

Attentional Capture in Specific Phobia

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Abstract
Attentional Capture in Specific Phobia
Mariann Rose Weierich
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This work examines the mechanistic role of attentional processing of threat-relevant visual stimuli in specific phobia using the theoretical framework of attentional capture. The attentional capture approach distinguishes between the facilitated orienting of attention to and difficulty disengaging attention from threat, and is associated with experimental paradigms that offer a nuanced examination of attentional processing in anxiety. In addition, most prior work in attentional processing in anxiety has focused on the spatial allocation of attention; the temporal allocation of attention in anxiety has been under-studied, although it also may underlie symptom onset and maintenance. The cue validity and rapid serial visual presentation (RSVP) paradigms can measure orienting and disengagement of attention using circumscribed phobia-relevant stimuli.

Experiment 1 examined the spatial allocation of attention in spider phobia using the cue validity paradigm. Consistent with hypotheses and recent work examining the capture of attention in anxiety, there was no evidence for facilitated spatial orienting of attention to phobic stimuli, although spider-phobic participants did exhibit difficulty with spatial disengagement from phobic stimuli. Experiment 3 examined the temporal mechanisms of attentional processing in spider phobia using the RSVP paradigm modified to address the limitations of Experiment 2. Consistent with hypotheses, the preliminary results suggest that phobic participants, relative to controls, experience facilitated temporal orienting of attention to phobic stimuli, in addition to more difficulty with temporal disengagement from threat-relevant stimuli. Both studies also eliminate negative valence of the stimuli as an explanation for the results. The results suggest that

specific phobia is characterized by enhanced perception of and difficulty disengaging from threat-stimuli within the immediate visual field, whereas preferential spatial orienting of attention may require more top-down processing.

The current work provides evidence that these basic attentional paradigms can be translated for the examination of the role of potentially problematic mechanisms of attentional processing in clinical anxiety. In turn, improved mechanistic models of anxiety disorders may lead to the development of more effective or efficient behavioral interventions.

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Overview

Attention to threat-relevant information is implicated widely in the etiology and maintenance of the anxiety response (e.g., Mathews, 1990). The present work represents the translation of the attentional capture model for the examination of the mechanisms of attentional processing of threat-relevant information in specific phobia. The question of interest is whether anxiety disorders are characterized by facilitated orienting of attention to threat, difficulty disengaging attention from threat, or a combination of both attentional mechanisms. A better understanding of the nature of attentional processing in anxiety disorders will enhance mechanistic models of anxiety, which in turn can explain symptom onset and maintenance, as well as inform interventions. Specific phobia is an anxiety disorder that is particularly well-suited for this initial translation of basic visual paradigms for the study of attention in anxiety; threat-relevant stimuli largely are visual and circumscribed, and the fear response is specific to the phobic stimulus, rather than to internal cues, as in panic disorder, or to stimuli that are less homogenous across patients, as in PTSD. I therefore chose specific phobic as the disorder of interest for this initial examination of the mechanisms of attentional processing in anxiety.

Most of the prior work examining attentional processing in anxiety and other psychological disorders has been based on the attentional “bias” construct (c.f., Mineka, Rafaeli, & Yovel, 2002), but this theoretical model does not distinguish between the subcomponents of attentional processing. In addition, most research that examines the role of attention in anxiety focuses on spatial allocation of attention, or the notion that anxious individuals scan their environment for threat. Measurement of spatial allocation of attention has been limited largely to the dot-probe paradigm, although recent work has

utilized a more contemporary task, the cue validity paradigm. The first of the present studies extends the literature in attention and anxiety by addressing the subcomponents of attentional processing in specific phobia utilizing the cue validity paradigm.

Spatial processing alone may not completely account for the attentional difficulties in anxiety; attention to anxiety-relevant information in its physical absence (e.g., continued attention to a mental representation of a spider after the spider is removed from the room) also might create significant difficulty for individuals with anxiety disorders. However, the temporal allocation of attention has been under-studied, and research to date has not examined the temporal allocation of attention in clinical anxiety. The second and third studies presented here are the first to employ the rapid serial visual presentation (RSVP) paradigm with photo stimuli for the examination of the temporal allocation of attention in individuals with an anxiety disorder.

Specific Phobia

A brief overview of specific phobia further supports the selection of this disorder as ideal for the present investigation of the attentional mechanisms underlying anxiety disorders. Specific phobia is defined by the DSM-IV as a “marked and persistent fear that is excessive or unreasonable, cued by the presence or anticipation of a specific object or situation” (American Psychiatric Association, 1994). Additional required criteria are that the individual must (1) experience the fear nearly every time he or she encounters the phobic stimulus; (2) recognize that the fear is unreasonable or excessive; (3) avoid the situation or endure exposure to it with extreme distress; (4) experience significant impairment in functioning or significant distress about having the phobia; and (5) have

had the problem for at least 6 months in the absence of another DSM-IV disorder that better accounts for the symptoms. Specific phobias are categorized into five types: animal type (e.g., snake, spider), natural environment type (e.g., bodies of water), blood-injection-injury type (e.g., shots), situational type (e.g., public transportation), and “other” type (e.g., vomiting, clowns). The current work focuses on snake and spider animal type phobias as common examples of specific phobias. The point prevalence for snake and spider phobias has been estimated at 5.5% and 3.5%, respectively (Fredrikson, Annas, Fischer, & Wik, 1996).

Across phobia types, the most common response to exposure to the feared object or situation is a panic attack, or a panic-like reaction, that includes a rush of fear, followed by a rapid heartbeat or pounding in the chest, muscle tension, shortness of breath or rapid breathing, and an urge to flee (Thyer & Himle, 1987). Unlike individuals with other anxiety disorders, such as social phobia or panic disorder, individuals with specific phobia do not report anxiety about the experience of the physical symptoms of anxiety (i.e. anxiety sensitivity) (Taylor, Koch, McNally, & Crockett, 1992). That is, the phobic stimulus elicits a severe anxiety response that is particular to that external stimulus, rather than the experience of an aversive internal state (i.e., the physiological experience of anxiety). The initial translation of cognitive theory and measurement for the examination of attentional processing in anxiety disorders requires a disorder with such clear-cut characteristics.

Theoretical Models of Attention and Anxiety

Most broad theoretical models of anxiety implicate attention to threat-relevant information in the etiology and maintenance of disorder (Mathews, 1990; Mathews & MacLeod, 1994; Mogg & Bradley, 2003; Williams, Watts, MacLeod, & Mathews, 1988). Individuals with anxiety disorders, including specific phobia, generally are thought to attend preferentially to threat-relevant information (e.g., Wenzel & Holt, 1999). Because this behavior appears to result in increased distress, the role of attention as a potentially causal or maintaining factor for symptoms has become the focus of a large body of research. For example, associative network models of fear and anxiety posit systems of concepts stored as “nodes” in memory (Bower, 1981; Foa & Kozak, 1986; Lang, 1979). Each node is connected to related nodes such that the mental representation of a feared object or situation is associated with related representations (e.g., “snake” is linked to “slimy”, “striped”, “coil”, etc.). The activation of one node upon the perception of a threat-relevant cue can activate the associated nodes in any direction, such that the activation of “coil” upon seeing a garden hose, for example, can activate “snake” and provoke a fear response in an individual with snake phobia. The networks of linked nodes can become very elaborate and the strength of association between nodes can become quite strong in fear situations and in anxiety disorders. Attention, voluntary or not, naturally is required to activate a concept and its associated nodes. The basic question of interest, therefore, is whether there is something special about the role of attention in anxiety disorders such as specific phobia. Do individuals with anxiety disorders attend differently to stimuli that are assumed to activate their fear networks? The behavioral literature supports the notion of differential attentional processing in anxiety (e.g.,

MacLeod & Mathews, 1988; Mathews & MacLeod, 1994; Mogg & Bradley, 2003; Ohman & Mineka, 2001; Teachman & Woody, 2003, Williams, Mathews, & MacLeod, 1996). In addition, recent evidence from neuroscience suggests that attentional processing in anxiety may include reduced cognitive control over the processing of threat-relevant information (cf. Bishop, Duncan, Brett, & Lawrence, 2004).

In phobia, converging evidence from recognition memory studies also suggests that phobics exhibit poorer memory for peripheral objects when a phobic stimulus is present (Wessel & Merckelbach, 1998). Phobic subjects may experience narrowed attentional processing of threat-relevant stimuli that significantly impairs concurrent attentional processing of other environmental information. It appears clear that something is different about attentional processing in anxiety. Less clear is the precise nature of the differences in attentional processing between anxious and non-anxious individuals – do individuals with clinical anxiety orient attention preferentially toward threat, or do they have more difficulty disengaging from threat, once it is attended?

“Attention” Defined

Before further discussing the theory and research on the role of attention in specific phobia, it is necessary to specify a definition of attention. One erroneous, yet common, assumption made by researchers is that each mention of attention refers to the same construct (c.f., Styles, 1997). This assumption fosters a significant degree of confusion in the understanding of the theoretical models that implication “attention” and the comparison of findings about “attention” across studies. In fact, even vision scientists, whose work *is* the study of attention, have not reached a consensus definition (Styles, 1997). One major goal of researchers in experimental psychopathology is to translate

theoretical assumptions and measurement paradigms from basic vision science to the study of psychopathology. Thus, it is imperative to adopt a common working definition of attention in which to ground our investigations.

For the purpose of the study of attentional processing in anxiety, it seems reasonable to begin with the classic general definition provided by William James: "Everyone knows what attention is. It is the taking possession by the mind in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought...It implies withdrawal from some things in order to deal effectively with others" (1890). More precisely, visual attention can be defined as the processing capacity by which we select certain visual stimuli for further processing (Pashler, 1998; Scholl, 2001). This selection is subject to limited capacity, as we can attend only to a finite number of stimuli simultaneously. Additionally, this selection mechanism can require considerable effort. In anxiety, the notion is that attention preferentially selects threat-relevant information for elaborated processing (Williams, Mathews, & MacLeod, 1996). Such selection can significantly limit the concurrent processing of other, potentially important, information. The degree of effort required to maintain attention to threat-relevant information is part of the present question. It is possible that the effort involved in attentional processing of threat is invested in attempts to *avoid* the stimuli, but that this effort frequently is unsuccessful. The larger question is whether attentional processing of threat-relevant information in individuals with anxiety disorders is characterized by enhanced orienting of attention to threat, or by a relative difficulty with disengagement once threat information is attended.

In the service of the examination of the mechanisms of attentional processing in anxiety, it is useful to adopt a mechanistic model of attention that elaborates upon these questions. Posner's (1980) three-step processing model of the shift of attention incorporates attentional subcomponents: attentional *engagement*, *disengagement*, and *re-engagement (orienting)*. That is, attention first is *engaged* with a location or object, as the reader's attention currently is engaged with this page. Attention then must be released, or *disengaged*, from the attended object or location, in order to *re-engage* with (i.e., be *oriented* toward) a different location or object (Posner & Cohen, 1984). This cyclical model is particularly useful for outlining the mechanisms of attentional processing in anxiety; symptoms of anxiety may be caused or maintained by difficulty with disengagement from or enhanced orienting to anxiety-relevant information (e.g., Amir, Elias, Klumpp, & Przeworski, 2003; Fox, Russo, Bowles, & Dutton, 2001).

The theoretical model of attentional capture (Yantis & Jonides, 1984) takes into account the subcomponent processes of attention, and it fits well with Posner's nuanced three-step model. This model suggests that the difficulties experienced by individuals with anxiety disorders, including specific phobia, are caused or maintained not only by an abnormal "bias toward", or facilitated orienting of attention to, threat-relevant information, but also by difficulty disengaging from that information once it is perceived. This distinction is potentially important, as the mechanistic contribution of each processing subcomponent to anxiety symptoms might vary by anxiety disorder. For example, individuals with specific phobia might experience symptoms due to enhanced orienting of attention to their phobic objects, whereas individuals with GAD might experience symptoms due to difficulty disengaging from worry-relevant information once

it is attended. This distinction between subcomponents also is potentially clinically relevant; if the difficulty is facilitated orienting of attention to threat, treatment can focus on reducing scanning or vigilance behaviors, for example. On the other hand, difficulty disengaging from the trigger stimulus might be addressed by helping patients to disengage more adaptively (i.e., faster).

Attentional Capture Approach

As noted, the field has learned a tremendous amount from the attentional bias approach; however, both the theoretical approach of attentional bias and the related measurement models used for the study of the role of attention in anxiety may not adequately address the nature of attention in anxiety. The theoretical assumptions and experimental paradigms of contemporary vision science can be translated for the study of the influence of attentional processing in anxiety, and this alternate approach addresses the limitations of the prior models. The measurement paradigms developed for the study of attentional capture allow for the parsing of attentional processing into the subcomponents of orienting and disengagement of attention.

One necessary element of the argument that attentional processing may maintain anxiety symptoms is a clear understanding of whether problematic processing reflects preferential orienting of attention to threat or difficulty disengaging attention from threat cues once they are attended. In recent years, several pioneers have begun to adopt this approach (e.g. Amir, Elias, Klumpp, & Przeworski, 2003; Fox, Russo, Bowles, & Dutton, 2001; Koster, Crombez, Verschueren, & DeHouwer, 2004), although a comprehensive discussion of the theoretical distinction does not yet exist in the clinical literature.

Theoretical Model: Attentional Capture

The theoretical model of attentional capture (Yantis & Jonides, 1984) is a better fit than the bias model for the conceptualization of the role of attention in anxiety. Attentional capture occurs when attentional resources are drawn involuntarily by an environmental stimulus. For example, the abrupt onset of a stimulus tends to draw attention in a stimulus-driven manner, as does an object that flashes (Yantis & Jonides, 1984; 1990). This capture of attention may be involuntary and unconscious, yet not capacity-free, such that the individual may be less able concurrently to allocate attention to another stimulus or task in the presence of the attended stimulus (e.g., Folk, Remington, & Johnston, 1992; Theeuwes, 1991). One fundamental characteristic of the attentional capture construct is its allowance for the prioritization of potentially dangerous, or otherwise important stimuli, such that the capture of attentional resources by these stimuli is adaptive (e.g., Most, Scholl, Clifford, & Simons, 2005). Evolutionarily, it makes sense that a poisonous snake captures attention, for example. In anxiety disorders, however, the range of objects or situations that are perceived as “dangerous” can be wider than is logical. For example, a coiled garden hose might capture the attention of an individual with snake phobia. This theoretical model of attentional capture, therefore, maps well onto the phenomenology of anxiety disorders such as specific phobia, in which attentional capture by phobic stimuli often precludes attention to other potentially important information.

Within the vision science literature, there often is debate as to whether the capture of attention under certain conditions reflects a perceptual effect or an attentional effect (e.g., Yantis & Jonides, 1984). The former implies that properties of the stimulus draw

attention, whereas the latter assumes that the implicit attentional goals of the individual, such as vigilance for threat, direct attention preferentially to certain objects or locations. In both cases, the allocation of attention is assumed to be relatively involuntary. For the current examination of attentional processing of threat in specific phobia, it seems likely that the top-down attentional goals of an individual with phobia interact with perceptual characteristics of feared animal (e.g., legs) to facilitate orienting of attention to threat. Disengagement from threat, on the other hand, may reflect a greater influence of attention, as features of an object are less likely in themselves to continue to hold attention (Yantis & Jonides, 1984). Whether due to the relative influence of top-down or of bottom-up processing, the capture of attention by threat-relevant stimuli represents a distressing problem for individuals with anxiety disorders.

Contemporary measurement paradigms for the attentional capture framework have been developed by visual-perception researchers, and it is possible to translate these paradigms for the study of the processing of visual threat information in anxiety. These tasks are designed to measure orienting and disengagement of attention, and they represent the state of art in the measurement of the subcomponents of visual perception.

Traditional Theoretical Approach: Attentional Bias

The majority of research that incorporates an experimental approach to the study of anxiety disorders has been based on the theorized “attentional bias” for threat-related stimuli in the environment (MacLeod & Rutherford, 1998; MacLeod & Mathews, 1988; Mathews & MacLeod, 1985; McNally, 1999). The bias construct is incomplete with respect to the current conceptualizations of attention held by vision scientists, as it does

not discriminate between the subcomponents of attention. Anxious individuals may, on average, exhibit facilitated orienting of attention toward threat-relevant environmental stimuli to a greater extent than non-anxious individuals. An alternate possibility is that anxious and non-anxious individuals may attend, on average, equally efficiently to threat-relevant stimuli, but anxious individuals may experience more difficulty disengaging their attention from threat once they have attended to it. The distinction is important, as the various anxiety disorders might differ depending on which subcomponents are problematic for each, and the development of appropriate behavioral treatments can be enhanced by a clearer understanding of attentional mechanisms. For example, facilitated orienting of attention to negative facial expressions might be prominent in social phobia, whereas difficulty with disengagement from trauma-relevant stimuli might represent the greater impediment in PTSD. Unlike the relatively broad attentional bias construct, the theoretical and measurement models of attentional capture fit the phenomenology of attention in anxiety (i.e., the theorized behavioral impairment associated with attention to threat), because they are able to address the distinction between the subcomponents of attention.

Measurement of Attentional “Bias”

In the past two decades, numerous researchers in the field of experimental psychopathology have utilized performance-based paradigms to examine the role of the theorized attentional bias in anxiety (e.g. Mathews & MacLeod, 1985; McNally, Riemann, & Kim, 1990; Watts, McKenna, Sharrock, & Tresize, 1986). Their work largely has relied upon two measurement paradigms: the Stroop task and the dot-probe task.

Stroop Paradigm

The emotional Stroop paradigm is a commonly-used measure that attempts to discover whether threat-relevant stimuli interfere with concurrent task demands (e.g., MacLeod, 1991). In the Stroop task, subjects view words printed in different colors. The task is to name the colors rather than reading the words. The original Stroop effect was found with color names printed in different colors; subjects took longer to name the word color when the color name was incongruent with the print hue (Stroop, 1935). In other words, the word meaning interferes with color naming when the meaning is inconsistent with the color percept. In the anxiety literature, researchers commonly use a variant of the original design, the emotional Stroop task (MacLeod, 1991). Word stimuli in this design are chosen for their affective value for the population of interest. In studies of social phobia, for example, emotion words might include “embarrass”, or “awkward”.

In studies of anxiety using the emotional Stroop paradigm, anxious subjects are expected to take longer to name the color of anxiety-related words because those word meanings presumably draw attention more efficiently than neutral words. For both supra- and subliminal Stroop tasks, longer response times for color-naming of anxiety-related words compared to color-naming of neutral words are interpreted as greater attentional bias to the anxiety-relevant word stimuli. For example, a subject with OCD might show slower color-naming of obsession-related words compared to neutral words.

A variety of studies present evidence for Stroop interference in anxiety disorders (Williams, Mathews, & MacLeod, 1996). For example, studies have found interference effects of fear-relevant words for participants with specific phobia (Kindt & Brosschot, 1997; Watts, McKenna, Sharrock, and Trezise, 1986), GAD (Mogg, Bradley, Williams,

& Mathews, 1993), social phobia (Mattia, Heimberg, & Hope, 1993), panic disorder (McNally, Riemann, & Kim, 1990), and PTSD (Paunovic, Lundh, & Oest, 2002). In addition, results from one version of the Stroop task using color-masked photo stimuli found enhanced interference of snake stimuli for snake-fearful subjects (Constantine, McNally, & Hornig, 2001). When effects are found, they generally are reported as interference in anxious participants and the absence of such interference in control participants. However, several studies have failed to find Stroop interference effects for fear-relevant stimuli (e.g., Bryant & Harvey, 1995; Kindt & Brosschot, 1997; Mathews & Sebastian, 1993). In sum, Stroop results generally appear to support the existence of differential processing of threat-relevant information in anxiety. That is, it is fairly consistently found that anxious individuals experience some difficulty completing target tasks (i.e., color-naming) in the presence of anxiety-relevant stimuli. What is unclear is the mechanism underlying this relative difficulty.

Limitations of Stroop paradigm

Although many Stroop results in studies of anxiety appear to suggest a unique role of attention in anxiety, clear interpretation of these results with respect to the orienting and disengagement subcomponents processes of attention is limited. The target and distractor stimuli are superimposed in this task, as target color and distractor word are properties of the same stimulus. It therefore is not possible to determine whether the interference effect reflects orienting of attention to threat words, or difficulty disengaging from them (Fox, Russo, Bowles, & Dutton, 2001). For example, if an individual with social phobia takes longer to name the colors of social threat words compared to neutral words, this could reflect facilitated orienting of attention to social threat meaning,

difficulty disengaging attention from social threat meaning, or both. It follows that a clear understanding of the mechanistic role of attention in anxiety cannot be achieved using this task. In addition, target tasks and threat-relevant stimuli generally are not superimposed spatially in the real world; this characteristic of the Stroop task limits its ecological validity.

Dot-Probe/Attentional Probe Paradigm

The dot-probe, or attentional-probe, paradigm also has been used to measure attentional bias in anxiety (MacLeod, Mathews, & Tata, 1986; Mogg & Bradley, 2003). Participants view two stimuli, such as one neutral and one threat-relevant word, presented above and below fixation for 500 milliseconds (See Figure 1). Stimuli then offset, and a probe (e.g., dot) appears in the location of one of the stimuli. Participants respond by indicating the location of the probe. If a participant has been attending to the threat-relevant stimulus, the response time for indicating the probe location in the threat position should be faster than the response time for the probe in the neutral stimulus location. It follows that faster response times to the threat location are interpreted as an attentional bias for threat.

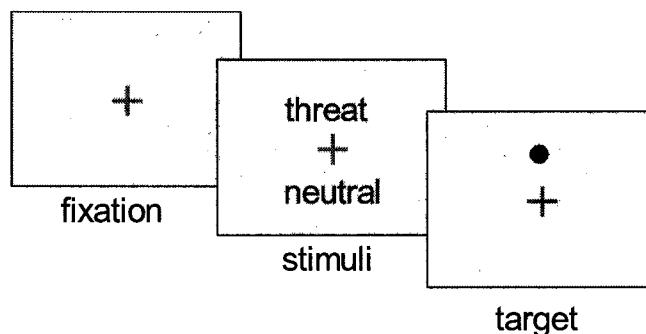


Figure 1. Spatial measurement of attentional “bias”: Dot-probe paradigm. A faster response time to the target dot in the same position as the threat word than to the target dot in the same position as the neutral word is considered an index of attentional bias to threat.

This paradigm has been modified to address one concern regarding the nature of the probe detection. It is possible for a subject to detect the presence of a simple probe (e.g., dot) without shifting attention when the initial stimuli and the probe both are presented within foveal vision. That is, participants can detect the onset of the probe in the periphery while maintaining attention at the other cue location. The modified version of the task requires a discrimination task as the probe, such as the identification of one symbol versus another, rather than simple detection of an object onset, such as a dot (Bradley, Mogg, Falla, & Hamilton, 1998). Although participants can detect simple features of probes in the periphery, they must attend to the probe object in order to discriminate between possible responses.

