Attentional Biases in Spider Fear: Hypervigilance and Disengagement Difficulty

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Statement of Sources

I declare that this report is my own original work and that contributions of others have been duly acknowledged.

_____ Date: _____

Tess Nikitenko

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Table of Contents

Abstract 1

The Attention Network Model 3

Attentional Biases and the Orienting Network 3

Neuroanatomical Structures of Attentional Bias 9

Electrophysiological Correlates of Attention 10

Rationale and aim 11

Hypotheses 13

Method 13

Participants 13

Materials and Apparatus 15

Procedure 19

Design and Data Analysis 21

Results 22

Demographics 22

Accuracy 23

Reaction Time 24

Peak P1 Amplitude 25

Valence and Arousal Ratings 29

Subjective Units of Distress Ratings..... 31

Discussion 32

Behavioural Measures 33

Electrophysiological Correlates of Attention..... 35

Limitations 39

Implications 40

Summary and Conclusion 41

References 43

Appendices 53

List of Tables and Figures

Figure 1. Schematic overview of the modified spatial cueing task with example images for each cue type (neutral, feared and positive valence) 18

Table 1. Mean Age, Hours of Sleep, and Raw Scores on Measures of Spider Fear, Anxiety, Reading Ability, Video Game Experience and alertness for Low and High Fear Spider Groups …….…….. 23

Table 2. Mean Accuracy to Targets Following Spider, Butterfly and Beetle Cues in Valid and Invalid Trials for High and Low Fear Spider Groups 24

Figure 2. Mean reaction time for targets following spider, butterfly and beetle cues for high and low spider fear groups.…… 25

Figure 3. Grand averaged waveforms for valid trials at the left (O1) and right (O2) occipital electrodes with 2D map showing site amplitude at average peak P1 latency..... 26

Table 3. Mean Amplitude of Contralateral P1 Components at the Left (O1) and Right (O2) Occipital Electrodes Following Spider, Butterfly and Beetle Cues in Valid and Invalid Trials for High and Low Spider Fear Groups ……..…….....…… 27

Table 4. Mean Valence and Arousal Ratings for Spider, Beetle and Butterfly Cue Images ……..…….…….……..… 29

Table 5. Mean Subjective Units of Distress Scale Ratings Obtained Prior to Task and During Task Breaks ……..…….……..... 31

Attentional Biases in Spider Fear: Hypervigilance and Disengagement Difficulty

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Abstract

The aim of this study was to examine attentional biases of hypervigilance and disengagement difficulty in spider fear. Twenty-eight females between the ages of 18-36 years were grouped into high (*n*=14) and low (*n*=14) fear groups and completed a modified spatial cueing task comprising photographic cues of spiders (feared stimulus), beetles (neutral stimulus) and butterflies (positive valence stimulus). Cues were either valid (appeared on the same side as the target), or invalid (appearing on the opposite side). It was hypothesised that high fear participants would show faster reaction time and greater P1 amplitude following valid spider cues as an indicator of hypervigilance, and slower reaction times following invalid spider cues indexing disengagement difficulty. Instead, high fear participants showed greater reaction time to all targets, with this increase greater following spider cues. These findings were interpreted as interference following feared stimuli. P1 amplitude was higher overall in the high fear group, but both groups showed greater amplitude following spider cues relative to beetle and butterfly cues. Enhanced P1 amplitude in the high fear group was interpreted as increased attentional processing following feared images. This research provides preliminary support for Attentional Control Theory (ACT; Eyesenck et al., 2007) and suggests emphasis on attentional mechanisms in the treatment of spider fear.

Attentional bias is the facilitated attention toward or away from a stimulus, and plays a central role in the aetiology and maintenance of anxiety disorders (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg & van Ijzendoorn, 2007). The attentional bias towards threat is well documented (Bar-Haim et al., 2007; Cisler & Koster, 2010; Van Bockstaele et al., 2013), however, the specific modes of attention that are affected are still under investigation.

Early neural processes involved in attentional bias involve the facilitated detection and processing of threatening stimuli, known as hypervigilance. This may be followed by difficulty disengaging attention from threatening stimuli in order to shift and re-engage attention elsewhere (Bar-Haim, Lamy & Glickman, 2005; Cisler & Koster, 2010). These findings have been demonstrated through behavioural measures such as reaction time and electrophysiological measures by way of event-related potentials (ERPs). According to Posner and Petersen's (1990) attentional network model, these functions are likely to be orchestrated by the orienting module of attention, which determines engagement, shifting and disengagement from stimuli.

These early neural processes form an important process in anxiety disorders, including specific phobia. With a population prevalence of 3.5% (Fredrikson, Annas, Fischer, & Wik, 1996) one of the most common subtypes of specific phobia is fear of spiders. As in anxiety disorders generally, arachnophobia is more likely to affect females than males (Leutgeb, Sarlo, Schongasser & Schienle et al., 2015). In order to provide effective treatments for this population, it is important that the neural mechanisms involved in anxiety disorders are comprehensively understood. Research in this area will enable treatments to be more effective by targeting the underlying cognitive processes more accurately. For example, recent research (Fox, Zougkou, Ashwin & Cahill, 2015), has shown success using attention bias modification.

The Attentional Network Model

Posner and Petersen (1990) proposed a model of attention comprising three components: alerting, orienting, and executive control. Alerting refers to the level of arousal required to attend to a stimulus; orienting encompasses the shifting, engagement and disengagement of attention; whilst the executive control network orchestrates goal-directed action and response control. The attentional module of interest in this research is the orienting network. In their recent conceptualisation, Petersen and Posner (2012) proposed that there are two separate processes within the orienting network, the bottom-up (ventral system) and top-down (dorsal system).

The attentional network model (Posner & Petersen, 2012), links to Attentional Control Theory (ACT; Eysenck, Derakshan, Santos, & Calvo 2007). ACT (Eysenck et al., 2007) posits that anxiety results in disruption between the orienting and executive control networks of the attention system, characterised by increased bottom-up (stimulus driven) processing and decreased top-down (goal-directed) processing, leading to increased dependence on the orienting system in response to a stimulus, and less influence from the executive control system (Eysenck et al., 2007). For example, goal-directed action (such as responding to a target in an experimental task) is delayed due to stimulus driven impulses, such as being in the presence of a feared stimulus.

Attentional Biases and the Orienting Network

Despite the prevalence of specific phobia, there is a lack of research on the attentional mechanisms of specific fear. The majority of research investigating attentional bias in visual paradigms has been limited to the differences between high and low trait anxious individuals. Whilst this is useful literature to review in order to inform potential mechanisms of specific fear, state anxiety is more similar to specific

fear than trait anxiety. However, research on state anxiety is again limited (Bar-Haim et al., 2007; Cisler & Koster, 2010; Van Bockstaele et al., 2013).

Hypervigilance to threat-related stimuli is a robust attentional bias mechanism that has been established in trait anxious individuals allocating preferential attention to threatening stimuli (Bar-Haim et al., 2007). Hypervigilance is indexed experimentally through faster reaction times following threatening images appearing as informative cues preceding a target in visual attention tasks (such as dot-probe and spatial cueing (Bar-Haim et al., 2007; Cisler & Koster, 2010; Van Bockstaele et al., 2013). This difference between anxious and non-anxious individuals has also been demonstrated through electrophysiological measures (Armstrong, Hemminger & Olatunji, 2013; Fox, Russo, Bowles & Dutton, 2001; Johnstone, 2015; Leutgeb et al., 2015; Pflugshaupt et al., 2005; Rinck & Becker, 2006; Rossignol, Campanella, Bissot & Philippot, 2013). After initial hypervigilance, it has been suggested that threat-related stimuli result in two further potential mechanisms of attentional bias: a) the impaired ability to disengage attention away from threatening stimuli, or b) the swift shifting of attention away from threat, or avoidance, as indexed by differences in reaction time following threat-related versus neutral cues in visual attention tasks (Bar-Haim et al., 2007; Fox et al., 2001). In previous research on trait-anxious individuals, delayed disengagement (indexed by greater reaction time when reorienting attention away from threatening stimuli) is more readily observed with short stimulus durations (100ms-200ms; Koster, Crombez, Verschuere, Van Damme, Wiersema, 2006a).

Evidence in support of attentional biases has been demonstrated in the literature by utilising a variety of experimental paradigms, including the dot-probe task (MacLeod, Mathews & Tata, 1986). This task involves the simultaneous

horizontal presentation of threatening and neutral stimuli on a computer screen for a brief duration (~500ms), followed by a target or probe appearing on the screen after the stimuli have disappeared. This probe is randomised to appear in place of one of the stimuli, and the participant is required to indicate via button press on which side the probe appears (MacLeod et al., 1986). Hypervigilance and disengagement difficulty are well-replicated phenomena in trait anxious participants completing the dot-probe task, such that hypervigilance is demonstrated by faster reaction times compared to controls when the probe appears on the same side as a threatening rather than neutral stimulus (Lipp & Derakshan, 2005; Mogg & Bradley 2006). Disengagement difficulty is indexed by slower reaction times compared to controls when the probe replaces a neutral stimulus, suggesting that the threat-related stimulus captures and holds attention in those with higher trait or state anxiety (Koster, Crombez, Verschuere & De Houwer, 2006b; Yiend & Mathews, 2001)

Koster and colleagues (2006b) used a dot-probe task to compare attentional biases in high and low trait anxious participants. They found that high trait anxious individuals produced greater reaction times to both moderate and high threat images in comparison to the low trait anxious group, who only demonstrated an increase in reaction time in high threat conditions. This result in the high trait anxious group was interpreted as evidence of disengagement difficulty in shifting attention from the moderate threat images. Other evidence for disengagement difficulty was found by Yiend and Mathews (2001) utilising a dot-probe task. High and low trait anxious individuals were compared on reaction times to targets cued by threatening and non-threatening pictorial cues in a dot-probe task. They found a general slowing effect in the high trait anxious participants following threatening cues, which was interpreted as difficulty disengaging from threat in combination with a more generalised

interference effect positively correlated with perceived level of threat.

In research specifically investigating these mechanisms in spider fearful individuals, Lipp and Derakshan (2005) discovered that high spider fear participants responded faster to target probes replacing spider relative to neutral picture cues in a dot probe task as compared with low spider fear participants, indexing hypervigilance. Similarly, in a dot probe paradigm Mogg and Bradley (2006) found that high spider fear participants showed a greater hypervigilance towards spider stimuli than low fear participants. An additional finding in this study was associated with varying exposure durations (200, 500 and 2000ms), with high fear participants showing that as exposure duration increased, hypervigilance decreased, as indexed by greater reaction time following longer exposure (Mogg & Bradley, 2006).

