Direction of stimulus movement alters fear-linked individual differences in attentional vigilance to spider stimuli.

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Abstract

Researchers have proposed that high spider-fearful individuals are characterised by heightened attentional vigilance to spider stimuli, as compared to low spider-fearful individuals. However, these findings have arisen from methodologies that have uniformly employed only static stimuli. Such findings do not inform upon the patterns of fear-linked attentional selectivity that occur in the face of moving feared stimuli. Hence, the present study developed a novel methodology designed to examine the influence of stimulus movement on attentional vigilance to spider and non-spider stimuli. Eighty participants who varied in level of spider-fear completed an attentional-probe task that presented stimuli under two conditions. One condition presented stimuli that displayed an approaching movement, while the other condition presented stimuli that displayed a receding movement. Fear-linked heightened attentional vigilance was observed exclusively under the latter condition. These findings suggest that fear-linked attentional vigilance to spider stimuli does not represent a uniform characteristic of heightened spider-fear, but rather is influenced by stimulus context. The means by which these findings inform understanding of attentional mechanisms that characterise heightened spider-fear, and avenues for future research, are discussed.

Introduction

Across individuals the physical approach of a potential threat signals increasing probability of danger and will likely to result in attentional vigilance to the threat and the elicitation of a fear response. For example, observing the sudden approach of a speeding truck as we cross the road will likely capture our attention and provoke anxiety, leading us to move outside its path. Likewise, if a nesting magpie were to swoop at us from its tree in a display of territorial aggression, then the bird will likely capture our attention and provoke anxiety, leading us to move away from the tree. Hence, despite the resulting anxiety response, enhanced attentional vigilance to rapidly approaching threats allows for a heightened ability to avoid the danger posed by such threats. Conversely, were it that case that the same objects were not approaching, for example if the truck or bird were receding, then these objects would be less likely to capture attention and provoke an anxious response.

Some theorist have proposed that attentional vigilance to approaching objects, like those described above, reflects an evolutionary trait present in all individuals that functions to heighten fear (Hsee, Tu, Lu, & Ruan, 2014) and attentional vigilance (Franconeri & Simons, 2003; Parker & Alais, 2007) in order to limit risk to our well-being posed by environmental threats. Specifically, individuals who suffer from specific fears, such as fear of spiders, have been found to display heightened attentional vigilance to feared stimuli relative to non-feared stimuli. However, despite the plausible impact of approach and receding movements on attentional vigilance to threatening stimuli, researchers investigating individual differences in such patterns of attention have almost exclusively employed static stimuli. For example, using a Stroop-like paradigm researchers have demonstrated that high spider-fearful individuals, relative to low spider-fearful individuals,

show longer latencies to colour name spider-related words as compared to spider-unrelated words, indicating relatively heightened attention to the lexical content of the spider-related words (Kindt & Brosschot, 1997; Watts, McKenna, Sharrock, & Trezise, 1986). Investigators using visual search paradigms have also demonstrated that individuals with heightened spider-fear display heightened attention to static pictures of spiders. For example, high spider-fearful individuals demonstrate speeded detection of pictures of spiders presented amongst static arrays of non-spider pictures, such as insects, mammals, or flowers (Öhman & Mineka, 2001; Pflugshaupt et al., 2005; Rinck, Reinecke, Ellwart, Heuer, & Becker, 2005). Additionally, when searching for an insect target stimulus in an array of static spider stimuli, high spider-fearful individuals demonstrate heightened attention towards the spider stimuli, relative to low spider-fearful individuals (Miltner, Krieschel, Hecht, Trippe, & Weiss, 2004; Rinck et al., 2005).

Another common paradigm for assessing attentional vigilance to static stimuli in spider-fear is the attentional-probe task (MacLeod, Mathews, & Tata, 1986). In this task participants are presented with pairs of static stimuli, for example an image of a spider and an image of a butterfly. Shortly after, a probe is presented in the location previously occupied by one of the stimuli, and participants must quickly identify the probe. It is assumed that probe identification latencies will be shortest when attention has been allocated to the where the probe had appeared. Hence, by comparing the speed with which participants correctly identify probes that appear in each stimulus position, the relative degree to which participants demonstrate attentional vigilance to each of the two stimuli can be determined. Using this paradigm, investigators have revealed patterns of probe identification latencies that are indicative of heightened attentional vigilance to static

spider-related stimuli amongst high spider-fearful individuals as compared to low spider-fearful individuals (Lipp & Derakshan, 2005; Mogg & Bradley, 2006).