Shorter response times to probes in the same position as anxiety-relevant stimuli compared to control stimuli have been found in participants with GAD (Bradley, Mogg, Millar, & White, 1995), social phobia (Mansell, Clark, Ehlers, & Chen, 1999; Musa, Lepine, Clark, & Mansell, 2003; Pishyar, Harris, & Menzies, 2004), panic disorder (Kroeze & van den Hout, 2000), and PTSD (Bryant & Harvey, 1997), compared to non-

anxious control participants. However, the one dot-probe study measuring attention in specific phobia failed to find an attentional bias toward threat information in spider or blood-injury phobia (Wenzel & Holt, 1999). That study used positive (e.g., cheer), negative (e.g., nausea), neutral (e.g. table), and threat-relevant (e.g., web, syringe) word stimuli, and the authors concluded that individuals with phobia might not show the effect when semantic processing is required. Again it appears that the published results generally support the existence of differential attentional processing in anxiety, and the researchers have largely interpreted the results as implicating preferentially oriented attention to threat. One exception to the interpretation of results as a “bias toward” threat is a recent paper that used the dot-probe paradigm to examine selective attention related to general threat photo stimuli in unselected participants (i.e, there was no assessment of participant anxiety) (Koster, Crombez, Verschueren, & DeHouwer, 2004). The authors found slower response times to probes in the opposite position from threat photos, such as those from the International Affective Photo System (IAPS), and they interpreted this result as difficulty with disengagement from threat. It is difficult to compare dot-probe study results due to the heterogeneity of populations studied and stimuli used, but the effects typically are reported in anxious participants but not in non-anxious participants (e.g., Yiend & Mathews, 2001). In some studies, the effect is reversed in low or non-anxious participants; these participants have faster response times to probes in the opposite location as threat stimuli compared to neutral or positive stimuli (e.g., Bradley, Mogg, & Millar, 2000; Ioannou, Mogg, & Bradley, 2004).

It appears clearer with the dot-probe paradigm than with the Stroop task that anxiety-relevant stimuli may differentially influence attention in individuals with anxiety

disorders. This increased level of consistency might reflect the superior construct validity of the dot-probe task compared with Stroop (Mineka, Rafaeli, & Yovel, 2002); because the distractor and target task are not superimposed, the task is more likely to tap actual shifts of attention. In effect, the results suggest that attentional processing in anxiety might be characterized by specific difficulties with disengagement or orienting, although, as discussed below, the dot-probe design cannot parse the two subcomponents of attention.

Limitations of dot-probe paradigm

The addition of a target discrimination task has enhanced the interpretation of results; however, two major limitations to interpretation remain. First, as noted by several researchers (Bradley, Mogg, & Millar, 2000; Fox, Russo, Bowles, & Dutton, 2001), the commonly used 500 ms duration of the stimulus pair presentation is relatively long. It is possible to attend to one location and shift to the other within a 500 ms window, as the initial orienting response has been found both at 100 ms and 200 ms (e.g., Christie & Klein, 1995). It also is possible to attend to one location, shift to the other location, and then shift back within 500 ms (e.g., Fox et al., 2001). Therefore, it is not possible to determine whether the longer response times to probes in the non-threat location reflect facilitated attention to or difficulty disengaging from the threat-relevant stimuli, or both. Adding to the confusion is the conflicting language used by researchers to describe their results. As noted, although most authors of dot-probe studies present their data as evidence of attentional bias toward threat, one more recent paper nicely addresses the issue of orienting and disengagement and presents dot-probe results as evidence for the

latter (Koster, Crombez, Verschueren, & DeHouwer, 2004). In either case, the 500 ms stimulus presentation time precludes accurate interpretation.

Second, both threat-relevant and neutral stimuli are presented simultaneously within a participant's minimum visual field around fixation; one cannot know where subjects are attending (Fox, Russo, Bowles, & Dutton, 2001). Participants cannot help but attend to both stimuli initially; therefore, measurement of initial biased allocation of attention to threat-related information is not possible.

General Measurement Issue: Stimulus Considerations

There are two common problems with stimulus sets used in many prior studies that utilize the Stroop and dot-probe paradigms to assess the role of attention in anxiety. First, the stimuli developed by cognitive researchers to study basic visual attention do not correspond well to the stimuli encountered in the world. Although this is preferable in basic research that examines visual processing, the measurement of attentional processing in individuals with psychological disorders, such as specific phobia, requires stimuli that more closely approximate the triggers that lead to distress. Tasks that rely upon word stimuli, therefore, often are less relevant for this population, as, for example, an individual with spider phobia rarely sees the word "spider" appear in her kitchen. That is, one general assumption about attentional processing in anxiety is that anxiety-relevant trigger stimuli in the world often are percepts, such as a frown on someone's face to a social phobic, or a smudge of dirt to someone with OCD. Although interpretation, or semantic processing, of stimuli such as words also may be problematic for individuals with anxiety disorders, the study of basic attentional processing is concerned with the detection of perceptual information. A caveat: it also might be the case that word stimuli

are the optimal choice for the examination of the role of attentional processing in some anxiety disorders. For example, in GAD, the content of worry may be more conceptual and semantic than perceptual, such that word stimuli are most appropriate.

A related advantage of the use of snake and spider phobias for the examination of attentional processing in anxiety is that, whereas the range of trigger stimuli for various anxiety disorders often includes cues related to other sensory modalities, the triggers in specific phobias often are purely visual. For example, auditory cues, such as the sound of a person laughing, might be a trigger for a patient with social phobia; and olfactory cues such as the smell of a rapist's brand of cologne might trigger PTSD symptoms for a rape victim. Snakes and spiders, however, generally are perceived visually; they are detected less often by scent or sound, with the notable exception of the distinctive sound of rattlesnakes. It follows that the examination of the mechanisms of visual attentional processing is particularly relevant for this type of anxiety disorder, and that photos are the optimal experimental stimuli for use in attentional paradigms.

The second common limitation of most prior stimuli is that inattention to stimulus valence and emotionality issues often clouds the interpretation of results (c.f. Ruiz-Caballero & Bermudez, 1997). Researchers frequently compare threat-relevant stimuli to neutral stimuli and/or positive stimuli without including negative, non-threat stimuli, for example. Thus, the results may represent subjects' sensitivity to negative valence rather than anxiety relevance. Results also may be due to preferential processing of general emotionality, rather than threat-relevance (Mathews & Klug, 1993). That is, researchers sometimes attribute effects to the negative valence of stimuli when the effect may be due to general (positive or negative) degree of emotional arousal. The present work continues

the current trend toward the use of photo stimuli to more closely approximate the real-world experience of threat-relevant stimuli, and also includes the proper controls for valence and emotionality.

Summary of Attentional Bias Approach

Based on the evidence from the extensive attentional bias research, it appears likely that there is *something* special about the role of attentional processing in anxiety. Differential attentional processing of threat-relevant information appears to be associated with anxiety (Mineka, Rafaeli, & Yovel, 2002). However, we cannot determine the precise nature of the attentional differences, as the methods based on the relatively vague bias construct cannot disambiguate the subcomponent processes of attention. It follows that our understanding of the mechanistic role of attentional processing is limited. Research can be better served by a more contemporary approach that addresses this significant shortcoming. The theoretical and measurement models of attentional capture serve such goals. Measurement paradigms also should address the stimulus considerations that have been overlooked in the prior use of attentional paradigms.

Temporal/spatial allocation of attention

One additional theoretical distinction is relevant to the model of attentional capture in anxiety. Attention can be allocated spatially or temporally, and the relative influence of these aspects of problematic attentional processing in anxiety should be included in mechanistic models of symptom onset and maintenance. Spatial allocation of attention refers to the shift of attention from one location in space to another. Tasks that require individuals to search among items in a display, for example, are spatial tasks. Generally, the theorized bias in anxiety has been thought to result from spatial vigilance

(e.g., Ioannou, Mogg, & Bradley, 2004; Ohman, Flykt, & Esteves, 2001), or constant scanning of the immediate environment for threat. For example, a person with spider phobia might have her attention drawn along the baseboards of a room upon entering, or an individual with social anxiety might scan faces at a party for perceived critical expressions. Accordingly, measurement of the attentional bias construct largely has relied upon spatial paradigms. As discussed earlier, the two most commonly used measures of attentional “bias” in anxiety are the emotional Stroop and dot-probe paradigms. It is unclear whether the emotional Stroop paradigm measures spatial or temporal allocation of attention, as both target (color) and distractor (word meaning) are properties of the same stimulus, so it is not possible to determine the cause of the interference. The dot-probe task was designed for the spatial measurement of attentional bias. Individuals are required to attend to one location or another on the screen, and they also may need to re-allocate attention to another spatial location during a trial. In addition, several measures of attentional *capture* address spatial allocation of attention; the visual search paradigm and the Posner cue validity paradigm recently have been used to provide more precise measurement of the subcomponents of spatial attention (e.g., Amir, Elias, Klumpp, & Przeworski, 2003; Fox, Russo, Bowles, & Dutton, 2001; Ohman, Flykt, & Esteves, 2001, Yiend & Mathews, 2001). Overall, a considerable literature addresses spatial allocation of attention in anxiety and has found differential processing in anxiety. Further, evidence for both spatial orienting of attention (e.g., Ohman et al., 2001) and difficulty with spatial disengagement (e.g., Amir et al., 2003; Fox et al., 2001) in anxiety has been found using measurement paradigms developed from the attentional capture perspective. The temporal and spatial aspects of attentional allocation provide multiple ways to measure

the construct, in much the same way as multi-method measurement (e.g., self-report and behavioral observation) is preferred in clinical research. It follows that the examination of the allocation of attention can be optimized by the measurement of both dimensions.

Spatial and Temporal Allocation of Attention in Anxiety

As noted, most experimental paradigms used to study attention and anxiety measure spatial processing; the temporal allocation of attention has been under-studied in anxiety. Temporal allocation of attention refers to the distribution of attention over time, or how long an individual attends to one stimulus, or stimulus representation, without redirecting attention to another stimulus in the same location. Although most feared stimuli do not appear or disappear suddenly, there are instances in which the temporal allocation of attention is likely to present difficulties for persons with anxiety disorders. For example, a glimpse of a snake on television might capture the attention of a snake phobic, even when the image is presented very briefly or the channel is changed. Although the threat-relevant cue then would be replaced temporally by non-threat material in the same *spatial* location, the individual with snake phobia might nonetheless continue to process the trigger stimulus, which could lead to symptom onset or exacerbation.

The measurement of both temporal and spatial allocation of attention is important for the understanding of the mechanisms of attentional processing in anxiety, as well as for the development of effective behavioral interventions that can be tailored to the various disorders. Recent work in attentional retraining for the purpose of reducing anxiety (e.g., Rutherford, MacLeod, & Campbell, 2002) highlights the need for treatment paradigms that correspond to the targeted problematic processing. Thus, for example,

someone with GAD might benefit more from temporal retraining of attention that leads to decreased difficulty with temporal disengagement from worry-relevant information.

Parsing the relative influence of the temporal and spatial dimensions of attention in anxiety may be particularly valuable for the tailoring of treatments.

It may be that the relative influence of temporal and spatial mechanisms of attention varies by disorder. For example, a person with GAD may be less likely to scan her environment and thereby have her attention captured spatially, although the same person may be quite likely to experience difficulty disengaging from anxiety-relevant information over time, which might precipitate or maintain worry. It also is possible that both spatial and temporal difficulties with allocation of attention are implicated in symptom onset and maintenance in some disorders. A social phobic, for example, might have her attention drawn spatially to “unfriendly” faces at a social gathering, and also be unable to disengage temporally from the perceived negative information when the “unfriendly” expressions are replaced by welcoming smiles. In specific phobia, it makes sense that phobic individuals might experience difficulty disengaging spatially and temporally from phobic stimuli.

Spatial Measurement of Attentional Capture: the Cue Validity Paradigm

The cue validity paradigm (Posner, Snyder, & Davidson, 1980) measures primarily spatial allocation of attention. This paradigm presents only one stimulus at a time, correcting one difficulty with interpretation of the dot-probe paradigm. Participants initially fixate on a central point on the screen. A single cue stimulus is presented to the right or left of fixation, unlike in the dot-probe paradigm, wherein two stimuli are presented simultaneously. The cue offsets, and the target stimulus appears in either the

cued (valid) or the non-cued (invalid) location (see Figures 2 & 3). In the following experiment, the target was one of two possible symbols, and reaction time for symbol discrimination was the dependent measure. The cueing paradigm allows examination of the efficiency of orienting attention to an object, and the efficiency of disengaging attention from an object. For valid cue trials, the speed of target discrimination reflects the speed with which attention is oriented to the cue object. For example, Christie and Klein (1995) found that target discrimination on valid trials was faster when the cue was a common word versus when the cue was a non-word. Such modulation of attentional orienting as a function of cue meaning was observed at cue-target stimulus onset asynchronies (SOAs) of 100 ms and 200 ms. For invalid cue trials, the speed of symbol discrimination reflects the efficiency of disengaging attention from the cued location and re-orienting it to the target location.

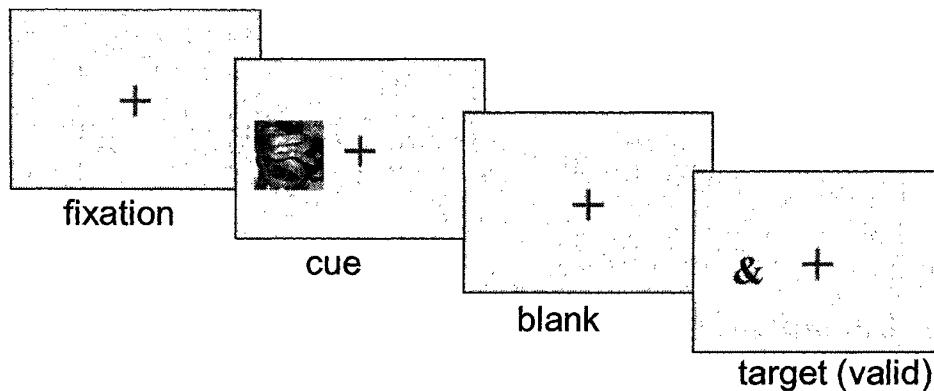


Figure 2 . Valid trial of Posner cue validity paradigm. A single cue appears to one side of fixation, a 40 ms blank prevents masking, and the target appears in the same position as the cue. Participants should be faster to respond to targets in the valid position than in the invalid position.

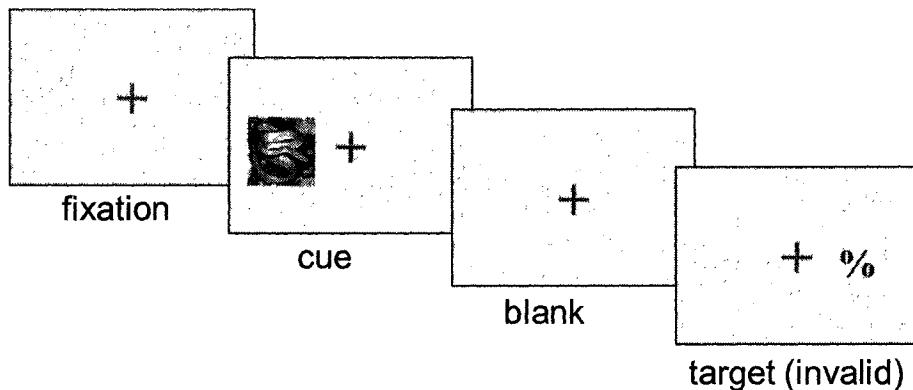


Figure 3. Invalid trial of Posner cue validity paradigm. A single cue appears to one side of fixation, a 40 ms blank prevents masking, and the target appears in the opposite position as the cue. Participants should take longer to respond to targets in the invalid, or uncued location, as they must disengage from the cue position and shift attention to the opposite location.

One essential parameter, cue validity, ensures sustained attention to the cued location; the target appears in the valid location (i.e., the same position as the cue) most (75%) of the time. That is, the high probability of a target in the cue location trains subjects to attend preferentially to the cued location. This contingency results in the basic cueing effect, which is the mean response time to the invalid (uncued) location minus the mean response time to the valid (cued) location. The cueing effect typically is a positive value. Attending to the cued location on invalid trials results in longer response times to the target, as participants must disengage their attention from the cued location to attend to the target. As discussed earlier with the dot-probe paradigm, a useful modification of the task requires participants to perform a discrimination task following the onset of the target stimulus. For example, the target might be one of two symbols (e.g., "%" and "&"), and participants must identify the symbol. This ensures subjects' allocation of attention to the target rather than simple detection of a featural change in the periphery.

As noted, response times for the target discrimination are faster after valid cues than after invalid cues. That is, when participants direct their attention to the cue prior to the presentation of a target, they take additional time to disengage from the cue to re-allocate attention to a target in the other location. For anxious participants, response times after a phobic cue object should be slower than those of control subjects if difficulty with disengagement from threat-relevant stimuli exists. Therefore, for example, if the cue is a negative socially-relevant stimulus, subjects with social phobia should take longer to shift attention to the true target location in the invalid condition due to a relative difficulty with disengagement from the anxiety-relevant stimulus.

The cueing paradigm has been used to examine difficulty with disengagement in sub-clinical anxiety (Fox, Russo, Bowles, & Dutton, 2001). High trait-anxious subjects showed longer response times for detecting targets following invalid angry face cues than did controls. Similar findings were reported for general threat pictures, such that high trait-anxious individuals showed greater difficulty disengaging from threatening photographs relative to non-anxious controls (Yiend & Mathews, 2001). A third set of studies reported greater difficulty in disengaging from emotional face stimuli (angry or happy) for high trait-anxious subjects compared to low-anxious subjects (Fox, Russo, & Dutton, 2002). The one recent study with clinical anxiety found difficulty with disengagement from threat-relevant stimuli in social phobia (Amir, Elias, Klumpp, & Przeworski, 2003).

The cueing paradigm also provides a measure of enhanced orienting of attention to threat-relevant target stimuli. At very short stimulus onset asynchronies (SOAs), or the time between cue onset and target onset (e.g., 100 ms to 200 ms), faster response times to

threat-relevant stimuli compared to neutral stimuli in the valid (cued) location reflect faster orienting to threat (Christie & Klein, 1995). One study did not find differences in orienting attention to threatening stimuli between high and low trait anxious subjects at a 150 ms SOA (Fox, Russo, Bowles, & Dutton, 2001). This result was consistent with their hypothesis that anxious individuals would not show enhanced orienting to anxiety-relevant information compared to non-anxious individuals. Spatial attentional capture by abrupt onset (i.e., onset of cue) should not vary by diagnostic group. That is, anxious and non-anxious individuals presumably detect low-level features of objects, such as color or shape, equally efficiently. The results support the notion that the difficulty for anxious individuals instead may lie with disengagement from threat-relevant information.

The cueing paradigm clearly is capable of measuring differences in attentional processing with respect to emotional stimuli. As is true with the dot-probe paradigm, careful consideration of stimulus presentation times is essential to the design. On valid cue trials, cue-target SOAs that are too long allow enough time for the subject to shift attention to the cue on all trials, obscuring differences in the efficiency of orienting. As noted above, the optimal timing parameters for an initial orienting response should be in the range of 100-200 ms SOA, as used by Fox et al. (2001) and Christie and Klein (1995). For assessment of disengagement, a longer cue-target SOA is required to ensure that participants have had opportunity to shift attention to the cued location prior to target appearance; the cued location must be reliably attended to examine the efficiency of disengaging attention from that location. Fox et al. (2001) successfully used a 300 ms cue-target SOA to examine efficiency of disengagement.

The present experiment was divided into two sub-experiments. Both included valid and invalid cue trials. In the attentional orienting sub-experiment, cue-target SOA was set at 120 ms to examine initial shifts of attention, and response times following valid cues were of central interest. In the attentional disengagement sub-experiment, the cue-target SOA was set at 300 ms to ensure that participants had attended to the cue object prior to the appearance of the target object, and response times following invalid cues were of central interest.

Experiment 1

The aim of Experiment 1 was to examine the role of the subcomponents of the spatial allocation of attention in specific phobia using the cue validity paradigm. Photo stimuli were used to enhance the ecological validity of the findings. Additionally, negative, non-threat stimuli were included, which allowed differentiation between attentional processing of threat-relevant information and negatively valenced information. Consistent with the basic vision literature (e.g., Christie & Klein, 1995), and the results of recent studies that examined the subcomponents of attentional processing in subclinical anxiety (e.g., Fox et al., 2001) and social phobia (e.g., Amir et al., 2003) using spatial paradigms, I hypothesized that (1) spider-fearful participants would not show faster orientation of attention to phobia-related stimuli compared to other stimulus types and compared to control participants, and (2) spider-fearful participants would experience difficulty with disengagement of attention from phobia-related stimuli compared to other stimulus types and compared to control participants. This pattern would indicate that phobic status is not one of the parameters that influences the efficiency of spatial orienting of attention to a stimulus. But, once attended and identified, phobic status may

affect the dwell time of attention, with phobic participants attending to threat-relevant stimuli longer before they can orient their attention spatially elsewhere. On the other hand, phobic individuals are likely to experience difficulty disengaging spatially from phobia-relevant stimuli once they have been attended. This maps onto behavior in the world; a spider phobic is unlikely to let a spider out of her sight lest it approach her, for example.

Method

Participants

Participants were 12 spider-fearful and 12 non-fearful controls who were recruited from the University of Iowa undergraduate introductory psychology subject pool. Potential participants were pre-screened for eligibility using a subset of questions from the Snake Anxiety Questionnaire (SNAQ) (Klorman, Weerts, Hastings, Melamed, & Lang, 1974), and the Fear of Spiders Questionnaire (FSQ) (Szymanski & O'Donohue, 1995) (see Appendix A for Experiment 1 pre-screen items). The pre-screening procedure limited the number of questionnaire items, therefore the entire measures could not be used. I used score cutoffs that corresponded to full-measure means that were found to be consistent with high animal fear in prior studies (Constantine, McNally, & Hornig, 2001; Klorman, Weerts, Hastings, Melamed, & Lang, 1974; Muris & Merckelbach, 1996; Teachman & Woody, 2003). Accordingly, eligible spider-fearful participants scored high on the 15 FSQ items (i.e., at least 75 of 90 possible points) and low on the 15 SNAQ items (i.e., 3 or fewer of 15 possible points). Two pre-screened spider-fearful male participants were excluded from the analysis due to their non-fearful questionnaire

responses (i.e., FSQ scores in non-phobic range) after session one. Non-fearful control participants scored low on both pre-screening measures of animal fear (i.e., 15 or fewer points on the FSQ and 3 or fewer points on the SNAQ). Study participants were primarily female and White (see Table 1). Participants were compensated with course credit for the two separate 60-minute experimental sessions.

Table 1.

Experiment 1 Demographic data

	Control (n=12)	Spider-fearful (n=10)
Age	19.2 (1.5)	19.2 (1.7)
Gender		
Female	9 (75%)	10 (100%)
Male	3 (25%)	0 (0%)
Ethnicity		
White	10 (83%)	7 (70%)
Asian	2 (17%)	2 (20%)
Latino/a	0 (0%)	1 (10%)

Procedure

Sessions

Each participant completed two sub-experiments in two sessions. In one session, the speed of orienting attention toward phobic, negative, and neutral stimuli was assessed. In the other block, the speed of disengaging attention from phobic, negative, and neutral stimuli was assessed. Participants completed the full battery of self-report questionnaires after the first session, and they repeated the state version of the State-Trait Anxiety Inventory after the second session. The state anxiety measure provided an assessment of participants' level of anxiety immediately following the experiment. Experimental session order (i.e., orienting or disengagement) was counterbalanced by participant.

Overview of Cue Validity paradigm

For both the orienting and disengagement sub-experiments, participants were seated in a comfortable chair at a viewing distance of 70cm from the monitor. Participants read the task instructions on the computer screen (see Appendix C for complete task instructions). The following events constituted an experimental trial. Participants viewed a blank screen with a central fixation marker for 1000 ms. Next, a photo cue stimulus appeared to the left or the right of fixation for 80 ms (orienting blocks) or 260 ms (disengagement blocks); these presentation times are described in more detail within the block descriptions. The cue then offset, followed by a 40 ms blank to prevent masking of the cue by a target. The target letter appeared either in the same location as the cue (valid trials, see Figure 2) or the opposite location as the cue (invalid trials, see Figure 3). Participants then identified the target letter (i.e., "X" or "O") as

quickly as possible by pressing one of two buttons on a response box. Participants received feedback on the accuracy of their responses; “correct” or “incorrect” appeared on the screen following each response. During the experiment, a research assistant monitored participants’ eye movements from fixation. The research assistant flagged trials during which participants made saccadic eye movements, and these trials were excluded from the analyses.