Another useful paradigm to assess attentional biases in the orienting network is the spatial cuing task (Posner, 1980). It has been suggested that the spatial cueing task presents a less problematic assessment of attentional capture because only one stimulus is presented at a time, unlike the dot-probe task (Derryberry & Reed, 1994). This experimental paradigm aims to differentiate between attentional engagement and disengagement by separating these components (Clarke, MacLeod & Guastella, 2013). In an archetypal spatial cueing task, participants are required to focus their vision on a central fixation point until a central (endogenous) or peripheral (exogenous) cue facilitates a visual attentional shift to a particular location, usually left or right of the central fixation point, followed by the presentation of a target requiring a response. It has been suggested that exogenous cues yield facilitatory effects when the latency between cue and target is less than 200ms (Fox et al., 2001). In invalidly cued trials, the cue directs attention to the opposite side of the computer monitor, or the un-cued location, before the target is presented. Conversely, valid

targets appear at the cued location (Vandenberghe & Gillebert, 2013). In comparison to the dot-probe paradigm, the spatial cueing task allows definitive analysis of the processes of hypervigilance and disengagement by presenting a single pictorial cue (feared or neutral) for each trial at the same (valid) or opposite (invalid) spatial location to the target (Fox et al., 2001). In research focussing on trait anxious individuals, images have mostly been of threat-related or neutral facial expressions (Bar-Haim et al., 2007). At the present time there is minimal research using the spatial cueing task to assess attentional biases in spider fear.

Koster and colleagues (2006a) utilised a spatial cueing task to compared the performance of high versus low trait anxious individuals to targets cued by neutral, highly threatening or moderately threatening images. In the 100ms exposure times, shorter reaction times were demonstrated by high trait anxious participants following valid threat cues, whilst greater response times were found in high trait anxious participants following threatening invalid cues, demonstrating disengagement difficulty to threatening stimuli. High trait anxious participants also demonstrated greater response times to valid highly threatening cues presented for longer durations of 200ms and 500ms. The authors concluded that longer latencies are more likely than shorter latencies to produce attentional avoidance following threat, rather than disengagement difficulty (Koster et al., 2006a). This built on research conducted the previous year by Bar-Haim and colleagues (2005), who obtained robust evidence for attentional bias in anxiety through increased reaction times. In this study, participants were allocated into high and low anxiety groups based on upper and lower quartiles of scores obtained on the State-Trait Anxiety Inventory (STAI; Speilberger, 1983) and completed an endogenous spatial cueing task. High anxiety participants

exhibited slower response times regardless of facial expression cue (angry, neutral, fearful, happy and sad) in comparison to low anxiety participants.

In similar research focussing on specific fear, Amir and colleagues (2003) used a modified spatial cueing paradigm with threat-related and neutral words as cues to assess attentional bias in social phobia. Two-thirds of all trials were validly cued, and one-third invalidly cued. They found that participants demonstrated longer response times following presentation of invalid cues and shorter latencies following validly cued targets as would be expected through a general effect of validity. However, this effect only appeared in trials where the target followed a social threat-related word rather than a neutral word. Amir et al. (2003) concluded that individuals with social phobia had difficulty disengaging their attention from social threat-related words relative to controls as indexed by longer reaction times following an invalid threat-related cue.

Thus far, the only spatial cueing paradigm that has been used to assess attentional biases in spider fear has been by Johnstone (2015). Johnstone used a modified spatial cueing task to assess early attention differences between high and low spider fear participants. This task comprised photographic cues of spiders and cows with 50% valid and 50% invalid targets comprising 128 trials. Hypotheses were in line with findings in similar tasks assessing trait anxiety, with faster reaction times following valid spider cues in high fear participants compared to low fear participants as evidence of hypervigilance. As evidence for disengagement, it was hypothesised that high fear participants would obtain greater reaction times compared to low fear participants following invalid spider cues, as the feared stimulus would capture and hold attention. Neither of these hypotheses were supported. Instead, Johnstone (2015) found greater reaction times in high fear

participants following both image types which was interpreted as interference in the goal-directed task of responding to targets.

Neuro-anatomical Structures of Attentional Bias

It has been suggested that both voluntary and involuntary visual attention processes are modulated at their earliest point in the middle occipital gyrus, within the extrastriate cortex, before activation is seen in the primary visual cortex (Fu, Greenwood & Parasuraman, 2005). Research using fMRI has shown that neural networks activated during endogenous and exogenous orienting include the anterior cingulate cortex, precuneus, cuneus, and the temporoparietal junction centering on the supramarginal gyrus and extending to the superior temporal lobe (Peelen, Heslenfeld & Theeuwes, 2004).

It is thought that early attentional biases such hypervigilance may involve an amygdala response due to automatic fear responses generated following exposure to threat relevant stimuli (Cisler & Koster, 2010). This is consistent with research positing that the amygdala receives visual threat-related information via the magnocellular route and thalamo-amygdala connection which transmits information to the visual cortex (Berggren & Derakshan, 2013; Öhman, 2009).

In their most recent conceptualisation of the attentional network model, Petersen and Posner (2012) differentiated between the dorasal attention system (top-down visuospatial orienting), and the ventral attention system (bottom-up reorienting). Based a review of imaging research of attention by Corbetta and Shulman (2002), they propose that the dorsal system is comprised of frontal eye fields and the intraparietal sulcus/superior parietal lobe, whilst the ventral attention system consists of certain regions within the temporoparietal junction and the ventral frontal cortex (Petersen & Posner, 2012).

Electrophysiological Correlates of Attention

Neural activity elicited by attentional biases can be measured using event-related-potentials (ERPs). ERPs are time-locked recordings of electrophysiological activity generated by the brain in response to stimuli, which are recorded on the scalp using electroencephalographic (EEG) technology (Dennis & Chen, 2007; Woodman, 2010). Whilst ERPs are a useful measure in assessing the temporality of neural processes, there is a surprising lack of ERP research investigating the early neural processes involved in attention and how these may be modulated by anxiety and fear in attentional tasks. There is no current ERP component which provides consistent evidence for disengagement difficulties. However, it has been suggested by several studies that the P1 component is a potential marker of facilitated attention towards threat.

P1 Component. The P1 is a positive polarity event-related potential (ERP) occurring approximately 100ms post stimulus, which indexes early visual processing and may be modulated by attention and arousal (Hillyard, Luck, & Mangun, 1994). It is maximal in ERP studies at lateral occipital sites, and peaks approximately 80-130ms post-stimulus (Hillyard, Luck, & Mangun, 1994). Previous research has demonstrated that variations in the posterior P1 component are associated with early visual processing and automatic orienting of attention to visual stimuli (Dennis & Chen, 2007; Kolassa, Musial, Kolassa & Miltner, 2006). The P1 component is generated in the extra-striate visual areas and is considered to index hypervigilance, or facilitated attention towards threat (Kolassa et al., 2006). The P1 component is enhanced in exogenous attentional paradigms, attaining greater amplitude for validly cued trials in comparison to invalidly cued trials (Chica Bartolomeo & Lupiáñez 2013; Eimer, 1998; Fu, Fan, Chen & Zhuo, 2001; Hopfinger & West, 2006; Luck,

1995; Mangun, 1995; Talsma, Mulckhuyse, Slagter & Theeuwes, 2007).

Spider fear is particularly amenable to ERP studies of attentional bias as even schematic images can induce enhanced P1 amplitude in spider phobic participants (Venettacci, 2014). However, studies investigating P1 amplitude differences in spider fear are minimal, with researchers utilising different tasks and investigating later ERP components. Kolassa and colleagues (2006) compared participants with spider phobia to clinical controls (social phobia) and non-phobic control participants using an emotional Stroop task comprising schematic spider and flower images. They found that both phobic groups demonstrated increased P1 amplitude following exposure to both image types in comparison to control participants. They concluded that early ERP components are modified by anxiety status and not necessarily by exposure to representations of the specific phobia.

To date, the only modified spatial cueing paradigm assessing high and low spider fear participants is that of Johnstone (2015). Johnstone hypothesised that high fear participants would generate greater P1 amplitude to spider images compared to low fear participants, however, this was not supported. No significant difference in peak P1 amplitude was observed between groups following exposure to spider or cow images, in fact, the low fear group showed increased P1 amplitude following spider images versus cow images. Johnstone (2015) concluded that this general hypervigilance is indicative of a phylogenetic mechanism in low fear participants.

Rationale and aim

Research in attentional biases of specific phobia has been limited as the majority of research has focussed on trait anxious individuals rather than state anxiety, which is more closely linked to specific phobia (Mogg, Holmes, Garner & Bradley, 2008). There is also a need for closer analysis of electrophysiological

markers of attentional bias in specific phobia, as the majority of literature thus far relies on behavioural measures (Bar-Haim et al., 2007; Cisler & Koster, 2010; Van Bockstaele et al., 2013). Cisler and Koster (2010) surmised that thorough investigation of the attentional components of hypervigilance, avoidance and disengagement difficulty is required in order to gain comprehensive understanding of the cognitive functions involved in the maintenance of specific fear and anxiety disorders. Research in this area will inform treatment techniques for specific fear such as attention bias modification, which targets underlying cognitive processes involved in attentional bias (Fox et al., 2015).

The aim of this research is to add to previous evidence of hypervigilance and disengagement difficulty in high fear participants following exposure to spider images in order to build upon the research conducted by Johnstone (2015). A modified spatial cueing paradigm was designed for this research to include not only feared (spider) and neutral (beetle) images, but also a positive valence image (butterfly). Further modifications were made to this task such that more trials were included (576 in total, with 192 trials per image type compared to Johnstone's 128 trials with 64 per image type). The percentage of valid trials was increased from 50% to 75% in order to reach consistency with other spatial cueing paradigms finding behavioural evidence of hypervigilance and disengagement difficulty (Fox et al., 2001; Mogg et al., 2008). Fox and colleagues (2002) postulated that a higher proportion of valid cues ensures that participants learn to rely on the cue as a useful indicator of upcoming target location, therefore eliciting attentional biases. As suggested by Chica Martín-Arévalo, Botta and Lupiáñez (2014), a discrimination task (where the participant presses the left button in response to one target type, for example, a horizontal dot pair, and a right button response indicating a vertical dot

pair) was chosen over a detection task (where the participant simply indicates with a corresponding button press whether the target appears in the right or left visual hemifield). This was implemented in order to increase cognitive load and intensify facilitatory effects. It is suspected that these changes may better elicit both disengagement difficulty as well as both specific and general hypervigilance in high fear participants.

Hypotheses

Utilising a modified spatial cueing it was hypothesised that high fear participants would show faster reaction times following valid spider cues as an indicator of hypervigilance compared to low fear participants (Lipp & Derakshan (2005; Mogg & Bradley, 2006), and that this would be followed by beetle cues and butterfly cues respectively. Based on research by Kolassa and colleagues (2006), it was hypothesised that hypervigilance among high fear participants would be demonstrated by greater P1 amplitude compared to low fear participants, and that this amplitude would decrease over beetle and butterfly image conditions respectively. As evidence for disengagement difficulty, based on research by Koster and colleagues, (2006a), it was hypothesised that high fear participants would display slower reaction times following invalid spider cues compared to low fear participants.

Method

Participants

Ethical approval was gained through the University of Tasmania Human Research Ethics Committee (see Appendix B). A total of 319 participants were recruited via advertisements placed on University of Tasmania (UTas) campuses and community notice boards in the Hobart region, Tasmania. Participants were screened

using the Spider Phobia Questionnaire (SPQ; Watts & Sharrock, 1984). Exclusion criteria included neurological, sleep or psychiatric disorders (excluding major depressive disorder and generalised anxiety disorder), head injury, epilepsy, current pregnancy, illicit drug use within the past month, and use of alcohol within the past 24 hours. In addition to participants' medical history, screening was undertaken using the Kessler Psychological Distress scale (K10; Kessler et al., 2002) and the Alcohol Use Disorders Identification Test (AUDIT; Babor et al., 2001), excluding participants with scores greater than 36 and 19 respectively. Respondents meeting eligibility criteria were invited to attend a two-hour experimental session at the University of Tasmania.

