p < .06$), suggesting longer response times for GAD than non-GAD participants.

Table 7
Means and Standard Deviations for Measures Derived from the Attentional Disengagement Task

	GAD Group (*n* = 31)		Non-GAD Group (*n* = 32)	
Measure (ms)	*M*	*SD*	*M*	*SD*
Aver-InV	610.93	98.75	521.95	62.35
Aver-V	588.91	94.75	562.59	91.83
Ple-InV	565.98	92.92	537.92	89.77
Ple-V	582.45	94.49	559.89	96.36
Neu-InV	576.01	99.65	529.49	87.78
Neu-V	572.97	96.33	542.26	84.89

Note: Aver-InV = invalidly-cued aversive trial mean response time; Aver-V = validly-cued aversive trial mean response time; Ple-InV = invalidly-cued pleasant trial mean response time; Ple-V = validly-cued pleasant trial mean response time; Neu-InV = invalidly-cued neutral trial mean response time; Neu-V = validly-cued neutral trial mean response time.

Table 8

Mixed Analysis of Variance: GAD vs. Non-GAD for Attentional Disengagement Task

	Full Sample (*N* = 63)			
Measure	*F*	df	*p*	η_p^2
GAD	3.44	1, 61	.06	0.05
Valence	6.01	2, 122	.003	0.09
Valence x GAD	6.19	2, 122	.003	0.09
Validity	4.32	1, 61	.04	0.07
Validity x GAD	6.83	1, 61	.01	0.10
Valence x Validity	1.06	2, 122	.35	0.02
Valence x Validity x GAD	4.56	2, 122	.01	0.07

Note: GAD = generalized anxiety disorder status (GAD, Non-GAD); Valence = aversive, pleasant, neutral picture cues; Validity = valid and invalid cues.

Several significant interactions were also observed. A significant interaction effect of Cue Valence x GAD status indicated that response times on cue valences differed in GAD and non-GAD participants (see Table 8 and Figure 1). Simple effects analyses demonstrated that response times for GAD compared to non-GAD participants were significantly longer on aversive cues, $F(1, 61) = 8.24$, $p < .01$, and were non-significantly different for pleasant and neutral cues.

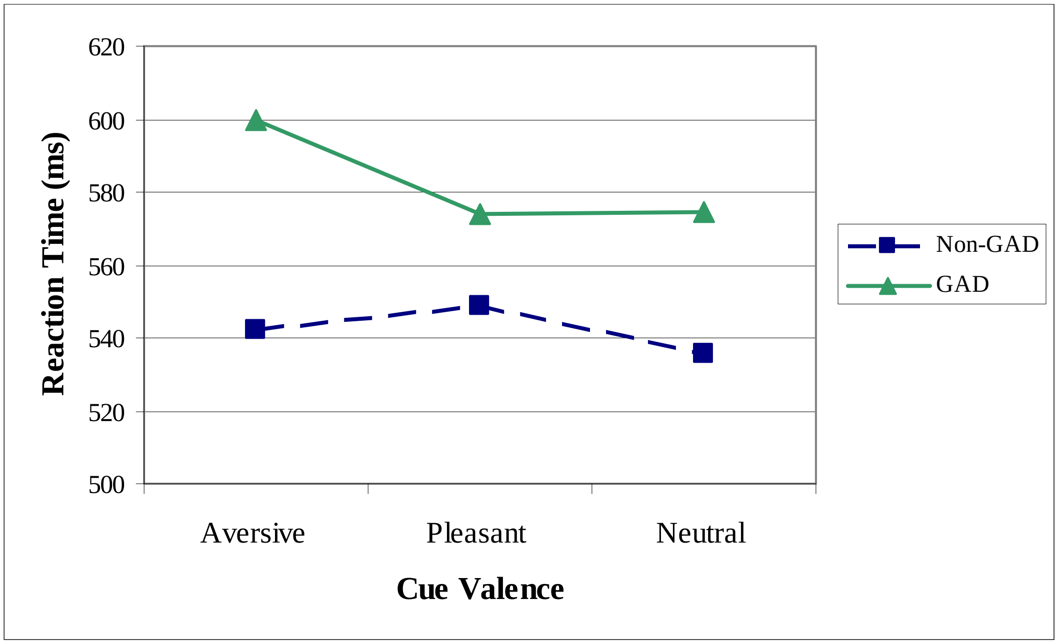

Figure 1. Interaction between Cue Valence and GAD Status.