The target appeared in the same location as the cue in 75% of the trials, thus providing participants with a strong incentive to attend to the cued location. Participant demonstration of a baseline cueing effect (i.e., longer response time to targets in the invalid location compared to the valid location) is a necessary condition for examining modulation of attentional shifts within the cueing paradigm. Orienting to and difficulty disengaging from threat-relevant stimuli were measured by presenting photos of spiders (threat-relevant), snakes (negative, non-threat) and frogs (neutral) in the cue position, and using two different cue presentation times (see block-specific descriptions). Each cue type appeared equally often, and cue order was randomized by the computer program. The animal stimuli were color photos of spiders, snakes, and frogs that were removed from their backgrounds to control for possible effects of background features (see Appendix B for sample stimuli). The stimulus set consisted of 12 photos of each animal type, for a total of 36 photo stimuli. All stimuli were approximately 6cm wide and 6cm high, and the edges of the photos closest to center were presented approximately 6cm to the right or left of fixation. Target stimuli were the letters “X” and “O”. The experiment was presented on a dark gray screen. The cue validity paradigm was programmed using E-Prime software (Schneider, Eschman, & Zuccolotto, 2002a; 2002b).

Orienting session

Participants completed 604 orienting trials of the cueing paradigm. The first 28 trials were practice trials, for which response time data were not analyzed. 432 (75%) of the remaining 576 test trials were valid (i.e., the target appeared in the same position as the cue). The invalid trials allow us to determine the existence of a baseline cueing effect. As noted, this baseline cueing effect is a necessary condition for testing the modulation of cueing by group and stimulus type. For measurement of orienting of attention, I used a 120 ms SOA (see Figure 4). The dependent variable for the orienting session was the mean reaction time for correct target identification on *validly cued* trials. Although data from invalid trials were important for the establishment of a baseline cueing effect, the variable of interest was reaction time to the cued location. Faster reaction times to threat-relevant cues (spider) compared to neutral (frog), or negative, non-threat (snake) cues provide an index of *orienting* of attention to those threat cues.

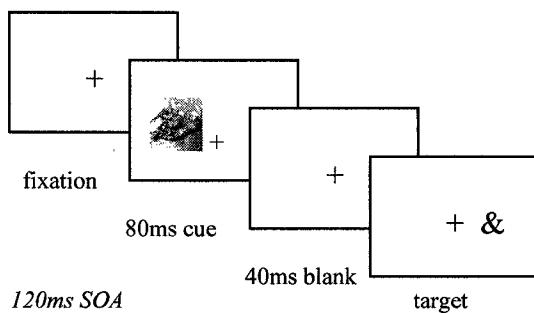


Figure 4. Invalid trial in orienting block; time between cue onset and target onset is 120ms.

Disengagement session

Participants completed 604 disengagement trials, of which the first 28 were practice trials. Of the test trials, 144 (25%) were invalid (cue in opposite position from target). The majority of the cues were valid, which gave participants an incentive to keep

attention focused on the cue location as predictive of target position, and allowed measurement of a cueing effect. For the session measuring disengagement of attention, I used a 300ms SOA (see Figure 5). This timing allows participants time to orient attention to the cue, but does not allow shifting of attention from the cue prior to target onset (Fox, Russo, Bowles, & Dutton, 2001; Theeuwes, Godijn, & Pratt, 2004). The dependent variable for this block was the *cueing effect*, or the mean reaction times on *invalidly cued* trials minus the mean reaction times on *validly cued* trials for each stimulus type. Because participants must disengage their attention from the cued location to identify the target in the invalid location, the cueing effect should be a positive value, as response times to targets in the uncued location should be longer than response times to the cued location.

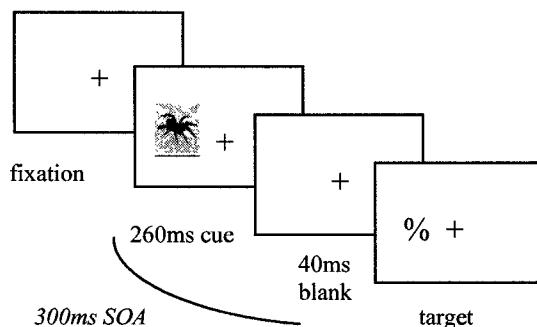


Figure 5. Valid disengagement trial; time between cue onset and target onset is 300 ms.

In addition to the basic cueing effect, I computed an index of difficulty with disengagement from threat-relevant cues that controlled for the basic cueing effect by subtracting the cueing effect for neutral (frog) stimuli from the cueing effect for threat (spider) stimuli. Similarly, I computed an index of difficulty with disengagement from

threat-relevant cues that controlled for negative valence by subtracting the cueing effect for negative, non-threat (snake) stimuli from the cueing effect for threat stimuli. This index allows differentiation of difficulty disengaging from phobic stimuli beyond difficulty disengaging from negatively-valenced stimuli.

Questionnaire measures

At the end of the first experimental session, participants completed a battery of self-report measures that included the Fear of Spiders Questionnaire (FSQ) (Szymanski & O'Donohue, 1995), the Snake Anxiety Questionnaire (SNAQ) (Klorman, Weerts, Hastings, Melamed, & Lang, 1974), Fear Questionnaire (FQ) items relevant to snake and spider fear (Marks & Mathews, 1979), the State-Trait Anxiety Inventory – State version (STAI-S) (Spielberger, Gorsuch, & Lushene, 1970), and the Beck Depression Inventory-II (BDI-II) minus the suicidality item (Beck, Steer, & Brown, 1996). IRB approval necessitated omission of the suicidality item, as the research assistants who assisted in data collection were not qualified to assess suicidal ideation should a participant endorse that item.

The FSQ is a commonly-used 18-item questionnaire for which responses are given on a 7pt scale. Items tap two dimensions of the phobic response: avoidance/help-seeking (e.g., "If I came across a spider now, I would leave the room") and fear of harm (e.g., "If I saw a spider now, I would be very afraid of it"). The FSQ has been found to have good psychometric properties; it has been shown to have test-retest reliability of .97, and it is internally consistent (Cronbach's $\alpha = .92$).

The SNAQ (Klorman et al., 1974) is a commonly used 30-item True/False measure of snake fear that includes items such as "I am terrified by the thought of

touching a harmless snake". The SNAQ has a reported test-retest reliability of .75 (Klorman et al., 1974).

The selected Fear Questionnaire items measure self-reported avoidance of snakes and spiders using a single rating for each on a 9pt scale, as well as a subjective rating of the present state of phobic symptoms on a 9pt scale. The FQ has been shown to discriminate between phobics and non-phobics, and it has good reported test-retest reliability for individual phobia items ($r = .93$) and global phobia severity rating ($r = .79$) (Marks & Mathews, 1978). The authors do not report internal consistency, as the full measure contains single items specific to particular fears, rather than multiple items related to particular fears.

Results

Questionnaire Data

A one-way ANOVA with group as the factor and questionnaire scores as dependent variables revealed that spider-fearful participants had significantly higher scores on the FSQ, $F(1,20)=256.86, p<.001$; the FQ spider fear item, $F(1,20)=79.31, p<.001$; the FQ fear severity item $F(1,20)=12.41, p<.01$, and the STAI-S, $F(1,20)=15.30, p<.01$, compared to controls (see Table 2). Spider-fearful participants also scored significantly higher than control participants on the SNAQ, $F(1,20)=6.97, p<.05$; and the FQ snake-fear item, $F(1,20)=5.73, p<.05$. There were no significant differences between groups on the BDI-II, $F(1,20)=3.13, p=.092$.

Table 2.

Experiment 1 Questionnaire Data

	Controls (n=12)	Spider-fearful (n=10)
	<i>M (SD)</i>	<i>M (SD)</i>
Fear of Spiders Questionnaire (FSQ)	3.0 (5.4) ***	66.7 (12.5) ***
Snake Anxiety Questionnaire (SNAQ)	2.8 (2.1) *	7.2 (5.4) *
Fear Questionnaire – spider fear	0.8 (1.2) ***	6.5 (1.8) ***
Fear Questionnaire – snake fear	0.8 (1.0)*	2.1 (1.4)*
Fear Questionnaire – fear severity	1.3 (2.1) **	4.2 (1.7) **
State Anxiety Inventory (STAI-S)	28.0 (5.9) **	39.1 (7.3) **
Beck Depression Inventory (BDI-II)	3.8 (3.7)	6.8 (4.2)

Note. STAI scores are averaged across sessions. * $p < .05$ ** $p < .01$ *** $p < .001$

Response time data trimming

Reaction time data for both blocks were trimmed to eliminate outliers. Trials with reaction times that were less than 175ms or greater than 2000ms were not included in the analysis. This trim procedure is a standard, conservative method of excluding response time outliers, and this procedure eliminated 3% of trials. Trials during which participants made saccadic eye movements from fixation also were excluded, which eliminated just under 3% of trials.

Orienting

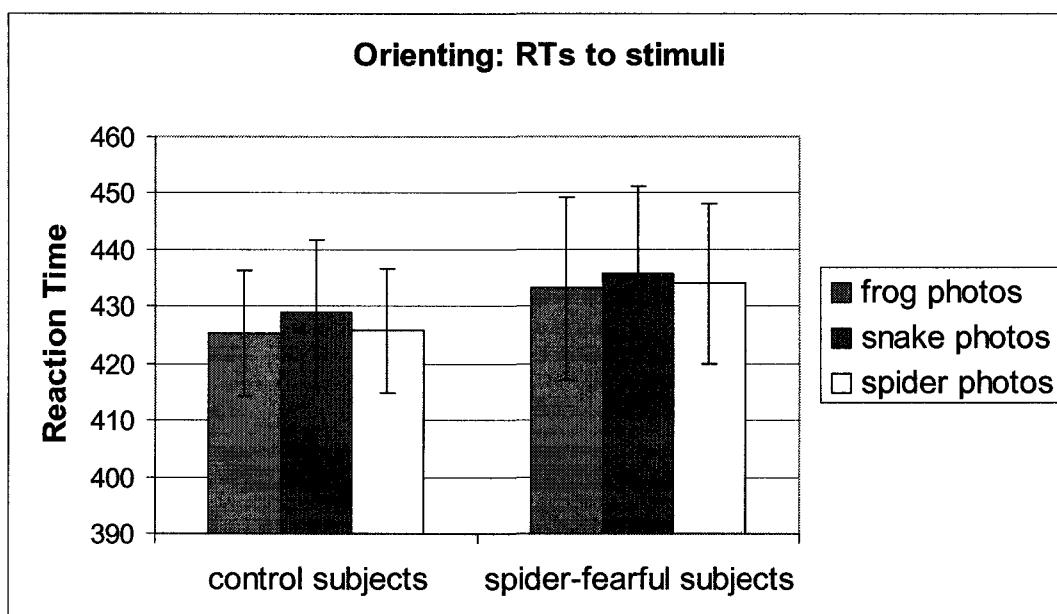
The baseline cueing effect was observed; participants showed longer response times on invalid trials ($M=450.32$) than on valid trials ($M=432.04$). Demonstration of a baseline cueing effect is a necessary condition for examining modulation of attentional shifts within the cueing paradigm. All participants showed a valid cueing effect in the orienting session, thus, the data from all participants contributed to the analysis of group and stimulus effects.

Response time data from the valid trials were analyzed to determine the speed of orienting of attention to the three stimulus types; the orienting effect is the response time to target stimuli that appear in the same position as the cue. A two-way mixed model ANOVA was conducted with group as the between-subjects factor, stimulus type as a within-subjects factor, and reaction time as the dependent variable. There was no significant main effect of group, $F(1, 20) = .171, p=.683, \eta^2 = .008$; spider-fearful and control participants did not differ in reaction times to targets in the same position as the cue (see Table 3 and Figure 6). There also was no significant main effect of stimulus type, Wilk's $\Lambda = .94, F(2, 19) = .623, p=.547, \eta^2 = .06$, and the interaction between group and stimulus type was not significant, Wilk's $\Lambda = .996, F(2,19) = .037, p=.963, \eta^2 = .004$. Spider-fearful and non-fearful control participants did not appear to attend differentially to the stimulus types on valid trials. The effect size for the interaction was quite small (i.e., less than 1% of the variance), which suggests that the absence of significant differences is not attributable to Type II error.

Table 3.

Experiment 1 Orienting block mean reaction times to valid cues.

Stimulus type	Reaction time	
	Controls (n=12)	Spider-fearful (n=10)
Neutral (frog)	425.38 (38.0)	433.28 (50.9)
Negative (snake)	428.83 (44.3)	435.71 (49.4)
Threat (spider)	425.78 (37.8)	434.06 (44.3)

Note. Reaction times in milliseconds. Standard deviations are reported in parentheses.*Figure 6.* Reaction times for identification of target stimuli on valid trials at 120ms SOA. There was no Group x Stimulus type interaction. Error bars denote standard errors.

Disengagement

The basic cueing effect was observed in the disengagement session for all but four participants. Disengagement data were excluded for 2 control participants and 2 spider-fearful participants due to negative cueing effects (i.e., faster reaction times following invalid cues than valid cues for two or more stimulus types). It is unclear why the negative cueing effect occurred for some participants, but their data cannot be used to examine the modulation of disengagement, as they do not show a reliable baseline cueing effect. For the remaining 10 control participants and 8 spider-phobic participants, response times were faster in the valid condition than in the invalid condition; these data contributed to the analysis of group and stimulus effects.

A two-way mixed model ANOVA with group as a between subjects factor and stimulus type as a within subject factor revealed no significant group differences in the magnitude of the cueing effect, $F(1, 16) = .278, p=.605, \eta^2 = .017$ (see Table 4 for means). There was a significant main effect of stimulus type, Wilk's $\Lambda = .499, F(2,15) = 7.52, p<.01, \eta^2 = .501$, and a significant interaction of stimulus type by group, Wilk's $\Lambda = .518, F(2,15) = 6.99, p<.01, \eta^2 = .482$. Follow-up paired samples t-tests showed no significant within-subjects differences between stimulus types for control participants, $p > .05$. For spider-fearful participants, two within-subjects comparisons were significant; these participants took significantly longer to disengage from spider stimuli ($M=26.69, SD=16.6$) than from neutral (frog) stimuli ($M=3.94, SD=17.1$), $t(7)=3.86, p<.01, d=1.39$ (see Figure 7). Spider-fearful participants also took significantly longer to disengage from spider stimuli than from snake stimuli ($M=11.34, SD=22.4$), $t(7)=2.40, p<.05, d=.78$.

Spider-fearful participants did not show significant differences between disengagement from snake and frog stimuli, $t(7)=.711, p=.50, d=.37$.

Table 4.

Experiment 1 Disengagement; basic cueing effect by group and stimulus type.

Stimulus type	Controls	Spider-fearful
	$M (SD)$	$M (SD)$
Neutral (frog)	15.23 (13.13)	3.94 (17.07)
Negative (snake)	18.11 (14.37)	11.34 (22.37)
Threat (spider)	16.91 (9.14)	26.69 (16.59)

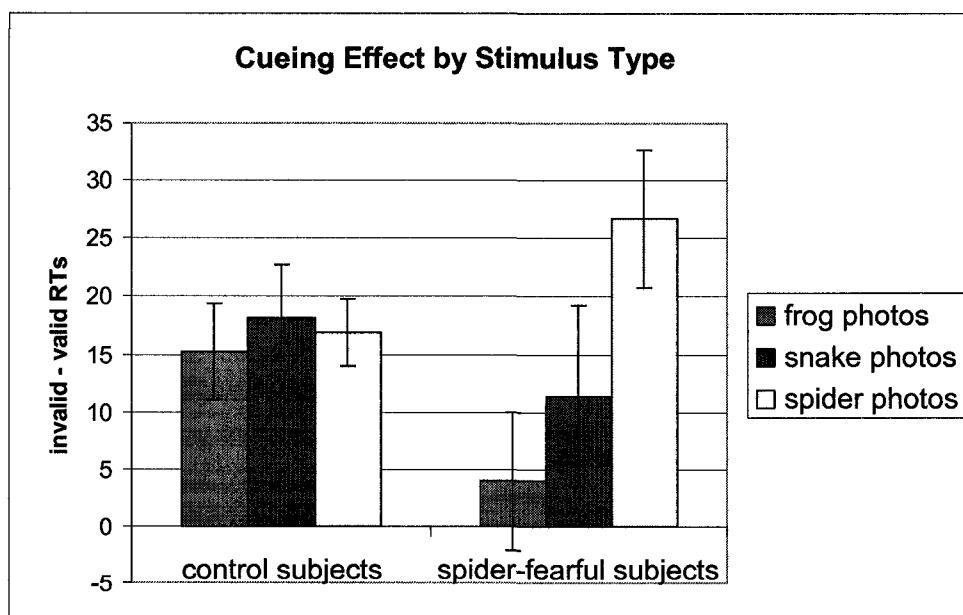


Figure 7 . Disengagement basic cueing effect, or reaction times on invalid trials minus reaction times on valid trials. Error bars denote standard errors.

One of the aims of the present study was to examine the cueing effect for threat stimuli independently of the basic cueing effect or the cueing effect for negatively valenced stimuli. I controlled for the basic cueing effect by subtracting the frog (neutral) cueing effect from the spider cueing effect, and controlled for negative valence by subtracting the snake (negative) cueing effect from the spider cueing effect (see Figure 8).

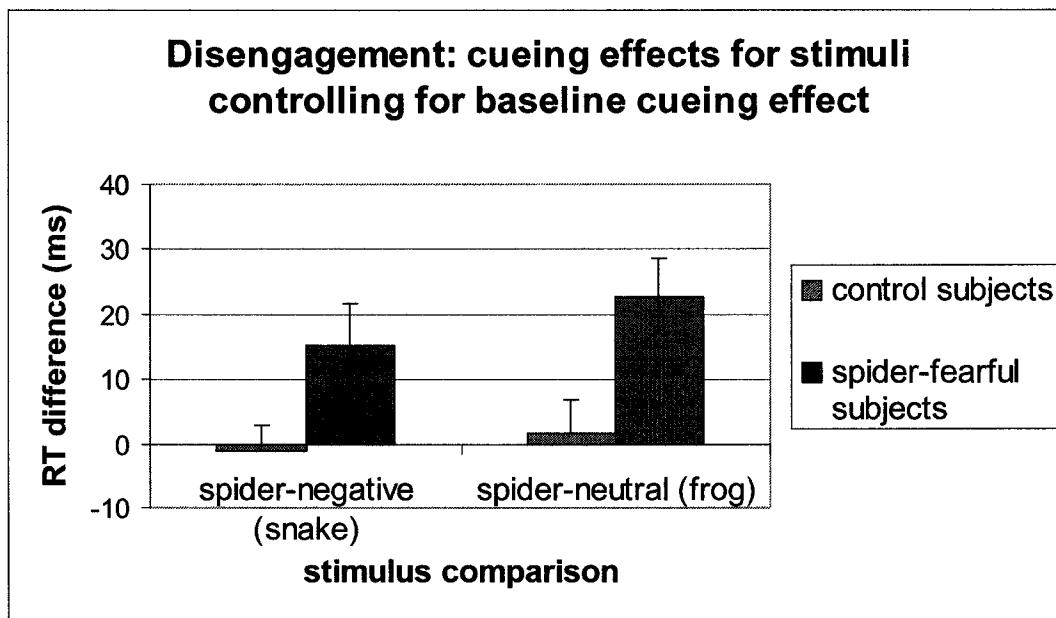


Figure 8. Group differences in disengagement effect for spider stimuli controlling for negative, non-threat cueing effect and neutral cueing effect. Error bars denote standard errors.

Independent samples t-tests revealed significant differences between groups for difficulty with disengagement from spider stimuli. Spider-fearful participants' cueing effect for spider stimuli controlling for the baseline neutral cueing effect ($M=22.75$, $SD=16.68$) was significantly greater than control participants' difference ($M=1.69$, $SD=16.31$), $t(16) = 2.69$, $p=.017$, $d=1.28$. Spider-fearful participants' difference between

spider cueing effect and negative non-threat (snake) cueing effect ($M= 15.35$, $SD= 18.12$) also was significantly greater than control participants' difference ($M= -1.19$, $SD= 12.48$), $t(16)=-2.19$, $p=.048$, $d=1.06$.

Experiment 1 Discussion

Consistent with prior research (Fox et al., 2001), I did not find evidence for facilitated orienting of attention to threat in spider-fearful participants compared to non-fearful controls. There also was no evidence for within-subject enhanced orienting of attention to spider stimuli compared to negative or neutral stimuli. These preliminary results are inconsistent with theories of attentional "bias toward" threat-relevant information in anxiety disorders. I adjusted timing parameters to assess the orienting response within the 100ms to 200ms initial orienting window that has been stated in the literature (e.g., Christie & Klein, 1995; Fox, Russo, Bowles, & Dutton, 2001), which resulted in the accurate measurement of the orienting response to cue stimuli. It was hypothesized that there would be no group differences in the orienting of attention to the onset of cue stimuli, regardless of their phobia-relevant features (e.g., spider legs). This is consistent with a perceptual explanation of attentional capture; phobic stimuli did not differentially attract the attention of individuals with phobia, although these individuals presumably have implicit attentional goals that include detection of threat. These data also are consistent with the finding that, during free viewing of real-world scenes, semantically salient objects (e.g., a toaster in a bathroom) do not preferentially draw attention; although, once attended and identified, they are attended longer than semantically consistent objects (e.g., a hair dryer in a bathroom) (Henderson, Weeks, & Hollingworth, 1999).

The hypothesis for difficulty with spatial disengagement from phobia-relevant information was supported. Spider-fearful participants showed greater difficulty disengaging from spider stimuli compared to control participants, and they also showed greater difficulty disengaging from spider stimuli compared to negative or neutral stimuli. This also is consistent with recent research that utilizes this paradigm with sub-clinical anxiety (Fox et al., 2001; Yiend & Mathews, 2001), and social phobia (Amir, Elias, Klumpp, & Przeworski, 2003). Spider-fearful participants also had significantly greater difficulty disengaging from spider stimuli, controlling for the baseline cueing effect and the cueing effect for negative stimuli, compared to control participants. This finding supports the notion that individuals with specific phobia experience attentional capture by threat-relevant information that is greater than that of simply negative information. The evidence that potentially problematic attentional processing of anxiety disorder-relevant information is unique (i.e., beyond the effects of negative valence) supports the notion that there is something special about attentional processing in anxiety disorders. The present work provides evidence that non-anxious participants do not process negatively-valenced visual stimuli differently from neutral stimuli. On the other hand, phobic participants appear to process phobic stimuli differently than both negative, non-threat and neutral stimuli. The differential processing of negative valence supports the notion of that the processing of threat is unique in phobic individuals. Beyond that baseline level of visual processing of threat, phobic individuals' attention appears to be held more strongly, and potentially problematically, by phobic stimuli. The evidence supports the notion that these participants may experience considerable difficulty disengaging their

attention from phobic stimuli, and suggests that interventions that retrain individuals to disengage more effectively may be useful clinically.

As discussed earlier, the spatial allocation of attention is only part of the potential pattern of attentional difficulties in anxiety disorders. Temporal allocation of attention also may present problems for individuals with anxiety disorders, including specific phobia. One of the aims of the present work is to provide converging evidence for differential attentional processing in the temporal domain.