A total of 35 participants aged 18-36 (*M*=22.3, *SD*=4.9) years completed the experimental session. First year undergraduate psychology students received two hours course credit for participation. Seven participants' data were excluded due to scores above the median on the secondary measure of spider fear, the Fear of Spiders Questionnaire (FSQ; Szymanski & O'Donohue, 1995) (*n*=3), accuracy below 70% on any individual condition (*n*=1), excess artifacts in ERP data (*n*=1), and outlying reaction times as assessed by box and whisker plots for each condition (1.5 times > interquartile range; *n*=2).

The final sample comprised 28 participants. The high spider fear group (*n*=14) scored 14 and greater on the SPQ, while the low spider fear group (*n*=14) obtained scores of seven and below. All participant scores were within the 25th (scores 6 and below) and 75th percentiles (scores 14 and above), except one participant with a score of seven included in the low fear group. Participant groups were compared on caffeine and nicotine consumption, illicit drug use, handedness, and education level.

Materials and Apparatus

Questionnaire Measures. The Spider Phobia Questionnaire (SPQ; Watts & Sharrock, 1984) was used as the primary measure of spider fear and to assign participants to either low or high fear categories. The SPQ comprises 43 yes/no questions regarding sensitivity to spiders (e.g., "Are you always on the lookout for spiders?"). The questions are designed to indicate cognitive-behavioural dimensions of vigilance, preoccupation, coping and avoidance in response to spiders. The SPQ subscale measuring spider knowledge was excluded for the purposes of this research, resulting in a total of 33 questions. Five questions are reverse-scored to control response bias. The SPQ possesses good test-retest reliability (r=0.94) and internal consistency (Cronbach's α =0.91) (Muris & Merchelbach, 1996).

The Fear of Spiders Questionnaire (FSQ; Szymanski & O'Donohue, 1995) was used as a secondary measure of spider fear. The FSQ is sensitive in detecting spider fear in phobic as well as sub-clinical individuals (Muris & Merchelbach, 1996). The FSQ comprises 18 questions designed to assess phobic symptoms (e.g., "If I encountered a spider now, I wouldn't be able to deal effectively with it"). Answers are measured on a seven-point Likert scale ranging from 1 (definitely not) to 7 (absolutely). The FSQ possesses good test-retest reliability (r=0.91), and internal consistency (Cronbach's α=0.97) (Muris & Merchelbach, 1996).

The Kessler Psychological Distress Scale (K10; Kessler et al., 2002) is a 10 item scale measuring psychological distress on a six-point Likert scale. Questions require participants to rate their experiences of psychological distress over the preceding four weeks (e.g., "Did you feel so restless that you could not sit still?"). Responses ranged from 1 (all of the time) to 6 (none of the time), with lower scores indicative of lower psychological distress. Scores range from 10 to 50. This research

excluded participants with a high level of psychological distress as indexed by scores over 36 (Kessler et al., 2002). The K10 possesses good internal consistency (Cronbach's α=0.93) (Kessler et al., 2002).

The State-Trait Anxiety Inventory Form Y-2 (STAI; Speilberger, 1983) is a 20-item inventory used to assess trait anxiety, including feelings of stress, worry and discomfort. The STAI contains questions relating to how the individual generally feels (e.g., "I feel inadequate"). Responses are given via a four-point Likert scale from 1 (almost never) to 4 (almost always), with higher scores positively correlated with trait anxiety. This was included to compare participants on measures of trait anxiety and to control for confounding effects. The STAI possesses good test-retest reliability (r=0.69-0.89) and internal consistency (Cronbach's α=0.86-0.95) (Spielberger et al., 1983).

The Weschler Test of Adult Reading (WTAR; Wechsler, 2001) is a test used to measure intellectual functioning and is comprised of 50 words with irregular grapheme-to-phoneme correspondence requiring accurate pronunciation. Each correctly pronounced word equals a score of one. The WTAR possesses good concurrent validity, with scores highly correlated with measures of verbal comprehension (r=0.74), verbal IQ (r=0.75), and full-scale IQ (r=0.73; Wechsler, 2001). Scores were used to compare intellectual functioning between high and low fear groups.

The Alcohol Use Disorders Identification Test (AUDIT; Babor et al., 2001) is designed to identify problem drinkers and comprises ten questions covering hazardous alcohol use and dependence symptoms. The AUDIT was used as a screening tool to control for confounding effects of alcohol on brain activity, with participants scoring higher than 19 excluded.

The Karolinska Sleepiness Scale (KSS; Akerstedt & Gillberg, 1990) was used to measure participants' alertness on the day of testing. The KSS is a single question ("how do you feel at the present moment?"). Participants answered by selecting a score on a nine-point scale with scores ranging from one ("extremely alert") to nine ("extremely sleepy").

The Subjective Units of Distress Scale (SUDS; Wolpe, 1982) was utilised prior to task commencement and in three breaks during the experimental task to assess temporally relevant state anxiety. Participants are required to indicate their current level of anxiety on a scale of 0 ("no anxiety") to 100 ("extreme anxiety").

Participants were also asked a video gaming experience question (VGEQ) which was custom made by researchers examining attentional biases at UTas the previous year (Johnstone, 2015). The question is "How often would you normally play video games?") with five response choices ranging from ("never play video games") to ("often play video games - more than 5 hours a week").

Spatial Cueing Paradigm. The spatial cueing task used in this research was presented using NeuroScan STIM 3.1 software. Written instructions were presented on screen, followed by 10 practice trials. The test phase comprised 576 trials presented in random order, with four blocks of 144 trials. Participants were given breaks between each block in order to rate their current level of anxiety and refocus their attention. Trials commenced with a central fixation cross (500ms) followed by a pictorial cue appearing in the left or right visual hemifield which was either fear-relevant (spider), neutral (beetle), or positive valence (butterfly). This image was presented on screen for 200ms. This was followed after an interstimulus interval (ISI) of 50ms by a target comprised of vertical or horizontal dot pairs presented for 2000ms appearing in the left or right visual hemifield. The pictorial cue either validly

(appeared on the same side; 75% of trials), or invalidly (appeared on the opposite side; 25% of trials) predicted the target. The centre of each image measured 3.5cm away from the central fixation cross. Participants were instructed to respond via button press on a NeuroScan response pad, with vertical dot pairs requiring a left button response and horizontal dot pairs requiring a right button response. Intertrial intervals (ITI) between the target and the subsequent trial were varied randomly, with intervals set at 2100ms, 2200ms, or 2300ms.

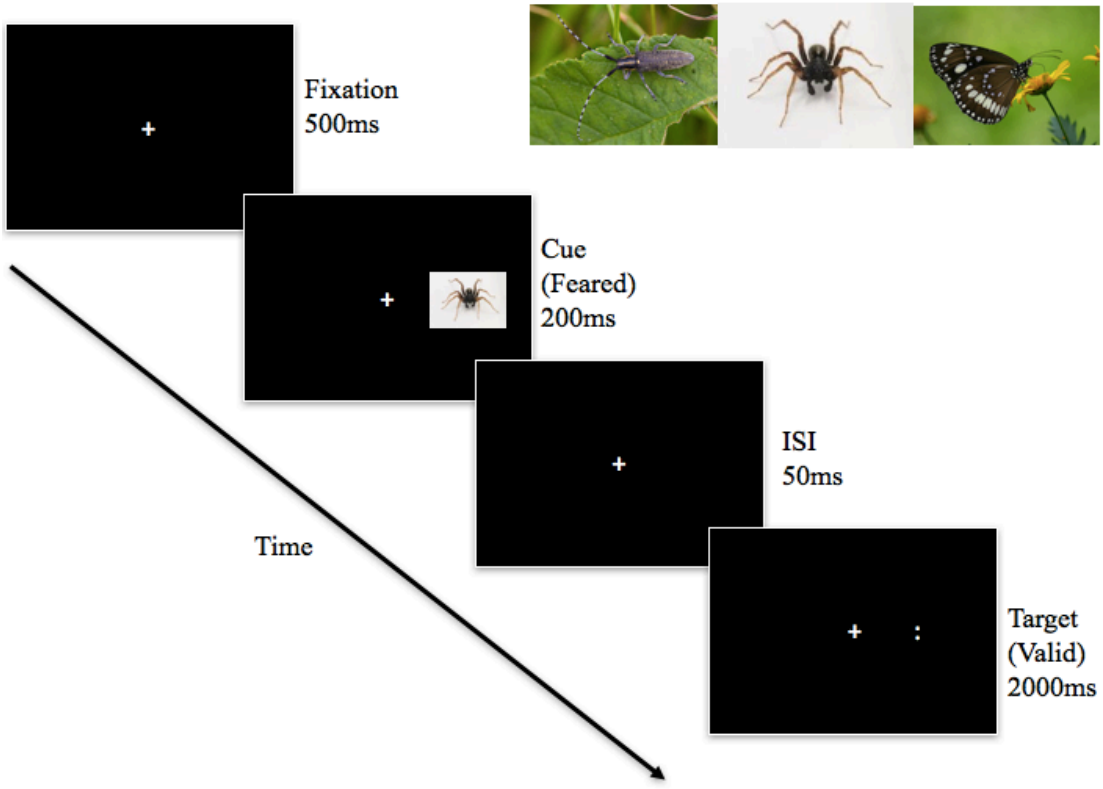

Figure 1. Schematic overview of the modified spatial cueing task with example images for each cue type (neutral, feared and positive valence).

Photographs of spiders, beetles and butterflies used in this task were sourced from the internet via Flickr (2016) and Encyclopedia of Life (2016), and were Creative Commons licenced. Images were cropped and resized to measure 8cm by

6cm. Each image category comprised 24 different images, with the task repeating each image eight times.

Electroencephalographic (EEG) Recording. EEG data was recorded via NeuroSCAN system (Scan 4.5 system) and 32 channel Quik-Cap with Ag/AgCl sintered electrodes mounted to adhere to the international 10-20 system of electrode placement. Electro-oculographic (EOG) activity was monitored via electrodes placed on the outer canthi of both eyes (horizontal EOG) and supra- and infra-orbitally (vertical EOG), and referenced to linked mastoids. Continuous EEG data was recorded from 32 sites and sampled continuously at a rate of 1000Hz, whilst electrical impedance was kept below 10kΩ. Behavioural data was merged with continuous EEG data offline, and data was filtered with a low pass zero phase shift filter (30Hz, 24dB/Oct). Ocular artifact rejection was used to minimise the impact of eye blinks on other electrode channels. Due to short inter-stimulus intervals (ISI), cue-related components were visible in the pre-stimulus interval for the target. Therefore, a long pre-stimulus interval was chosen to obtain an adequate baseline, with epochs extracted from 300ms before stimulus onset to 700ms post stimulus. Baseline correction was conducted, followed by artifact rejection, with trials containing artefacts above 70 μV and below -70 μV rejected. Occipital P1 component was determined from grand averaged waveforms from lateral occipital sites (O1 and O2) for each condition and was defined as the maximum amplitude between 70-140ms post target onset.