For individuals with clinical phobia of spiders the movement of spiders, and approaching movements in particular, often hold a direct motivational meaning, acting as a cue of increased likelihood of harm that in turn elevates fear. For example, in their survey of patients with spider phobia McNally and Steketee (1985) observed that movement was a particularly salient and fear-inducing feature of spiders for 77% of respondents. Researchers have also demonstrated that approaching movements specifically are a particular cause of elevated fear amongst individuals with clinical phobia of spiders. Rachman and Cuk (1992) asked patients with spider phobia and non-phobic controls to observe a live spider in a terrarium and to later report on observed spider behaviour and their level of fear during viewing. Spider phobic participants, compared to control participants reported observing greater frequency of approach movements, and greater fear in response to approach movements. The specific impact on fear of approaching movements made by threat-related stimuli, such as spiders, has also been observed amongst individuals generally. Threat-related stimuli has been observed to elicit heightened activity in cortical regions associated with threat processing, and greater fear, when exhibiting approaching movements relative to when not exhibiting approaching movements (Mobbs et al., 2010; Riskind, 1997; Riskind, Kelley, Harman, Moore, & Gaines, 1992; Sagliano, Cappuccio, Trojano, & Conson, 2014).

While some studies have examined attentional processing in response to moving spider stimuli, critically no previous research has directly examined fear-linked differences in attentional vigilance to spider stimuli under conditions where spider stimuli display approaching movements. For example, Vrijssen et al. (2009) investigated attentional vigilance to images of spiders and non-spider objects that simultaneously moved in left,

right, up, or down directions along a path on a computer screen. Alpers, et al. (2009) employed fMRI neuroimaging techniques to assess changes in amygdala activity in the face of images of spider and birds that were overlaid. Carretié et al. (2009) examined neural indices of attentional distraction under conditions where a spider stimulus moved across a computer screen towards participants' point of attentional fixation. Rinck et al. (2010), presented participants task-irrelevant moving and non-moving spiders within an immersive virtual environment, observing that spider-fearful participants demonstrated equivalent attention toward static spiders and moving spiders. In considering this finding, Rinck and colleagues proposed that spiders moving side to side or up and down may be no more threatening to fearful participants than static spiders, and suggested that the movement of spider stimuli may moderate attention to a greater degree if the movement was clearly associated with changes in potential of danger.

Given these findings, conditions under which feared stimuli move in an approaching direction provide a novel and intriguing circumstance under which to examine fear-linked differences in attentional vigilance to spider stimuli. Hence, the aim of the present study was to examine fear-linked differences in attentional vigilance to spider stimuli under conditions where stimuli display approaching movements, and to contrast this with fear-linked differences in attentional vigilance to spider stimuli under conditions where stimuli display an equivalent amount of movement in a receding direction. Critically, this comparison will ensure that any moderating influence of approaching movement implicates the direction of movement, and is not simply the result of the presence of movement alone. The study developed a novel variant of the attentional-probe task (MacLeod et al., 1986) capable of measuring attentional vigilance to spider stimuli relative under two conditions. One condition presented stimuli that gradually became larger in size so as to display an

apparent approach movement towards the viewer. A second condition presented stimuli that gradually became smaller size so as to display an apparent receding movement from the viewer.

A logical contemplation reveals three alternative possibilities that could arise when comparing fear-linked differences in attentional vigilance to spider stimuli under these conditions. It may be the case that the discrepancy between approaching movement and receding movement exerts no effect on fear-linked differences in attentional vigilance to spider stimuli. If this were the case, then fear-linked differences in attention vigilance to spider stimuli would not differ under conditions where spider stimuli display approaching movement or conditions where spider stimuli display receding movement. Alternatively, it may be that fear-linked differences in attentional vigilance to spider stimuli are enhanced under conditions where spider stimuli are approaching, relative to when spider stimuli are receding. Lastly, it may be that fear-linked differences in attentional vigilance to spider stimuli are enhanced under conditions where spider stimuli are receding, relative to when spider stimuli are approaching. By examining fear-linked differences in attentional vigilance to spider stimuli under conditions where spider-related stimuli are approaching, and conditions where spider-related stimuli are receding, the present methodology will determine the validity of each of these alternative possibilities.

