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Preattentive processing of feared stimuli in blood–injection–injury fearful subjects ☆

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ABSTRACT

This research aimed to study the defence responses of blood–injection–injury (BII) fearful subjects elicited by the preattentive processing of their feared objects and by an abrupt acoustic stimulus. We selected 21 BII fearful subjects and 25 non-fearful controls from an initial sample of 128 women, according to their scores on the Fear Survey Scale (damage subscale) and the Mutilation Questionnaire. Subjects were exposed to a burst of white noise to promote a defence response, and to 48 pictures, depicting mutilations, as well as other affective contents, displayed through a backward masking procedure. Heart rate (HR), skin conductance response (SCR) and corrugator supercilii activity were continuously recorded throughout the task. Both groups showed similar SCRs, EMG activity and cardiac defence responses to the acoustic stimulus, though fearful subjects showed greater initial HR deceleration than controls. While BII fearful subjects displayed the usual defence response when exposed to a non-feared threatening stimulus, the preattentive processing of the pictures did not reveal autonomic differences between fearful subjects and controls. Mutilation pictures, however, evoked the greatest EMG activity, but only in the fearful group. These data further extend previous research on conscious perception of blood-related stimuli in BII fearful subjects, by showing a failure to recruit autonomic defence responses when blood-related pictures appear outside of conscious awareness.

1. Introduction

Subjects exposed to relevant fear stimuli usually respond with enhanced psychophysiological reactivity that is stronger when fearful subjects are exposed to their feared object (e.g., Globisch et al., 1999; Wendt et al., 2008). This reaction usually includes skin conductance response (SCR) and blood pressure increases, heart rate (HR) acceleration, or startle reflex enhancement, and appears even when the feared stimuli are presented outside awareness (Öhman and Soares, 1993). However, the study of blood–injection–injury (BII) phobic subjects has failed to find a consistent pattern of physiological responses to their feared objects. In contrast to other specific phobias (e.g., spiders or snakes), several studies have found an initial heart rate acceleration in BII phobics to the first presentations of pictures depicting mutilations, which attenuated and changed to deceleration in subsequent presentations of pictures (e.g., Klorman et al., 1977). In this line, Hamm et al. (1997) did not find enhanced autonomic reactivity, i.e., HR acceleration and greater SCRs when BII phobic subjects viewed pictures related to their phobia.

Classically, the cardiac response of BII phobics when confronted with their feared object had been defined as a diphasic reaction characterized by an initial phase related to HR and blood pressure increases, immediately followed by a second phase characterized by bradycardia and low blood pressure that, in some instances, might give rise to fainting (Graham et al., 1961). The first phase was considered as being related to sympathetic activity, while the second was proposed as being under parasympathetic control (Graham et al., 1961; Sarlo et al., 2002). However, contrasting data have been found in the studies conducted on BII phobics. For example, while some researchers have found HR deceleration when BII phobics are exposed to blood-related stimuli, like pictures (e.g., Hamm et al., 1997), other authors, using longer exposures, like surgery film-clips, have found an initial HR acceleration (during the first 66 seconds of exposure) followed by a diminution of the HR, that falls under baseline (i.e., deceleration) at the end of the exposure, (e.g., Sarlo et al., 2002). Other studies have only found HR acceleration when BII subjects are exposed to blood-related film-clips, but accompanied by a marked fall in systolic blood pressure (Sarlo et al., 2008). As proposed by these authors, the dysfunctional cardiovascular reaction observed in BII phobics would depend more on the involvement of the sympathetic system, rather than the parasympathetic system. Taken together, BII phobics show, overall, a diminished readiness for active defence when they

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are confronted with their feared stimulus (Sarlo et al., 2010), as shown by atypical cardiovascular reactions, together with a lack of increases of skin conductance response and startle reflex potentiation in comparison to other unpleasant contents and non-phobic subjects.

Several explanations have been proposed for these atypical responses observed in BII phobics when they are exposed to blood-related stimuli: a) a conflicting activation of both branches of the autonomic nervous system (Graham et al., 1961) or, at least, a dysregulation of the sympathetic reactivity (Sarlo et al., 2008); b) the prevalence of an emotional response of disgust over fear, which would exert conflicting influences on autonomic reactivity (Page, 1994); c) a disturbance in the cognitive regulation of emotion, as shown by diminished activity in the medial prefrontal cortex when exposed to blood-related pictures (Hermann et al., 2007), a region critically related to the cognitive regulation of emotion (Ochsner and Gross, 2005); and d) a lack of attentional bias, i.e., BII phobics do not assign more attentional resources to blood-related stimuli than non-phobic controls (Sarlo et al., 2010, 2011).

A question unsolved to date, however, is whether the preattentive processing of the feared stimuli will elicit defence responses in BII phobics. It has previously been well established that fear-relevant stimuli engage a preattentive processing that is enhanced in fearful subjects (Flykt et al., 2007; Fox et al., 2007; Öhman et al., 2001). Using a backward masking procedure, Öhman and Soares (1994) found that subjects with phobia to snakes or spiders showed greater SCRs promoted by the unconscious perception of pictures related to their feared object, but not to other contents, while in nonphobic controls no differences were found between picture categories. These results, in addition, were paralleled by the affective ratings reported by the subjects when exposed to the same, unmasked, pictures. It has been suggested, therefore, that the conscious perception of the phobic object is not necessary for the engagement of defensive responses, and that the preattentive processing of the feared stimulus is sufficient to activate a fear response (Lang et al., 2000; Öhman, 2005). These data might be pointing to a flexible brain mechanism that quickly identifies and responds to relevant threatening stimuli from the environment, and this would include the amygdala (Öhman et al., 2007; Tamietto and de Gelder, 2010) as well as other cortical structures, like the ventromedial prefrontal cortex (Carretié et al., 2005, 2009). Experimental data show that this brain mechanism may be active in some specific phobias (e.g., spider or snake phobias), but it is unclear whether it leads to similar responses in BII phobics when confronted with their feared objects, since these subjects do not assign greater attentional resources to blood-related pictures than to other affective contents (Buodo et al., 2006, 2007; Sarlo et al., 2011). Hence, the first goal of this research was to investigate whether the preattentive processing of mutilation pictures elicited defence-related psychophysiological responses in BII fearful subjects.