Procedure

Informed consent was obtained (see Appendix C) and online screening was used to collect participant demographics, brief medical history, fear of spiders (SPQ, FSQ), alcohol use (AUDIT), and psychological distress (K10). Participants that met

inclusion criteria were invited to attend a two-hour experimental session and instructed to abstain from alcohol for 24 hours, and from caffeine and nicotine two hours prior to testing. Upon arrival, participants provided details regarding caffeine intake, medication usage and current menstrual phase, before completing the Karolinska Sleepiness Scale (Akerstedt & Gillberg, 1990), the STAI (Speilberger, 1983) and the WTAR (Wechsler, 2001; see Appendix A).

An elasticised EEG cap was fitted to the participant's head and electrodes applied with conductive gel. Participants were seated approximately 50cm in front of the computer monitor to complete two tasks in standardised order; a Flanker go/nogo task which was used in a separate study, and the pictorial spatial cueing paradigm for this study. In preparation for the task, participants were asked to respond as quickly and accurately as possible to targets presented on screen, whilst maintaining visual focus on the central fixation cross to minimise potential eye movements. Prior to task commencement and during three breaks in the experimental task, participants were asked to rate their anxiety levels on the 100-point Subjective Units of Distress Scale (SUDS). Once the spatial cueing task was completed, participants rated the arousal (1=low arousal to 9=highly arousing) and valence (1=highly unpleasant to 9=highly pleasant) of each photograph used in the task using a 9-point Likert scale. Each image was displayed on the computer monitor for a duration of 2000ms before participants were prompted to select a rating for each category. Once a rating had been selected for each category, the following image was displayed. This task continued until all images used in the task had been rated for valence and arousal. At this point, participants were debriefed and thanked for their time.

Design and Data Analysis

Analysis of mean reaction time was conducted using a 2(Group: High fear, Low fear) x 2(Cue: Valid, Invalid) x 3(Image: Spider, Butterfly, Beetle) mixed measures analysis of variance (ANOVA). Incorrect trials and response times greater than three standard deviations for each individual's mean were excluded from analysis.

Electrophysiological measures comprised analysis of peak P1 amplitude. Analysis of peak P1 component was assessed via a 2(Group: High fear, Low fear) x 2(Cue: Valid, Invalid) x 3(Image: Spider, Butterfly, Beetle) x 2(Visual Field: Left, Right) x 2(Laterality: Contralateral, Ipsilateral) mixed measures ANOVA. Given that P1 amplitude is typically greater at contralateral sites, extra variables of visual field and laterality were included in this analysis to account for potential variance.

Additional analysis of arousal and valence to the photographic images was conducted to compare ratings given by low versus high fear groups. This analysis was performed using a 2(Group: High fear, low fear) x 3(Images: Spider, butterfly, beetle) mixed measures ANOVA. Anxiety was assessed between high and low fear groups by comparing SUDS ratings prior to task commencement (rating 1), and during each block break (rating 2, rating 3, and rating 4). This was assessed with a 2 (Group: high fear, low fear) x 4 (Time: rating 1, rating 2, rating 3, rating 4) mixed measures ANOVA.

Significant interactions were assessed by investigating simple main effects to find where differences between variables occurred. Post-hoc analyses adhered to an alpha level of 0.05 as an indicator of statistical significance, which was maintained using Bonferroni corrections. When independent variables exceeded two levels (i.e., included the variable of Image: spider, butterfly, beetle), sphericity was controlled

via Greenhouse-Geisser corrections. Effect size was reported as partial eta squared in main effects and interactions, with values of >.01 considered small, >.09 as medium, and >.14 interpreted as large effects. Hedge's *g* was used to ascertain effect size of simple main effects, with values of >.2 considered small, >.5 as medium, and >.8 interpreted as large effects. Practice trials were not included in analyses. Significant and hypothesis-specific *F*-tests are included in the results section, whilst hypothesis relevant non-significant *F*-tests (p >.05) can be found in Table 1, Appendix D.

Results

Demographics

Table 1 shows the mean age and mean raw scores on questionnaire measures for each group. There was a significant difference in spider fear between groups, with the high fear group obtaining significantly higher scores on measures of spider fear (SPQ, FSQ). There were no significant differences between groups on age, alcohol dependence (AUDIT), sleepiness on day of testing (KSS), and hours of sleep the night previous. Measures of trait anxiety (STAI), verbal intelligence (WTAR), and psychological distress (K10) were trending toward significance, with moderate effect sizes noted such that the high fear group attained greater scores on the STAI and K10, while the low fear group scored higher on the WTAR.

Table 1

Mean Age, Hours of Sleep, and Raw Scores on Measures of Spider Fear, Anxiety, Reading Ability, Video Game Experience and alertness for Low and High Fear Spider Groups

	Low Fear *M(SD)*	High Fear *M(SD)*	*F*(1, 26)	*p*	Hedge's *g*
Age (years)	23.4 (5.2)	22.4 (5.7)	0.2	.204	0.17
Sleep (hours)	7.9 (2.0)	7.8 (1.1)	0.03	.862	0.06
$SPQ_{/33}$	3.4 (1.8)	19.1 (4.7)	135.7	<.001	4.27
$FSQ_{/126}$	24.7 (7.3)	96.9 (13.0)	327.3	<.001	6.64
STAI $Y\text{-}2_{/20}$	34.5 (9.1)	41.4 (10.0)	3.6	.069	0.69
$WTAR_{/50}$	39.8 (6.0)	35.2 (8.0)	2.9	.098	0.63
$K10_{/10}$	15.4 (5.7)	19.4 (6.1)	3.2	.085	0.66
$AUDIT_{/10}$	2.4 (1.6)	5.4 (4.7)	0.4	.511	0.25
$VGEQ_{/1}$	2.4 (1.2)	2.6 (1.8)	0.1	.765	0.11
$KSS_{/1}$	5.3 (1.7)	5.2 (1.8)	0.0	.915	0.04

Note. Standard deviations are presented in parentheses.

Accuracy

Table 2 shows the mean accuracy to targets following spider, butterfly and beetle cues during valid and invalid conditions. Analysis of accuracy (percentage of correct trials) showed a significant main effect of Image, $F(2, 47)=3.6$, $p=.033$, $\eta_p^2=.12$, such that accuracy was significantly lower following spider cues ($M=93.8$, $SD=3.3$), compared to butterfly cues ($M=95.2$, $SD=2.0$; $p=.022$, $g= .51$). However, despite a moderate effect size, this comparison does not remain significant with a Bonferroni correction applied ($\alpha=.017$). There were no significant differences

between spider and beetle cues (*M*=94.4, *SD*=2.7; *p*=.274, *g*=.20), or butterfly versus beetle cues (*p*=.076, *g*=.34).

Table 2

Mean Accuracy (%) to Targets Following Spider, Butterfly and Beetle Cues in Valid and Invalid Trials for High and Low Fear Spider Groups

	Spider		Butterfly		Beetle	
	Valid	Invalid	Valid	Invalid	Valid	Invalid
Low Fear	94.4 (4.0)	93.5 (7.0)	95.7 (3.1)	94.8 (3.9)	96.1 (3.4)	94.6 (5.1)
High Fear	93.6 (4.0)	93.6 (4.7)	95.1 (3.0)	95.2 (3.4)	93.6 (4.2)	93.3 (4.0)

Note. Standard deviations are presented in parentheses.

Reaction Time

Figure 2 shows the mean reaction time for targets following each image type in high and low fear groups. There was a significant main effect of Group, $F(1, 26)=5.5$, $p=.028$, $\eta_p^2=.17$, indicating that reaction times were significantly greater in the high fear group (*M*=596.4, *SD*=59.5) compared to the low fear group (*M*=516.9, *SD*=59.5). The main effect of Validity was significant, $F(1,26)=16.5$, $p<.001$, $\eta_p^2 = .39$, with reaction times to invalid targets (*M*=551.4, *SD*=45.0) significantly greater than reaction times to valid targets (*M*=534.9, *SD*=40.4) across all participants and images. The main effect of Image was also significant, $F(2, 43)=3.5$, $p=.037$, $\eta_p^2 = .12$, which was qualified by a significant Image x Group interaction, $F(2, 43)=3.5$, $p = .047$, $\eta_p^2= 12$. This indicated a significant effect of Image in the high fear group, $F(2, 21)=4.7$, $p = .027$, $\eta_p^2= .27$. Pairwise comparisons indicated that high fear participants attained significantly greater reaction times to targets following spider

cues (*M*=579.4, *SD*=68.7), compared to both butterfly cues (*M*=566.2, *SD*=63.4; *p*=.011, *g*=.19) and beetle cues (*M*=562.7, *SD*=74.9; *p*=.005, *g*=.23), whilst the comparison of butterfly and beetle cues was non-significant, (*p*=.335, *g*=.05). Tests of the simple effect of Group for each image (Bonferroni corrected α=.017) showed that RT to targets was greater for high relative to low fear participants following spider images (*M*=62.3, *SD*=83.5; *p*=.010, *g*=1.09). These differences between groups were not significant following beetle images (*M*=45.2, *SD*=90.8; *p*=.010, *g*=.68), or butterfly images (*M*=50.1, *SD*=81.7; *p*=.010, *g*=.84). The main effect of image in the low fear group was non-significant, $F(2, 22)=0.1$, $p = .896$, $\eta_p^2 = 01$.

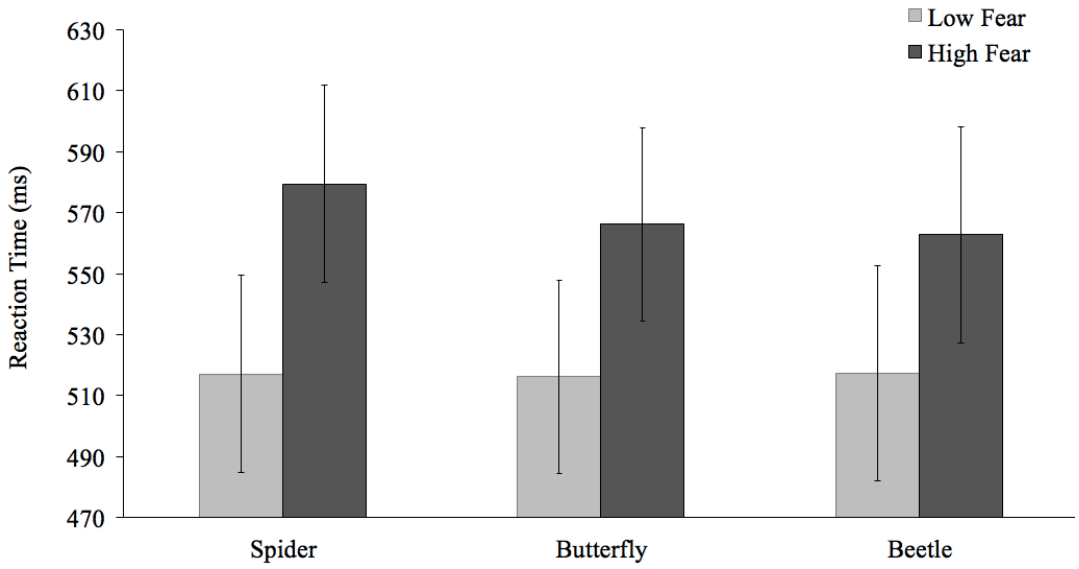

Figure 2. Mean reaction time for targets following spider, butterfly and beetle cues for high and low spider fear groups (error bars represent 95% CIs).

