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Does fear expectancy prime fear? An autonomic study in spider phobics

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ABSTRACT

This study investigated whether fear expectancy in phobic individuals induces priming of the defensive system, thus generating a "blind" phobic response even to non-phobic stimuli. We employed a paradigm in which two different visual cues signalled the upcoming picture presentation of either a spider or an innocuous animal (congruent condition). Unknown to the participants, the visual cue was incorrectly followed by a picture from the opposite category on two additional trials (incongruent condition). Cardiac and skin conductance responses were recorded from young adults with ($n = 15$) or without ($n = 14$) spider phobia during both the expectation and exposure of these pictures in the congruent and incongruent conditions. In the congruent condition, the autonomic responses during expectation matched the responses during exposure. In particular, non-phobic controls showed an orienting response (bradycardia and moderate skin conductance increase) to both picture categories, while spider phobics showed an orienting response to the innocuous animals and a defence response (tachycardia and marked skin conductance increase) to spiders.

In the incongruent condition, the autonomic responses during exposure were driven by the affective content of the pictures, and their amplitude was greater than in the congruent condition, likely due to the signal–stimulus discrepancy. In particular, the response to the innocuous picture of phobic participants expecting a spider did not shift in the direction of the defence response.

Thus, spider phobics did not show priming of the defensive system but maintained discrimination between phobic and innocuous stimuli. Finally, the greatly amplified response to the incorrectly signalled spider in phobics suggests a discrepancy–phobia interaction.

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1. Introduction

Fear is a powerful emotion, serving a primary protective purpose. In humans, fear appraisal entails a more complex processing than simple detection of threat. In fact, potentially aversive events are evaluated and filtered by the high cognitive functions that exert a context-sensitive control of human fear. As a consequence, most people only experience fear occasionally. On the contrary, stimulus-driven reactions of fear can be effectively induced in individuals affected by animal phobia that is a syndrome characterized by intense and incontrollable fear toward a specific animal (DSM-IV, American Psychiatric Association, 2000) which is invariably and unrealistically appraised as a source of imminent threat. In particular, during the encounter with their feared animal, individuals affected by animal phobia show a classical defence response characterized by a sympathetically dominated autonomic response profile (i.e. increased heart rate, blood pressure and electrodermal activity) and the increased activation of the amygdala, primarily involved in the detection of motivationally relevant stimuli, and insula, specifically linked to defensive response mobilization (Fredrikson et al., 1985; Globisch et al., 1999; Sarlo et al., 2002; Wendt et al., 2008). Experimental studies have shown that phobic participants react with fear even in circumstances that others deem harmless; in fact, photographs (Hare and Blevings, 1975; Fredrikson, 1981; Dilger et al., 2003; Kolassa et al., 2005; Straube et al., 2006; Wendt et al., 2008; Knopf and Possel, 2009) or even drawings (D'Alessandro et al., 2004a,b) of the feared object are sufficient to evoke in phobics a clear autonomic defensive pattern, i.e. elevation of both skin conductance and heart rate and activation of fear-related brain network. In addition, phobics react with an arousal response even in condition of subliminal stimulation that is without the conscious perception of their phobic object (Ruiz-Padial et al., 2005; Sebastiani et al., 2011).

Two integral components of phobic experience are the anticipatory anxiety, occurring when phobic participants expect to encounter their feared object, and the expectancy bias that makes phobics incline to overestimate both the likelihood of incurring negative consequences from an encounter with the phobic object and the probability of such encounter (Aue and Hoeppli, 2012; de Jong and Muris;, 2002). As a consequence phobics tend to be hypervigilant and to scan the environment for signs of fear-relevant information (Cisler et al., 2007; Kolassa et al., 2007; Lipka et al., 2011; Ohman et al., 2001; Pflugshaupt et al., 2005; Thorpe and Salkovskis, 1999). Increased vigilance was recently reported

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(Michalowski et al., 2009) in spider phobia participants, which, in fact, responded with overall larger P1 amplitudes than controls in a context in which phobia-relevant stimuli were likely to occur. Also, Wik et al. (1993, 1996) reported that, when explicitly exposed to neutral stimulation, such as a neutral movie, phobics showed higher inconsistent expectations to see their feared object than controls. In addition, a concomitant reduction of primary visual cortex activity in phobics suggested a strategy of anticipatory avoidance that temporarily inhibited the cortico-geniculate pathway.

Phobia-related avoidance behaviour in relation to hypervigilance and expectancy bias has been recently studied by Aue et al. (2013). In particular, these authors reported that the more fearful and personally salient the experience is from the phobic object, the more phobics adopt visual avoidance strategies. In the absence of alternative efficient regulatory strategies to reduce arousal and decrease the intensification of threatening thoughts, looking away from spiders may function to down-regulate mental and physiological arousal as well as expectancy bias (Aue et al., 2013).

Although numerous studies have shown that there is an attentional bias in the processing of fear-related information with fast detecting abilities and high level of vigilance in fearful participants (D'Alessandro et al., 2009; Pessoa et al., 2002; Sebastiani et al., 2010; Straube et al., 2006), there is little investigation about the exact relation between fear expectancy and fear responding. Previous studies have shown that specific expectations about a stimulus can bias perception on different modalities such as taste intensity, (Woods et al., 2011), auditory information (Grings et al., 1980) or intensity of noxious stimuli (Koyama et al., 2004). A mechanism of "preception" that is the preparatory tuning of stimulus processing according to the participants' expectations was speculated (Lykken et al., 1972). Furthermore, it has been observed that when participants can predict the onset of a nociceptive stimulation not only perception but also the autonomic responses to the noxious stimulus (Lykken et al., 1972; Tursky and Watson, 1964), and the pain-related brain activity (Koyama et al., 2004) are attenuated.