Method

Participants

The purpose of participant recruitment was to create two participant groups that differed in spider fear, with one group representing individuals with relatively higher levels of spider-fear and one group representing individuals with relatively lower levels of spider-fear. Participants were recruited from a group of 700 undergraduate students who earlier

identified their willingness to be invited to participate in the study as part of a bi-annual student recruitment procedure that is conducted by the psychology department at the university. All individuals reserved the right to refuse the invitation to participate.

Eighty individuals were recruited to participate. These participants comprised 24 males and 56 females, and had a mean age of 18.09 years ($SD = 1.32$, Range, 17 - 23). During the experimental session participants completed the Fear of Spiders Questionnaire (FSQ). In order to create two participant groups representing individuals that were relatively higher in spider-fear and individuals that were relatively lower in spider-fear, a median split was conducted on participants' FSQ scores. Individuals who fell in the bottom half of this split were labelled the Lower Spider-fear Group ($N = 40$, 16 male; Age, $M = 18.08$, $SD = 1.31$; FSQ scores, $M = 13.18$, $SD = 9.01$, range = 0 - 33), and individuals who fell in the top half of this split were labelled the Higher Spider-fear Group ($N = 40$, 8 male; Age, $M = 18.10$, $SD = 1.36$; FSQ scores, $M = 68.24$, $SD = 21.87$, range = 34 - 114). This gave rise to a between groups factor of Spider-fear Group (Lower Spider-fear Group, Higher Spider-fear Group).

Materials

Fear of Spiders Questionnaire. The Fear of Spiders Questionnaire (Szymanski & O'Donohue, 1995) is an 18 item self-report questionnaire that provides a measure of spider phobia. The questionnaire requires participants to indicate the degree to which they experience a range of behaviours and cognitions commonly experienced by spider-fearful individuals. Responses are made using a seven-point scale ranging from "Totally Disagree" to "Totally Agree". Scores on the FSQ range from 0 to 126, with higher scores reflecting greater fear of spiders. The FSQ has been shown to have high test-retest reliability and construct validity amongst undergraduate student populations (Muris & Merckelbach, 1996; Szymanski & O'Donohue, 1995)

Apparatus. The attentional assessment task was run using a PC and a 22-inch widescreen colour monitor at a resolution of 1920×1080 pixels with a 15 ms refresh rate. Task responses were made using a standard two button mouse.

Stimulus images. The attentional assessment task utilised 96 colour images of spiders and 96 colour images of butterflies. These images were selected from images publicly available on the internet. Each image was modified to have a square dimension and a white background. Each image was cropped such that the animal was positioned on as much of the image space as possible. An additional set of 24 images was created for use in an initial practice task. This practice set contained images of typical household objects (e.g. kitchenware) presented on a white background¹. All images in the set had a resolution of 390×390 pixels.

Attentional assessment task. The purpose of the attentional assessment task was to assess the degree to which participants demonstrated attentional vigilance to spider images as compared to butterfly images. To do so, the task employed the attentional-probe methodology typically used to assess individual differences in attentional vigilance to stimuli. Crucially however, in order to determine whether fear-linked attention vigilance to spider stimuli is enhanced or attenuated in response stimuli that are approaching compared to stimuli that are receding, the present task incorporated a novel motion manipulation. Specifically, on half of trials stimuli displayed an approaching movement toward the participant, whereas on the other half of trials stimuli displayed a receding movement from the participant. Notwithstanding the direction of movement displayed by the images, the

¹ The full set of images used in the experiment can be obtained by contacting the corresponding author.

characteristics of trials under each condition closely mirrored conventional methods of assessing attentional vigilance. These characteristics were as follows.

The task contained 384 experimental trials. All trials were presented on a blank white background. Each trial began with the 500 ms presentation of a fixation cue in the centre of the screen. After presentation of the cue an image pair was presented. This image pair consisted of one image of a spider and one image of a butterfly. One image appeared on the left side of the screen and the other image appeared on the right side of the screen. The spider and butterfly image appeared in each location with equal frequency across trials. The centre of each image was 55 mm from the centre of the screen, subtending a visual angle of 10.48° between the centres of each stimulus image at a viewing distance of 60 cm. After 500 ms the image pair was removed from the screen and a probe was presented in the location previously occupied by one of the preceding images. The probe appeared in each location with equal probability, such that on half of trials the probe appeared in the location of the spider image and on half of trials the probe appeared in the location of the butterfly image. The probe comprised a small grey arrow, 5 mm in length, which pointed upward or downward with equal frequency. Participants were required to indicate the direction the arrow pointed by pressing the corresponding arrow-key on the keyboard. After a correct response the screen was cleared and the next trial commenced after a 1000 ms delay. After an incorrect response participants were informed via an on-screen message that their response was incorrect and the next trial commenced after a 1000 ms delay. For each trial the latency and accuracy of participants' response to the probe was recorded.