Peak P1 Amplitude

Figure 3 shows grand averaged ERP waveforms with average peak P1 components occurring approximately 100ms post target onset for valid trials at the left (O1) and right (O2) occipital electrodes.

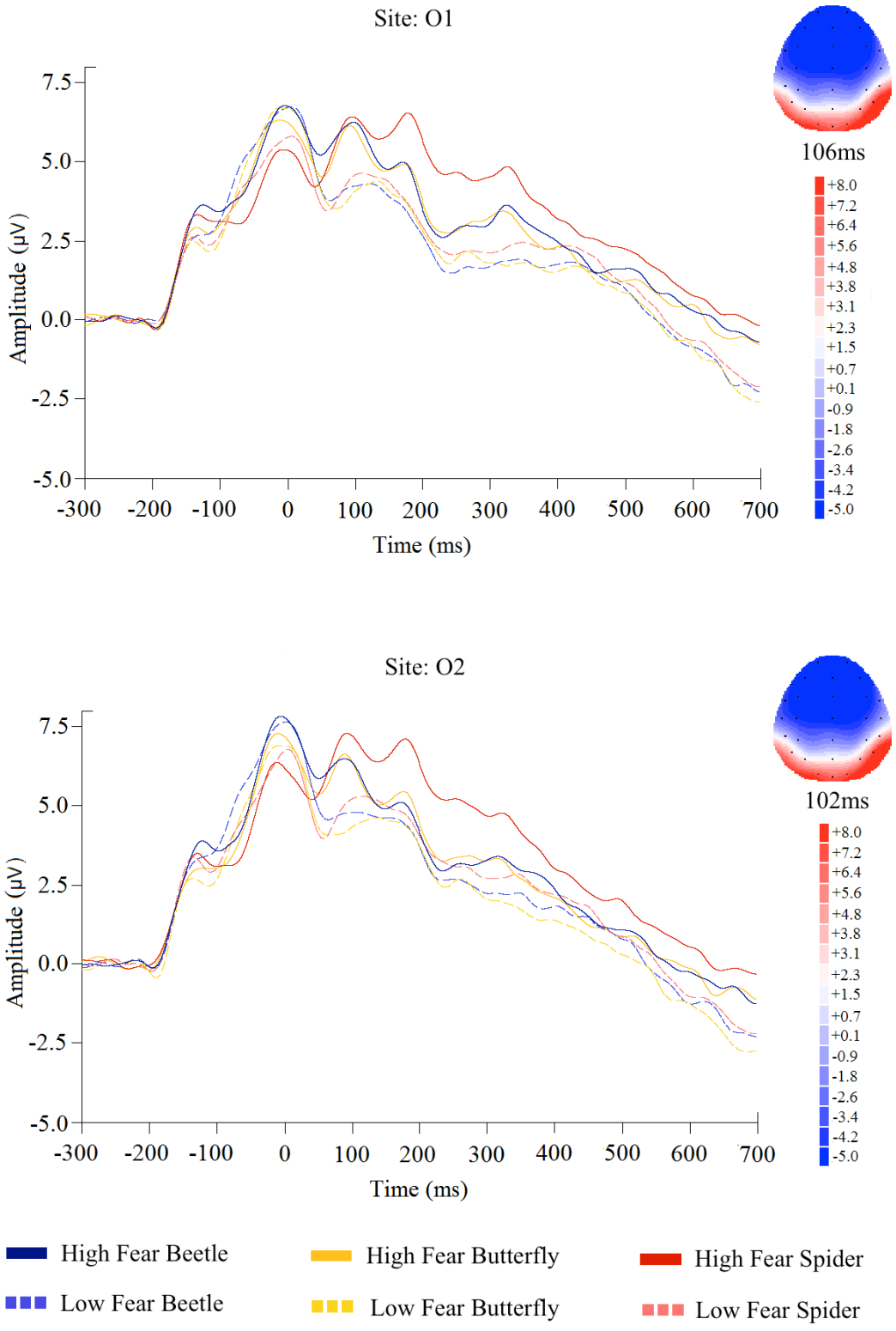

Figure 3. Grand averaged waveforms for valid trials at the left (O1) and right (O2) occipital electrodes with 2D map showing site amplitude at average peak P1 latency.

Table 3 shows the mean peak P1 amplitude to targets following spider, butterfly and beetle cues in valid trials for high and low fear groups at the left (O1) and right (O2) occipital electrodes.

Table 3

Mean Amplitude of Contralateral P1 Components at the Left (O1) and Right (O2) Occipital Electrodes Following Spider, Butterfly and Beetle Cues in Valid and Invalid Trials for High and Low Spider Fear Groups

		Spider		Butterfly		Beetle	
		Valid	Invalid	Valid	Invalid	Valid	Invalid
Site: O1	Low Fear	4.2	6.5	4.0	5.9	3.8	6.1
		(1.6)	(2.9)	(2.4)	(2.9)	(2.5)	(2.9)
	High Fear	7.5	8.9	6.9	7.6	7.4	7.9
		(1.6)	(2.9)	(2.4)	(2.9)	(2.5)	(2.9)
Site: O2	Low Fear	5.3	6.5	4.6	6.1	5.3	5.9
		(2.7)	(3.1)	(2.9)	(3.3)	(2.7)	(2.6)
	High Fear	7.4	9.2	6.7	8.5	7.0	9.1
		(2.3)	(2.0)	(7.0)	(3.9)	(2.8)	(3.0)

Note. Means are presented in micro-volts. Standard deviations are presented in parentheses.

A main effect of Validity was revealed, $F(1, 26)=24.0$, $p<.001$, $\eta_p^2=.48$, with invalid cues ($M=7.0$, $SD=1.7$) eliciting greater P1 amplitude than valid cues ($M=6.0$, $SD=1.4$). A main effect of Laterality was demonstrated, $F(1, 26)=9.9$, $p=.004$,

η_p^2=.28, with greater P1 amplitude found at the contralateral occipital electrode to the target (*M*=6.6, *SD*=1.5) than the ipsilateral occipital electrode (*M*=6.4, *SD*=1.5). There was a significant main effect of Group, *F*(1, 26)=9.6, *p*=.005, η_p^2=.27, with the high fear group obtaining higher P1 amplitude (*M*=7.7, *SD*=2.1) than the low fear group (*M*=5.2, *SD*=2.1), and a significant main effect of Image *F*(2, 52)=6.6, *p*=.003, η_p^2=.20, with all participants obtaining significantly greater P1 amplitude following spider cues (*M*=6.8, *SD*=1.4) compared to butterfly cues (*M*=6.3, *SD*=1.7, *p*=.005, *g*=.32) and beetle cues (*M*=6.4, *SD*=1.5, *p*=.003, *g*=.27).There was no significant difference in P1 amplitude generated following beetle compared to butterfly cues (*p*=.544, *g*=.06). The hypothesised Validity x Image x Group interaction was non-significant *F*(2, 44)=0.19, *p*=.791, η_p^2=.01, indicating that the effects of Group and Image were the same across valid and invalid trials.

A significant interaction of Validity x Laterality was found, *F*(1, 26)=11.6, *p*=.002, η_p^2=.31, with tests of simple effects revealing a significant effect of validity at contralateral sites to the target *F*(1, 26)=41.7, *p*<.001, η_p^2=.62, such that invalidly cued targets elicited greater P1 amplitude (*M*=7.4, *SD*=2.3) than validly cued targets (*M*=5.8, *SD*=2.1). This validity effect was not significant at ipsilateral sites, *F*(1, 26)=2.3, *p*=.142, η_p^2=.08.

The Visual Field x Laterality interaction was significant, *F*(1, 26)=5.2, *p*=.030, η_p^2=.17, with pairwise comparisons showing significant greater amplitude at the contralateral electrode (*M*=6.8, *SD*=2.4) compared to the ipsilateral electrode (*M*=6.1, *SD*=2.2; *p*=.002, *g*=.30) for targets presented in the left visual field. There was no significant difference between contralateral (*M*=6.4, *SD*=2.1) and ipsilateral sites (*M*=6.7, *SD*=2.3) following targets presented in the right visual field (*p*=.282, *g*=.13). The main effect of Visual Field target presentation was non-significant. All

other main effects and interactions were non-significant (See Table 1 in Appendix D for *F*-tests).

Valence and Arousal Ratings

Table 4 contains the mean valence and arousal ratings for spider, butterfly, and beetle images. Analysis of valence ratings revealed a significant main effect of Image, $F(2, 41)=115.8$, $p<.001$, $\eta_p^2=.82$, with all participants rating spider images ($M=3.0$, $SD=1.3$) as significantly more unpleasant than butterfly images ($M=6.7$, $SD=1.2$, $p<.001$, $g=2.92$) and beetle images ($M=5.3$, $SD=1.1$ $p<.001$, $g=1.88$). The comparison between butterfly and beetle images was also significant ($p<.001$, $g=1.20$). There was a significant main effect of Group, $F(1, 26)=14.7$, $p=.001$, $\eta_p^2=.36$, with high fear participants rating all images as significantly less pleasant ($M=4.4$, $SD=0.9$) than the low fear group ($M=5.7$, $SD=0.9$, $p=.001$, $g=1.40$).

Table 4

Mean Valence and Arousal Ratings for Spider, Beetle and Butterfly Cue Images

	Valence			Arousal		
	Spider	Butterfly	Beetle	Spider	Butterfly	Beetle
Low Fear	4.4 (1.6)	7.2 (1.2)	5.4 (1.1)	2.5 (1.8)	2.5 (1.7)	2.1 (1.0)
High Fear	1.7 (0.7)	6.3 (1.1)	5.1 (1.0)	4.9 (2.3)	1.9 (1.2)	2.4 (1.6)

Note. Standard deviations are presented in parentheses.

Main effects were qualified by a significant Image x Group interaction, $F(1.6, 40.7)=12.5$, $p<.001$, $\eta_p^2=.32$. Tests of simple effects revealed that the low fear group demonstrated a significant effect of Image, $F(1, 18)=23.9$, $p<.001$, $\eta_p^2=.65$, with pairwise comparisons eliciting a significant difference across all image conditions,

such that low fear participants rated butterfly images as significantly more pleasant than beetle images (p<.001, g=1.52), and spider images (p<.001, g=1.85). The high fear group attained a significant effect of Image on valence ratings, F(2, 25)=156.5, p<.001, η_p^2=.92. The comparison of valence ratings in the high fear group for spider and beetle images did not reach significance after a Bonferroni correction (α=.017; p=.032, g=.68). All pairwise comparisons were significant (p<.001), with spider images rated less pleasant compared to beetle images (g=3.82), and butterfly images (g=4.84). Butterfly images were rated as significantly more pleasant than beetle images (g=1.11). A series of one-way ANOVAs (α=.017), revealed a significant difference between groups for spider images F(1, 26)=31.7, p<.001, g=2.07, and non-significant differences between butterfly images F(1, 26)=3.9, p=.059, g=.72, and beetle images F(1, 26)=0.7, p=.398, g=.32.