Temporal Measurement of Attentional Capture: the RSVP Paradigm

Anxious individuals may experience involuntarily sustained temporal attention to threat-relevant stimuli that decreases their ability to attend to subsequent stimuli presented in the same visual field. Normal individuals exhibit a refractory period following identification of one stimulus, during which the individual is less able to allocate attention to another stimulus due to the capacity required for processing the first stimulus (e.g., Chun & Potter, 1995; Shapiro, Raymond, & Arnell; 1994). This period of impaired performance is termed the *attentional blink*. The blink phenomenon can be measured using the RSVP paradigm.

In the original RSVP design, participants view a stream of rapidly presented black letters, within which is one white letter (first target) (see Figure 9). In half of the trials, a black “X” (second target) is presented in one of several positions within an 800ms window following the white letter. Participants’ task is to identify the white letter, and indicate whether the “X” was present in the stream. The time between a correctly identified white letter (T1) and a correctly detected “X” (T2) for a given subject

represents the measure of the attentional blink, or difficulty disengaging attention from T1. The dependent variable is the percentage of correctly identified T2 stimuli, given a correctly identified T1, for each position after T1. For normal individuals, the duration of the blink (i.e., the period of relative difficulty with T2 identification) averages between two and five positions (200-500ms) following T1 (Shapiro, Raymond, & Arnell, 1994). The position of a particular stimulus following T1 is termed a “lag” (e.g, the 1st stimulus after T1 is at “lag 1”).

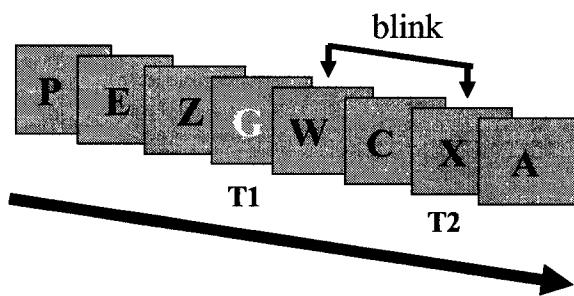


Figure 9. Original design of attentional blink paradigm. Participants identify the white letter and indicate the presence or absence of the black X. The X is present at lag 3, and a failure to detect it in the given example would indicate an attentional blink of at least 300ms, if each stimulus was presented for 100ms.

The prototypical attentional blink curve reflects the percentage of correct T2 identification at each lag (see Figure 10). The most pronounced period of impaired performance (i.e., lower percent correct detection of T2 given correctly identified T1) usually is found in the first few lags following T1. The exception to this performance deficit is at the first lag following T1, as performance is enhanced at this lag due to the ability of individuals to “bind”, or concurrently identify, the lag 1 stimulus with the identified T1 stimulus due to temporal proximity (Shapiro, Raymond, & Arnell, 1994).

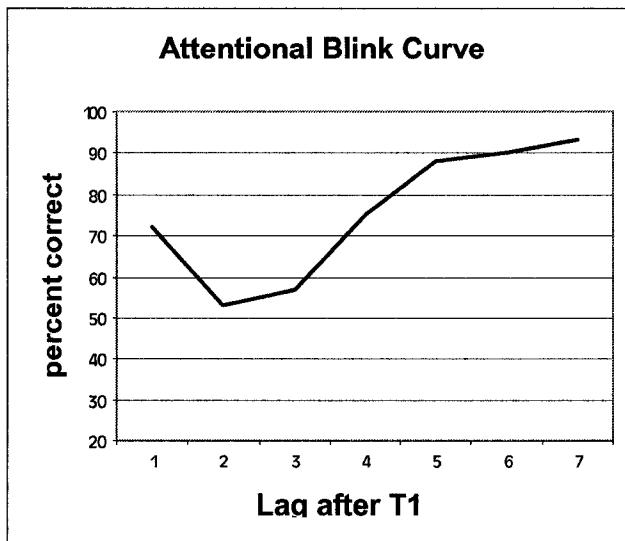


Figure 10. Prototypical attentional blink curve. The line represents percent correct T2 detection given correct identification of T1 for 7 lags. The most pronounced deficit in T2 detection is shown at lag 2, or two positions after T1, and performance improves as the distance from T1 increases.

Attentional Blink: Disengagement

When the letter stimuli are replaced by anxiety-relevant stimuli, we expect a threat-relevant T1 to result in a larger blink for anxious subjects, as these individuals are likely to experience more difficulty disengaging from threat-relevant information (see Figure 11). When a threat-relevant stimulus (e.g., spider) appears in the T1 position among neutral distractors, individuals with high fear of spiders are expected to show worse T2 detection performance in the lags immediately following T1, as the threat-relevant image should hold their attention more than a neutral T1.

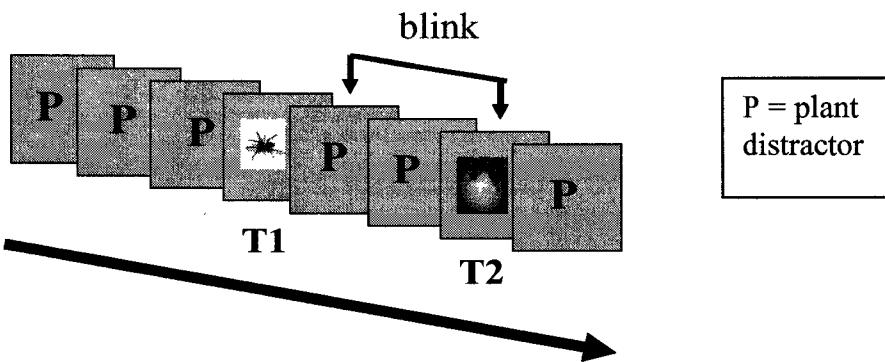


Figure 11. Disengagement trial of attentional blink (RSVP) paradigm. Participants identify the animal and indicate the presence or absence of fruit. If phobic individuals have more difficulty disengaging from their feared animal at T1, their attentional blink should be more pronounced than that of individuals who are not afraid of the animal at T1.

Relative difficulty disengaging from threatening or negative stimuli has been found in recent studies using negative kanji (Japanese characters) in normal subjects (Ogawa & Suzuki, 2004), negative words in high trait anxiety (Barnard, Ramponi, Battye, & Mackintosh, *in press*), and negative images in normal subjects (Most, Chun, Widders, & Zald, *in press*). These findings support the notion that both anxious and non-anxious individuals may experience difficulty disengaging temporally from negative or threat-relevant information.

In addition, Arend and Botella (2002) presented streams of word stimuli, with threat and neutral words in the T1 position. Contrary to the hypothesis that anxious individuals would have difficulty disengaging from threat-relevant information at T1, the authors found a *reduced* blink period following threat-relevant words at T1 for high trait-anxious subjects relative to non-anxious subjects. The authors interpreted this finding as representative of more efficient processing of threat-relevant word stimuli by anxious subjects. It remains to be seen whether the same effects might hold for photo (i.e., non-semantic) stimuli. That is, it may be that anxious individuals have overlearned negative

words such that they process (i.e., read) them more efficiently, although their response to non-semantic stimuli might not show the same effect. Yet another study found relative difficulty with disengagement from threat words (e.g., death) compared to neutral words (e.g., table) in all subjects using an RSVP paradigm, but failed to find a greater disengagement effect in anxious participants (Yovel, 2002). However, for this study, the reported percentages of correctly detected T2 stimuli at the lag most likely to show the effect were less than 10%. Thus, a floor effect may have prevented detection of any group differences.

Attentional Blink: Orienting

A second possibility is that anxious individuals might exhibit an attenuated blink, or facilitated *orienting* of attention to the second target (T2), when the second target is threat-relevant (see Figure 12). Such a finding would support the theorized bias toward threat-relevant information, as the interruption of an otherwise normal attentional blink would provide strong evidence for the individual attending more quickly to threat-relevant stimuli. A spider-phobic participant is expected to detect a spider stimulus in the T2 position more efficiently than a neutral stimulus if that participant exhibits facilitated allocation of attention to threat.

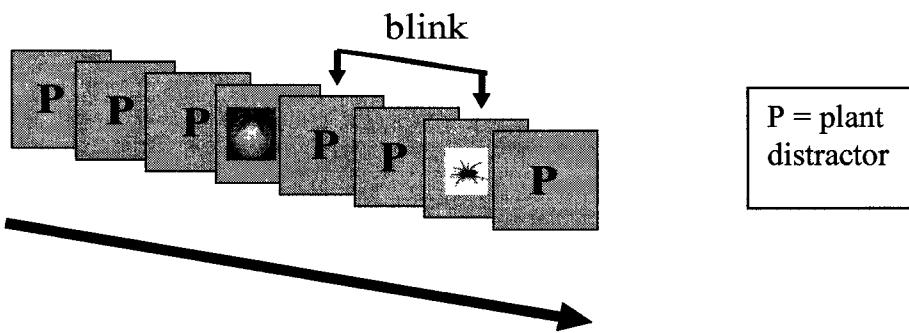


Figure 12. Orienting trial of attentional blink (RSVP) paradigm with threat-relevant stimuli. Participants identify the fruit and indicate the presence or absence of an animal. If phobic participants exhibit facilitated orienting of attention toward their fear-relevant animal, they should show an attenuated blink when their feared animal is in the T2 position.

Anderson and Phelps (2001) found an orienting effect in non-anxious subjects with negative words in the T2 position, and another study recently found evidence of facilitated orienting of attention toward valenced words at T2 (Keil & Ihssen, 2004). It appears that all individuals experience enhanced detection of negative stimuli compared to neutral stimuli, which suggests that the proper controls for emotionality and valence are a necessity for accurate interpretation of results when doing translational work. Another study also failed to find group differences in orienting between anxious and non-anxious participants in the RSVP task with anxiety-relevant and neutral words in the T2 position, although the absence of findings may have been due to design issues that resulted in below-chance performance in the task (Yovel, 2002).

The RSVP task also has been used in the clinical literature to compare basic temporal allocation of attention in dysphoric individuals compared to normal controls (Rokke, Arnell, Koch, & Andrews, 2002). The authors used the original design with streams of letters to measure temporal processing efficiency. In this case, the authors found that dysphoric subjects exhibited a larger attentional blink than control subjects.

This result was interpreted as a general attentional processing deficit in dysphoria, and it suggests the need to control for baseline mood state of participants during the RSVP task.

Attentional Blink: Summary

In sum, temporal allocation of attention has been under-studied in anxiety, although recent work confirms the relevance of the temporal dimension as potentially problematic. The RSVP paradigm lends itself well to the study of facilitated orienting of attention to and difficulty disengaging from anxiety-relevant information over time, and one purpose of the present work is to determine whether the effects are enhanced in anxiety disorders such as specific phobia. The present studies utilize the RSVP paradigm for the examination of the mechanisms of temporal allocation of attention in specific phobia.

Experiment 2

The RSVP paradigm assesses temporal allocation of attention and can be used to disambiguate the subcomponent processes of attention that might underlie symptom onset and maintenance in anxiety. The aims of Experiment 2 were to examine the role of temporal orienting of attention to and disengagement of attention from threat stimuli in spider and snake phobia, and to determine the feasibility of the use of photo stimuli within the RSVP paradigm. I had two primary hypotheses. First, I hypothesized that phobic individuals would experience enhanced temporal orienting of attention to phobia-relevant stimuli (i.e., a smaller attentional blink) to a greater degree than non-fearful control participants, and that this effect would be independent of negative valence. This hypothesis contrasts with the hypothesized absence of enhanced spatial orienting of attention to threat. It is more likely that fear-relevant information will interrupt

concurrent visual processing of non-threat information when the threatening stimulus appears in the attended location, than that threat-relevant information will draw attention to a different location. Second, I hypothesized that phobic individuals would experience greater difficulty disengaging attention temporally from phobia-relevant stimuli (i.e., a larger attentional blink) than control participants; this effect also should be independent of negative valence.

Method

Participants

Participants were 9 spider-fearful, 15 snake-fearful, and 18 non-fearful controls who were recruited from the Yale undergraduate introductory psychology subject pool as well as via recruitment posters on campus. I pre-screened potential participants for eligibility using a subset of questions from the Snake Anxiety Questionnaire (SNAQ) (Klorman, Weerts, Hastings, Melamed, & Lang, 1974), and the Fear of Spiders Questionnaire (FSQ) (Szymanski & O'Donohue, 1995) (see Appendix D for pre-screen items). The pre-screening procedure limited the number of questionnaire items, therefore the entire measures could not be used. I used score cutoffs that corresponded to full-measure means that were found to be consistent with high animal fear in prior studies (Constantine, McNally, & Hornig, 2001; Klorman, Weerts, Hastings, Melamed, & Lang, 1974; Muris & Merckelbach, 1996; Teachman & Woody, 2003). Accordingly, eligible spider-fearful participants scored high on the 10 FSQ items (i.e., at least 42 of 60 possible points) and low on the 10 SNAQ items (i.e., 2 or fewer of 10 possible points). The point cutoffs for Experiment 2 differed from those of Experiment 1, as the number of items allowed in the pre-screening process varied by research site. Eligible snake-fearful participants scored

low on the FSQ items (i.e., 10 or fewer of 60 possible points) and high on the 10 SNAQ items (i.e., at least 7 of 10 possible points). Control participants scored low on both measures of animal fear. Study participants did not differ significantly on demographic variables (see Table 5). Participants were compensated with course credit or cash payment of \$15 for participating in the 90-minute experiment.

Table 5.

Experiment 2 Demographic Data

	Controls (n=18)	Snake-fearful (n=15)	Spider-fearful (n=9)
Age	20.2 (2.55)	20.0 (3.5)	20.8 (3.2)
Gender			
Male	4 (22%)	3 (20%)	1 (11%)
Female	14 (78%)	12 (80%)	8 (89%)
Ethnicity			
White	10 (56%)	11 (73%)	4 (45%)
African-American	2 (11%)	0 (0%)	1 (11%)
Asian	5 (27%)	4 (27%)	2 (22%)
Latino/a	1 (6%)	0 (0%)	2 (22%)

Procedure

The RSVP task was programmed using E-Prime software (Schneider, Eschman, & Zuccolotto, 2002a; 2002b). Experimental stimuli were color photo stimuli taken from the Internet and equated for size and background using Adobe Photoshop (see Appendices E & F for sample photographs). Stimulus photos were 6cm high and 6cm

wide, and they were presented at fixation on a black screen. Distractor stimuli were plant and flower photos, critical stimuli were spider, snake, and frog (neutral) photos, and an additional set of target stimuli were apple, orange, and grape photos. Individual photo backgrounds were either solid (e.g., color of table on which spider stood), textured (e.g., sand beneath frog), or natural (e.g., branch beneath snake). Target stimuli were sized to fill the 6cm x 6cm space as much as possible.

The stimulus set contained 26 photos from each stimulus type category (e.g., 26 spider stimuli, 26 apple stimuli). Target and distractor stimuli were randomly selected for each trial. Each RSVP photo stream contained 18-20 photos. The first target (T1) in each stream was preceded randomly by 8 or 10 randomly selected distractor photos, and second targets (T2) appeared randomly in one of 8 positions, or lags, after T1. Each photo stimulus type appeared 4 times at each lag for each of the two conditions (i.e., the disengagement block, the orienting block). One additional randomly selected distractor photo was presented at the end of each RSVP stream to mask T2 images in the 8th position.

Participants were seated in a comfortable chair approximately 70 cm from the computer monitor in a sound attenuated room that was dimly lit using a 40 watt lamp placed behind a desk. Participants completed six blocks of the RSVP paradigm for a total of 576 trials: two orienting blocks; two disengagement blocks; and two single-task, or control, blocks. The single-task blocks were identical in stimulus-presentation design to the orienting and disengagement blocks, with the exception of instructions. Participants did not report the first target for single-task blocks. Eight practice trials preceded each block, and block types were counterbalanced across participants (i.e., each participant

completed both disengagement blocks and the disengagement control block, then both orienting blocks and the orienting control block, or vice versa).

Orienting trial blocks

Participants completed two orienting trial blocks. Each block began with 8 practice trials, followed by 96 test trials. All photos were presented for 100ms; this is a common presentation time for complex stimuli in the RSVP paradigm, and it is the timing parameter that most consistently produced the blink in the piloting phase of the study design. Each photo in the RSVP stream contained fruit (neutral) target stimuli in the T1 position, and T2-present trials (50%) had an animal at the T2 position (see Figure 13).

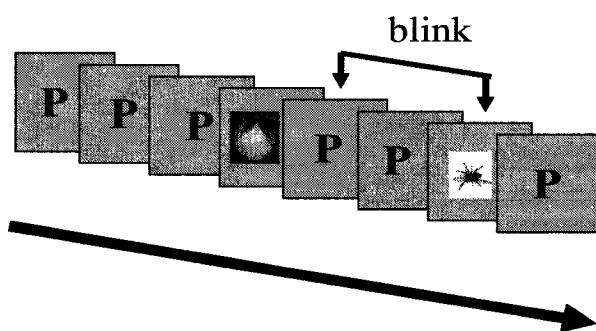


Figure 13. RSVP orienting trial with a neutral stimulus in the T1 position and an animal in the T2 position.

Each block was preceded by a text screen that clearly stated the tasks for that block and the order of the stimuli (see Appendix H for text instructions). For the orienting block, participants were asked to identify the fruit and indicate whether the animal was present or absent. Following each photo stream, the words “apple”, “grape”, and

“orange” appeared in that order on the screen (see Appendix I). Participants pressed the “1”, “2”, or “3” keys, which corresponded to the word position on the screen, to report the identified fruit. Following that response, participants viewed the words “animal present?” on the screen, and responded with “4” for present and “5” for absent. The “4” and “5” keys were labeled with “p” for present, and “a” for absent. Participants then pressed the spacebar to begin the next trial. Responses were not timed.

Disengagement trial blocks

The disengagement blocks were identical to the orienting blocks with the exception of target order. For the measurement of disengagement, animal stimuli appeared in the T1 position, and fruit appeared in the T2 position on 50% of trials (see Figure 14). Participants were asked to identify the animal and indicate whether the fruit was present or absent.

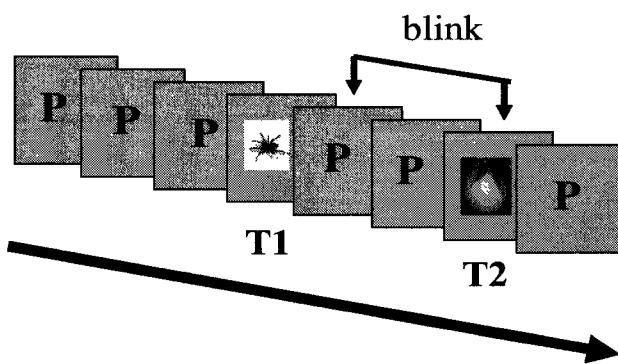


Figure 14. Disengagement trial with an animal in T1 position and a neutral stimulus in the T2 position.

Single-task blocks

Two single-task control blocks of 96 trials each also were presented. One of these blocks served as a control for the orienting condition, and the other served as a control for the disengagement condition. For each block, the stimulus presentation streams were

identical to those of the orienting and disengagement blocks, but participants were *not* required to identify the first target (T1). Participants reported only the presence or absence of the T2 stimulus during these blocks. This procedure provides a baseline measurement of detection of the T2 stimuli; performance on T2 detection should not be subject to an attentional blink if participants are not required to attend to the T1 stimulus. Performance on these control blocks can assist in ruling out stimulus type effects that may interfere with interpretation of dual-task blocks; if a particular stimulus type is too difficult to detect, for example, performance on the single-task will be impaired.

Questionnaire/Interview measures

Following completion of the experimental tasks, participants completed a battery of self-report measures that included the Fear of Spiders Questionnaire (FSQ) (Szymanski & O'Donohue, 1995), the Snake Anxiety Questionnaire (SNAQ) (Klorman, Weerts, Hastings, Melamed, & Lang, 1974), Fear Questionnaire (FQ) items relevant to snake and spider fear (Marks & Mathews, 1979), the State-Trait Anxiety Inventory – State version (STAI-S) (Spielberger, Gorsuch, & Lushene, 1970), and the Beck Depression Inventory-II (BDI-II) (Beck, Steer, & Brown, 1996). The experimenter also conducted a brief interview with each participant; the interview included Structured Clinical Interview for DSM-IV (SCID-IV) modules for major depression, psychotic symptoms, and phobic symptoms.

We also used a version of the FSQ with items modified to measure snake fear. The modified measure (see Appendix G) was included due to its ability to tap avoidance and fear of harm, as well as its continuous rating scale, which allows participants to provide a more nuanced report of symptoms. Scores on the FSQ modified for snake fear

were highly correlated with scores on the SNAQ in Experiment 2 ($r(42)=.92, p<.01$) and Experiment 3 ($r(18)=.90, p<.01$).

Results

Questionnaire/Interview Data

Participants completed questionnaire measures and responded to interview questions following the experimental task. Group scores on questionnaire measures are summarized in Table 6. Contrary to expectations based on pre-screening data, snake-fearful participants generally did *not* report clinical levels of snake fear. For example, when responding to the SCID interview questions, participants in the snake-fearful group denied unreasonable fear and frequently acknowledged that they would be able to touch a snake held by someone else. The snake-fearful group mean on the Fear Questionnaire phobia severity rating also was lower than expected for a high-fear group. Mean FQ severity ratings for a sample of 20 phobic inpatients was 7 of 8 possible points (Marks & Mathews, 1978). Although I did not expect mean severity ratings of that magnitude for our undergraduate sample, the mean snake-fear group score ($M=2.8, SD=1.4$) was considerably lower than what would be considered high-fearful. This mean score corresponds to self-reported symptom severity that is “slightly/not really disturbing. In contrast, the mean spider-fear group rating ($M=4.1, SD=1.7$) corresponds to self-reported symptom severity that is “definitely disturbing/disabling”. The snake-group responses are inconsistent with the diagnostic criteria for phobia; therefore, we dropped this group from the present analyses.

Table 6.

Experiment 2 Questionnaire Data Means

	Controls (n=18)	Snake-fearful (n=15)	Spider-fearful (n=9)			
Measure	M	SD	M	SD	M	SD
FSQ	8.1	(11.1)**	28.8 (20.1)		68.0 (15.8)**	
FQ-spider fear	0.8	(1.1)**	3.1 (1.8)		5.9 (2.1)**	
SNAQ	3.1	(1.7)	18.0 (4.5)		5.7 (4.9)	
FSQ-snake	15.5	(11.8)*	77.1 (12.1)		30.4 (23.5)*	
FQ-snake	1.3	(0.9)	5.5 (1.7)		1.6 (1.6)	
FQ-severity	0.6	(0.7)**	2.8 (1.4)		4.1 (1.7)**	
STAI-S	30.1	(7.2)*	35.0 (8.4)		42.0 (13.2)*	
BDI-II	6.3	(5.3)	7.4 (5.6)		10.8 (6.5)	

Note. Significant group differences are noted only for spider-fearful and control groups. Snake-fearful participants' questionnaire data are presented for illustration of diagnostic issues.