In addition to an absence of defence responses promoted by the conscious perception of blood-related stimuli, BII phobics show a diminished sympathetic reactivity when exposed to other aversive stimuli, like non-painful electrical pulses (Donadio et al., 2007). A previous study has also reported a relationship between the cardiac defence response provoked by an intense, aversive acoustic stimulus and the HR changes promoted by mutilation pictures in an unselected sample (Sánchez-Navarro et al., 2006). From these findings it is not clear whether the abnormal response shown by BII phobics to their feared objects is a general inability to display a defence response –independently of the threatening stimuli- or, by contrast, it is specific to their phobic stimuli.

Hence, a second goal of this research was to check whether BII fearful subjects displayed the typical defence response promoted by a threatening, but non-feared, acoustic stimulus, and whether this response differed from that shown by non-fearful controls. The cardiac defence response to high intensity stimuli has been the subject of a wide body of research (Graham, 1979; Sokolov, 1963; Turpin, 1983, 1986; Turpin et al., 1999; Vila et al., 2007). Recent research has described the cardiac defence response to a high intensity stimulus as a complex pattern that extends over approximately 80 seconds and that is composed of two accelerative and two decelerative HR components (Vila et al., 2007). The first accelerative wave (short latency) appears immediately after the aversive stimulus, peaking around 3 s. and extends for between 5 and 10 s. The second acceleration wave (long latency) usually peaks around second 35 after the stimulus onset, and covers up to second 40. Thus, we employed a high intensity acoustic stimulus (105 dB) and expected to find cardiac defence responses in our subjects within the parameters described by Vila et al. (2007). We also measured other autonomic (SCR) and facial (corrugator supercilii activity) responses elicited by the acoustic stimulus.

To address these questions, we designed an experiment in which a sample of BII fearful subjects, and a non-fearful control sample, were first exposed to an intense white noise and later to a set of pictures depicting fearful (mutilation, human attack, and phobic animal), and pleasant (erotic) contents presented by a backward masking procedure, while several autonomic (HR and SCR) and facial activity (corrugator supercilii) indices were recorded.

2. Materials and methods

2.1. Participants

Since the prevalence of BII phobia is higher among females (Bienvenu and Eaton, 1998), we selected only women for our study. A total of 128 female student volunteers answered the 72-item Fear Survey Schedule (FSS; Wolpe and Lang, 1964), which yielded a Cronbach's alpha = .958, and the Mutilation Questionnaire (MQ; Klorman et al., 1974). From their ratings in the damage subscale of the FSS (Cronbach's alpha = .90), subjects were selected if their ratings were above 75% (fearful) or below 25% (non-fearful) of the whole sample. The final sample comprised 46 women (Mean age = 23.52, SD = 6.02), 21 classified as BII fearful subjects (FSS Damage subscale mean = 65.55, SD = 7.15, range = 57–81) and 25 as non-fearful controls (FSS Damage subscale mean = 33.50, SD = 3.59, range = 28–38), $t(44) = 19.68$, $p < .0001$. Both groups differed in the MQ, with BII fearful subjects obtaining higher ratings (MQ mean = 17.29, SD = 4.47, range = 9–24) than controls (MQ mean = 10.68, SD = 3.15, range = 5–20), $t(44) = 5.86$, $p < .0001$. Control subjects did not show any specific fear according to their FSS scores.

2.2. Materials and design

In line with previous research (Turpin et al., 1999; Vila et al., 2007), and in order to elicit a cardiac defence response, the acoustic stimulus consisted of a 500 ms, 105 dB(A) white noise with a virtually instantaneous rise time delivered through headphones.

Target pictures were composed of three threatening categories (phobic animals, human attack and mutilations) and one pleasant category (erotica) — to control for affective valence effects. Each picture category comprised 12 pictures selected from the International Affective Picture System (IAPS; Lang et al., 2008), attending to their ratings for the Spanish population (Moltó et al., 1999; Vila et al., 2001).[1] The four categories differed in affective valence, $F(3,44) = 285.65$, $p < .001$ (mutilations < human attack < phobic animals < erotic; $Ps < .001$ for all single

[1] IAPS code for the pictures employed in the study. Mutilations: 3000, 3010, 3051, 3053, 3060, 3064, 3100, 3102, 3150, 3170, 3261, 3400. Human attack: 3500, 3530, 6230, 6260, 6300, 6312, 6313, 6350, 6360, 6510, 6550, 6560. Phobic animals: 1040, 1050, 1070, 1080, 1090, 1113, 1120, 1200, 1201, 1280, 1300, 1301. Sex: 4608, 4631, 4652, 4658, 4659, 4660, 4664, 4670, 4680, 4690, 4800, 4810. Neutral (masks): 5500, 5510, 5520, 5530, 5531, 5532, 5533, 5534, 6150, 7000, 7002, 7004, 7006, 7009, 7010, 7020, 7025, 7030, 7031, 7034, 7035, 7040, 7050, 7060, 7080, 7090, 7100, 7130, 7140, 7150, 7160, 7170, 7175, 7185, 7187, 7190, 7205, 7207, 7217, 7224, 7233, 7234, 7235, 7700, 7820, 7830, 7900, 7950.