Analysis of arousal ratings revealed a significant main effect of Image, F(1, 33)=11.4, p=.001, η_p^2=.31, with all participants rating spider images (M=3.7, SD=2.1) as more arousing than beetle images (M=2.3, SD=1.3, p<.001, g=.79). Butterfly images (M=2.2, SD=1.5) were rated as less arousing than spider images (p=.003, g=.81). Arousal ratings for butterfly and beetle images were not significantly different (p=.830, g=.07). The main effect of Group was non-significant F(1, 126)=2.15, p=.154, η_p^2=.08. There was a significant Image x Group interaction, F(1, 33)=10.02, p=.002, η_p^2=.28, with tests of simple effects revealing a significant difference in Image for the high fear group, F(1, 18)=18.0, p<.001, η_p^2=.58. Pairwise comparisons showed that spider images were rated by the high fear group as significantly more arousing than both beetle images (p<.011, g=.1.23) and butterfly images (p<.001, g=1.59) respectively. A series of one-way ANOVAs (α=.017), revealed a significant difference between groups for spider images F(1, 26)=10.1,

p=.004, g=1.16, and non-significant differences between butterfly images F(1, 26)=1.2, p=.284, g=.40, and beetle images F(1, 26)=0.2, p=.630, g=.18.

Subjective Units of Distress Scale ratings

Table 5 shows the mean Subjective Units of Distress Scale (SUDS) ratings. Tests of between subjects effects showed a significant main effect of Group, F(1, 26)=8.8, p=.006, η_p^2 =25, such that the high fear group rated their distress levels as higher (M=15.8, SD=10.8) than the low fear group (M=3.7, SD=10.8; g=1.09). A main effect of Rating was found, F(2, 49)=7.8, p =.001, η_p^2=.23. This was qualified by a significant Rating x Group interaction, F(2, 49)=10.1, p <.001, η_p^2 =.28, with tests of simple effects revealing a significant effect of Rating in the high fear group, F(2, 24)=12.4, p<.001, η_p^2=.49, such that ratings of distress increased from times 1-2 (p<.001, g=.95), 1-3 (p<.001, g=.90), and 1-4 (p=.002, g=.80). Ratings at times 2-3 did not differ significantly (p=.865, g=.03), nor did ratings 2-4 (p=1.000, g<.001), or 3-4 (p=.844, g=.02). There was no significant effect of rating in the low fear group F(2, 18)=7.9, p=.749, η_p^2=.02.

Table 5

Mean Subjective Units of Distress Scale Ratings Obtained Prior to Task and During Task Breaks

	Subjective Units of Distress Scale			
	Rating 1	Rating 2	Rating 3	Rating 4
Low Fear	4.3 (7.6)	3.2 (4.2)	3.2 (4.6)	3.9 (6.6)
High Fear	6.1 (10.6)	18.9 (15.1)	19.3 (17.0)	18.9 (19.2)

Note. Standard deviations are presented in parentheses.

Discussion

The aim of the present research was to investigate attentional biases of the orienting network in high spider fearful individuals, including disengagement difficulty and hypervigilance. Attentional Control Theory (ACT) posits that anxiety results in disruption between the orienting and executive control networks of the attention system, characterised by increased bottom-up (stimulus driven) processing and decreased top-down (goal-directed) processing, thus leading to increased dependence on the orienting system in response to a stimulus, and less influence from the executive control system (Eysenck et al., 2007).

The hypothesis that high fear participants would show faster reaction times and greater P1 amplitude following valid spider (feared) cues as an indicator of hypervigilance compared to low spider fear participants was not supported, with a significant Image x Group interaction instead showing a general slowing of reaction time among high fear participants compared to low fear participants across all image types, which was greatest for spider trials regardless of validity. As ERP evidence for cortical hypervigilance, it was expected that high fear participants would produce greater P1 amplitude to targets following spider cues, followed by beetle and butterfly cues respectively. This hypothesis was not supported due to a non-significant Group x Validity x Image interaction. However, there were significant main effects of Group and Image, such that high fear participants obtained greater P1 amplitude following all images in comparison to low fear participants, and P1 amplitude time-locked to the target following spider cues was greater than beetle and butterfly conditions overall.

Finally, as evidence for disengagement difficulty it was hypothesised that high fear participants would display slower reaction times following invalid spider

cues compared to low fear participants, however, this was not supported given the non-significant Image x Validity x Group interaction.

Behavioural Measures

Reaction Time. The hypothesised differences in reaction time in high fear participants indexing hypervigilance and disengagement difficulty were not found, which is surprising given that the majority of previous research has demonstrated enhanced hypervigilance by faster reaction time obtained by high fear participants in the dot-probe task (Lipp & Derakshan, 2005; Mogg & Bradley, 2006). However, there is some evidence for generalised slowing within the dot-probe task (Yiend & Mathews, 2001). The finding that reaction times were greater across all image conditions in the high fear group is more indicative of an interference effect, adding further evidence to Johnstone's (2015) finding of generalised slowing in high fear participants (interpreted as interference). However, in the present research, slowed reaction times following spider cues were significantly greater in high fear compared to low fear participants. This slowing suggests greater interference effects under conditions of higher state anxiety. This may be due to disruption of the ventral and dorsal components of the orienting network, such that the overactive ventral system (bottom-up, automatic orienting) disrupts top-down control over the top-down orienting system (ventral orienting network; Petersen & Posner, 2012).

Given that this paradigm included a discrimination task rather than the detection task used by Johnstone (2015), it is also possible that high fear participants were more susceptible to interference due to increased cognitive load, with greater attentional interference demonstrated following spider images than beetle and butterfly images. This is in contrast to Johnstone's (2015) finding of greater reaction times for high fear participants in both threat-related and neutral images, which was

interpreted as general interference. The present findings are consistent with ACT (Eysenck et al., 2007) and demonstrate that high fear participants may be less able to inhibit emotional impact on behaviour, as elicited through exposure to feared images. Eysenck and colleagues (2007) postulated that the interference effects of anxiety on attentional control would become greater as task demands increase, which helps to explain the greater slowing found following spider images relative to neutral images in the present research compared to the general slowing found by Johnstone (2015). It is possible that increased cognitive load in visual tasks serves to amplify the slowing effects in reaction time due to interference caused by state anxiety.

It is thought that early attentional biases may involve an automatic amygdala response following exposure to threat-related stimuli (Cisler & Koster, 2010). This is consistent with research positing that the amygdala receives visual threat-related information via the magnocellular route and thalamo-amygdala connection which transmits information to the visual cortex (Berggren & Derakshan, 2013; Öhman, 2009). Further research should investigate whether the interference effects found in this study are tied to this automatic amygdala response.

Accuracy. Whilst there were no specific hypotheses regarding accuracy, it is interesting to note the significant main effect of image, with all participants obtaining lowest accuracy to targets preceded by spider images. However, high fear participants also showed a reduction in efficiency for spider trials, demonstrated by additional slowing of reaction time. Although non-significant following a Bonferroni correction, this difference was a moderate to large sized effect. This further supports the proposal of an interference effect regardless of fear status, yet amplified for people with high spider fear. Early visual identification of threatening images such as spiders has been postulated to be a phylogenetic mechanism in which all people are

evolutionarily programmed to show hypervigilance to potentially threatening stimuli as a primitive survival mechanism (Öhman, 2009). There was no evidence of a speed-accuracy trade-off, as no other main effects or interactions were significant.

Electrophysiological Correlates of Attention

Cortical hypervigilance was expected to be demonstrated by increased P1 amplitude between groups, with the high fear group attaining greater amplitude than the low fear group overall, in line with previous research (Kolassa et al., 2006; Venetacci, 2014). It was also expected that P1 amplitude increase would be dependent on image type such that spiders would elicit greater P1 amplitude followed by beetles and butterfly images respectively in each group. However, in the present study, there was a main effect of Group found in P1 amplitude such that the high fear group attained greater amplitude than the low fear group, thus eliciting an expected effect that Johnstone (2015) did not. Nonetheless, this was not qualified by the hypothesised Group x Image interaction in which it was expected that spider images would lead to greater P1 amplitude to the target than neutral or positive valence images.

This finding is consistent with research by Kolassa and colleagues (2006) which utilised an emotional Stroop paradigm. Kolassa and colleagues found that both phobic groups (social phobia and arachnophobia) demonstrated increased P1 amplitude in comparison to psychologically healthy control participants. They concluded that early ERP components are modified by anxiety status and not necessarily by exposure to representations of the specific phobia.

A supplementary finding in this research not central to the hypotheses, but worthy of discussion, is the reverse validity effect found in the P1 component. This was demonstrated via a Validity x Laterality interaction showing a greater P1

amplitude arising from invalid trials at contralateral sites to the target. This is in direct contrast to research by Fu and colleagues (2005), which provided evidence for greater P1 amplitude recorded at posterior sites (occipital, temporal and parietal electrodes) for valid rather than invalid trials.

Ordinarily in spatial cueing paradigms, valid trials result in higher P1 amplitude than invalid trials (Chica et al., 2013; Eimer, 1998; Fu et al., 2001; Hopfinger & West, 2006; Luck, 1995; Mangun, 1995; Talsma et al., 2007). Whilst the reverse validity effect found in the present research is not entirely uncommon in previous literature, it is often found when cognitive load is increased (Fu et al., 2009), or ISI durations are longer (566-766ms; Hopfinger & Mangun, 2001). Other studies have found mixed results dependent on other variables. For example, Rossignol et al. (2013) found greater amplitude P1 components following valid cues in participants with high fear of negative evaluation (FNE), but greater amplitude following invalid cues in low FNE participants. Santesso et al. (2008) found greater P1 amplitude for valid trials following presentation of an angry face, yet greater P1 amplitude in invalid trials following happy faces.

This research aimed to build upon the findings of Johnstone (2015), by modifying the paradigm to increase the likelihood of finding evidence for specific behavioural and cortical hypervigilance and difficulty disengaging. ISIs and stimulus durations for this modified spatial cueing paradigm were chosen based on research by Mogg et al. (2008) and Koster et al. (2006a), whose findings we also aimed to extend. As suggested by Chica et al. (2014), a discrimination task was chosen over a detection task in order to increase cognitive load and increase facilitatory effects. This was also intended to avoid any effects which may be attributed to inhibition of return (IOR; Posner, Rafal, Choate & Vaughan, 1985). IOR is proposed to be an

evolutionary predisposition in which humans avoid attending to previously attended locations, with the attentional system instead directing attention to un-cued locations (Klein, 1988). IOR typically occurs in discrimination tasks with stimulus onset asynchronies (SOAs) of approximately 700ms duration. Discrimination tasks are also not as reliant on the inclusion of catch trials (in which no target appears proceeding a cue for a certain percentage of trials) as detection tasks, as the accuracy of discrimination itself is ample to ensure task compliance without the inclusion of catch trials.

The effect of the cue on the target-locked ERPs wave necessitated the extraction of longer epochs (-300ms–700ms). This was due to a short ISI (50ms) used in this paradigm. As there is a lack of ERP research utilising a spatial cueing paradigm with threat-related image cues, the design of this task was mostly based on studies eliciting behavioural results only (Koster et al., 2006a; 2006b; Mogg et al., 2008). Cleaner ERP waves could have been generated by using the Adjacent Response (Adjar) technique (Woldorff, 1993), in which ISIs are varied or 'jittered'. Theoretically, if the variation in ISIs is wide enough, overlapping adjacent responses in the ERP wave will be cancelled out during the averaging process. Bound by time and software constraints, it was not possible to conduct this technique in the present research.