A significant interaction of Cue Validity x GAD status was also observed, indicating that response times on validly-cued and invalidly-cued trials significantly differed when comparing GAD and non-GAD participants (see Table 8 and Figure 2). Simple effects analyses showed the GAD group had significantly longer response times on invalidly-cued trials compared to the non-GAD group, $F(1, 61) = 9.27$, $p < .003$, suggestive of overall slower disengagement across cue valences. A non-significant group difference was observed for validly-cued trials, indicating similar localization/engagement processes across cue valences in both groups. Paired *t*-tests revealed that GAD participants did not respond differently on validly and invalidly-cued trials. However, non-GAD participants had significantly longer response times on valid than invalid trials, $t(31) = 3.09$ $p < .004$, suggestive of an IOR effect (i.e., inhibition of return from previously searched area and possible strategic attentional avoidance).

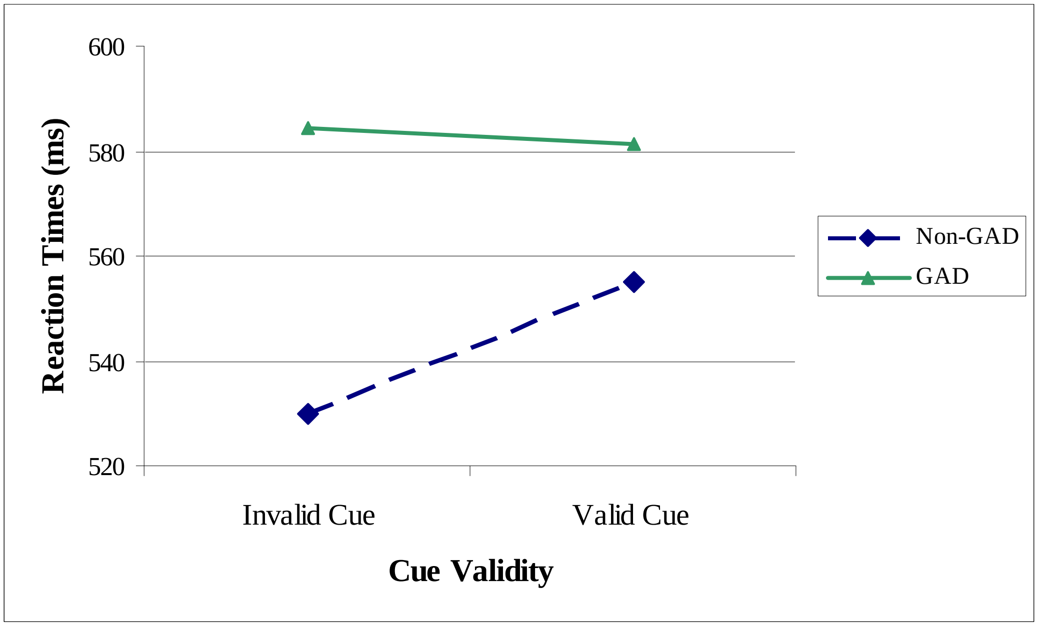

Figure 2. Interaction between Cue Validity and GAD Status.

The critical Cue Valence x Cue Validity x GAD status interaction was also significant, demonstrating that cue valence by cue validity effects differed for GAD compared to the non-GAD group (see Table 8 and Figure 3). To explore this 3-way interaction further, 3 (Valence) x 2 (Validity) repeated measures ANOVAs were conducted for GAD and non-GAD participants, separately. For the GAD group, there was a significant main effect for Cue Valence, $F(2, 60) = 8.53$, $p < .001$, $\eta_p^2 = .22$, but not for Cue Validity. Paired *t*-tests revealed longer response times for aversive than neutral cues among GAD participants, $t(30) = 2.75$, $p < .01$, and non-significant differences comparing pleasant to neutral cues and aversive to pleasant cues. The result remained significant after Bonferroni correction (.05/3 = .017). There was also a trend toward a Cue Valence x Cue Validity interaction, although this effect did not reach statistical significance ($p < .06$). Paired *t*-tests revealed that response times following