Expectancy can also affect emotion. However, there is some ambiguity as to whether brain emotional processing is enhanced (Bermpohl et al., 2006) or attenuated (Belova et al., 2007) by participants' expectations. Indeed, following the motivational model of emotion of Lang (Lang et al., 1997a), it is reasonable to assume that positive and negative emotions engage attention and expectancy in opposite ways; that is positive emotions dispose the organism toward stimulus processing – orienting/appetitive responses – while negative affects, prompt a state of rejection of stimulus information — defence/aversive responses. In this vein, it has been reported that expectancy of negative pictures – contrary to positive ones – selectively enhances the cognitive interference exerted by the actual presentation of those stimuli (Kleinsorge, 2009).

Altogether, these findings suggest that in phobia the anticipatory anxiety associated with the expectancy bias might contribute to the early and involuntary priming of the defensive system that could impact the conscious perception of the subsequent stimulus and thus produce a "blind" phobic response. This hypothesis is partially supported by the defence cascade model of fear (Lang et al.,1997a) that describes the aversive/defensive system as a "cascade" of related defensive events each one activated at higher thresholds of arousal, and promptly primed by the previous component of the cascade. Neuroimaging research showed that at the peak level of anticipatory arousal, referred as circa-strike stage, reached during the fore period of frightening stimulation, the locus of behavioural control is switched from higher forebrain areas to hard-wired defensive networks in the midbrain (Mobbs et al., 2009). In this context of diminished conscious control and strong aversive drive, it may well be that an orienting response to changes or novel stimuli would be less likely to happen than defence response.

The main purpose of the current study was to verify whether, as predicted by the defence cascade model, expectancy of the phobic object in phobic individuals could strictly bias the autonomic responses to subsequent stimuli thus generating an "inexorably blind" phobic response also to non-phobic visual stimuli. To this aim, we employed a paradigm in which two different visual cues signalled the upcoming picture presentation of either a spider or an innocuous animal (congruent condition). Within the same experimental session, and unknown to the participants, a couple of incongruent stimulations in which the stimulus presented was incorrectly signalled – that is the spider was signalled as the innocuous animal and the innocuous animal was signalled as the spider – were administered. Cardiac and skin conductance responses were recorded from young adults with or without specific phobia for spiders during both the expectation and exposure of these pictures in the congruent and incongruent conditions.

According to the hypothesis of priming of the defence system we expected that spider phobics reacted with a typical defence response not only to the spider but also to the innocuous animal when incorrectly signalled as a spider.

2. Methods

2.1. Participants

Volunteers were recruited from a group of 190 students at the University of Pisa. The Italian version of the Spider Phobia Questionnaire (SPQ) (Klorman et al., 1974) was used to rate the aversion to spiders of each participant. The SPQ is a 31 item self report instrument that measures fear of spiders. Scores range from 0 to 31 with higher scores indicating greater fear. In participants with scores higher than 20, the presence of specific phobia for spiders was confirmed by a psychiatrist (AG), according to the DSM-IV, APA, 2000. Fifteen individuals (2 males, 13 females; mean age $\pm$ SD, 22.3 $\pm$ 1.3), with a mean SPQ score of 24.2 (range 21–28), corresponding to the 90° percentile of the sample's scores distribution, were assigned to the group of phobics. Fourteen participants (2 males, 12 females, mean age $\pm$ SD, 22.5 $\pm$ 1.4) with a mean SPQ score of 2.3 (range 0–5) corresponding to the 60° percentile of the sample's distribution, served as controls.

The prevalence of women in our sample of phobic individuals reflects the gender differences in the prevalence of animal/spider phobia in the general population (Fredrikson et al., 1996).

Participants included in the study were drug free, had normal or corrected-to-normal vision and did not present any medical, neurological or psychiatric disorders, apart from phobia. All participants signed an informed consent approved by a local Ethical Committee.

2.2. Stimuli

The experiment consisted of a single session in which volunteers were asked to view a sequence of pictures each preceded by a visual cue. The experimental sessions were carried out in a darkened and sound attenuated room whose temperature was comfortable and kept constant. Stimuli were presented in the centre of a screen at a distance of 57 cm from participant's eyes so that each image covered an area of about 15 $\times$ 20°. In order to reduce head movements and to maintain the distance from the screen fixed, participants positioned their head on a suitable support.

Pictures were selected from the International Affective Picture System (IAPS) (Lang et al., 1997b) and consisted of 5 pictures of spiders (IAPS numbers: 1200, 1201, 1220, 1230, 1240) and 5 picture of innocuous animals such as rabbits or horses (1450, 1600, 1610, 1620, 1670). The normative ratings (mean $\pm$ SD) for valence, arousal and dominance are indicated in Table 1. Visual cues were red and blue circles.

2.3. Procedure

Following the positioning of recording electrodes, participants were instructed about the experimental paradigm, and in particular on the predictive meaning of the visual cues. Namely, it was specified that

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