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Expectancy influences on attention to threat are only weak and transient: Behavioral and physiological evidence

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ABSTRACT

Can prior expectancies shape attention to threat? To answer this question, we manipulated the expectancies of spider phobics and nonfearful controls regarding the appearance of spider and bird targets in a visual search task. We observed robust evidence for expectancy influences on attention to birds, reflected in error rates, reaction times, pupil diameter, and heart rate (HR). We found no solid effect, however, of the same expectancies on attention to spiders; only HR revealed a weak and transient impact of prior expectancies on the orientation of attention to threat. Moreover, these asymmetric effects for spiders versus birds were observed in both phobics and controls. Our results are thus consistent with the notion of a threat detection mechanism that is only partially permeable to current expectancies, thereby increasing chances of survival in situations that are mistakenly perceived as safe.

1. Introduction

Cognitive biases have been observed in both clinical and subclinical fear (Aue & Okon-Singer, 2015; Hirsch, Clark, & Mathews, 2006; Mathews, Mackintosh, & Fulcher, 1997), while their existence in healthy individuals is more heavily debated (e.g., Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendorn, 2007). Several of these biases, including those in attention and expectancies, have been suggested to provoke and maintain anxiety disorders (Butler & Mathews, 1983; Taylor & Rachman, 1994). Systematic investigations of the biases and their interactions may yield a better understanding of the neurocognitive mechanisms underlying different types of fear, which is an important precondition for the development of adequate treatments. Following our earlier research on the topic (e.g., Aue, Guex, Chauvigné, & Okon-Singer, 2013), here we further investigate the question of whether – and to what extent – biased expectancies might cause biases in attention to threat.

Cisler and Koster (2010) classify threat-related biases in attention as (a) early automatic vigilance for threat (Mogg & Bradley, 1998), termed *facilitated attention* (hereafter referred to as vigilance); (b) *difficulty in disengaging attention* from threat once it has been oriented to (Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002; Yiend & Mathews, 2001); and (c) *attentional avoidance* of threat (Amir, Foa, & Coles, 1998; Mogg, Bradley, DeBono, & Painter, 1997). The authors relate these different types of attention bias to different information processing stages. Specifically, vigilance to threat is seen as a result of automatic processing particularities arising from the initiation of an innate threat detection mechanism centered around the amygdala. Difficulty in disengagement of attention from threat, in contrast, is considered to be

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related to a mixture of strategic and automatic processing deficits that reflect defective attentional control mediated by the prefrontal cortex. Attentional avoidance of threat, finally, is thought to result from strategic processing peculiarities associated with the regulation of negative emotion that is also mediated by the prefrontal cortex.

Such a distinction of attention bias components can possibly explain some seemingly discrepant findings in the literature (e.g., phobia being characterized by vigilance to threat vs. avoidance of threat). For instance, in phobia, problems arising during early automatic processing of a threatening situation may temporarily lead to hypervigilance, whereas deficits during later strategic processing may be reflected in visual avoidance, corresponding to the so-called vigilance-avoidance pattern (cf. Amir et al., 1998, and Mogg et al., 1997; for supportive evidence). Yet, there are also counterexamples to the vigilance-avoidance pattern idea in pathological fear. For instance, some authors find no evidence for vigilance to threat during automatic information processing and report only attentional avoidance during strategic information processing (e.g., Aue, Hoeppli, Piguet, Sterpenich, & Vuilleumier, 2013; Hermans, Vansteenwegen, & Eelen, 1999). These inconsistencies remain to be resolved by future research.

Much can be learned from the identification of the concrete factors that cause vigilance and avoidance. One of these influential factors might relate to prior expectancies that, at times, are themselves biased. Indeed, *expectancy biases* are common in exaggerated fear and phobia (Aue & Hoeppli, 2012; Foa & Kozak, 1986). For example, spider phobics have been reported to overassociate spiders with negative outcomes (*consequences expectancy bias*; e.g., Mühlberger, Wiedemann, Herrmann, & Pauli, 2006; Muris, Huijding, Mayer, den Breejen, & Makkelie, 2007). Furthermore, spider phobics, but not nonfearful controls, overestimate the likelihood of encountering spiders (*encounter expectancy bias*; e.g., Aue & Hoeppli, 2012; Aue et al., 2015; de Jong & Muris, 2002). Comparable biases have been reported for other anxiety disorders (Amrhein, Pauli, Dengler, & Wiedemann, 2005; Foa, Franklin, Perry, & Herbert, 1996; McManus, Clark, & Hackmann, 2000).