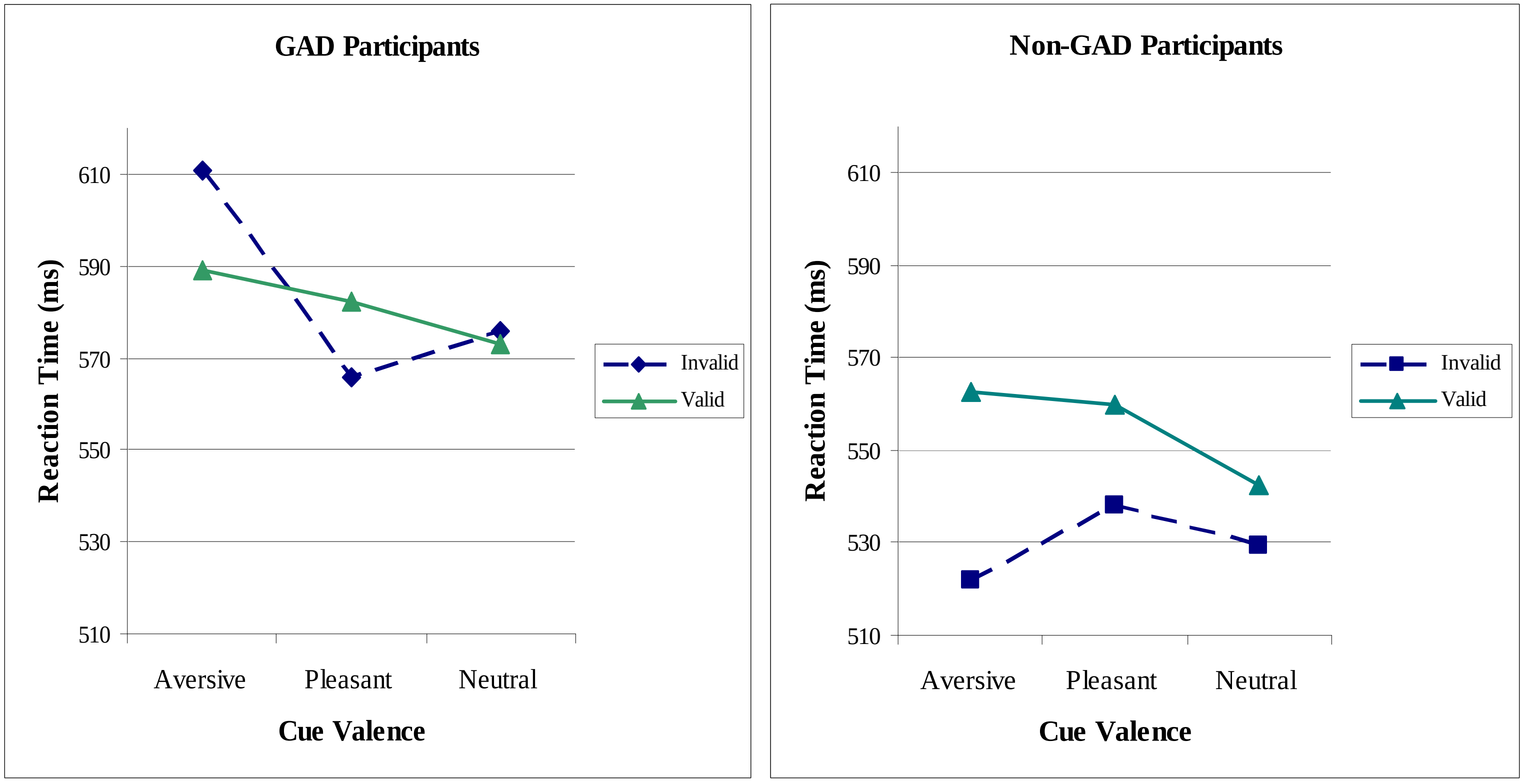

Figure 3. Interaction between Cue Valence, Cue Validity, and GAD Status.

aversive-invalid cue trials were significantly slower than response times following neutral-invalid cue trials, $t(30) = 2.63$, $p < .01$, and pleasant-invalid cue trials, $t(30) = 3.71$, $p < .001$, supporting slowed disengagement from aversive stimuli. Non-significant differences were observed for all other pairwise comparisons of cue validity by cue valence (pleasant-neutral for invalidly-cued trials, and aversive-pleasant, aversive-neutral, pleasant-neutral for validly-cued trials). After Bonferroni correction (.05/6 = .008), only the aversive-pleasant comparison on invalidly-cued trials remained significant. Cue validity effects (i.e., mean response time on invalidly-cued trials minus validly-cued trials) for aversive cues were larger ($M = 22.03$, $SD = 13.39$) than the negative cue validity effect for pleasant cues ($M = -16.47$, $SD = 11.33$), $t(30) = 2.45$, $p < .02$, evidencing greater difficulty disengaging from aversive than pleasant cues, and a slight IOR effect for pleasant cues. No significant differences between aversive and neutral ($M = 3.04$, $SD = 12.57$) or between pleasant and neutral cue validity effects were found. The result remained significant after Bonferroni correction (.05/3 = .017).