* p<.05. ** p<.001

For spider fear measures, spider-fearful participants' scores were significantly different from those of control participants and snake-fearful participants (see Table 6). On the Fear of Spiders Questionnaire, spider-phobic participants scored significantly higher ($M=68.0$, $SD=15.8$) than control participants ($M=8.1$, $SD=11.1$), $t(25) = 11.92$, $p<.001$, and snake-fearful participants ($M=28.8$, $SD=20.1$) $t(22) = 5.26$, $p<.001$. FSQ means for the spider-fearful group were lower than those of other documented spider

phobic samples (e.g., $M=84.9$, $SD=13.7$, Teachman & Woody, 2003; and $M=89.1$, $SD=19.6$, Muris & Merckelbach, 1996). This reflects the exclusionary criteria in the present study. Individuals with the highest reported levels of spider fear on the pre-screening measures also were likely to report fear of snakes, although only spider-fearful participants with low or no snake fear were eligible to participate. Spider-fearful participants also scored significantly higher ($M=5.9$, $SD=2.1$) than control participants ($M=0.8$, $SD=1.1$), $t(25) = 7.01$, $p<.001$, and snake-fearful participants ($M=3.1$, $SD=1.8$), $t(22) = 5.86$, $p<.001$ on the Fear Questionnaire item of spider fear.

Spider-phobic participants ($M=4.1$, $SD=1.7$) also reported a significantly higher degree of fear than controls ($M=0.6$, $SD=0.7$) on the Fear Questionnaire severity item, $t(25) = 6.41$, $p<.001$. On measures of snake fear, spider-phobic participants were not significantly different from control participants. Spider-fearful subjects ($M=42.0$, $SD=13.2$) reported a higher degree of state anxiety than control participants ($M=30.1$, $SD=7.2$), $t(25) = 2.47$, $p=.031$, on the STAI-S following the experimental tasks. Spider-fearful ($M=10.8$, $SD=6.5$) and control participants' ($M=6.3$, $SD=5.3$) scores on the BDI-II were not significantly different, $t(25) = -1.88$, $p=.076$.

None of the control or spider-fearful participants self-reported clinical levels of depression or psychotic symptoms on SCID interview questions following the experimental task. None of the control participants reported clinical levels of current or lifetime snake or spider fear during the interview. All spider-fearful participants reported clinical levels of spider fear (e.g., having had intense fear of spiders their entire lives), with varying degrees of impairment that met diagnostic criteria (e.g., cannot re-enter a

room in which a spider had been seen), and all spider-fearful participants denied clinical levels of snake fear during the interview.

T1 Performance

For the RSVP paradigm, the primary dependent variable of interest (i.e., percent correct detection of T2) is predicated on correct T1 identification. This requirement ensures that participants process the T1 stimulus; the attentional blink phenomenon requires processing of a first target that subsequently interferes with the second. Inaccurate identification of T1 might reflect random responding, which would violate the requirement. A one-way ANOVA revealed no significant group differences in T1 identification accuracy for any of the four T1 stimulus types, all $p > .05$. Accuracy rates by T1 stimulus type are presented in Table 7. These results indicate that participants in the three groups attended to the T1 task and performed equally well, correctly identifying T1 stimuli in almost 90% of trials. Participants in all groups appeared to have more difficulty identifying fruit stimuli in the T1 position compared to animal stimuli. This may have been due to the featural similarity between fruit and distractor (plant and flower) stimuli, which suggests the need to control for this property of the distractors in further studies.

Table 7.

Experiment 2. First target identification accuracy by stimulus type.

	Disengagement			Orienting	Mean
	Frog T1	Snake T1	Spider T1	Fruit T1	
Controls	.90 (.30)	.94 (.23)	.95 (.22)	.83 (.38)	.91 (.28)
Spider-fearful	.88 (.32)	.91 (.28)	.93 (.25)	.79 (.41)	.88 (.31)
Mean accuracy	.89 (.33)	.93 (.25)	.94 (.24)	.81 (.40)	

Note. No significant group differences within blocks.*T2 Performance*

The critical data for this study were participants' T2 detection rates, or the percent of correctly detected T2 stimuli given correct identification of T1 stimuli. I excluded from the analysis all trials in which participants did not accurately identify T1. It also was important to examine false-alarm rates (i.e., responding T2 present on T2-absent trials) for potential biased responding. False alarm rates did not vary significantly by group (see Table 8), although some participants in each group had relatively high rates.

Table 8.*Experiment 2 Percentage T2 False-Alarm rates.*

T1 stimulus type	Controls	Spider-fearful
Disengagement block		
Frog	15 (36)	19 (40)
Snake	17 (37)	20 (40)
Spider	17 (38)	21 (41)
Orienting block		
Fruit	8 (28)	9 (29)

Note. Mean percentage (*SD*).

The basic blink effect was observed¹; participants' overall detection rates for T2 animal stimuli produced the prototypical blink pattern (see Figure 15). To examine the basic cueing effect in the orienting block, a two-way repeated measures ANOVA was conducted with Group as the between-subjects factor and Lag as the within-subjects factor. There was a main effect of Lag, $F(7,175)= 4.39, p=.002, \eta^2=.150$, with a Greenhouse-Geisser correction for non-sphericity. Within-subjects contrasts revealed a significant cubic trend for Lag, $F(1,25)=11.98, p=.002, \eta^2 = .324$, and a significant linear trend for Lag, $F(1,25) =7.38, p=.012, \eta^2 = .228$, indicating that T2 performance

¹ Raw T2 percent correct identification data are presented. Initially I used an A' transformation that corrects for variability in false alarm rates (i.e., reporting T2 present on T2-absent trials), although false alarm rates did not vary by group. Given our primary interest in difference values (i.e., within-group differences between blink magnitudes for each stimulus type), the transformation is unnecessary, as false-alarm rates did not vary by stimulus type.

decreased from lag 1 to lag 2, then improved from lag 2 to later lags. This is the hallmark of the attentional blink curve. There was no significant between-groups difference for the basic blink effect across stimulus types, $F(1,25)=.581, p=.453, \eta^2=.023$. For the disengagement block, two-way repeated measures ANOVA also revealed a main effect of Lag, $F(7,175)= 18.76, p<.001, \eta^2=.429$. Within-subjects contrasts revealed a significant linear trend for Lag, $F(1,25)=54.74, p<.001, \eta^2=.686$, and a significant cubic trend for Lag, $F(1,25)=16.26, p<.001, \eta^2=.394$, again indicating that T2 performance decreased from lag 1 to lag 2, and improved from lag 2 to later lags. There also was no significant between-groups effect for the basic blink effect across stimulus types, $F(1,25)=.143, p=.709, \eta^2=.006$.

For both orienting and disengagement blocks, the blink effect was most obvious (i.e., T2 performance was worse) at 200 ms, or lag 2, which is consistent with prior studies (e.g., Shapiro, Raymond, & Arnell, 1994). Results are presented by block type.

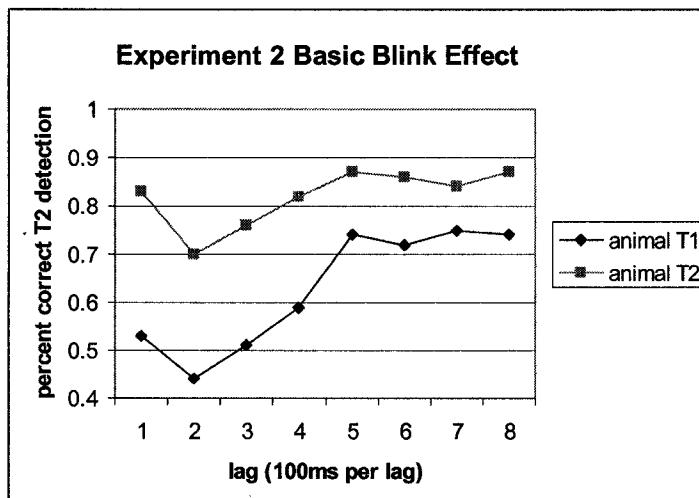


Figure 15. Basic blink for disengagement and orienting conditions averaged across participants. The basic blink effect is observed, and lag 2 is the lag most likely to show the effect in both conditions.

Orienting

A three-way repeated-measures ANOVA was conducted with Group as the between-subjects factor, Lag and Stimulus Type as within-subjects factors, and percent correct detection of T2 as the dependent variable, to determine whether preferential orienting to threat stimuli occurred. The analyses revealed a significant main effect of Lag, $F(7,175) = 4.39, p=.002, \eta^2=.150$, with a Greenhouse-Geisser correction for non-sphericity; and a significant main effect of Stimulus Type, $F(2,50) = 17.57, p<.001, \eta^2=.413$, indicating both the presence of the basic attentional blink effect, as well as an overall difference in T2 detection by stimulus type across lags. There was no significant main effect of Group, $F(1,25) = .581, p=.453, \eta^2=.023$, although the observed power for this comparison was low at .114. The Group by Stimulus Type interaction was not significant, $F(2,50) = 2.64, p=.081, \eta^2=.096$, but follow-up analyses were conducted for spider stimuli to determine potential trends (see Figures 16 & 17). Consistent with the hypotheses, spider-phobic participants showed a non-significant trend toward greater orienting of attention toward spider stimuli at T2 ($M=.88, SD=.19$), compared to control participants ($M=.68, SD=.34$), $t(25) = 1.67, p=.054$, one-tailed, $d=.73$.

Inspection of the basic blink data is important for ensuring that the experiment is measuring the blink effect. However, the basic blink effect is not the comparison of most interest; we are interested in the orienting effect toward phobia-relevant stimuli, controlling for the baseline blink effect to neutral (frog) stimuli and the blink effect to negative (snake) stimuli. I therefore looked at the difference between the magnitude of the blink effect for spider stimuli and the magnitude of the blink effect for snake and frog stimuli. Because the basic blink data show lag 2 (i.e., 200 ms) as the lag most likely to show the blink effect, I used this lag for the comparison of differences. There were no

significant differences between spider-fearful ($M=.08, SD=.17$) and control participants ($M=.11, SD=.34$), $t(25) = .23, p = .82, d=.11$, for comparison of orienting to spider stimuli controlling for neutral stimuli (see Figure 18). There was a non-significant trend between spider-fearful ($M=.22, SD=.39$) and control participants ($M=-.05, SD=.32$), $t(25) = -1.98, p=.059, d=-.76$, for comparison of orienting to spider stimuli controlling for negative stimuli.

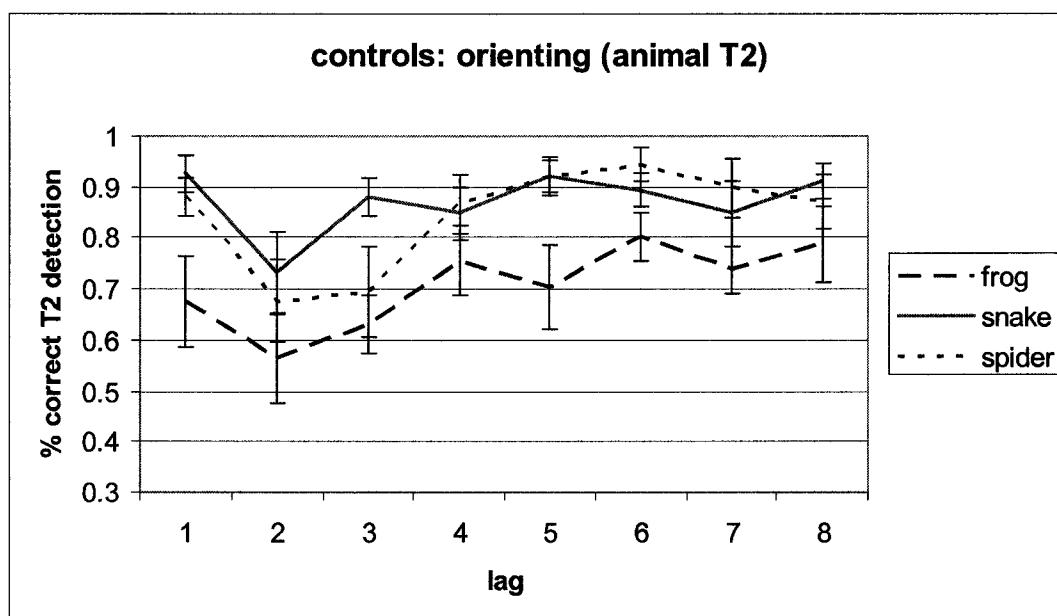


Figure 16. Experiment 2. Basic orienting blink curve for control participants with animal stimuli in T2 position.

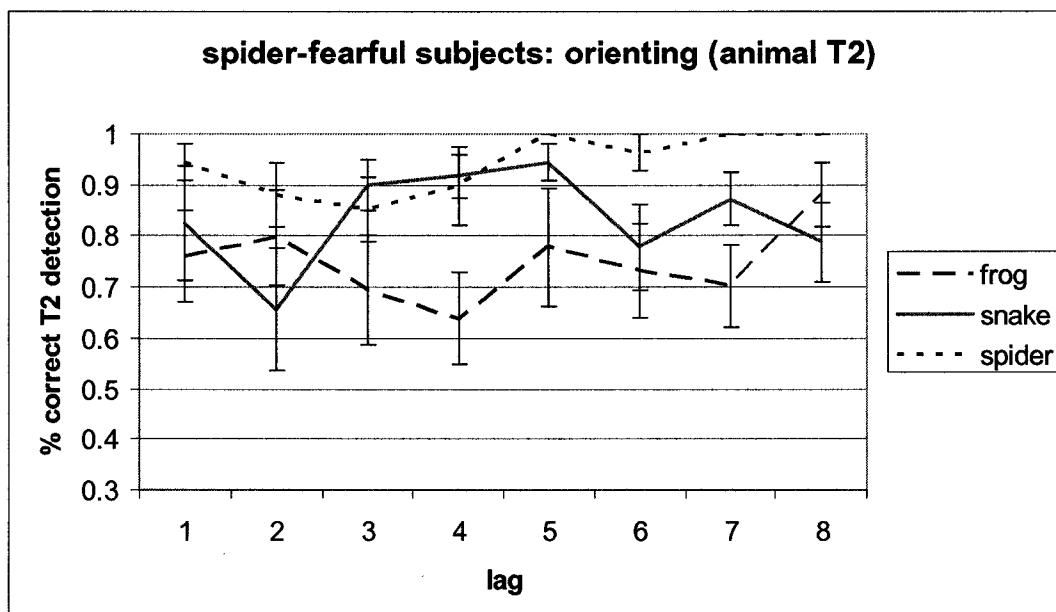


Figure 17. Experiment 2. Basic orienting blink curve for spider-phobic participants with animal stimuli in T2 position.

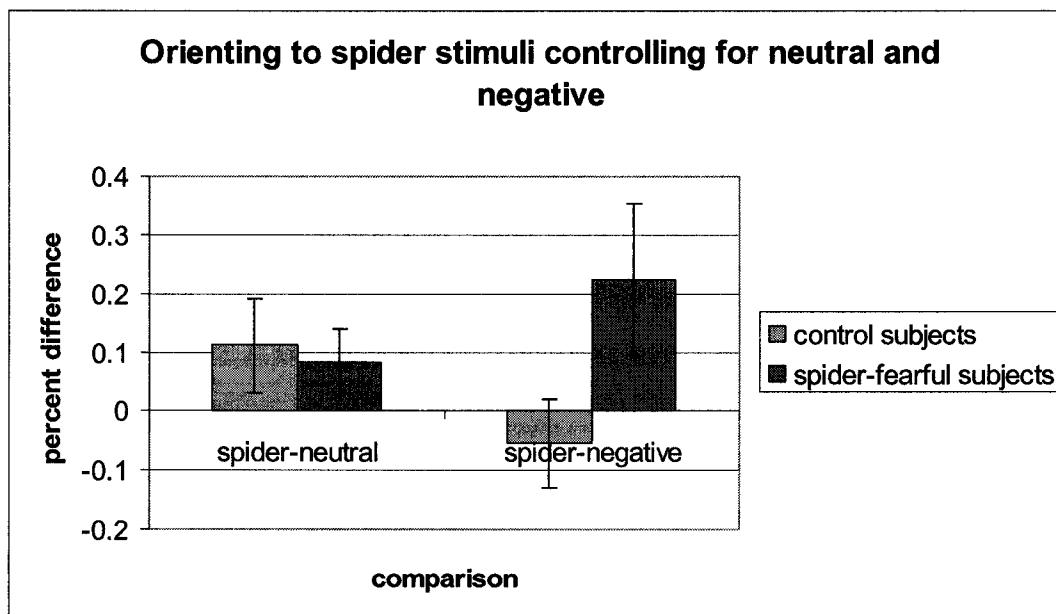


Figure 18. Experiment 2. Orienting effect for spider stimuli controlling for neutral (frog) and negative (snake) stimuli.

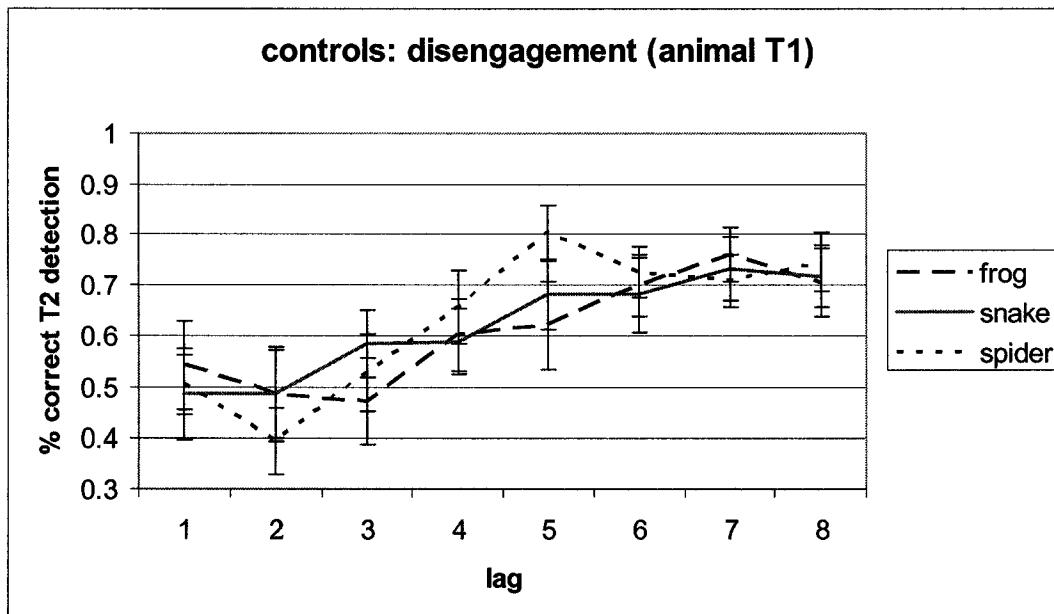


Figure 19. Experiment 2. Basic disengagement blink curve for control participants with animal stimuli in T1 position.

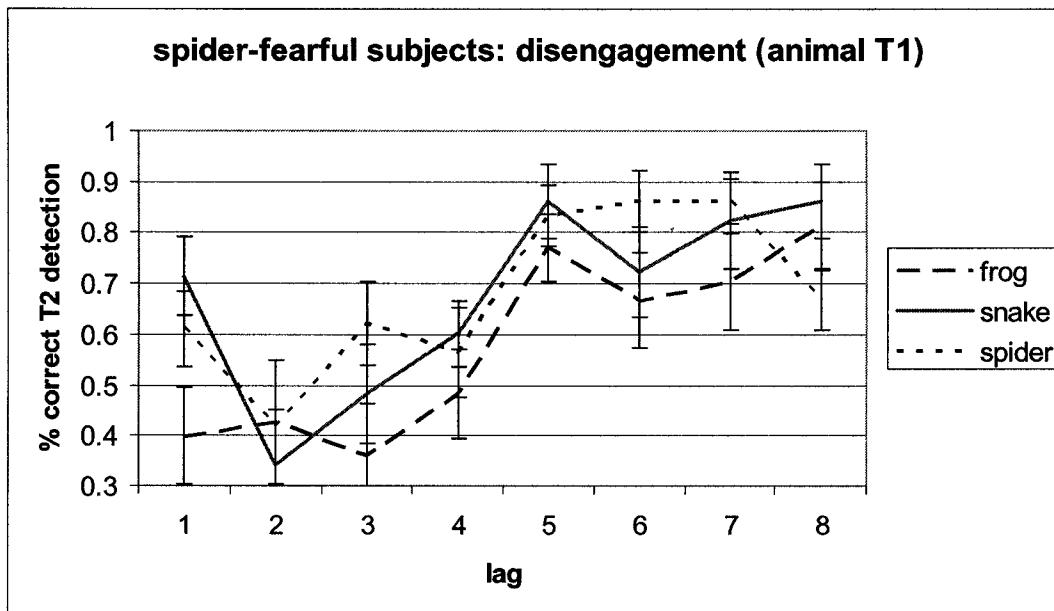


Figure 20. Experiment 2. Basic disengagement blink curve for spider-phobic participants with animal stimuli in T1 position.

Disengagement

A three-way repeated measures ANOVA with Group as the between-subjects factor, Stimulus Type and Lag as within-subjects factors, and percent correct T2 identification as the dependent variable, revealed a significant main effect of Lag, $F(7,175) = 18.76, p < .001, \eta^2 = .429$ (see Figures 19 & 20). There also was a significant main effect of Stimulus Type, $F(2,50) = 3.58, p = .035, \eta^2 = .125$. There were no significant interactions of Group by Stimulus Type, $F(2,50) = 1.88, p = .163, \eta^2 = .070$, or Lag by Stimulus Type, $F(14,350) = .832, p = .635, \eta^2 = .032$. The Group x Stimulus Type x Lag three-way interaction also was not significant, $F(14,350) = 1.19, p = .275, \eta^2 = .046$.

Again, the basic blink data are important for ensuring that the experiment is measuring the blink effect, although the basic blink effect is not the measurement of greatest interest. I was most interested in the disengagement effect from phobia-relevant stimuli, controlling for the baseline disengagement effect from neutral (frog) stimuli and negative (snake) stimuli. I therefore looked at the difference between the magnitude of the disengagement effect for spider stimuli and the magnitude of the disengagement effect for snake and frog stimuli at lag 2, or the lag most likely to show the effect (see Figure 21). There were no significant group differences between spider-fearful participants ($M = .01, SD = .45$) and control participants ($M = .09, SD = .33$), $t(25) = .554, p = .585, d = .20$, for comparison of disengagement from spider stimuli controlling for neutral stimuli. There also were no significant differences between spider-fearful participants ($M = -.07, SD = .52$) and control participants ($M = .09, SD = .38$), $t(25) = .949, p = .35, d = .35$, for the comparison of disengagement from spider stimuli controlling for negative (snake) stimuli.

Single Task Blocks

I included single-task (i.e., no identification of T1) blocks to determine whether participants were able to detect T2 stimuli without the added demand of the T1 identification task. Differential performance for a particular stimulus type might indicate difficulties with stimulus detection that are featural rather than attributable to threat-relevance or valence. Consistent with expectations, participants' single-task data did not show a blink pattern; participants showed a high percentage of correct identification of single-task targets (T2) when T1 identification was not required.