For each participant, probe identification latencies were used to generate an index of attentional vigilance to spider images. This Attentional Vigilance to Spider Images Index expressed the degree to which identification latencies for probes that appeared in the locus

of spider images were speeded relative to probes that appeared in the locus of butterfly images. The index was computed using the following calculation:

Attentional Vigilance to Spider Images Index =

$$\begin{aligned} & (Mean\ probe\ identification\ latency: Probes\ in\ locus\ of\ butterfly\ Images) \\ & - (Mean\ probe\ response\ latency: Probes\ in\ locus\ of\ spider\ Images) \end{aligned}$$

Hence, increasing positive values on this index represent greater attentional vigilance to spider images relative to butterfly images, whereas increasing negative values on this index score represent greater attentional avoidance of spider images.

In order to assess the effect of stimulus movement on attentional vigilance to spider stimuli experimental trials were equally divided between an Approach Movement Condition and a Recede Movement Condition. This gave rise to a within-groups factor of Stimulus Movement Condition (Approach Movement Condition, Recede Movement Condition). In order to display an apparent approaching movement, stimulus images presented in the Approach Movement Condition were presented at a size of 40 mm x 40mm on-screen, before expanding to a size of 60 mm x 60 mm across the full duration of their presentation. In order to display an apparent receding movement, trials in the Recede Movement Condition were presented at a size of 80 mm x 80 mm on-screen, before contracting to a size of 60 mm x 60 mm across the full duration of their presentation. This use of expanding and contracting images has previously been shown to convey apparent approaching and receding stimulus movements (e.g. Rinck & Becker, 2007; Vagnoni, Lourenco, & Longo, 2012). In order to maximise the salience of the moving images on the experimental trials a number of trials in which stimuli did not move were randomly interspersed across the task.

These 192 trials presented images in fixed sizes of 40 mm x 40mm, 60 mm x 60 mm, and 80 mm x 80 mm on-screen with equal frequency. These trials gave rise to a third level in the within-groups Stimulus Movement Condition factor (Static Condition).

Procedure

Upon arrival to the experimental session participants were provided with an information sheet and consent form. Once written consent was obtained participants completed the FSQ, before being seated in front of the computer at a viewing distance of approximately 60 cm and informed of the requirements of the attentional assessment task. Participants were told to attend to the fixation cue each time it appeared, and to identify the orientation of the probe each time it appeared by pressing the appropriate response button as quickly and as accurately as possible. The attentional assessment task was preceded by a short practice version of the task comprising 72 trials using the practice stimulus set. After participants completed the attentional assessment task, they were debriefed and the session ended.

Results

Accuracy of participants' probe discrimination responses was reassuringly high ($M = 97.94\%$, $SD = 1.69$, range = $91.84\% - 100\%$). Prior to computation of Attentional Vigilance to Spider Images Index scores probe discrimination latencies were filtered to exclude latencies that were shorter than 200 ms or that exceeded 2000 ms. Remaining response latencies for correctly discriminated probes were used to compute an Attentional Vigilance to Spider Images Index for trials in delivered the Approach Movement Condition, for trials delivered in the Recede Movement Condition, and trials delivered in the Static Condition. After computation of theses scores, any participant who demonstrated an index score greater than three standard deviations from the mean index score computed within either

condition were excluded from statistical analysis. One participant from the Lower Spider-fear Group and one participant from the Higher Spider-fear Group had an outlying index score. Consequently, these participants were excluded from subsequent analyses. Index scores for each spider-fear group, under each stimulus movement condition, are presented in Table 1 below.

TABLE 1 HERE

In order to determine whether the degree to which spider-fear groups differed in attentional vigilance to spider images was affected by the direction of stimulus movement, a 2 x 3 mixed-design ANOVA was conducted on Attentional Vigilance to Spider Images Index scores. This analysis considered Spider-fear Group (Lower Spider-fear Group, Higher Spider-fear Group) as the between-groups factor and Stimulus Movement Condition (Approach Movement Condition, Recede Movement Condition, Static Condition) as the within-groups factor. Though the aim of the present study specifically concerned differences in fear-linked attentional bias amongst the two directly contrasting movement conditions, the Static Condition was included in the analysis to allow comparison of the effect of each stimulus movements on attentional processing relative to conditions where stimuli did not move.