For non-GAD participants, there was a main effect for Cue Validity, $F(1, 31) = 13.31$, $p < .001$, $\eta_p^2 = .30$, indicating longer response times on validly-cued than invalidly-cued trials, suggestive of an IOR effect. There was no main effect for Cue Valence. A trend toward a Valence x Validity interaction was demonstrated, although this effect did not reach statistical significance ($p < .07$). Paired *t*-tests revealed longer response times on aversive-valid than neutral-valid trials, $t(31) = 3.68$, $p < .001$, suggestive of slower initial engagement with aversive cues, and non-significant differences for all other pairwise comparisons of cue validity by cue valence. This result remained significant after Bonferroni correction (.05/6 = .008). The cue validity effect for aversive cues was larger (M = -40.64, SD = 11.09) than that observed for neutral cues (M = -21.97, SD = 10.97), $t(31) = -2.22$, $p < .02$. The negative value of the cue validity effect for aversive cues is suggestive of IOR and does not support difficulty disengaging from threatening stimuli. There were no significant differences between aversive and pleasant (M = -12.76, SD = 6.89) or pleasant and neutral cue validity effects. After Bonferroni correction (.05/3 = .017), the result remained significant.

Comparing GAD and non-GAD groups, the cue validity effect for aversive cues was significantly different between groups, $t(61) = 3.9$, $p < .001$, with a larger positive effect observed in the GAD group. Non-significant differences between groups were observed in cue validity effects for pleasant and neutral stimuli. The result remained significant after Bonferroni correction (.05/3 = .017).

Additional analyses

Given the high correlation between the GAD-Q-IV and BDI-II, exploratory analyses were performed using the BDI-II as a covariate to investigate whether the GAD and non-GAD group differences in performances on the attention tasks (SCW Test, TMT, spatial cueing task) were not unduly influenced by depression. The BDI-II was first mean-centered to reduce multicollinearity with the GAD-Q-IV (Aiken & West, 1991).

Separate ANCOVAs were calculated, with diagnostic group (GAD, non-GAD) as the independent variable and the centered BDI-II as a covariate, for each subtest in the SCW Test and the TMT: Part A and B. No significant differences were found between the GAD and non-GAD groups on the SCW Test or the TMT (all p's = ns; see Table 9).

Table 9

Analysis of Covariance: GAD vs. Non-GAD on Stroop Test and Trail-Making Test with BDI-II as a Covariate

	Full Sample (*N* = 61)			
Measure	*F*	df	*p*	η_p^2
SW-R	0.13	1, 58	.72	0.002
SW-T	0.13	1, 58	.73	0.002
SC-R	1.67	1, 58	.20	0.03
SC-T	1.67	1, 58	.20	0.03
SCW-R	0.03	1, 58	.87	0
SCW-T	0.03	1, 58	.86	0.001
	Full Sample (*N* = 59)			
TMT-A	2.39	1, 56	.13	0.04
TMT-B	2.16	1, 56	.15	0.04

Note: BDI-II = Beck Depression Inventory – II; SW-R = Stroop-Word raw score; SW-T = Stroop-Word T-score; SC-R = Stroop-Color raw score; SC-T = Stroop-Color T-score; SCW-R = Stroop-ColorWord raw score; SCW-T = Stroop-ColorWord T-score; TMT-A = Trail-Making Test: Part A total score; TMT-B = Trail-Making Test: Part B total score.

For the spatial cueing task, a 2 (GAD status: GAD and non-GAD) x 3 (Cue Valence: neutral, pleasant, aversive) x 2 (Cue Validity: valid and invalid) mixed ANCOVA was conducted, using the centered BDI-II as a covariate. Most original main effects and interactions remained significant (all *p*s < .05; see Table 10). However, the Cue Valence x Cue Validity x GAD status interaction became non-significant, suggesting no differences in cue valence by cue validity effects between the GAD and non-GAD groups when covarying for the BDI-II. There was also no longer a trend toward significance for the main effect of GAD status.