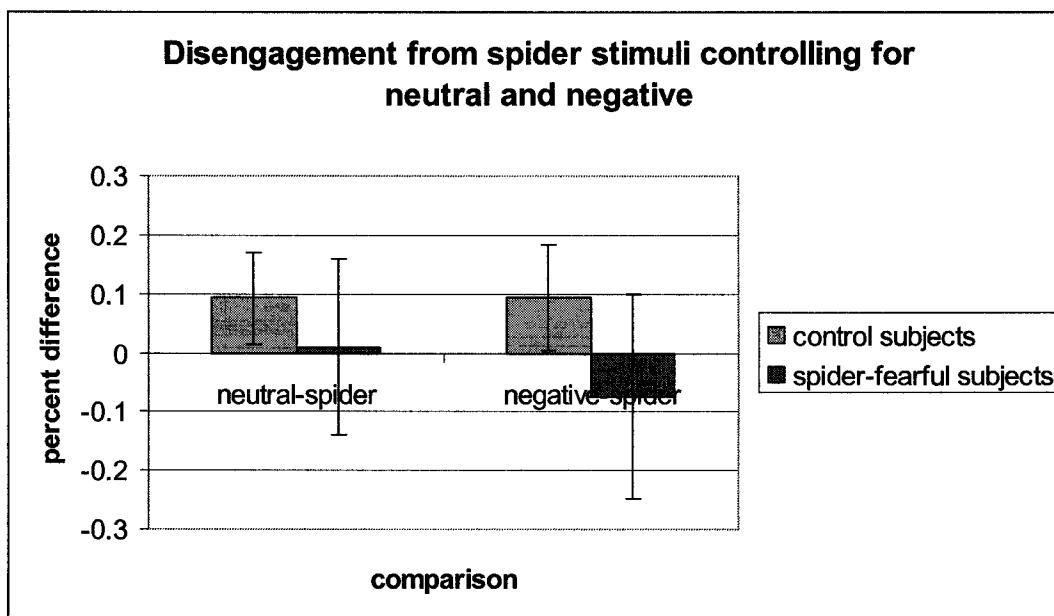


Figure 21. Experiment 2. Disengagement effect for spider stimuli controlling for neutral (frog) and negative (snake) stimuli.

Experiment 2 Discussion

The hypotheses of enhanced temporal orienting of attention and difficulty with temporal disengagement from phobia-relevant stimuli in fearful participants compared to non-fearful controls were not supported. For spider-fearful participants, there was a non-significant trend toward enhanced orienting toward spider stimuli in the T2 position, and a non-significant trend toward enhanced orienting for spider stimuli controlling for negative stimuli. Post-hoc power analyses for these comparisons indicated that increased sample size might result in significant differences between groups for facilitated orienting toward threat-relevant stimuli, such that spider-phobic participants might experience a significantly attenuated blink when the T2 stimulus is a spider. In addition to a lack of power, there also were several design problems that may have contributed to the absence of hypothesized results. Rather than increasing sample size with a potentially problematic design, I chose to correct these problems prior to further data collection.

The diagnostic difficulty with the snake-fearful group (i.e., non-phobic questionnaire and interview responses post-experiment) appeared to have been caused by the vulnerability of the snake fear measures to false-positive responding. For example, one item on the SNAQ is “When I see a snake, I feel tense and restless”. Although snake-phobic individuals almost certainly will endorse this item, so also might individuals who merely dislike snakes, but who do not experience excessive fear of them. I had hoped that the FSQ, modified for snake fear, might provide a clearer measure of snake fear due to its continuous response scale, however, it is likely that this measure also allowed frequent false-positive responding. This problem has been documented; one study that examined diagnostic issues with the SNAQ found that many individuals who report a high degree

of snake fear on the measure do not show commensurate fear on behavioral avoidance tasks (Klieger & Siejak, 1997). Such an absence of fear in the presence of a live snake is inconsistent with a diagnosis of snake phobia. Many researchers utilize this measure to select high snake-fear participants, although the argument can be made that conservative cutoffs (i.e., 85th percentile) are more likely to exclude false-positive response profiles. The snake-fearful participants for the present study also were not those who reported the highest degree of snake fear on the pre-screening measure, as those individuals often also reported the exclusionary criterion of moderate or high spider fear. As noted earlier, the spider-fearful participants also were not those who reported the highest levels of spider fear, although they reported phobic levels of spider fear during the post-experiment interview.

Spider-fearful participants reported significantly higher levels of state anxiety than control participants following the experimental task. Although conclusions cannot be drawn based on these data due to the lack of power in Experiment 2, this variable might point to a need to control for state anxiety in further work. On the other hand, it may be the case that phobic participants only exhibit problematic attentional processing when experiencing state anxiety.

Participants' T2 identification performance in orienting blocks was quite high for all T2 stimulus types, which indicates a potential design problem. Prior research shows that the basic blink effect results in considerably depressed detection of T2 stimuli following T1 identification. Given the research showing that unselected participants exhibit an attenuated blink when negative information is in the T2 position (e.g., Anderson & Phelps, 2001), one argument for the enhanced orienting performance in

Experiment 2 might be that all participants preferentially detect threatening animals at T2. This explanation follows from the notion of preparedness; humans are thought to be hard-wired to perceive dangerous animals as negative (Ohman & Mineka, 2001). Were this the case, T2 detection of frog stimuli should be worse than T2 detection of spider and snake stimuli. The data do not fully support this explanation; although performance with frog stimuli at T2 appeared to be worse than performance for snake and spider stimuli at T2, the differences were not significant. An alternate, more likely, explanation is the existence of a ceiling effect. That is, if the orienting blocks were too easy, spider-fearful participants would not have room to display enhanced orienting to their feared animal. The trend toward enhanced orienting to spider stimuli for spider-fearful participants supports the notion that a ceiling effect must be ruled out.

In contrast to performance on the orienting blocks, performance at the 200ms lag (i.e., the lag most likely to show the blink effect) on the disengagement blocks was below chance. Although no differences were found within or between groups for disengagement from the three stimulus types, these findings may reflect a floor effect. It follows that fearful participants do not have room to show more difficulty disengaging from their fear-relevant stimuli at T1. Modifications to decrease the difficulty of these blocks would eliminate the floor effect explanation for the observed null findings.

Experiment 3

Experiment 3 had two overarching aims. Aim 1 was to address the design limitations of Experiment 2. To achieve this aim, I made five key design modifications. First, I increased the contrast between distractor items and target items in order to eliminate the

floor effect found in the disengagement condition of Experiment 2. I accomplished this by replacing some of the distractor stimuli (i.e., brightly colored plants and flowers) with more homogenous distractor stimuli (i.e., trees) so that the target animal and fruit stimuli would be more easily detected. Second, I increased the difficulty of the orienting trial blocks to eliminate the ceiling effect found in Experiment 2; I reduced stimulus presentation time from 100ms SOA to 70ms SOA. Third, I decreased the number of lags, or positions between T1 and T2, from eight to three; I focused on the lags most likely to show the effect (i.e., 200-300ms after T1) (e.g., Shapiro, Raymond, & Arnell, 1994), and one later lag as a measure of return to baseline performance following the blink period. This increases power, as each participant completes more trials at each lag. Fourth, I excluded snake-fearful participants from the design; the diagnostic difficulties observed with Experiment 2 were likely to occur again in Experiment 3, obscuring clean results. I retained snake stimuli in the study as a negative, non-phobic stimulus type. Finally, I eliminated the single-task control blocks, as single-task performance was not relevant to the critical comparisons. Aim 2 was the same as in of Experiment 2: to examine the orienting of temporal attention to and difficulty with temporal disengagement from phobia-relevant information in spider phobics compared to non-fearful controls.

Method

Participants

For this preliminary study, participants were 4 spider phobics and 9 non-fearful controls who were recruited through the Yale University undergraduate introductory psychology subject pool. Participants were pre-screened as in Experiment 2, using a subset of questions from the Fear of Spiders Questionnaire and the Snake Anxiety Questionnaire.

Pre-screen items and cutoff scores were the same as those used for Experiment 1. Eligible fear-group participants scored high on spider fear but low on snake fear, and eligible control participants scored low on both snake and spider fear. Participants received course credit for the 75-minute experiment. There were no differences between groups on demographic variables (see Table 9).

Data were excluded for one spider-phobic participant due to an excessively low T1 accuracy rate (i.e., 48%) and an inflated false-alarm rate (i.e., 42% rate of reporting detection of T2 on T2-absent trials). This participant's T1 accuracy rate was below chance, which was grounds for automatic exclusion. Even with an A' transformation to adjust the performance data for false alarm rates, data with T1 identification below chance may reflect random responding.

Table 9.

Experiment 3 Demographic Data

	Controls (n=9)	Spider-phobic (n=4)
Age	21.7 (1.9)	18.3 (.5)
Gender		
Male	3 (33%)	1 (25%)
Female	6 (67%)	3 (75%)
Ethnicity		
White	8 (88%)	3 (75%)
African-American	1 (12%)	0 (0%)
Latino/a	0 (0%)	1 (.25%)

Procedure

Participants completed two 10-trial practice blocks plus two orienting blocks of 108 trials and two disengagement blocks of 108 trials, for a total of 452 total trials of the RSVP paradigm. As outlined earlier, several design modifications were made, although the procedure was similar to that of Experiment 2. For both block types, distractor stimuli were more homogenous, and the reduction in number of lags resulted in 12 trials per stimulus type, per lag.

Orienting blocks

Participants completed two orienting blocks. The blocks were identical to those of Experiment 2, with two exceptions. First, the distractor stimuli were more homogenous,

and, second, stimuli within each stream were presented for 70 ms to decrease performance. Fruit stimuli appeared at T1, and animal stimuli appeared at T2; participants were asked to identify the fruit and indicate the presence or absence of the animal.

Disengagement blocks

Participants completed two disengagement blocks. These blocks also were identical to those of Experiment 2, with one exception. The enhanced homogeneity of the distractor stimuli increased their contrast with the target stimuli, increasing performance on these blocks. Animal stimuli appeared at T1, and fruit stimuli appeared at T2; participants identified the animal and indicated the presence or absence of the fruit.

Questionnaire/Interview measures

Participants completed the same battery of self-report and interview measures as in Experiment 2.

Results

T1 Performance

Independent samples t-tests revealed no significant differences in overall T1 identification accuracy between control ($M=.89$, $SD=.04$) and spider-phobic ($M=.88$, $SD=.05$) groups, or for any of the four T1 stimulus types. Accuracy rates by T1 stimulus type are presented in Table 10. These results indicate that both groups attended to the T1 task and performed equally well, correctly identifying T1 stimuli in just under 90% of trials. It is reasonable to assume that T1 stimuli were identifiable, and that T2 detection reflected processing of T2 stimuli given attention to T1 stimuli. Participants were attending to the T1 stimuli. In general, participants in both groups appeared to have more

difficulty identifying fruit stimuli in the T1 position compared to animal stimuli. This is likely because fruit were the T1 stimuli in the facilitation blocks, in which all stimuli were presented at a faster rate. Participants also appeared to have more difficulty identifying frog stimuli in the T1 position compared to snake and spider stimuli.

Table 10.

Experiment 2 First target identification accuracy by stimulus type

	<u>Disengagement</u>			<u>Orienting</u>	
	Frog T1	Spider T1	Snake T1	Fruit T1	Mean
Control	.92 (.27)	.97 (.16)	.94 (.24)	.83 (.38)	.89 (.26)
Spider-phobic	.87 (.34)	.98 (.28)	.95 (.28)	.82 (.38)	.88 (.32)
Mean accuracy	.90 (.31)	.98 (.22)	.95 (.26)	.83 (.38)	.89 (.29)

Note. No significant group differences within block types.

T2 Performance

The critical data for this study were participants' T2 detection rates, or their ability to correctly detect the T2 stimulus given correct identification of the T1 stimulus. I excluded from the analysis all trials in which participants did not accurately identify T1, because inaccurate identification of T1 might reflect inattention to the T1 stimulus. By definition, the attentional blink requires attention to T1, in order to assess difficulty processing subsequent stimuli. In addition, participant data were examined for excessive (i.e., above chance) false alarm rates, or reporting T2 present on T2-absent trials. Several participants in Experiment 2 had relatively high false alarm rates, therefore the

instructions for Experiment 3 were altered to emphasize the importance of reporting the presence of the T2 stimulus only when certain it was present (see Appendix J for instructions). In Experiment 3, no participants were excluded due to false-alarm rate. False-alarm rates were higher for the spider-fearful group, although, with the exception of a lesser tendency to false-alarm following spider stimuli, they did not vary by stimulus type within blocks (see Table 11).

Table 11.

Experiment 3 Percentage T2 False-Alarm rates.

T1 stimulus type	Controls	Spider-phobic
Disengagement block		
Frog	3 (18)	6 (24)
Snake	3 (18)	7 (25)
Spider	3 (16)	4 (31)
Orienting block		
Fruit	6 (23)	15 (36)

Note. Mean percentage (*SD*).

Orienting

Participants' percent correct detection of T2 animal stimuli followed the typical blink pattern (see Figures 22 & 23). The lowest T2 performance for this block was at lag 3, or 210 ms, ($M=.57$, $SD=.23$). Although the SOAs for the orienting blocks in the present study were faster (i.e., 70 ms per stimulus) than those of Experiment 1 (i.e., 100

ms per stimulus), the blink effect still should be most obvious at approximately the same temporal position as that of Experiment 1 (i.e., 200 ms). Better average T2 detection performance at lag 2 ($M=.65$, $SD=.15$), and lag 8 ($M=.72$, $SD=.10$) compared to performance at lag 3 would support the evidence of a blink at lag 3.

A two-way repeated measures ANOVA with Group as the between-subjects factor, Lag as the within-subjects factor, and correct detection of T2 as the dependent variable, revealed no significant main effect of Lag, $F(2,22)=1.52$, $p=.242$, $\eta^2 = .121$, indicating the potential absence of the basic blink effect across groups. There also was no significant main effect of Group, $F(1,11)= 4.72$, $p=.053$, $\eta^2 = .300$. Observed power for this comparison was low, at .288. However, there was a significant interaction of Group by Lag in the expected direction, $F(2,22)=3.07$, $p=.034$, one-tailed, $\eta^2 = .218$, indicating that the absence of a statistically significant basic blink effect across groups may have been due to a “reverse” blink effect for one group (i.e., *better* performance at the lag most likely to show the effect).

A three-way repeated measures ANOVA with Group as the between-subjects factor, Stimulus Type and Lag as within-subjects factors, and percent correct T2 detection as the dependent variable, revealed a significant main effect of Stimulus Type, $F(2,22)=25.66$, $p<.001$, $\eta^2 = .700$; and a significant Stimulus Type by Group interaction, $F(2,22)=9.59$, $p=.001$, $\eta^2 = .466$ (see Figures 21 & 22). There was no significant interaction of Stimulus Type by Lag, $F(4,44)=.234$, $p=.918$, $\eta^2 = .021$; or Stimulus Type x Lag x Group, $F(4,44)=1.12$, $p=.36$, $\eta^2 = .092$.

The basic blink effect was most obvious for control participants at 210ms, or lag 3, which is consistent with the literature. Consistent with the hypothesis of an attenuated

blink in spider-phobics, this pattern was inverted for spider-phobic participants, indicating facilitated orienting of attention at lag 3. Follow-up t-tests showed that one basic blink magnitude differed significantly between groups. At lag 3, spider-phobic participants showed enhanced orienting of attention toward spider stimuli at T2 ($M=.94$, $SD=.09$), compared to control participants ($M=.39$, $SD=.31$), $t(11) = 3.4$, $p=.001$, $d=2.41$.

The basic blink data are important for ensuring that the experiment is measuring the blink effect. However, the basic blink effect is not the comparison of most interest; we are interested in the orienting effect toward phobia-relevant stimuli, controlling for the baseline blink effect to neutral (frog) stimuli and the blink effect to negative (snake) stimuli. I therefore looked at the difference between the magnitude of the blink effect for spider stimuli and the magnitude of the blink effect for snake and frog stimuli.

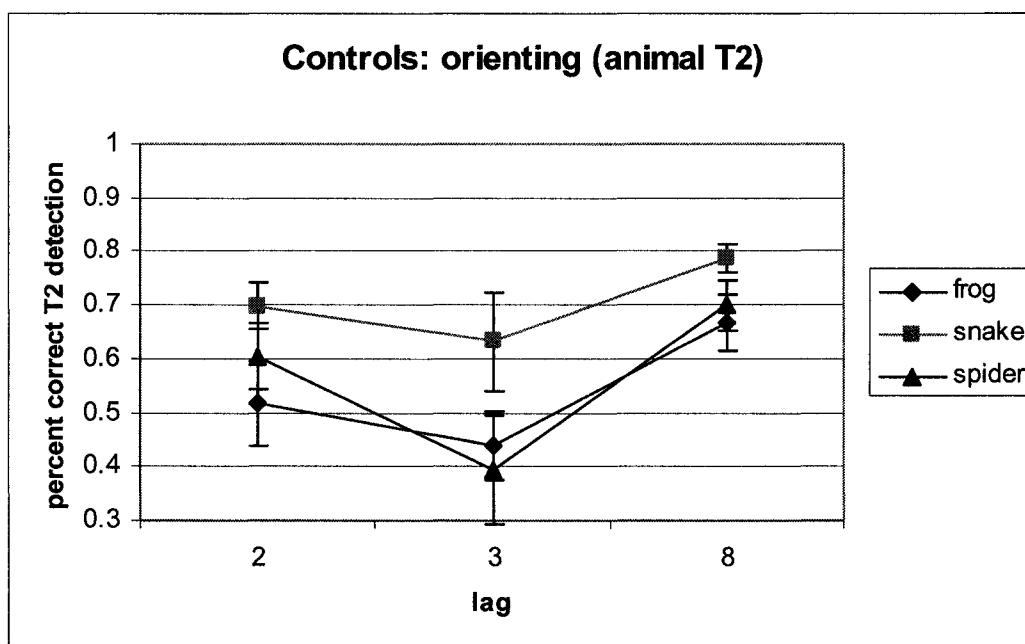


Figure 22. Experiment 3. Temporal orienting of attention to threat stimuli in the T2 position by T2 stimulus type. Control participants show no facilitated orientating of attention to spider and frog stimuli at the lag 3. Control participants show moderately enhanced orienting of attention to snake stimuli.

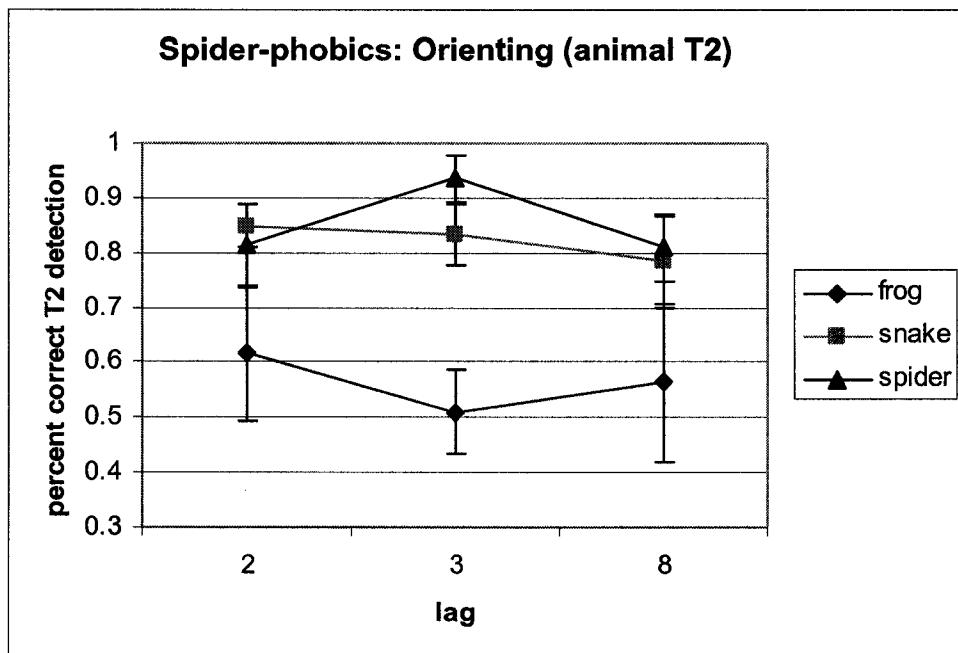


Figure 23. Experiment 3. Temporal orienting of attention to threat stimuli in the T2 position by T2 stimulus type. Spider phobic participants show enhanced orienting of attention to spider stimuli and snake stimuli at lag 3.

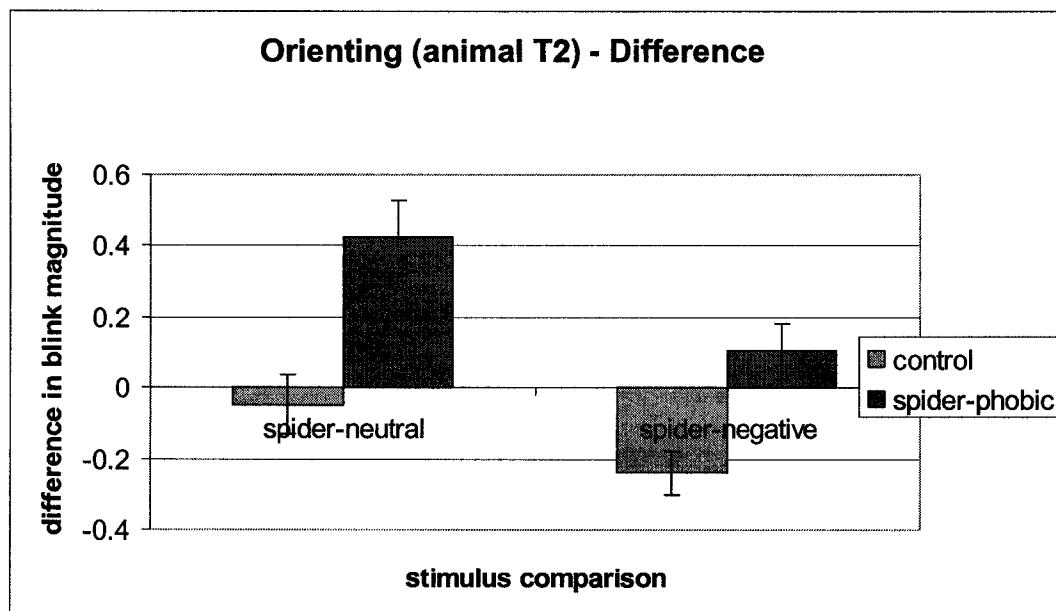


Figure 24. Experiment 3. Difference in magnitude of orienting effect for spider stimuli minus neutral stimuli and negative stimuli.

The preliminary data showed no significant differences between orienting to spider stimuli and snake or frog stimuli at lags other than lag 3 (210ms). At lag 3, spider phobic participants ($M=.42$, $SD=.20$) showed a significantly enhanced orienting to spider stimuli controlling for neutral stimuli than did control participants ($M=-.05$, $SD=.25$), $t(11) = -3.29$, $p=.007$. $d=2.07$ (see Figure 24). Spider-phobic participants ($M=.10$, $SD=.16$) also had a significantly greater orienting effect for spider stimuli controlling for negative stimuli than did control participants ($M=-.24$, $SD=.18$), $t(11) = 3.24$, $p=.008$., $d=1.99$. The orienting effect was in the reverse direction for control participants; control participants showed enhanced orienting to neutral and snake stimuli compared to spider stimuli.

Disengagement

Participants' percent-correct detection of T2 fruit stimuli given animal T1 stimuli followed the typical blink pattern. A two-way ANOVA with Group as the between-subjects factor, Lag as the within-subjects factor, and percent correct T2 detection across stimulus types as the dependent variable revealed a significant main effect of lag, $F(2,22) = 26.12$, $p<.001$, $\eta^2 = .704$. A within-subjects contrast revealed a linear trend for lag $F(1,11) = 41.55$, $p<.001$, $\eta^2 = .791$. This pattern reflects the prototypical attentional blink; the effect was most obvious at 200 ms, or lag 2 ($M=.58$, $SD=.19$), and performance improved as T2 distance from T1 increased; this was apparent in the improvement in lag 3 performance ($M=.69$, $SD=.16$) and lag 6 performance ($M=.85$, $SD=.08$). The between-subjects Group effect was not significant, $F(1,11) = .446$, $p=.518$, $\eta^2 = .039$.