Given the prevalent nature of both attention and expectancy biases in anxiety disorders, it is imaginable that one type of bias originates in the other. For instance, because highly fearful and phobic individuals overestimate the likelihood of being confronted with situations they fear (i.e., encounter expectancy bias), they may subsequently modify their deployment of attention. In some cases, such as a likely attack by a predator, it may be adaptive to be particularly vigilant; increased vigilance may ultimately result in facilitated detection of the threat source. Combined with an expectancy-triggered preparation of adequate behavioral responses that enable quick distancing from the anticipated source of threat, facilitated detection may thus save time that is essential to survival. However, if flight is determined to be nonessential for survival, highly fearful and phobic individuals may ultimately engage in visual avoidance of the threat source in order to successfully regulate their fear. Whether sustained vigilance or avoidance arises from enhanced encounter expectancies may thus depend on the moment in time and/or the type of anticipated consequences (i.e., consequences expectancy bias).

One may also hypothesize about the existence of the reverse link, namely, that attention deployment has a causal impact on expectancies. Focusing on negative aspects in a situation may increase the subjective likelihood of similarly negative things happening in the future, simply because people base their appreciation of the future on available information. These reflections suggest that expectancies and attentional processes may be intimately linked in pathological fear, with one bias causing the other. In fact, the "combined cognitive biases hypothesis" (Hirsch et al., 2006; see also Everaert, Koster, & Derakshan, 2012; Ingram, 1984; J.M.G.Williams, Watts, MacLeod, & Mathews, 1997) states that cognitive biases in psychopathology rarely operate independently but, rather, most often mutually influence each other. Along these lines, Peschard and Philippot (2015) suggested attentional and memory processes in anxiety to be closely connected. According to these authors, it is the focus of attention that determines awareness of working memory content, and the focus of attention should itself be influenced by factors such as task goals, stimulus salience, and long-term memory.

Theoretical considerations raised by researchers in the tradition of the combined cognitive biases hypothesis (e.g., Everaert et al., 2012; Hirsch et al., 2006) comprise memory, interpretation, and attention biases, as well as self-imagery bias. We (Aue & Okon-Singer, 2015) recently proposed that this theoretical perspective can be easily broadened to include expectancy biases. The identification of mutual influences between different types of cognitive bias (e.g., attention bias, expectancy bias, interpretation bias, memory bias) is thought to have an important impact on the understanding of the basic mechanisms underlying anxiety disorders and might inspire the development of new, more efficient, therapeutic approaches that straightforwardly address the causal factors. Yet, to date, studies examining (causal) relations between attention and expectancy biases are surprisingly sparse.

In two experiments, we investigated the nature of the relationship between attention and expectancies. An eye-tracking experiment (Aue, Hoeppli et al., 2013) revealed that self-determined visual avoidance of depicted spiders in spider phobics during strategic information processing was associated with a reduced subsequently indicated encounter expectancy bias in these individuals (i.e., the less attention that was paid to a picture of a spider, the lower the subjective likelihood of encountering the animal displayed). Hence, visual avoidance in phobic fear may be hypothesized to downregulate encounter expectancies and thereby to possibly downregulate experienced fear. Interestingly, the opposite relationship was observed for the control group, which was characterized by low spider fear: These participants showed a positive correlation between the extent of visual avoidance of the spiders and their encounter expectancies for spiders. Therefore, healthy participants may be better at regulating their expectancies (and fear) if they are particularly attentive to potentially menacing situations. Yet, because our experimental paradigm did not allow the investigation of causality, these interpretations of the data are to be treated with reservation.

In a second study, we (Aue, Guex et al., 2013) directly examined causality in the expectancy-attention relationship. To measure vigilance to threat in spider phobic and nonfearful controls, we used a visual search task (Flykt, Lindeberg, & Derakshan, 2012; Öhman, Flykt, & Esteves, 2001; Soares, Esteves, Lundqvist, & Öhman, 2009). Participants saw a 3 (rows) × 3 (columns) search array, their task being to rapidly detect a spider or a bird target displayed among eight butterflies (distractors). Vigilance to threat was assessed by comparing the participants' reaction times (RTs) for the detection of spider versus bird targets.

To test whether prior expectancies exert a causal influence on vigilance to threat, we manipulated encounter expectancies; verbal cues preinformed the participants about the likelihood that the target in the subsequently displayed visual search array would be a spider or a bird. Because expectancies were hypothesized to effectuate a top-down influence on early attention deployment in the visual search task, we had predicted an effect of congruency, with detection of spider targets being facilitated by spider cues and detection of bird targets being facilitated by bird cues.[1]

[1] More concretely, we had hypothesized that high expectancies regarding the appearance of threatening (i.e., spiders) versus nonthreatening (i.e., birds) animals