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We prefer what we fear: A response preference bias mimics attentional capture in spider fear

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ABSTRACT

The extent to which emotionally significant stimuli capture visual attention remains elusive because a preference for reporting or choosing emotionally significant stimuli could mimic attentional capture by these stimuli. We conducted two prior-entry experiments to disentangle whether phobic and fear-relevant stimuli capture attention or merely produce a response bias in spider-fearful participants. Prior entry denotes the effect that attended stimuli are perceived earlier than unattended stimuli as indicated by temporal order judgments. We presented phobic (spiders), fear-relevant (snakes) and neutral stimuli in pairs with varying temporal onset. The participants' task was to indicate which stimulus was presented first (Experiment 1) or second (Experiment 2). In the first experiment, spider-fearful but not control participants indicated that they had perceived spiders as occurring earlier in time, suggesting a prior-entry effect for spiders in this group. But surprisingly, in the second experiment, spider-fearful participants indicated more frequently that they had seen spiders as being presented second. This finding rules out a genuine prior-entry effect and instead suggests a strong preference for the response option associated with the feared animal. This response bias may result from a hypervigilance toward the feared stimulus and contribute to maintaining avoidance behavior in individuals with specific phobias.

1. Introduction

Visual attention can be modulated in a top-down manner (for example through behavioural goals; e.g., when searching for a red dot) or in a bottom-up manner (for example through stimulus characteristics; e.g., when a red dot among green dots automatically captures attention and thereby "pops out"; Yantis, 2000). A crucial variable in the bottom-up modulation of attention is the saliency of a stimulus (e.g., Pashler, 1988; Theeuwes, 1992). The red circle among green circles will capture attention only because of its high saliency that results from the strong colour contrast between red and green. However, saliency does not only depend on stimulus characteristics but also on the emotional significance of a stimulus: fear-relevant stimuli (e.g., spiders or threatening faces) are more likely to capture attention compared to neutral stimuli (e.g., Eastwood, Smilek, & Merikle, 2001; Fox et al., 2000) and lead to faster visuomotor processing compared to neutral stimuli (Haberkamp & Schmidt, 2014; Haberkamp et al., 2013), probably following from the evolutionary advantage of being able to detect dangers in the environment (Mathews & Mackintosh, 1998). Although, recent studies emphasise attentional capture for emotionally significant stimuli, the extent of such an effect remains elusive.

One way to measure attentional capture is to use *temporal order judgments (TOJs)*. In this task, two stimuli are presented with varying stimulus-onset asynchronies (SOAs), and attention is either directed to one of the two stimuli (*cued trials*) or remains undirected (*uncued trials*). In TOJs, the participants indicate which of the two stimuli appeared first (or, occasionally, second; e.g., Scharlau, 2004; Shore et al., 2001; Yates & Nicholls, 2009). Typically, attended stimuli are perceived earlier than unattended stimuli (Stelmach & Herdman, 1991; Titchener, 1908), a phenomenon known as *prior-entry effect*. For example, if a square and a diamond are presented simultaneously and an observer attends the square, she will perceive the square as occurring before the diamond. Prior-entry effects have been demonstrated within and between different modalities (vision: Scharlau, 2007; Weiß & Scharlau, 2011, 2012; audition: Kanai, Ikeda & Tayama, 2007; touch: Nicholls, 2009, 2011; ; bimodal (vision, touch): Spence, Shore & Klein, 2001; for an overview see Spence & Parise, 2010).

The prior-entry effect is technically defined as a shift in the so-called *point of subjective simultaneity (PSS)*, which denominates the SOA at which both order judgments are made equally often, that is, the

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temporal interval between the stimuli at which both are perceived as appearing first with the same probability. Typically, the PSS in uncued trials is close to physical simultaneity whereas in cued trials the PSS is located at a temporal interval at which actually the uncued (i.e., unattended) stimulus is presented first. In other words, the unattended stimulus requires a headstart to be perceived simultaneously with the attended one.

Consistent with recent findings of attentional capture for fear-relevant stimuli (Yiend, 2010), West, Anderson, and Pratt (2009) reported that threatening faces capture attention and show a visual prior-entry effect compared to neutral faces (also Fecica & Stolz, 2008; but see Schettino, Loeys & Pourtois, 2013 for a failure to replicate prior entry by threat-relevant faces across a series of experiments). Equivalently, there is evidence from different experimental paradigms suggesting that spiders capture attention in spider-phobic individuals compared to neutral stimuli (Mogg & Bradley, 2006; Rinck & Becker, 2006; for a review on attentional bias in general see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007).

Several studies suggest that the key to these effects might not be that fear-related stimuli *attract* attention, but that it is difficult to *disengage* attention from them. Gerdes, Alpers, and Pauli (2008) measured eye movements in spider-phobic participants and report a difficulty to disengage attention from spider distractors, resulting in slower responses to task-relevant targets (for a similar finding in social anxiety see Taylor, Cross, & Amir, 2016).

Interestingly, their findings do not support attentional capture because the spider-phobic participants tended to fixate not only on spider distractors but on neutral distractors as well. This suggests a higher alertness or hypervigilance to distractors per se − as if any of the presented stimuli could possibly be a spider (constituting non-specific attentional capture; for similar results see Devue, Belopolsky, & Theeuwes, 2011).