A three-way repeated measures ANOVA with Group as the between-subjects factor, Stimulus Type and Lag as within-subjects factors, and T2 performance as the

dependent variable, revealed no significant differences of Stimulus Type, $F(2,22) = 2.512, p=.104, \eta^2 = .186$. There was a significant interaction of Group by Stimulus Type in the expected direction, $F(2,22) = 3.37, p=.027$, one-tailed, $\eta^2 = .235$ (see Figures 25 & 26), indicating that spider-phobic participants exhibited a greater attentional blink effect for spider stimuli compared to snake and frog stimuli.

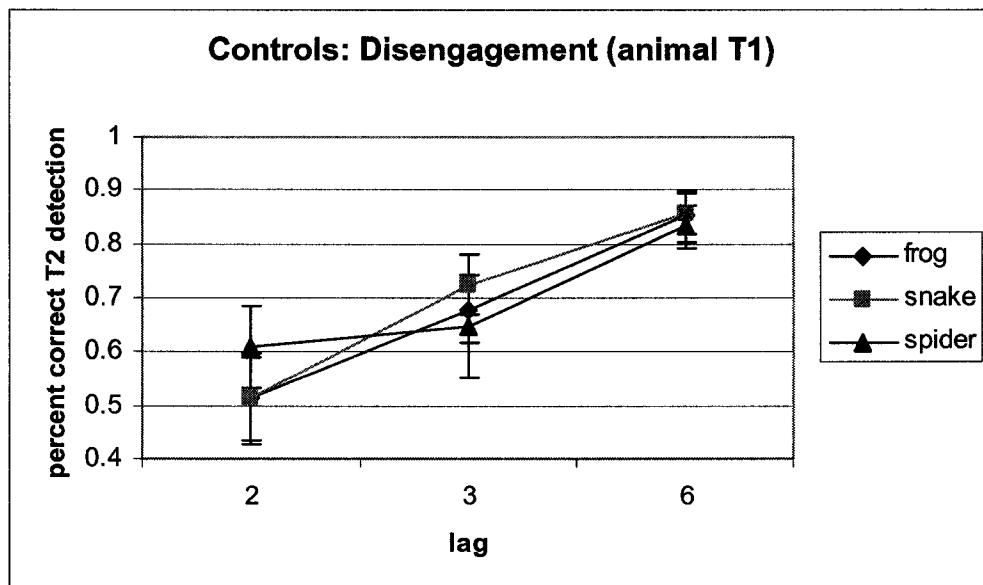


Figure 25. Experiment 3. Temporal disengagement from animal T1; control participants show no differences in disengagement by stimulus type.

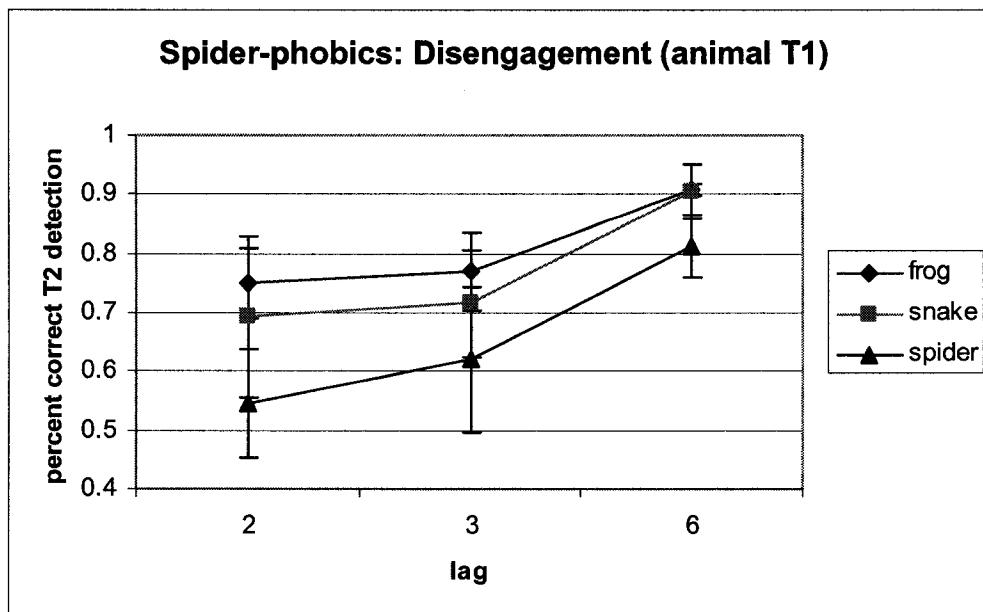


Figure 26. Experiment 3. Temporal disengagement from animal T1; spider-phobic participants show greater difficulty disengaging from spider stimuli at T1.

Again, the basic blink data are important for ensuring that the experiment is measuring the blink effect, although the basic blink effect is not the measurement of most interest. We are interested in the disengagement effect from phobia-relevant stimuli, controlling for the baseline disengagement effect from neutral (frog) stimuli and negative (snake) stimuli. I therefore looked at the difference between the magnitude of the disengagement effect between stimulus types.

The preliminary data show no significant differences between disengagement from spider stimuli and snake or frog stimuli at lags other than lag 2 (200 ms), therefore this lag was used for the analysis. At lag 2, spider phobic participants ($M=.20$, $SD=.18$) showed significantly greater difficulty disengaging from spider stimuli controlling for neutral stimuli than did control participants ($M=-.10$, $SD=.23$), $t(11) = -2.31$, $p=.041$, $d=1.45$ (see Figure 27). Spider-phobic participants ($M=.15$, $SD=.37$) did not show significantly greater difficulty disengaging from spider stimuli controlling for negative stimuli than control participants ($M=-.10$, $SD=.21$), $t(11) = -1.59$, $p=.139$, $d=.83$. Post-hoc power for this comparison is low, at .28, although the effect size is large, which indicates possible Type II error. Power was influenced by the extreme response times for one spider-fearful participant, which resulted in large standard deviations in this preliminary sample. The disengagement effect was in the reverse direction for control participants; control participants showed less difficulty disengaging from spider and snake stimuli compared to neutral stimuli.

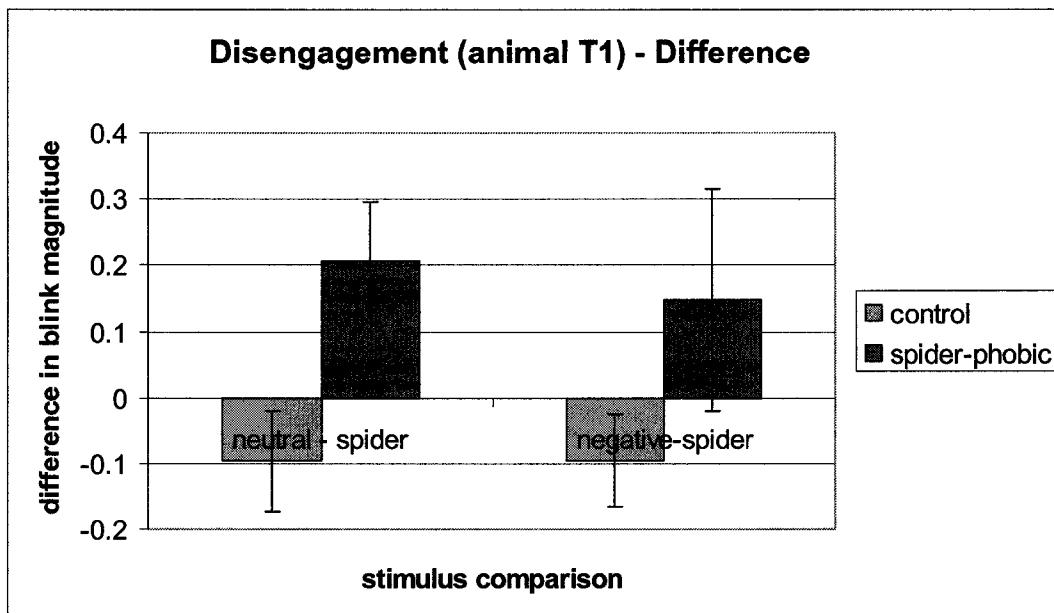


Figure 27. Experiment 3. Difficulty disengaging from spider stimuli controlling for (subtracting) negative and neutral blink effects. Standard error for spider-phobic participants' mean, controlling for negative valence, is driven by one participant's unusual scores (i.e., greater difficulty with disengagement from snake-stimuli relative to spider-stimuli) in this block. This participant also self-reported greater snake-fear than other spider-phobic participants on questionnaire measures.

Questionnaire/Interview Data

Participants' scores on questionnaire measures are summarized in Table 12.

Control participants' scores on the two spider fear measures were significantly different from those of spider-phobic participants. On the Fear of Spiders Questionnaire, spider-phobic participants scored significantly higher ($M=82.3$, $SD=21.8$) than control participants ($M=7.7$, $SD=5.0$), $t(11) = 10.2$, $p=.006$. Spider-phobic participants also scored significantly higher ($M=6.3$, $SD=1.7$) than control participants ($M=1.0$, $SD=.87$) on the Fear Questionnaire item of spider fear, $t(11) = 7.5$, $p=.000$. Spider-phobic participants ($M=4.5$, $SD=2.6$) also reported a higher degree of fear than controls ($M=1.4$, $SD=1.1$) on the Fear Questionnaire severity item, and the one-tailed t-test was significant, $t(11) = 3.0$, $p=.05$. On measures of snake fear, spider-phobic participants were not

significantly different from control participants, and the groups also did not differ significantly on state anxiety (STAI-S) measures or depression (BDI-II) measures following the experimental tasks. Although phobic participants reported more state anxiety and symptoms of depression than control participants, it is unlikely that the results

were attributable to those symptoms, as high scores for phobic participants were in the mild range for state anxiety and symptoms of depression.

None of the control or spider-phobic participants self-reported clinical levels of depression or psychotic symptoms on SCID interview questions following the experimental task. None of the control participants reported clinical levels of current or lifetime snake or spider fear during the interview. All four phobic participants reported clinical levels of spider fear (e.g., having had intense fear of spiders their entire lives), and denied clinical levels of snake fear during the interview.

Table 12

Experiment 3 Questionnaire Data

Measure	Controls (n=9)		Spider-phobic (n=4)	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
FSQ	7.7	(5.0)*	82.3 (21.8)*	
FQ-spider fear	1.0	(0.9)*	6.3	(1.7)*
SNAQ	5.1	(2.5)	7.0	(6.4)
FSQ-snake modified	25.2	(18.1)	39.7 (26.6)	
FQ-snake	1.7	(0.9)	2.3	(2.1)
FQ-severity	1.4	(1.1)**	4.5	(2.6)**
STAI-S	33.6	(7.3)	41.8 (13.7)	
BDI-II	5.0	(2.5)	8.7	(5.0)

Note. FSQ = Fear of Spiders Questionnaire and FSQ items modified for snake fear; scores range from 0-108. FQ items = Fear Questionnaire items scored from 0-8. SNAQ = Snake Anxiety Questionnaire; scores range from 0-30.

*p<.01. **p=.05, one-tailed.

Experiment 3 Discussion

The design modifications in Experiment 3 corrected several problems from Experiment 2. T2 detection performance decreased in the orienting blocks at the faster SOA, and T2 detection performance improved in the disengagement blocks with increased contrast between distractors and targets. T1 accuracy was acceptable for both block types. It appears likely that the design modifications increased the validity of the inferences drawn from performance on this paradigm.

The data provide preliminary support for the hypotheses that phobic participants show (1) more difficulty disengaging temporally from threat-relevant stimuli; and (2) enhanced orienting of temporal attention to their threat-relevant stimuli. Of particular interest is the finding that the within- and between- group differences in orienting to spider stimuli appear to be phobia-specific. The analysis of spider-stimulus orienting effects controlling for neutral (frog) and negative (snake) stimulus effects provides compelling evidence that spider phobics' attentional processing of phobic stimuli might be unique. This implies that, consistent with expectations, the difference between the blink magnitudes for spider stimuli and neutral stimuli in both orienting and disengagement blocks may not provide the cleanest measure of attentional processing of threat-relevance. The addition of a negative, non-threat stimulus category provides a necessary control for the measurement of preferential attentional processing of threat-relevant information beyond processing of negative information. The finding suggests a particularly robust effect, particularly as the sample size for this preliminary study is small. It appears clear that individuals with phobias do experience involuntarily facilitated temporal orienting of attention to threat. The disengagement effect, controlling

for negative valence, was not significant, although the effect size was large. It may be that individuals with phobias do not experience more difficulty disengaging from threat, although it seems more likely that the absence of an effect is due to inadequate sample size.

General Discussion

The current work makes three unique contributions to the literature in attention and anxiety. First, the preliminary data suggest that specific phobia may be characterized by (1) difficulty with spatial disengagement from threat-relevant information; (2) enhanced temporal orienting of attention to threat that is incrementally greater than temporal orienting of attention to negative valence; and (3) potential difficulty with temporal disengagement of attention from threat. Second, the present work provides behavioral data that converge with recent research implicating deficits in inhibitory control of threat-relevant information in anxious individuals. Finally, this work represents the successful initial translation of contemporary theory and methods from vision science for the study of attentional processing in clinical disorder.

Attentional Processing in Specific Phobia

Experiment 1 examined of the subcomponents of attention using the cueing paradigm. The findings suggest that specific phobia is *not* characterized by enhanced spatial orienting of attention to phobia-relevant stimuli. This finding is consistent with a small amount of recent research in the area of attention and anxiety using paradigms that distinguish between the subcomponents of attentional processing (e.g., Fox, Russo, Bowles, & Dutton, 2001). Also consistent with expectations and the literature in anxiety,

the results provide evidence that individuals with specific phobia experience difficulty with spatial disengagement from phobia-relevant stimuli. This effect also appears to be independent of difficulty with disengagement from negatively-valenced stimuli. These findings also represent the first use of this spatial paradigm with photo stimuli and a clinical population.

The results of the current work also show that individuals with specific phobia attend differently to their feared stimuli temporally when compared to non-fearful individuals. Experiment 3 provides preliminary evidence that spider-phobic individuals experience significantly enhanced temporal orienting of attention to phobia-relevant stimuli. This effect cannot be attributed to stimulus effects (e.g., spider stimuli easier to see), as non-fearful control participants did not show the same degree of orienting to the same stimuli. The effect also cannot be attributed to negative stimulus valence; spider-phobic participants displayed significantly enhanced orienting of attention to threat-relevant stimuli than to negative, non-threat stimuli. It therefore is likely that this preliminary finding reflects uniquely enhanced temporal orienting of attention to phobic stimuli in phobic participants. It is possible that this differential processing of threat-relevant stimuli has a significant role in the onset and maintenance of symptoms of phobia, as facilitated orienting of attention to threat-information clearly interrupts concurrent processing of other, potentially important, tasks.

The preliminary data also suggest that individuals with specific phobia may experience greater difficulty with temporal disengagement of attention from phobic stimuli. Experiment 3 indicates that phobic participants experience significantly greater difficulty disengaging from spider-stimuli compared to neutral stimuli, whereas non-

fearful controls do not. Again this effect cannot be attributed to stimulus differences. A negative valence effect cannot be ruled out based on these data; there were no significant group differences in disengagement from phobic stimuli controlling for negative stimuli. However, this absence of a significant effect may be driven by the data from one spider-phobic participant who also self-reported higher snake-fear than other spider-phobic participants, such that this participant showed greater difficulty disengaging from snake stimuli. A larger sample size will be necessary to determine whether the disengagement effect is phobic stimulus-specific, rather than attributable to negative valence.

The finding that individuals with specific phobia appear to experience enhanced orienting of attention to threat temporally, but not spatially, is interesting from a clinical perspective. Phobia and the other anxiety disorders often are characterized by scanning behaviors, as when an individual with spider phobia checks a room for spiders upon entering. Such scanning is a voluntary, goal-directed behavior that is motivated by a desire to avoid being surprised by threat. The present results show that spatial orienting of attention to phobia-relevant stimuli, such as spiders, is not enhanced in phobic individuals. It seems possible, therefore, that there is an interaction of goal-directed behavior (i.e., scanning), and lower level stimulus attributes during detection of threat. The purposeful scanning behavior may be more likely to result in enhanced temporal orienting once attention has been spatially directed to a particular location. Once his attention is directed to a windowsill, for example, a spider phobic might have his attention captured by a small dark shape with legs faster than a non-phobic. Should this be the case, it may be that teaching phobics to reduce scanning behaviors may be as useful as exposure to the threat-relevant stimulus. Exposure-based therapies that were

developed from the principles of learning (i.e., habituation to threat) are the gold-standard treatment for phobia, and they are highly effective (Antony & Barlow, 1998). We do not yet know whether exposure allows individuals to disengage more effectively, or to inhibit orienting behavior. Should the same pattern of spatial and temporal allocation of attention be found in other anxiety disorders, such as PTSD, the clinical utility could be considerable. Combat-related PTSD, for example, often is characterized by excessive scanning behaviors that are overlearned during the combat tour. Helping patients reduce their scanning behavior may be helpful in reducing the number of accessible problematic visual stimuli. The parsing of disengagement versus orienting of attention also might help discern whether individuals with anxiety experience symptoms as a result of threat stimulus detection versus continued processing of the lingering representations of such stimuli.

Implications for the Role of Cognitive Control in Anxiety

The present work provides interesting converging evidence for the role of inhibitory control of attentional processing of threat-relevant information in anxiety. The current behavioral evidence suggests that individuals with phobia, and, by extension, individuals with other anxiety disorders, may experience decreased executive functioning when attending to threat-relevant stimuli. Researchers recently have debated whether threat information can be detected without attention (e.g., Vuilleumier, Armony, Driver, & Dolan, 2001), or whether even minimal attentional resources are required for threat detection (Anderson, Christoff, Panitz, DeRosa, & Gabrieli, 2003; Bishop, Duncan, & Lawrence, 2004; Pessoa, Kastner, & Ungerleider, 2002, 2003). The most recent findings highlight the notion that some degree of attention is required for amygdala activation,

which is generally accepted as the brain's gateway for emotional processing (e.g., Carlsson, Petersson, Lundqvist, Karlsson, Ingvar, & Ohman, 2004). The evidence suggests that participation in a task that requires significant attentional resources precludes attention to and amygdala activation in response to non-task-relevant threat information (e.g., Pessoa et al., 2003, 2003). Neuroscientists who have conducted examinations of differential processing of threat have addressed individual differences in the degree to which anxiety status affects the initial amygdala response, as well as the degree to which pre-frontal functioning (i.e., executive control) is impaired. For example, one fMRI study examined the moderating role of state anxiety in pre-frontal activation to threat stimuli, and found that state anxiety is associated with reduced recruitment of executive control areas (i.e., lateral pre-frontal cortex and rostral anterior cingulate cortex) in the presence of task-irrelevant stimuli (Bishop, Duncan, Brett, & Lawrence, 2004). These results provide strong support for the notion that individuals experience decreased cognitive control over attentional processing of threat when in an anxious state.

In addition, an elegant recent positron emission tomography (PET) study compared snake and spider phobics' amygdala and pre-frontal cortex (PFC) activation to their phobic stimuli (e.g., spider stimuli to spider phobic), to non-phobic fear stimuli (e.g., snake stimuli to spider phobic), and to neutral stimuli. They found initial amygdala activation for both phobic and non-phobic fear stimuli at very short durations (i.e., 14 ms presentation followed immediately by 56 ms mask), indicating activation of the threat-detection system. At a longer duration, (i.e., after a 14 ms presentation, 294 ms blank, 56 ms mask) amygdala activation persisted, and recruitment of other affective areas occurred *only* for phobic stimuli. In contrast, at the longer duration, there was evidence of

recruitment of executive control areas (e.g., right PFC, dorsolateral prefrontal cortex) for non-phobic fear stimuli, but *deactivation* of these areas for phobic stimuli. This pattern of results suggests that state anxiety is not the only moderating variable. It is likely that phobic individuals experienced some degree of anxiety during the entire task, as they were viewing their phobic stimuli intermittently; the pattern of persistent affective processing (i.e., amygdala activation) only for their phobic stimuli provides evidence that the results cannot be attributed to state anxiety.

In light of this work, the present behavioral studies appear to provide converging evidence for reduced cognitive control over attentional processing of threat. The PET and fMRI data suggest possible neural correlates of the behavioral attentional processing data. For example, the PET procedure timeline combined with the cueing and RSVP paradigm timelines sketch the possible interplay of neural and behavioral mechanisms. Although the timelines cannot be precisely compared due to differences in the methods, it appears possible that amygdala activation occurs first (14 ms), which is consistent with the notion of the amygdala as a threat sensor for perceptual information. The spatial orienting response (i.e., the cueing results), which does not appear to discriminate by threat-relevance, may occur next within the 100 – 200 ms window. Once threat-relevant information is attended, relative difficulty with disengaging temporally from that information and more efficient orienting to that information *in the same spatial location* appears to occur around 200 ms (i.e., temporal orienting in RSVP paradigm). Difficulty with spatial disengagement from threat seems to occur at approximately the same point (300 ms in cueing paradigm) at which anxious individuals experience decreased executive control (e.g., less recruitment of PFC) and continued activation of amygdala

and other affective brain areas. Together, the neuroscience and behavioral data support the notion that anxious individuals experience significant difficulty with inhibitory control of attentional processing of threat.

Translation of Contemporary Theory and Methods

The current work also provides evidence that the cue validity and the RSVP paradigms, which have been developed by vision researchers to measure spatial and temporal allocation of attention, can be translated for the study of clinically relevant cognitive processing. These and similar paradigms are well-established in the cognitive literature for the examination of basic attentional processing, and they can be used to answer longstanding questions of interest regarding problematic processing in clinical disorders. I modified the cue validity and RSVP paradigms by replacing the original stimuli with disorder-relevant photo stimuli, and found that the cueing and blink effects could be found with the photo stimuli. The work also illustrates the need for careful attention to design parameters and systematic elimination of alternate explanations in order to be confident of the validity of the inferences drawn.

The data from Experiment 2 indicated design problems related to stimulus features and timing parameters. During the subsequent design modification phase, I systematically eliminated stimulus and timing problems. The improved design was used for Experiment 3, with greatly increased validity. The fundamental finding of group differences in the expected directions supports the notion that this and similar basic paradigms can be translated for the accurate examination of processing in clinical disorders.

The use of measurement paradigms that assess attentional processing in milliseconds prompts the question of generalizability. Measurement of attention during sudden onsets of photo stimuli represents an improvement over the use of word stimuli for the examination of attentional processing in phobia, but such improvement still may fail to approximate the experience of anxiety in the world. On the other hand, it is possible that the effects found with the relatively “safe” experimental stimuli translate to robust effects in the world when, for example, a spider-phobic individual encounters an actual spider. It also is quite likely that anxiety disorders that are associated with extreme responses to cues that may be only slightly threat-relevant, such as post-traumatic stress disorder, are characterized by responding on a timescale that is quite rapid. A related issue concerns the degree to which the behaviors participants *can* do in the experimental context translates to what they actually do in the world. These are empirical questions that should be addressed in the future.