Whilst investigation of ERP components of disengagement was not included in this research, it is notable that a reliable electrophysiological marker of disengagement remains elusive. Although there have been a number of ERP components proposed as markers of attentional disengagement such as the P4pc (Toffanin, de Jong & Johnson,2011), IIN (Hopfinger & Ries, 2005; Shin, Hopfinger, Lust, Henry & Bartholow, 2010) and N2pc (Buodo, Sarlo & Munafo, 2010; Eimer &

Kiss 2007; 2008; Weymar, Gerdes, Low, Alpers & Hamm, 2013), these have all been investigated in different attentional paradigms such as visual search and visual detection tasks. At this point in time, evidence in the literature thus far is inconclusive, with certain laboratories mainly replicating their own research. Investigation of these various markers was beyond the scope of the present research, however, further research is warranted given that investigation of electrophysiological markers of attentional disengagement is in its infancy.

Whilst high fear participants in this research did elicit greater amplitude P1 components than low fear participants, this is indicative of general rather than specific hypervigilance. However, given that there were no behavioural indicators of hypervigilance, the increased P1 amplitude demonstrated by high fear participants may be indicative of increased early visual processing and greater attentional selection required for target processing following cue-related interference. Given that the present study limited analyses to occipital electrodes, it may be worth investigating sites over the temporal and parietal regions in order to better record activity from locations outlined by Corbetta and Shulman (2002), which Petersen and Posner integrated into their latest attentional network model (2012). These areas include the frontal eye fields and intraparietal sulcus/superior parietal lobe (dorsal attention system), and the temporoparietal junction and ventral frontal cortex (ventral attention system; Corbetta & Shulman, 2002).

Certainly, further research is warranted in order to untangle these specific mechanisms of attentional bias more thoroughly. There some suggestion by Petersen and Posner (2012) that constructs such as emotional self-regulation may impact on individual variance in attentional ERP components. As there was no measure of self-regulation included in the present research, this adds an extraneous variable that

warrants further studies in emotional visual attention tasks inclusive of measures of self-regulation. For example, the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004).

Limitations

Key limitations of the present research include under-powered analyses due to insufficient sample size. Due to inherent time constraints and the exclusion of data points in order to maintain a clean sample, 14 participants were included in each group, despite a G-Power recommendation of 15 participants per group for appropriate power and effect sizes in mixed measures ANOVA. The findings of this research should be considered preliminary until replicated with a greater sample size.

Participants were screened with measures of spider fear, but a clinical diagnosis was not obtained for specific phobia. It is possible that different or greater effect sizes would be observed if comparing spider-phobics to low-fear non-phobics. It is also worth noting that measures of trait anxiety (STAI), verbal intelligence (WTAR), and psychological distress (K10) were trending toward significance, with moderate effect sizes noted such that the high fear group attained greater scores on the STAI and K10, while the low fear group scored higher on the WTAR. Future research should aim to match groups on such factors to limit variance that may be due to these factors rather than the manipulated variables.

Another limitation involves the absence of eye-tracking technology in order to ensure participants maintained visual focus on the central fixation cross as instructed. Although horizontal and vertical EOG activity was monitored and their effects on surrounding electrodes limited, this is a less accurate technique than the integration of eye-tracking technology in such a study where exogenous spatial cues are used. Integration of eye-tracking technology would have provided more

definitive confirmation of gaze fixation on the central fixation cross when cues and targets were presented peripherally. Horizontal eye movements were monitored using horizontal eye electrodes to ensure movement was minimal, however, without eye-tracking technology it is not possible to know the true extent of eye movements. This has implications for whether covert attention is truly being measured, rather than overt attention.

In order to thoroughly investigate disengagement difficulty, the spatial cueing paradigm would benefit from a greater number of trials (in particular invalid trials), in order to improve the signal-to-noise ratio in the ERP recordings. This is necessary in order to better examine the disengagement and shifting of attention away from a feared stimulus that would be generated by invalid cues. Considering there needs to be a greater ratio of valid to invalid trials in order for cues to be predictive (Chica et al., 2014), and therefore, for hypervigilance to be investigated, hypervigilance and disengagement mechanisms would theoretically need to be studied within separate paradigms, as 50% validity in similar research has been demonstrated to elicit neither hypervigilance nor disengagement (Johnstone, 2015). Thus, future research investigating disengagement difficulty should make use of predictive cues with validity of 75% and over.

Implications

This research provides evidence for ACT (Eysenck et al., 2007). ACT posits that anxiety results in disruption between the orienting and executive control networks of the attention system, characterised by increased bottom-up (stimulus driven) processing and decreased top-down (goal-directed) processing, thus leading to increased dependence on the orienting system and reduced influence of the executive control network (Eysenck et al., 2007). For example, goal-directed action

(such as responding to the dot pair in the modified spatial cueing task) is delayed due to stimulus driven impulses, such as being in the presence of a feared stimulus. The finding of slowed reaction time among high fear participants adds support to this theory.

The finding that high fear participants in this study seemed to exert greater attentional resources following all images, but spiders in particular, has implications for a more integrative approach in studying the potential interference effects and increased attentional processing following exposure to threatening stimuli. ERP techniques have excellent temporal specificity, so whilst studies using functional magnetic resonance imaging (fMRI) technology have seen increased popularity in the past decade, there is more to be discovered within the temporal domains of attentional biases.

This research has implications for a more comprehensive understanding of attentional processes and how these may be modulated by emotions such as fear. This will lead to the development of more effective treatments for individuals with specific fear or clinical phobia, for example, attention bias modification (Fox et al., 2015).

Summary and Conclusion

The aim of this research was to investigate attentional biases specific to the orienting network of attention in high spider fear participants compared to low fear participants. Previous research provides support for attentional bias towards threat in anxiety, as well as specific fear via measures of hypervigilance, however, there is inconsistency within the literature in regards to disengagement difficulty and avoidance of threatening stimuli. Hypotheses regarding hypervigilance and disengagement difficulty were not supported. However, the behavioural results of

this study indicated a general slowing effect in reaction time among high fear participants that was greater following spider cues than beetle or butterfly cues. This finding can be considered preliminary support for ACT (Eysenck et al., 2007) in specific fear, and may arise due to interference mechanisms arising though threat-related attentional capture and subsequent amygdala activation. However, these results should be interpreted with caution as further replication is necessary to address the limitations of the present research. Electrophysiological results indicated greater P1 amplitude in the high fear group following all image conditions compared to the low fear group, suggestive of generalised cortical hypervigilance and increased attentional processing in high fear participants.

Future research in this area is encouraged in order to better understand the influence of emotions such as fear on the attentional networks and how these are demonstrated through behavioural and electrophysiological indices. Further studies in this area will not only increase understanding of attentional processes but also enable the development of more effective and treatments for specific phobia.

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Appendices

Appendix A

Experimental Screening Questionnaire

Note to interviewer: When booking, ask participant not to consume caffeine (2 hrs), tobacco (2hrs), alcohol (24 hours) and illicit drugs (none) prior to session, and let them know that they may have some residual electrode gel in their hair when they leave the session

Experimental session questions

(To be completed on the day of the experimental session)

Date ____/____/____ Participant ID _____

1. **Check that participant has abstained from alcohol for 24 hours and illicit drug use since completing the screening questionnaire**
3. **How many cups of coffee (or any other caffeinated drinks/products) have you consumed today? _____**
   If > 0. How many hours since your last caffeinated drink _____ hours
4. **Have you had any tobacco or nicotine products today? Yes / No**
   If yes, how many cigarettes (or nicotine products) have you had today? ____
   If yes, How many hours since your last cigarette (nicotine product) _____ hours
5. **Have you consumed any medications in the past week (or any prescribed medications since completing the screening questionnaire)?**
   If yes, please detail:

Medication	Number of occasions	Time since last used	Estimated dose

6. Approximately how many hours sleep did you have last night? ____

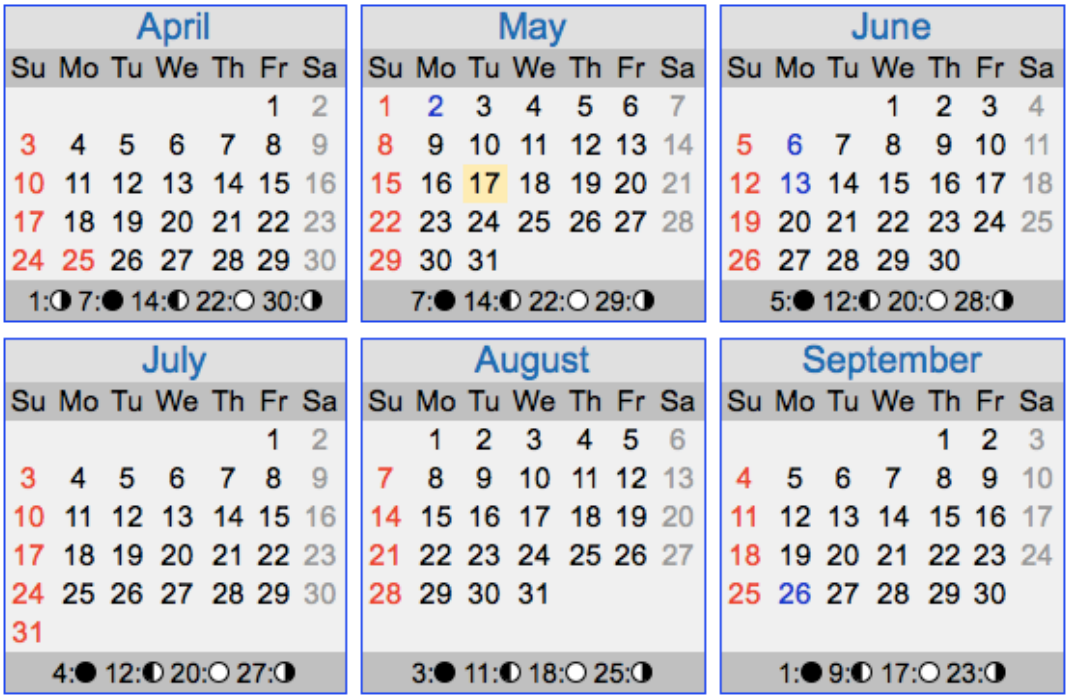
Karolinska sleepiness scale (participant can self-complete)

Please circle on the following scale of 1 to 9 how you feel **AT THE PRESENT MOMENT**:

1	2	3	4	5	6	7	8	9
Very alert		Alert – normal level		Neither alert nor sleepy		Sleepy – but no effort to stay awake		Very sleepy, great effort to stay awake, fighting

What was the date of the first day of your last period? If you don't remember the exact date you can give an approximate range (e.g. 5-8 May):

_____



April

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

1:◑ 7:● 14:◐ 22:○ 30:◑

May

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

7:● 14:◐ 22:○ 29:◑

June

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

5:● 12:◐ 20:○ 28:◑

July

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August

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28	29	30	31			

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September

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

1:● 9:◐ 17:○ 23:◑

Date: _____ Participant: _____

Video Gaming Experience Questionnaire

We are interested in how often you play video games, and may use this information to examine the effects of video game playing on visual attention and motor skills.