Table 10

Mixed Analysis of Covariance: GAD vs. Non-GAD for Attentional Disengagement Task with BDI-II as a Covariate

	Full Sample (N = 63)			
Measure	F	df	p	η_p^2
GAD	1.88	1, 60	.18	0.03
BDI-II	0.02	1, 60	.88	0.000
Valence	6.26	2, 120	.003	0.09
Valence x GAD	6.03	2, 120	.003	0.09
Valence x BDI-II	4.83	2, 120	.01	0.07
Validity	4.29	1, 60	.04	0.07
Validity x GAD	8.32	1, 60	.01	0.12
Validity x BDI-II	2.19	1, 60	.15	0.04
Valence x Validity	1.09	2, 120	.34	0.02
Valence x Validity x GAD	1.25	2, 120	.29	0.02
Valence x Validity x BDI-II	1.44	2, 120	.24	0.02

Note: GAD = generalized anxiety disorder status (GAD, Non-GAD); BDI-II = Beck Depression Inventory – II; Valence = aversive, pleasant, neutral picture cues; Validity = valid and invalid cues.

CHAPTER 4

DISCUSSION

Attentional biases and limited control over the allocation of attentional resources likely play a role in the etiology and maintenance of GAD. There is a paucity of research examining how specific components of attentional biases (e.g., engagement, disengagement, attentional avoidance) interfere with information-processing in persons with GAD; although, it appears difficulty disengaging from threatening information may underlie the perseverative and uncontrollable nature of worry central to the disorder. As predicted, significant differences in attentional control abilities and attentional biases were observed between persons with and without self-reported GAD on the attention tasks used in the present study.

On the SCW Test, used to measure selective attention, response inhibition, and controlled cognitive processes, the GAD group performed more poorly than the non-GAD group during the SC subtest. Identifying a color hue (SC subtest) is believed to require a more conscious effort, entailing the individual determine the hue and then select the corresponding lexical information to name the hue, whereas seeing and naming a color word (SW subtest) involves reduced lexical retrieval demands and a more automatic response, due to the extensive practice most people have in seeing and naming words. The slower SC subtest response times observed for GAD participants compared to non-GAD participants suggests they experienced greater difficulty applying the conscious attentional control strategies necessary for successful performance on this task. This interpretation is made cautiously; however, as similar difficulties should have been observed in the SCW subtest, which requires cognitive control involving the ability to inhibit a dominant attentional response (i.e., reading a word versus naming a color), and the GAD group performed as well on this task as the non-GAD group.

GAD participants also performed more poorly than non-GAD participants on the TMT: Part B, a measure of cognitive flexibility and the ability to divide attention. These findings provide further support for differences in attentional control between persons with and without GAD. No differences were hypothesized or observed between groups on the TMT: Part A, a measure of basic visual scanning and numeric sequencing, further indicating poorer performance by the GAD group on the TMT: Part B is likely attributable to limitations in more strategic attentional control abilities (i.e., divided attention, cognitive flexibility).

The emotional spatial cueing task, used to measure attentional biases associated with engagement toward and disengagement from threatening or emotional stimuli, revealed that the GAD group responded to valenced stimuli differently than the non-GAD group. Given persons with GAD were hypothesized to have less attentional control throughout this task, overall response times were expected to be slower across all cue valence and cue validity trials for GAD compared to non-GAD participants. The GAD group did appear to evidence overall longer response times than the non-GAD group; although, this trend did not reach statistical significance.

The cue valence and cue validity main effects showed differences in overall participant responding based on cue type. Participants were expected to respond more slowly to aversive than neutral stimuli, as threatening information is thought to be prioritized by the attentional system (Öhman & Mineka, 2001), and this main effect of cue valence was observed. The cue validity main effect showed response times were faster on invalidly-cued than validly-cued trials across participants. This effect was in the direction opposite than expected, indicating inhibition of return (IOR) may have occurred. IOR has been previously observed in the spatial cueing paradigm literature and describes the phenomenon in which attention is inhibited from returning to an area previously searched (Posner & Cohen, 1984), and may also be indicative of strategic attentional avoidance. IOR is more often observed when stimuli are presented long enough for conscious and strategic processing (e.g., Koster et al., 2006; MacLeod & Rutherford, 2004) and has been demonstrated in studies using longer SOAs, similar to the present study (e.g., Pérez-Dueñas et al., 2009; Waters, et al., 2007; Verkuil et al., 2009).

Of more theoretical importance, several significant interactions were revealed. The Cue Valence x GAD status interaction indicated the GAD group took longer to respond to aversive cues than the non-GAD group, as expected, but they did not differ in their response times for pleasant or neutral cues. Therefore, GAD participants appear to be more influenced than non-GAD participants by aversive stimuli specifically, versus emotional stimuli in general, and to a greater degree.