The analysis revealed a significant main effect of Stimulus Movement Condition, $F(2, 152) = 7.85$, $p = .001$, $\eta_p^2 = .09$, reflecting the fact that, on average, Attentional Vigilance to Spider Images Index scores were slightly larger when stimulus images were static ($M = 33.21$, $SD = 49.24$) as compared to when stimuli were receding ($M = 32.45$, $SD = 48.54$), and were smallest when stimulus images were approaching ($M = 21.28$, $SD = 48.02$). No main effect of Spider-fear Group was observed, $F(1, 76) = 1.44$, $p = .23$, $\eta_p^2 = .02$. Importantly, the

analysis did indeed reveal a significant interaction effect involving Spider-fear Group and Stimulus Movement Condition, $F(2, 152) = 3.27, p = .041, \eta_p^2 = .04$. This two-way interaction was consistent with the possibility that the degree to which spider-fear groups differed in attentional vigilance to spider images was modified by the direction of movement of the stimulus images. The nature of this interaction was examined to determine which level of Stimulus Movement Condition was associated with greatest evidence of fear-related attentional vigilance to spiders. The pattern of effects that gave rise to the interaction is presented Figure 1.

FIGURE 1 HERE

No simple main effect of Spider-fear Group was observed under the Static Condition, $F(1, 76) = .50, p = .48, \eta_p^2 = .006$ or the Approach Movement Condition, $F(1, 76) = .39, p = .54, \eta_p^2 = .005$. This indicating that heightened spider-fear was not associated with heightened attentional vigilance to spiders when stimuli were static or approaching. In contrast to the Approach Condition however, a significant main effect of Spider-fear Group was observed under the Recede Movement Condition, $F(1, 76) = 4.27, p = .042, \eta_p^2 = .053$. This main effect reflected the fact that, when stimulus images were receding, participants in the Higher Spider-fear Group demonstrated heightened attentional vigilance to spider images ($M = 43.57, SD = 48.50$) relative to participants in the Lower Spider-fear Group ($M = 21.33, SD = 46.57$). Hence, the nature of the interaction effect indicated that participants higher in spider-fear, as compared to participants lower in spider-fear, did not demonstrate increased attentional vigilance to spider images that were approaching, but did so for spider images that were receding.

Discussion

The aim of the present study was to investigate the effect of approaching stimulus movement and receding stimulus movement on fear-linked attentional vigilance to spider stimuli. The study employed a novel task capable of measuring attentional vigilance to spider stimuli under conditions where spiders and butterflies displayed an approaching movement towards the viewer, or a receding movement from the viewer. Importantly, results revealed differences in the pattern of fear-linked attentional vigilance to spider stimuli under approaching and receding stimulus movement conditions. Specifically, higher spider-fearful participants, as compared to lower spider-fearful participants, did not display heightened attentional vigilance to spider images when images displayed an approach movement, emulating the pattern of effect observed across static stimuli. However, higher spider-fearful participants, as compared to lower spider-fearful participants, did demonstrate heightened vigilance to spider images when images displayed a receding movement.

The present findings carry implications for theoretical accounts of fear-linked attentional vigilance to feared stimuli. While the present findings have demonstrated that the magnitude of fear-linked differences in attentional vigilance to spider stimuli can be dependent upon the movement conditions under which stimuli are presented, theoretical accounts of fear-linked differences in attentional vigilance to spider stimuli have most often been generated from observations of fear-linked heightened attentional vigilance under static stimulus conditions (Lipp & Derakshan, 2005; Mogg & Bradley, 2006; Pflugshaupt et al., 2005; Rinck et al., 2005). Thus, the present findings encourage novel theories regarding fear-linked patterns of attentional vigilance to feared-stimuli to account for the moderating influence of approaching and receding movements made by feared stimuli.