Clinical Utility of Methods

These paradigms also have potential clinical utility for the refinement of mechanistic models of anxiety disorders. Attentional retraining procedures that utilize performance-based paradigms have received increasing emphasis recently (e.g., MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). One elegant set of studies found that an anxiety response to a subsequent stressor can be induced through the manipulation of threat stimulus presentations in the dot-probe task (Mathews & MacLeod, 2002), which the authors interpret as evidence for the causal role of attentional processing of threat information in anxiety. Several researchers have presented intriguing findings that suggest that the retraining of attentional allocation (e.g., training patients to

attend to neutral rather than negative words) can result in decreased self-reported anxiety symptoms (e.g., Rutherford, MacLeod, & Campbell, 2002). These retraining paradigms generally utilize the dot-probe paradigm, which of course is a spatial paradigm. The results of the present work suggest that the retraining paradigms actually may train patients to disengage from threat rather than orient their attention preferentially to neutral or positive information. The present results also suggest that the use of temporal paradigms in attentional retraining may tap the dimension of processing that may be most problematic in some anxiety disorders. In sum, the results of the retraining studies are promising, and it seems likely that the paradigms used in the present work not only could be used as easily, but also would provide clearer interpretation of the mechanisms of change.

Translation of Attentional Capture Model

The present work also suggests that the theoretical model of attentional capture (Yantis & Jonides, 1984), which includes the subcomponents of attentional processing, appears to be well-suited to the examination of processing in specific phobia as an instance of anxiety disorder. The attentional capture construct eliminates the ambiguity of the "bias" construct; attentional capture allows the subdivision of attentional processing into the mechanisms of (1) orienting of attention to threat; and (2) disengagement of attention from threat. The present work is the first to use the cue validity paradigm and the RSVP paradigm with photo stimuli for the study of attentional processing in clinically anxious participants. The work provides converging evidence for the recent work that uses spatial paradigms to examine the role of the subcomponents of attentional capture in anxiety (e.g., Amir et al., 2003; Fox et al., 2001). The findings from Experiment 1 extend

the prior findings that suggest that attentional processing in anxiety is characterized by difficulty with spatial disengagement from threat-relevant information, rather than enhanced orienting of attention to threat-relevant information (e.g., Amir et al., 2003; Fox et al., 2001). In contrast, the preliminary findings in the temporal domain suggest prominent temporal orienting of attention to threat, in addition to potential difficulty with disengagement. This discrepancy across attentional modalities supports the notion that the temporal/spatial distinction is important for the thorough examination of attentional processing in anxiety.

Limitations

The present work also has several limitations. First, the RSVP data are preliminary; the cells in Experiment 3 must be filled in order to more confidently outline the mechanisms of temporal attentional difficulties in specific phobia. In particular, the disengagement data suffer due to the small sample size and the disproportionate influence of one participant's outlying data. Additional participants will be recruited to address this limitation. Second, the strongest evidence for effects that are specific to phobic stimuli is the presence of a crossover effect between the means for two groups of phobic individuals, such that the negative, non-threat stimulus for one group would be the phobic stimulus for the other. For example, for spider-phobic participants, spiders are threat stimuli and snakes are negative, non-threat stimuli, whereas the reverse is true for snake-phobic participants. In the present work, the observed difficulty with the recruitment of true snake-phobic participants limits the ability to interpret the incremental blink magnitude for phobic-stimulus as a function of threat-relevance rather than low-level stimulus differences. Third, I did not assess the potential moderating role of participants'

state anxiety prior to or during the experimental tasks. It is possible that anxiety levels by group peaked differentially during the sessions and affected performance. Indeed, I hypothesize that the subcomponents of attentional processing play a role in the onset or maintenance of symptoms; it is reasonable to assume that phobic participants experienced spikes of anxiety on viewing their feared stimuli during the experiments that may have contributed to the results. This response also may have habituated during the course of the experiment. Prompts for anxiety ratings could be built into the blocks at regular intervals to assess the potential influence of subjective state anxiety during the course of the experiment. Fourth, I did not assess sleep deprivation, caffeine consumption, or nicotine intake prior to experimental sessions; these are potential influences on performance that are likely to occur in an undergraduate population.

Clinical Implications

The clinical implications of the present work, as well as future work, might include increased diagnostic utility. Self-report measures remain the gold-standard in clinical psychology, out of necessity. Self-report is vulnerable to potential confounds such as social desirability. In addition, individuals are unlikely to be able to report problematic processing, such as attentional processing, that happens very rapidly and can lead to symptoms. Performance-based measures such as the RSVP and cue validity tasks provide a more objective means of assessing potentially problematic processing. Following the basic work necessary to identify the patterns of problematic processing in the various anxiety disorders, performance-based tasks will allow more definitive diagnosis of functional difficulties. In particular, performance-based tasks may reliably distinguish between the presence of disorder and false-positives. Finally, these tasks also

may be used as treatment outcome measures; it is possible that exposure-based therapies for anxiety disorders reduce problematic attentional processing, which in turn reduces symptom occurrence.

Future Directions

This work represents an initial step in the translation of the attentional capture model and temporal measurement paradigms for the examination of the mechanisms of attentional processing in clinical disorder. Future work should include a thorough examination of spatial and temporal disengagement and orienting of attention to threat in the various anxiety disorders. This information will assist in the development of more mechanistic models of the anxiety response as well as models of the potentially unique patterns of attentional difficulties for the different anxiety disorders. For example, the present data suggest that individuals with specific phobia experience both facilitated temporal orienting of attention to threat and difficulty disengaging spatially and temporally from threat. This pattern might reflect the nature of temporal allocation of attention in the circumscribed fear response (i.e., the fear response is specific to the phobic stimulus). On the other hand, anxiety disorders such as panic disorder include an element of more diffuse anxiety, and such disorders might be characterized by facilitated temporal allocation of attention to visual threat information, but not by difficulty with disengagement from visual information. That is, an individual with panic disorder might be capable of disengaging relatively efficiently from the visual stimulus at hand (e.g., visual cue associated with prior panic attack) while shifting to internal threat cues (i.e., increased heart rate). Although the bulk of the current literature focuses on spatial

attentional processing in anxiety, data from temporal designs will provide important converging evidence that supports the pervasiveness of attentional difficulties in anxiety.

A next step will be to determine the conditions under which these attentional effects occur. For example, should difficulty with spatial and temporal disengagement of attention be implicated in the onset and maintenance of symptoms of PTSD, it will be important theoretically and clinically to know the circumstances in which the difficulties exist. A hypothetical finding that individuals with PTSD do not experience problematic attentional processing when they are relaxed, for example, would add a moderating variable to a mechanistic model, as well as provide a rationale and logical point of entry for clinical intervention.

Summary

The current work represents the unique translation of a contemporary theoretical model and two visual-attention paradigms for the examination of the orienting and disenagement mechanisms of attention in specific phobia. Preliminary results indicate that phobic individuals experience facilitated temporal orienting of attention toward threat-relevant stimuli that is independent of their negative valence, and that phobic individuals also experience difficulty disengaging temporally and spatially from threat-relevant stimuli. This successful translation of a contemporary theoretical model of attentional processing, and two of its attending measurement paradigms, offers a valuable new approach to the understanding of attentional mechanisms that may be implicated in symptom onset and maintenance in anxiety, and provides a promising new direction for the development of treatments for anxiety disorders.

Appendix A

Experiment 1 pre-screening measure

Please indicate whether the following statements are mostly true or mostly false for you.

- | | | |
|--|---|---|
| 1. I avoid going to parks or on camping trips because there may be snakes about. | T | F |
| 2. If a picture of a snake appears on the screen during a motion picture, I turn my head away. | T | F |
| 3. I dislike looking at pictures of snakes in a magazine. | T | F |
| 4. Although it may not be so, I think of snakes as slimy. | T | F |
| 5. I enjoy watching snakes at the zoo. | T | F |
| 6. I am terrified by the thought of touching a harmless snake. | T | F |
| 7. When I see a snake, I feel tense and restless. | T | F |
| 8. I shudder when I think of snakes. | T | F |
| 9. Some snakes are very attractive to look at. | T | F |
| 10. I don't believe anyone could hold a snake without some fear. | T | F |
| 11. The way snakes move is repulsive. | T | F |
| 12. I'm more afraid of snakes than any other animal. | T | F |
| 13. I would not want to travel down south or in tropical countries, because of the greater prevalence of snakes. | T | F |
| 14. I have no fear of non-poisonous snakes. | T | F |
| 15. I think that I'm no more afraid of snakes than the average person. | T | F |

Please rate each item according to the following 7-point scale.

0=strongly disagree 1=moderately disagree 2=mildly disagree 3=sometimes agree 4=mildly agree 5=moderately agree 6=strongly agree

- | | | | | | | | |
|--|---|---|---|---|---|---|---|
| 1. If I came across a spider now, I would get help from someone else to remove it. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 2. Currently, I am sometimes on the lookout for spiders. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 3. If I saw a spider now, I would think it would harm me. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 4. I now think a lot about spiders. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 5. I would be somewhat afraid to enter a room now, where I have seen a spider before | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 6. I now would do anything to try to avoid a spider. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 7. Currently, I sometimes think about getting bit by a spider. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 8. If I encountered a spider now, it would take a long time to get it out of my mind. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 9. If I came across a spider now, I would leave the room. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 10. If I saw a spider now, I would think it will try to jump on me. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 11. If I encountered a spider now, I would have images of it trying to get me. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 12. If I saw a spider now, I would be afraid of it. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 13. If I saw a spider now, I would feel very panicky. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 14. Spiders are one of my worst fears. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 15. If I saw a spider now, I would probably break out into a sweat and my heart would beat faster. | 0 | 1 | 2 | 3 | 4 | 5 | 6 |

My eyesight, uncorrected or corrected, is 20/20.

True

False

Appendix B

Experiment 1 Sample stimuli



Photo stimuli removed from their backgrounds.

Appendix C

Experiment 1 Participant Instructions

Instructions were presented on the computer monitor.

INSTRUCTIONS

On each trial, you will first see two boxes with a plus sign between them and the message "press button".

Look directly at the plus sign, and then press a button when ready.

A picture (of a frog, snake, or spider) will then appear very briefly in one of the boxes followed by either an "X" or an "O" in one of the boxes.

Your task is to press the left button if the "X" appears or the right button if the "O" appears. Please respond AS QUICKLY AS YOU POSSIBLY CAN while remaining accurate. In addition, please DO NOT LOOK AWAY FROM THE PLUS SIGN DURING THE TRIAL. The experimenter will monitor your eye on a video monitor and give you feedback if your eyes move.

On most trials, the "X" or "O" will appear in the same box in which the picture appeared. On other trials, the "X" or "O" will appear in a different box. Your task is the same in both cases.

You will complete a practice session of 28 trials and an experiment session of 576 trials. A break is scheduled halfway through the experiment session. Please feel free to take additional breaks if needed.

If you have any questions, please ask the experimenter.

Appendix D

Experiment 2&3 pre-screen measure

Fear of Snakes/Spiders

*Please indicate whether the following statements are mostly true or mostly false for you.
(SNAQ items)*

- | | | |
|---|---|---|
| 1. If a picture of a snake appears on the screen during a motion picture, I turn my head away. | T | F |
| 2. I dislike looking at pictures of snakes in a magazine. | T | F |
| 3. Although it may not be so, I think of snakes as slimy. | T | F |
| 4. I am terrified by the thought of touching a harmless snake. | T | F |
| 5. I shudder when I think of snakes. | T | F |
| 6. I don't believe anyone could hold a snake without some fear. | T | F |
| 7. I'm more afraid of snakes than any other animal. | T | F |
| 8. I would not want to travel down south or in tropical countries, because of the greater prevalence of snakes. | T | F |
| 9. I have no fear of non-poisonous snakes. | T | F |
| 10. I think that I'm no more afraid of snakes than the average person. | T | F |

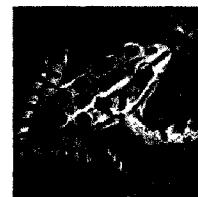
Please rate each item according to the following 7-point scale. (FSQ items)

0=strongly disagree 1=moderately disagree 2=mildly disagree 3=sometimes agree 4=mildly agree 5=moderately agree 6=strongly agree

1. If I came across a spider now, I would get help from someone else to remove it.
2. If I saw a spider now, I would think it would harm me.
3. I would be somewhat afraid to enter a room now, where I have seen a spider before
4. I now would do anything to try to avoid a spider.
5. Currently, I sometimes think about getting bit by a spider.
6. If I encountered a spider now, it would take a long time to get it out of my mind.
7. If I came across a spider now, I would leave the room.
8. If I saw a spider now, I would think it will try to jump on me.
9. If I saw a spider now, I would be afraid of it.
10. If I saw a spider now, I would probably break out into a sweat and my heart would beat faster.

Appendix E

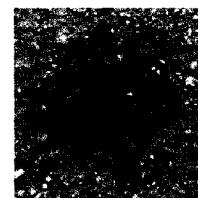
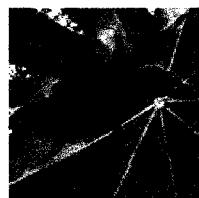
Experiments 2&3 Sample target photo stimuli



Examples of frog (neutral) stimuli (26 in complete set).



Examples of snake stimuli (26 in complete set).



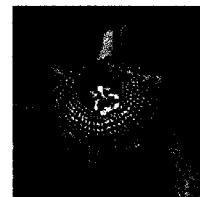
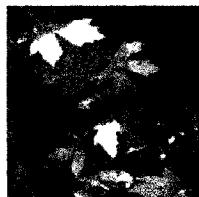
Examples of spider stimuli (26 in complete set).



Examples of fruit stimuli (26 of each fruit type in complete set).

Appendix F

Experiments 2&3 Sample distractor photo stimuli



Examples of plant/flower distractor stimuli used in Experiment 2 (60 in complete set).



Examples of less distinctive “tree” distractor stimuli used in Experiment 3. These stimuli were combined with the original distractor stimuli to create a complete set of 60 photos.

Appendix G

FSQ modified for snake fear and selected Fear Questionnaire items

(Experiments 2 & 3)

1

Fear of Spiders Questionnaire modified for Snake Fear²

0	1	2	3	4	5	6
strongly disagree	moderately disagree	mildly disagree	sometimes agree	mildly agree	moderately agree	strongly agree

1. If I came across a snake now, I would get help from someone else to remove it.
2. Currently, I am sometimes on the lookout for snakes.
3. If I saw a snake now, I would think it would harm me.
4. I now think a lot about snakes.
5. I would be somewhat afraid to enter a room now, where I have seen a snake before.
6. I now would do anything to try to avoid a snake.
7. Currently, I sometimes think about getting bit by a snake.
8. If I encountered a snake now, I wouldn't be able to deal effectively with it.
9. If I encountered a snake now, it would take a long time to get it out of my mind.
10. If I came across a snake now, I would leave the room.
11. If I saw a snake now, I would think it will try to *crawl* on me.
12. If I saw a snake now, I would ask someone else to kill it.
13. If I encountered a snake now, I would have images of it trying to get me.
14. If I saw a snake now, I would be afraid of it.
15. If I saw a snake now, I would feel very panicky.
16. Snakes are one of my worst fears.
17. I would feel very nervous if I saw a snake now.
18. If I saw a snake now, I would probably break out into a sweat and my heart would beat faster.

² Note: The word "spider" was replaced by the word "snake". The measure is otherwise unaltered with the exception of item number 11; the word "jump" was replaced with "crawl".

Selected items from the Fear Questionnaire (Marks & Mathews, 1978)

1. How much would you avoid a spider?

0	1	2	3	4	5	6	7	8
would not avoid	slightly avoid		definitely avoid		markedly avoid			always avoid

2. How much would you avoid a snake?

0	1	2	3	4	5	6	7	8
would not avoid	slightly avoid		definitely avoid		markedly avoid			always avoid

3. How would you rate the present state of your most phobic symptoms on the scale below?

0	1	2	3	4	5	6	7	8
no phobia present	slightly disturbing/ not really disturbing		definitely disturbing/ disabling		markedly disturbing/ disabling			very severely disturbing/ disabling

Appendix H

Experiment 2 Participant Instructions

Instructions for Participants

Please situate yourself comfortably in front of the computer. Take a moment to adjust your sitting position and distance from the computer, as it will be difficult to do so once the experiment has begun. During the experiment, the overhead lights will be turned off to minimize outside interference.

In this experiment, you will view streams of photographs, one after the other, very fast. Then you'll be asked questions about specific photos within the streams. I'll explain the experiment now, but don't worry about remembering everything.

Each stream of photos will be presented very rapidly – 10 photographs per second. Most of the photos are of plants or flowers. Each stream will also contain a photo that is either an animal (always a spider, snake, or frog), or fruit (always apples, oranges, or grapes). Some of the streams will also contain a second photo that is fruit if the first was an animal, and vice versa. Your primary task is to identify the first photo (first target) and your secondary task is to indicate whether the second photo (second target) was present or not.

There are four sections to the study, and the order of target photos will vary by section. Each section will be preceded by a screen that clearly states the order of target presentation for that section. During two of the four sections, you will only answer one question - whether the second target photo was present or not. Each photo stream is followed by the relevant questions and response options. Your responses will NOT be timed – take as much time as you need.

We're exploring the limits of 'visual attention' in this experiment, and this is a *very* difficult task. Sometimes the first target photo is very difficult to see, and you may often have no idea which of the items you saw during the stream. In this case, don't worry — just go with your intuition!

This task is very attention-demanding so *please* do your very best to stay alert and focused as much as possible throughout the experiment. We really appreciate your effort here — we know that this task can be long and frustrating, but it really helps us to understand the visual system if you try as hard as you can!

The experiment will involve 576 trials. After each trial you will press the spacebar to begin the next trial, and before doing so you can always take a short pause to stretch or get focused before continuing. Each new block will begin with a blue screen. You may want to take a brief break when these screens appear. All responses will be made using the 1,2,3,4 & 5 keys. The first response indicates which of the three target photos you saw – 1, 2 & 3 keys will correspond to the response options. So, for example, if the first target is fruit, “apple grape orange” will appear on the screen. They correspond to “1 2 3”. The next screen will ask “animal present?” We’ve labeled the “4” key with “p” for present, and the “5” key with “a” for absent. Sometimes it’s easy to get going so fast that you respond automatically with the wrong key. Remember, this is NOT timed, so take the time to focus on your responses.

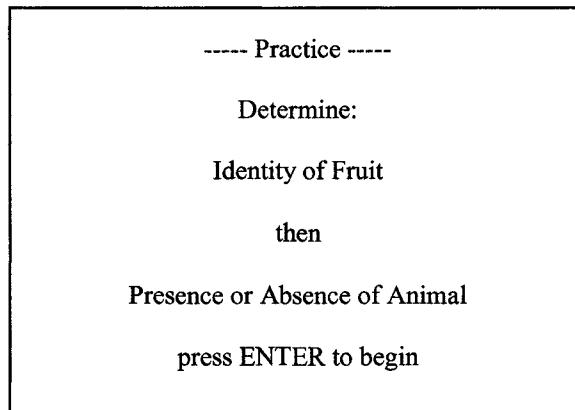
The first eight trials in each block will serve as practice trials, and we will not use the results from those. The purpose of the practice trials is just to give you a chance to become familiar with the particular photo targets and distractors that are being used here, and to become comfortable with the task.

The computerized portion of the experiment will take about 1 hr 15 minutes. Following these tasks, the experimenter will ask you a set of questions and ask you to complete a brief questionnaire.

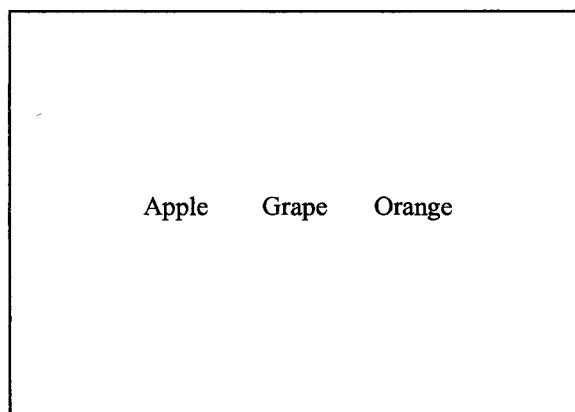
Please ask the experimenter at any time if you have any questions!

Appendix I

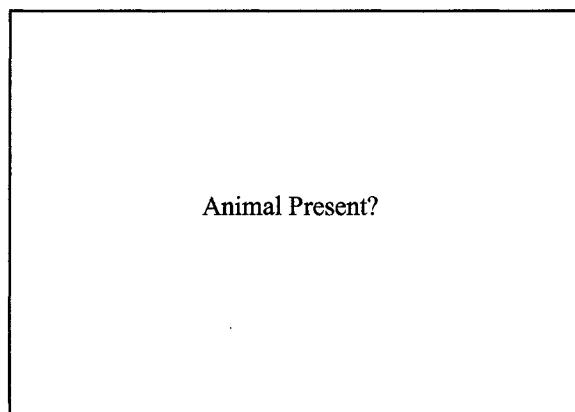
Experiments 2 & 3 Start and Response Screens



Block start screen with order of target tasks; participants viewed a similar display at the beginning of each practice block and each trial block.



T1 identification response screen; participants press “1” for Apple, “2” for Grape, and “3” for Orange.



T2 detection response screen; participants press key labeled “p” for present, or “a” for absent.

Appendix J

Experiment 3 Participant Instructions

Instructions for Participants

Please situate yourself comfortably in front of the computer. Take a moment to adjust your sitting position and distance from the computer, as it will be difficult to do so once the experiment has begun. During the experiment, the overhead lights will be turned off to minimize outside interference.

In this experiment, you will view streams of photographs, one after the other, very fast. Then you'll be asked questions about specific photos within the streams. I'll explain the experiment now, but don't worry about remembering everything.

Each stream of photos will be presented very rapidly – for half the experiment, you will view 10 photographs per second, and in the other half you will view approximately 13 photos per second. Most of the photos are of plants or flowers. Each stream will also contain a photo that is either an animal (always a spider, snake, or frog), or fruit (always apples, oranges, or grapes). Some of the streams will also contain a second photo that is fruit if the first was an animal, and vice versa. Your *primary* task is to identify the first photo (first target) and your *secondary* task is to indicate whether the second photo (second target) was present or not.

There are four sections to the study, and the order of target photos will vary by section. Each section will be preceded by a screen that clearly states the order of target presentation for that section. Each photo stream is followed by the relevant questions and response options. Your responses will NOT be timed – take as much time as you need.

We're exploring the limits of 'visual attention' in this experiment, and this is a *very* difficult task. Sometimes the first target photo is very difficult to see, and you may often have no idea which of the items you saw during the stream. In this case, don't worry — just go with your intuition! You may begin to think that you haven't seen the second photo for a while – it often is not there, so don't worry about it – just remember not to indicate that you saw it if you did not!

This task is very attention-demanding so *please* do your very best to stay alert and focused as much as possible throughout the experiment. We really appreciate your effort here — we know that this task can be long and frustrating, but it really helps us to understand the visual system if you try as hard as you can!

The experiment will involve 432 trials. After each trial you will press the spacebar to begin the next trial, and before doing so you can always take a short pause to stretch or get focused before continuing. Each new block will begin with a blue screen. You may want to take a brief break when these screens appear. All responses will be made using the 1,2,3,4 & 5 keys. The first response indicates which of the three target photos you saw – 1, 2 & 3 keys will correspond to the response options. So, for example, if the first target is fruit, “apple grape orange” will appear on the screen. They correspond to “1 2 3”. The next screen will ask “animal present?” We’ve labeled the “4” key with “p” for present, and the “5” key with “a” for absent. Sometimes it’s easy to get going so fast that you respond automatically with the wrong key. Remember, this is NOT timed, so take the time to focus on your responses.

The first ten trials in each block will serve as practice trials, and we will not use the results from those. The purpose of the practice trials is just to give you a chance to become familiar with the particular photo targets and distractors that are being used here, and to become comfortable with the task.

The computerized portion of the experiment will take about 45 minutes. Following these tasks, the experimenter will ask you a set of questions and ask you to complete a brief questionnaire.

Please ask the experimenter at any time if you have any questions!

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