As hypothesized, the Cue Validity x GAD status interaction demonstrated longer response times on invalidly-cued trials among GAD participants compared to non-GAD participants, suggestive of slower disengagement across cue valences for the GAD group. The groups performed similarly on validly-cued trials, indicating response times of initial orientation to/engagement with stimuli across cue valences did not differ between groups. Contrary to expectations, non-GAD participants exhibited longer response times on validly-cued than invalidly-cued trials, compared to GAD participants, who had relatively similar response times on both types of validity cue trials. Typically, response rates are expected to be longer on invalidly than validly-cued trials, as participants are required to shift their attention via disengagement from the cued to uncued location on invalid trials (Fox et al., 2001; 2002). In the current study, the inhibition of return (IOR) phenomenon likely explains the shorter response times on invalidly-cued trials among non-GAD participants. Given that IOR describes the situation in which attention is inhibited from returning to previously searched areas, it may be indicative of more effective and efficient attentional control in these participants. The lack of an IOR effect and the similar response times on both validity cue trials for GAD participants may suggest an overall limited ability to inhibit returning to already scanned areas (i.e., limited attentional control) and difficulty maintaining task-focused attention.

Although the Cue Validity x Cue Valence interaction was non-significant, suggesting participant response times on invalid trials relative to valid trials may not differ by cue valence, the critical Cue Valence x Cue Validity x GAD status interaction was significant. As predicted, GAD participants showed greater difficulty disengaging from threatening information than non-GAD participants, demonstrated by the larger *positive* cue validity effect for aversive cues in the GAD group. Further, GAD participants evidenced longer response times on invalidly-cued trials for aversive cues compared to invalid and valid trials with pleasant or neutral cues. Although the difference between aversive-invalid and neutral-invalid trials did not remain significance after Bonferroni correction, the trend ($p < .01$) toward a longer response time for aversive-invalid trials was in the expected direction. The lack of differential responding across cue valences on validly-cued trials in the GAD group indicates the bias toward threatening stimuli can not be accounted for by faster engagement with such stimuli, but rather difficulty disengaging from the threatening stimuli. For non-GAD participants, the overall significantly shorter response times on invalidly-cued to validly-cued trials (IOR effect), and the limited influence of cue valence on responding during invalid trials, demonstrates minimal to no difficulty disengaging from any of the cue valences. These findings of anxiety-related group differences in biases toward threatening information are consistent with those observed in research using similar research paradigms with high and low trait anxious persons (Fox et al. 2001, 2002; Yiend & Mathews, 2001; Waters et al., 2007).

As mentioned, the three-way interaction indicated an overall IOR effect for non-GAD participants. The magnitude of this effect was significantly larger during presentations of aversive stimuli than neutral stimuli, suggesting that not only was the non-GAD group able to disengage more quickly from threatening information than the GAD group, but they may have been engaging in strategic avoidance of such stimuli. This is further supported by the slower response times for aversive than neutral stimuli on validly-cued trials, indicating non-GAD participants did not show a bias toward initial orientation/engagement with aversive stimuli. Comparable reaction times for aversive and pleasant stimuli also suggest that non-GAD participants respond similarly to emotional stimuli, versus the more specific bias toward aversive stimuli observed in the GAD group. Together, these patterns provide evidence for the ability of non-GAD participants to more strategically allocate their attention to limit interference of emotional information and maintain task-focus, whereas GAD participants do not show a similar ability. These findings may also be indicative of the limited ability of the GAD group to adaptively engage in emotion regulation strategies (Koole, 2009) compared to the non-

GAD group, which is consistent with research demonstrating persons with GAD have difficulty in several aspects of emotion regulation (e.g., Mennin, Heimberg, Turk, & Fresco, 2005; Roemer et al., 2009).

Contrary to expectations, GAD participants did not evidence similar difficulties disengaging from pleasant cues as they did from aversive cues and, in fact, they responded comparably to pleasant and neutral cues on both validity trials. These results indicate attentional biases in persons with GAD are specific to threatening information rather than emotional information in general. Although not statistically significant, GAD participants even exhibited a slight IOR effect for pleasant stimuli, the opposite effect than was observed in response patterns for aversive stimuli. Some research indicates that persons with high trait anxiety can show a bias toward “safe” or “relieving” stimuli, possibly as a way to cope with threatening information (Derryberry & Reed, 1994; 1996). Coping effectively in this manner requires some level of flexibility in allocation of attentional resources, as individuals shift attention from threatening to non-threatening and safe information. The current study does not support these findings for persons with GAD; rather, individuals with GAD appear limited in their ability to utilize such adaptive coping strategies.