One plausible theory distinguishes contexts under which attentional vigilance to spider stimuli would be most adaptive, or least adaptive, to the behavioural avoidance of harm. It is not uncommon for individuals to find themselves in the presence of threats that have the potential to cause harm, for example in the presence of an oncoming vehicle or swooping bird. On the basis of experimental findings, researchers have proposed that spider stimuli are likely to represent a threat stimulus across our species, due to an evolutionary history in which spiders have demonstrated the potential to cause harm (Öhman, 2009). It is plausible to speculate that when such threats are approaching individuals will typically encode such stimuli as threatening (Hsee et al., 2014) and adopt attentional vigilance to the approaching stimulus so as to avoid the potential for harm (Franconeri & Simons, 2003). Consequently, under conditions where a spider is approaching it would not be unusual for individuals to encode the spider as a threat and to implement attentional vigilance to the spider so as to reduce the potential for harm. Conversely if such stimuli are remaining static, or moving away, most individuals would not typically encode the stimuli as threatening, and would not adopt attentional vigilance to the stimulus. However, some individuals experience high levels of spider-fear associated with an elevated threat value attributed to spiders. For these individuals, this heightened fear is associated with heightened attentional vigilance to spider stimuli even in the absence of approaching movements (e.g. Lipp & Derakshan, 2005; Mogg & Bradley, 2006; present findings). Hence, while individuals are likely to demonstrate equivalent vigilance to spider stimuli when such stimuli display threatening movements, individuals who experience high levels of spider-fear may be uniquely characterised by heightened levels of attentional vigilance to spider stimuli even under conditions where the potential for harm from the stimulus is relatively low. Of course further research will be required to determine the validity of these novel proposals.

Of course it is also important that the validity of the present findings be tested further. There has been some interest in testing the psychometric properties of cognitive experimental tasks that are designed to measure attentional vigilance, with several researchers having found low levels of reliability amongst attentional-probe designs (e.g. Schmukle, 2005; Staugaard, 2009). This has caused some investigators to encourage the need for caution in interpreting results drawn from tasks that measure biased attentional vigilance. For example, Rodebaugh et al. (2016) highlight the low internal reliability commonly associated with these measures to suggest that these measures may be diminished in the degree to which they are precise enough to allow investigators to draw sound conclusions on theories regarding attentional bias. The researchers instead propose alternative measures of attentional bias that have recently demonstrated greater levels of reliability than traditional measures. Conversely, other theorists have argued that low internal reliability does not necessarily compromise the ability of a cognitive task to detect differences between conditions. For example, De Schryver et al. (2016) alleges that two or more experimental conditions may demonstrate low or disparate levels of internal reliability, though demonstrate equal precision in their measurement of the effect of interest (e.g. as a result of between-condition differences in the variability of true-scores). In this case, any observed difference between these groups would be unlikely to reflect differences in measurement error alone. Notwithstanding these alternative positions however, most would agree that it would be desirable and advantageous to maximise the reliability of attentional bias measures. Hence, we would encourage researchers to seek to build upon the present experimental design in ways that can enhance the reliability of this methodology in measuring attentional vigilance to moving stimuli.

Researchers could also examine the degree to which the present findings reflect the influence of stimulus movement on fear-linked attentional responding to other types of feared stimuli. Such stimuli would include those that serve as common sources of fear (e.g. snakes, dogs, or feared objects), or stimuli that acquire fear associations through experimental manipulations (e.g. conditioning paradigms). Importantly, the investigation of such stimuli would determine whether the influence of stimulus movement on attentional responding observed in the present study is specific to spider-fear, or reflects the influence of stimulus movement on attentional vigilance to feared stimuli more generally.

Future research could also further evaluate the validity of the presently proposed account of fear-linked attentional responding by developing novel methodologies that enhance ecological authenticity of stimulus movements. For example, though the stimuli presented in the current task provided the illusion of apparent approaching or receding movements they did not exhibit realistic movements in a three-dimensional space. It is unknown whether the effects observed in the present study would markedly differ if more realistic three-dimensional movements were displayed. The presently employed methodology provides an appropriate framework for the implementation of such stimulus qualities, and researchers seeking to further investigate the influence of stimulus movement on fear-linked differences in attentional responding may wish to introduce such modifications to enhance the realism of approaching or receding stimuli.