Based on this evidence of an attentional bias in spider fear and the conceptually related — although mixed — evidence for prior-entry effects for threatening faces, a prior-entry effect for spider stimuli in spider-fearful participants seems plausible. However, there is also a large body of literature suggesting that spider-fearful individuals exhibit additional biases in information processing of fear-related stimuli which might well affect the results of prior-entry paradigms. For example, spider-fearful individuals show an *encounter expectancy bias*, that is, the tendency to overestimate the likelihood of facing spiders (Mühlberger, Wiedemann, Herrmann, & Pauli, 2006) as well as the consequences of such a confrontation (*consequences expectancy bias;* Aue & Okon-Singer, 2015). They also exhibit a *memory bias* by recalling past experiences with spiders in a distorted manner (Mitte, 2008) and a *size estimation bias* by overestimating the size of spiders (Shiban et al., 2016; Vasey et al., 2012). Finally, spider-fearful individuals show an *interpretation bias* where they interpret ambiguous situations as spider-relevant and, therefore, as threatening compared to non-anxious individuals (Haberkamp & Schmidt, 2015; Kolassa et al., 2007). In line with this interpretation bias, spider-fearful individuals have a more liberal criterion to indicate that they had seen a spider in contrast to non-anxious controls, indicating a *response bias* (Becker & Rinck, 2004) or *response preference* for spiders.

All of these biases illustrate distorted information processing of spiders by spider-fearful individuals. Of these, a biased response preference is most likely to influence the results of a prior-entry study because spider-fearful individuals might report more frequently that they had seen the spider first − irrespective of the actually perceived temporal order of the presented stimuli. Here, we conduct two prior-entry experiments: first, to test whether we find a prior-entry effect for phobic and fear-relevant stimuli (in line with West et al., 2009 and other reports of attentional capture in spider-fearful individuals; Mogg & Bradley, 2006; Rinck & Becker,2006); and second, whether this effect is actually caused by attentional capture or can rather be explained by a response preference.

Following West et al. (2009), we did not use additional visual cues to induce a prior-entry effect but rather assumed that the fear-relevant spider stimuli would capture attention in a bottom-up manner due to their emotional significance. Specifically, we presented pairs of natural images at varying SOAs to spider-fearful individuals and non-anxious controls; one image from an animal class (spiders, snakes, or butterflies), the other from a neutral non-animal class (mushrooms or flowers). Spiders represent *phobic* stimuli for the group of spider-fearful participants, but they are merely *fear-relevant* for the group of non-anxious controls. Snakes represent *fear-relevant* and butterflies *neutral* control stimuli for the two groups. In Experiment 1, we asked the participants which of the two stimuli was presented *first*. Results would be consistent with a prior-entry effect if spider-fearful individuals would report spider stimuli as occurring earlier in time compared to the fear-relevant (snakes) and neutral animal stimuli (butterflies; *within-group comparison*) and earlier than reported by the non-anxious control participants (*between-group comparison*). However, this pattern of results could also be explained by a response preference in spider-fearful individuals for reporting “spider” irrespective of the given task. Therefore, we conducted a second experiment with the same stimuli and a new set of participants in which we asked them which of the two stimuli was presented *second*. In this setting, a response preference (bias) would be demonstrated if the spider-fearful individuals would report the spider stimulus as occurring later in time than other stimuli and later than reported by non-anxious control participants. In other words, when spider-fearful participants show a response preference towards spider stimuli in general they would have the tendency to say “spider” more frequently irrespective of their task − thus, they would also indicate more often to have seen a spider second.

2. Experiment 1

2.1. Methods

The study was approved by the Ethical Committee of the Faculty of Psychology (Philipps-University Marburg).

2.1.1. Participants

Twenty-eight participants recruited through the University of Kaiserslautern took part in the study. All participants had normal or corrected-to-normal visual acuity and received 6 € per hour as payment. All of them gave informed consent and were treated in accordance with the ethical guidelines of the American Psychological Association. They were all naïve to the purpose of the current study.

Fourteen participants reported being highly afraid of spiders but not of snakes (8 women and 6 men) and 14 participants reported being afraid of neither spiders nor snakes (11 women, 3 men). Before the experiment, all participants were screened for fear of spiders or snakes, using two spider questionnaires and one snake questionnaire (Table 1; German version of the “Spider Questionnaire” SPQ; Hamm, 2006; original version by Klorman, Weerts, Hastings, Melamed, & Lang, 1974; German questionnaire “Fragebogen zur Angst vor Spinnen [Fear of spiders questionnaire]” FAS; Rinck et al., 2002; German version of the “Snake Questionnaire” SNAQ; Hamm, 2006; original version by Klorman et al., 1974).

To ensure that the two groups differed substantially, non-anxious control participants had to score below the 25th percentile in the SPQ and spider-fearful participants had to score above the 75th percentile in the SPQ. All participants had to score below the 50th percentile in the SNAQ to exclude snake-fearful individuals from the study. For the FAS, only guideline values exist (for participants’ scores see Table 1).

Three spider-fearful participants and two non-anxious participants were excluded after the diagnostic session due to high scores in the snake questionnaire. One participant who reported being highly afraid of spiders was excluded due to low scores in the two spider questionnaires. These participants are not included in the number of