Another unexpected finding for the GAD group was the non-significant difference in cue validity effects between aversive and neutral stimuli, although the trend was in the expected direction. Given the study results collectively reveal task performance was more impaired during the presentation of aversive cues, particularly when disengaging attention during invalidly-cued trials, the non-significant difference between the aversive and neutral cue validity effects may be the result of low power. However, it might also demonstrate an overall limited ability in GAD participants to adaptively allocate attention and maintain goal-oriented behavior throughout this task, even during presentation of neutral cues. To help clarify these findings, future studies should include additional measures of attentional control, such as self-report measures shown to correlate with performance-based attentional control measures (Derryberry & Reed, 2002; Peers & Lawrence, 2009; Rothbart, Ahadi, & Evans, 2000).

Notably, studies examining attentional engagement and disengagement for anxious persons using the spatial cueing task do not always assess or account for depressive symptoms (e.g., Fox et al., 2001, 2002; Verkuil et al., 2009; Yiend & Mathews, 2001), which are often comorbid with anxiety. Previous research does suggest that depressive symptoms and dysphoria influence attentional biases, including suppressing the effects of these biases (e.g., Bradley et al., 1995; Joormann, 2004; MacLeod et al., 1986; Mogg, Millar, et al., 2000) or requiring a longer stimulus presentation duration to make biases observable (e.g., Bradley, Mogg, & Lee, 1997; Gotlib, Krasnoperova, Yue, & Joormann, 2004; Mogg et al., 1995). Therefore, it is quite plausible that depressive symptom severity among GAD participants may have an influence on differential responding during attention tasks.

In the current study, additional analyses were conducted using the BDI-II as a covariate to determine whether responses on the SCW Test, TMT, and spatial cueing task were influenced by depressive symptoms. When covarying for the BDI-II, differences between the GAD and non-GAD group on the SCW Test and the TMT were no longer significant. On the spatial cueing task, the Cue Valence x Cue Validity x GAD status interaction also became non-significant, while all other original main effects and interactions remained. Given the design of this study, it is difficult to comprehensively assess how depressive symptoms may have influenced participant responding and what effects were specific to generalized anxiety versus depressive symptoms. For instance, the high positive correlation between the GAD-Q-IV and the BDI-II may indicate that these questionnaires are measuring partially overlapping constructs. Covarying for the BDI-II, therefore, may have diminished the ability of the GAD-Q-IV to form distinct GAD and non-GAD groups, resulting in the non-significant findings. The lack of significant results may also be due to reduced power with the addition of the covariate, and for the spatial cueing task, the effect size for the three-way interaction also decreased (η_p^2 from .07 to .02). Incorporating a separate depression group, utilizing matching procedures, or screening out participants with comorbid conditions may prove beneficial in addressing this difficulty in future studies. Given GAD and major depressive disorder are characterized by high levels of comorbidity and possible overlapping features, such as negative affect and neuroticism (Mineka, Watson, & Clark, 1998), delineating the effects of anxiety versus depression would allow for better understanding of information-processing biases unique to each disorder.

There are several methodological strengths of the present study. First, although participants were not clinically diagnosed with GAD, they were selected based on the self-report GAD-Q-IV measure, which demonstrates good diagnostic agreement with the clinician-administered semi-structured diagnostic interview, the Anxiety Disorders Interview Schedule (ADIS-IV; Brown et al., 1994). Additionally, a high correlation was observed between the GAD-Q-IV and the PSWQ, used to measure the extent to which worry is excessive, uncontrollable, and pervasive, supporting the distinction of our GAD and non-GAD groups. Using a GAD sample was an important next step in this area of research, given most research on attentional biases to date have examined high and low trait anxious individuals or individuals with other anxiety disorders (e.g., social anxiety disorder, post-traumatic stress disorder). Determining the possible differences in attentional biases in persons with GAD compared to individuals with other anxiety disorders may enhance our knowledge of the underlying mechanisms specific to the disorder.

The study's spatial cueing paradigm was modeled as closely as possible to other similar attentional bias tasks (e.g., Fox et al., 2002; Waters et al., 2007; Yiend & Mathews, 2001), another strength of the study that allows for comparison and generalizability of results. The utilization of IAPS pictures also allows for further generalization of previous research findings, which have more typically used threatening words and facial stimuli. Additionally, the present study is one of the few to assess differences in attentional responding to both pleasant and aversive stimuli, allowing for the examination of responses to emotional stimuli more generally rather than threatening stimuli specifically. Another study design strength was to ensure similar arousal levels across the pleasant and aversive stimuli, given arousal has been shown to influence the processing of affective picture stimuli in these experimental tasks (Cuthbert et al., 1996; Vogt et al., 2008) and is not always controlled for in research using similar paradigms.