The intention of the present study was to directly compare conditions under which stimuli executed approaching movements (thereby signalling more immediate danger) or receding movements (thereby signalling reduced danger). However, it is noteworthy that any effect observed under these conditions will result from a composite of the independent effects of movement of spider stimuli generally and the direction of the movement of spider

stimuli. For this reason, the present design cannot separate the degree to which effects in either the approach movement condition or recede movement condition reflect the effect of spider movement generally, or reflect the effect of the direction of movement. Hence, it would be informative to directly compare approach movement and recede movement conditions with conditions that display movement, but do not involve approaching or receding directions (e.g. movement side to side). This direct comparison could distinguish the unique influence of approaching and receding movement directions on fear-linked differences in attentional vigilance to feared stimuli.

It must also be noted that the present study utilised a recruitment procedure that divided participants into lower spider-fearful individuals and higher spider-fearful individuals on the basis of a median-split on self-reported level of spider fear. While this procedure matched the studies aim of comparing individuals who experience relatively higher or lower levels of spider-fear, statistical theorists have noted that such a procedure may not always be ideal (Iacobucci, Posavac, Kardes, Schneider, & Popovich, 2015). Specifically, the use of a median-split raises the possibility that those participants allocated to the higher spider-fear group, though experiencing levels of fear greater than the lower spider-fear group, may not experience levels of spider fear within a range of the distribution that may reflect very high or extreme levels of fear based on a normative distribution of the general population. Researchers wishing to avoid this possibility when investigating cognitive processes related to elevated spider fear may wish to limit recruitment to individuals who experience very low or very high levels of spider-fear as defined by a critical cut-off based on population norms.

As noted in the introduction, the movement of spiders represents a clear motivation cue signalling danger, and is particularly fear-inducing amongst individuals with clinical

diagnosis of spider phobia (McNally & Steketee, 1985; Rachman & Cuk, 1992). Thus, it is perhaps surprising that higher-fearful individuals in the present study did not differ from lower-fearful individuals in terms of the degree of attentional vigilance towards approaching spiders. This may reflect the fact that, while the former participants reported higher levels of spider fear than the latter, they were not selected on the basis of experiencing the pathological level of fear characteristic of clinical phobia. It may be that clinically phobic individuals would demonstrate greater attentional vigilance to approaching spiders than the participant presently in the “higher-fear” group. Because the present study the methodology did not assess the diagnostic status of participants for spider-phobia this possibility cannot be tested by the present study. Hence, in order to determine whether individual characterised by extreme levels of spider-fear are characterised by the same pattern of attentional responding as observed amongst higher-fearful individuals in the present study, future research could usefully seek to directly contrast the attentional profiles of people with clinical diagnoses of spider-phobia, non-clinical spider-fearful individuals, and non-spider-fearful individuals, under conditions where spider stimuli are approaching and receding.

Lastly, it is also important to note that the present methodology was not designed to measure those attentional mechanisms that are thought to underlie selective attention, including selective attentional engagement and selective attentional disengagement (Posner, Walker, Friedrich, & Rafal, 1984). Fear-linked differences in attentional vigilance to spider stimuli observed in the present study could arise due to differences in one, or both, of these attentional mechanisms. Research regarding emotion-based attentional responding to threat has resulted in the development of attentional probe-based methodologies capable of delineating individual differences in attentional engagement and disengagement

to stimuli (Grafton & MacLeod, 2014; Rudaizky, Basanovic, & MacLeod, 2014), and these methods are readily amenable to the integration of moving stimuli.

For the moment however, the present study has demonstrated that fear-linked differences in attentional vigilance to spider stimuli are influenced by the direction of movement of spider stimuli. Specifically, higher spider-fearful participants, as compared to lower spider-fearful participants, did not differ in attentional vigilance to spider images when images displayed an approach movement, though did demonstrate heightened vigilance to spider images when images displayed a receding movement. It is hoped that the present findings and the methodology described herein will contribute to further understanding of the attentional processes that characterise individuals with heightened levels of fear.

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Table 1. *Mean and standard deviation of Attentional Vigilance to Spider Images Index scores, in milliseconds, under each stimulus movement condition for participants in each Spider-fear Group; M (SD).*

Stimulus movement condition	Spider-fear Group	
	Low Spider-fear Group	High Spider-fear Group
Static Condition	29.27 (43.28)	37.15 (54.85)
Approach Movement Condition	17.89 (40.43)	24.68 (54.90)
Recede Movement Condition	21.33 (46.57)	43.57 (48.50)

Figure 1. Mean Attentional Vigilance to Spider Images Index scores, in milliseconds, under each stimulus movement condition for participants in each Spider-fear Group. Bars represent standard error of the mean.