How often would you normally play video games? Please choose one response.

- ☐ Never play video games
- ☐ Rarely play video games (less than 2 hours a month)
- ☐ Occasionally play video games (between 30 minutes and 2 hours a week)
- ☐ Regularly play video games (between 2 hours and 5 hours a week)
- ☐ Often play video games (more than 5 hours a week)

Appendix B
Ethics Approval Letter

Ethics Amendment Approval: H0011104 The effects of real versus hyper-real images on computer-based exposure treatment for spider phobia.

Katherine Shaw

Fri 1/04/2016 1:23 PM

To: Allison Matthews <allison.matthews@utas.edu.au>;

Cc: Kenneth Kirkby <ken.kirkby@utas.edu.au>; Amber Johnstone <amberj@utas.edu.au>; Tess Nikitenko <tessn@utas.edu.au>; Monique Williams <monique.williams@utas.edu.au>;

Dear Dr Matthews

Ethics Ref: H0011104
Title: The effects of real versus hyper-real images on computer-based exposure treatment for spider phobia.

This email is to confirm that the following amendment was approved by the Chair of the Tasmania Social Sciences Human Research Ethics Committee on 31/3/2016:

1. Removal of Honours students Isabel Hoystead, and Shelley Flynn.
2. Addition of incoming 2016 Honours students Tess Nikitenko and Monique Williams.
3. Modification to the attentional tasks used in the study.
4. Revised Attachment D - Information Sheet and Attachment E - Consent Form.

All committees operating under the Human Research Ethics Committee (Tasmania) Network are registered and required to comply with the National Statement on Ethical Conduct in Human Research (NHMRC 2007, updated May 2015).

This email constitutes official approval. If your circumstances require a formal letter of amendment approval, please let us know.

Should you have any queries please do not hesitate to contact me.

Kind regards
Katherine

Katherine Shaw
Executive Officer, Social Sciences HREC
Office of Research Services | Research Division
University of Tasmania
Private Bag 1
Hobart TAS 7001
T +61 3 6226 2763

Appendix C
Participant Consent and Information Sheet

PARTICIPANT INFORMATION SHEET
Spider Fear, Brain Activity, and Attention

Invitation
You are invited to participate in a research study into the effects of spider fear on attention during the viewing of spider images. This is an Honours study being conducted by Monique Williams and Tess Nikitenko under the supervision of Dr Allison Matthews (Chief Investigator, School of Medicine, Psychology).

1. 'What is the purpose of this study?'
The purpose is to investigate brain processes involved in attentional processing among males and females with high and low spider fear.

2. 'Why have I been invited to participate in this study?'
You are eligible to participate in this study because you have an intense fear of spiders or that you have a relatively low of fear spiders.

4. 'What does this study involve?'
This study will require you to attend one session (approximately 2 hours) at the University of Tasmania. In this session you will complete some questionnaires relating to your fear of spiders. You will then complete some computer tasks where you will respond (using a button press) to particular aspects of visual stimuli presented on a computer screen. These stimuli may include pictures, letters or objects (and may include pictures of spiders). Your brain activity will be measured while you complete these tasks.

It is important that you understand that your involvement is this study is voluntary. While we would be pleased to have you participate, we respect your right to decline. There will be no consequences to you if you decide not to participate, and this will not affect your relationship with the University. If you decide to discontinue participation at any time, you may do so without providing an explanation. All information will be treated in a confidential manner, and your name will not be used in any publication arising out of the research. All of the research will be kept in a locked cabinet in the office of Dr Allison Matthews or on a secure server at the University of Tasmania.

5. Are there any possible benefits from participation in this study?
You may or may not experience anxiety during the course of the study. However, if you do, it is hoped that you will notice a reduction in your anxiety

after a certain period of time. The results of this study will provide valuable information on the attentional processes involved in spider fear and will help us to further develop an online treatment program for people with phobias.

6. Are there any possible risks from participation in this study?
If you experience anxiety during the study, this may be unpleasant and include emotions of fear and worrying thoughts, wishing to avoid the situation, physical discomforts such as palpitations, sweating and over-breathing. The researchers will provide you with information for dealing with these symptoms if they unduly trouble you. However, if you find that you are becoming distressed or experience significantly elevated levels of anxiety you will be advised to receive support from a clinician or alternatively, we will arrange for you to see a counsellor at no expense to you..

There are no specific risks associated with the measurement of brain activity. However, if you have sensitive skin there is a small possibility of a slight skin reaction from electrode preparation materials. If you believe there is a chance that your skin may react you are advised to reconsider participation.

7. What if I have questions about this research?
If you would like to discuss any aspect of this study, or require further assistance with your fear of spiders after the study is completed, please feel free to contact Dr Allison Matthews on ph (03) 62267236, who would be happy to discuss any aspect of the research with you. Once we have analysed the information we will be putting a summary of our findings on the School of Psychology website for you to view. You are welcome to contact us at that time to discuss any issue relating to the research study.

This study has been approved by the Tasmanian Social Science Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study should contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. You will need to quote [H0011104].

Thank you for taking the time to consider this study. If you wish to take part in it, please sign the attached consent form. This information sheet is for you to keep.

Chief Investigator: Dr Allison Matthews
Student Investigators: Monique Williams and Tess Nikitenko

CONSENT FORM
Spider Fear, Brain Activity, and Attention

1. I have read and understood the 'Information Sheet' for this project.
2. The nature and possible effects of the study have been explained to me.
3. I understand that the study involves attending one session (approx. 2 hours) at the University of Tasmania whereby I will complete some questionnaires and some computer based attention tasks. These tasks may involve responding to pictures (including spiders), letters, or objects and brain activity will be monitored throughout the process.
4. I understand that participation involves some risk of experiencing a heightened level of anxiety; however, the researcher will be present at all times, I will be given information on how to cope with anxiety, and I will be referred to a counsellor if need be. I understand that measurement of brain activity involves minimal risk, and slight skin irritation may occur if I have sensitive skin.
5. I understand that all research data will be securely stored on the University of Tasmania premises for ten years and will then be destroyed.
6. Any questions that I have asked have been answered to my satisfaction.
7. I agree that research data gathered from me for the study may be published provided that I cannot be identified as a participant.
8. I understand that the researchers will maintain my identity confidential and that any information I supply to the researcher(s) will be used only for the purposes of the research.
9. I agree to participate in this investigation and understand that I may withdraw at any time without any effect, and if I so wish, may request that any data I have supplied to date be withdrawn from the research.

Name of Participant:

Signature: Date:

Statement by Investigator

☐ I have explained the project & the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐ The participant has received the Information Sheet where my details have been provided so participants have the opportunity to contact me prior to consenting to participate in this project.

Name of Investigator

Signature of Investigator

Dealing with Anxiety

The Nature of Anxiety

Anxiety is a normal and healthy reaction that allows you to deal with threat or danger. When you are confronted by a threatening situation your body automatically releases hormones which send signals to the body to prepare to 'fight' or 'flight'. We become more alert, our heartbeat speeds up, the muscles get tense ready for action, sweating increases to cool the body, and breathing rate speeds up so that we can get oxygen into our bodies more quickly. These changes allow us to run very quickly or fight our enemies. Sometimes when our breathing rate increases, we tend to over breathe or hyperventilate. This hyperventilation may cause a number of symptoms including dizziness, breathlessness or chest pains. It is important to realise that these feelings are part of a physical response to threat and are not a sign that you have some physical disease. These symptoms do not mean that you will die, go crazy, or lose control.

Management of Anxiety

Although anxiety is a normal, and at times, a useful response, excessive anxiety may interfere with your everyday life. Anxiety can be managed by reversing or interrupting the flight-or-flight response through the use of breathing or relaxation techniques. To reduce symptoms of hyperventilation it is necessary to increase and steady the levels of carbon dioxide in the blood. One method to do this is breathing into a paper bag. Another method to reduce over breathing and to **prevent anxiety from escalating** is the slow breathing exercise (see below). This exercise can be practiced daily **and** used at any time that you notice sensations of anxiety.

Breathing Exercise

1. Hold your breath and count to 5 (do not take a deep breath).
2. When you get to 5, breathe out and say the word 'relax' in a calm soothing manner.
3. Breathe in and out slowly through your nose in a 6 second cycle (breathe in for 3 seconds & out for 3 seconds). This will produce a breathing rate of 10 breaths per minute. Say 'relax' to yourself when you breathe out.
4. At the end of each minute hold your breath for 5 seconds and then continue breathing using the 6 second cycle
5. Continue breathing this way until all of the symptoms of over breathing have gone.

Exposure Treatment for Anxiety

If your anxiety is associated with specific objects or situations (such as spiders) it is also possible to reduce anxiety through exposure to the feared object or situation. **It is important to remain in the feared situation until there is a decrease in anxiety. Although your anxiety may rise when confronting the situation, it will also fall within a few minutes.** By remaining in the situation you will learn that there is nothing to fear.

What do I do if I am experiencing high levels of anxiety during the treatment?

If you are feeling anxious during the treatment, try to remain calm and do the above breathing exercise. Remember your anxiety will fall in a few minutes. If your anxiety becomes overwhelming, you are free to stop the treatment. If you are undertaking a session in the research clinic you will be assisted by the researchers to regain your composure. You do not have to continue with the treatment if you do not wish to.

If your anxiety becomes overwhelming when you are completing the treatment at home, again, try to remain calm and do the above breathing exercise. Remember your anxiety will fall in a few minutes. If you choose to stop following a circle on the screen with the computer mouse, the stimulus on the screen will disappear. This will allow you time to regain your composure. When you are ready to start again, you can start following the circle and the image will reappear. Again you are free to stop the treatment at any stage. You may like to enlist the help of a friend or relative, by showing them this information, they may be able to assist you should the need arise. If you are hyperventilating and the breathing exercise does not help, you may like to have a paper bag handy that you can breathe into. This will help to stop you from over breathing.

What if I need further help or treatment?

Please note that this information is NOT a substitute for diagnosis and treatment by an appropriate health professional. Please let us know if you require further assistance and we can refer you to an appropriate health professional. Your GP will also be able to refer you for further assessment and treatment if required.

The School of Medicine (Psychology), University of Tasmania, is not a health or crisis service and does not have the capacity to provide clinical advice or assistance if you require these services. **If you need urgent medical or psychological assistance, please contact your local doctor/GP or other health professional, or the emergency department of your local hospital.**

Appendix D

Non-significant, hypothesis relevant effects

Table 1

Non-significant F-tests for Accuracy, Reaction Time and Peak P1 Amplitude.

Effect	df	*F*	*p*	η_p^2
Accuracy				
Group	1, 26	27.0	.545	.014
Validity	1, 26	1.71	.202	.062
Validity x Group	1, 26	1.52	.228	.055
Image x Group	2, 46	1.74	.186	.063
Image x Validity	2, 43	0.13	.879	.005
Image x Validity x Group	3, 43	0.01	.985	.000
Reaction Time				
Validity x Group	1, 26	0.002	.967	.000
Image x Validity	2, 46	2.88	.072	.100
Image x Validity x Group	2, 46	0.78	.450	.029
P1 Amplitude				
Image x Group	2, 46	0.49	.594	.019
Validity x Group	1, 26	0.38	.542	.014
Validity x Visual Field x Group	1, 26	3.36	.078	.114