There are limitations with the spatial cueing task itself, however, given the lack of data on the task's psychometric properties. Furthermore, the spatial cueing paradigm does not necessarily provide a pure measure of attentional disengagement (Mogg, Holmes, Garner, & Bradley 2008), and it is likely difficult for any experimental task to separate out attentional processes which do indeed overlap. Creating a way to measure a single attentional construct is challenging, given the competing and co-occurring mechanisms involved in attention (e.g., automatic versus conscious and controlled processes, engagement versus disengagement, vigilance toward versus avoidance away from threat, high versus low state anxiety), as well as our limited understanding of the timing of these processes when determining stimulus presentation duration. The cue-target SOA of 500 ms was selected for the current study as it has been suggested to approximate the length of time when conscious, strategic processing of stimuli occurs (MacLeod & Rutherford, 2004). It is also the SOA used in similar experimental paradigms (Waters et al., 2007; Yiend & Mathews, 2001). Knowing when exactly conscious processing begins is complicated; nevertheless, and it cannot be easily separated from the influences of automatic processing (MacLeod & Rutherford, 2004). Future research using the spatial cueing task would benefit from more comprehensive assessment and methodology, including multiple measures of attentional control (e.g., self-report, performance-based), additional behavioral measures (e.g., eye gaze/eye blink tracking), state anxiety and worry induction tasks and measures, and examining participants with different psychopathologies in one experimental task to compare responding patterns between diagnostically distinct groups.

Findings from the current study support the notion that persons with GAD have impaired information-processing abilities associated with limited control over goal-directed attention allocation and difficulty disengaging from threatening information. These attentional processes likely contribute to the initiation and maintenance of GAD and intensify the central feature of the disorder, pathological worry. Given research examining the engagement-disengagement dimensions of attention in persons with GAD is limited, continuing to investigate these processes may better elucidate the nature of this chronic and disabling disorder. Research aimed at identifying the relationship between attention, worry, and GAD will assist in the development of better targeted interventions, an important next step as rates of response to psychological treatments for GAD are poorer than those for other anxiety disorders (Borkovec & Ruscio, 2001).

Indeed, studies that induce and/or modify attentional biases and show such biases impact vulnerability to anxiety have already provided evidence for the causative role of information-processing in the development of anxious states (e.g., MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; Krebs, Hirsch, & Mathews, 2010). Numerous investigations to date have demonstrated that when cognitive impairments and/or biases are targeted in interventions, such as through attention retraining programs, reductions in anxiety and mood symptoms occur (e.g., MacLeod et al., 2002; Mohlman, 2008; Schmidt, Richey, Buckner, & Timpano, 2009; Wilson, MacLeod, Mathews, & Rutherford, 2006). These programs may be particularly relevant for persons with GAD, as they involve exercises that improve ability to disengage from threat and more adaptively allocate attentional resources. In fact, persons with GAD who engaged in an 8-session attention modification program evidenced a decrease in attentional biases toward threat and a decrease in anxious symptoms, whereas those in the attention control condition did not (Amir, Beard, Burns, & Bomyea, 2009). Another 5-session attention retraining program also proved significantly more successful in reducing threat biases and anxious and depressive symptoms in participants with severe worry compared to a sham-training condition (Hazen, Vasey, & Schmidt, 2009). Reductions in anxious symptoms following improved attentional control and decreased biases implicate the role of these attentional processes in the maintenance of GAD.

Improved understanding of attentional processes in GAD will facilitate the development of these effective attention retraining/modification programs, which have significant clinical implications. Attention retraining procedures could be used either independently or to augment treatments shown to be effective in reducing anxiety, such as cognitive-behavioral therapy. Mindfulness and acceptance-based therapies provide one such example of the benefits of incorporating attention modification training, as individuals instructed to better control their attention benefit from symptom reduction (e.g., Ortner, Kilner, & Zelazo, 2007). Such therapies assist in teaching how to disengage from maladaptive thoughts and decrease perseveration and rumination through mindfulness meditation exercises, in turn, often decreasing emotional distress. Persons with GAD have already shown to benefit from such therapeutic interventions (see Hofmann, Sawyer, Witt, & Oh, 2010). Continuing to gain knowledge of how underlying cognitive processes and attentional biases contribute to GAD will further aid in the development of these more targeted and effective assessments and treatments.

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