



Differences in startle modulation during instructed threat and selective attention

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Abstract

This study investigated whether attentional processes contribute to fear-potentiated startle. Ten subjects participated in a threat of shock experiment and an attentional control condition. In the threat of shock experiment, visual cues indicated whether or not an aversive shock might occur. In the attentional control, the shocks were replaced by faint vibrotactile stimuli that had to be counted. The P300 amplitudes of the ERP evoked by the visual cues did not differ under threat and counting, which suggested that both conditions engaged attention to the same extent. In contrast, startle potentiation in the threat condition was an order of magnitude larger than the marginally significant attentional startle facilitation in the counting condition. These results indicate that an attentional contribution to fear-potentiated startle under the present experimental conditions is small. In addition, contextual effects of threat of shock became manifest as baseline startle was facilitated relative to the attention condition. This may reflect a more sustained state of anxiety on which cue-specific fear responses are superimposed.

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1. Introduction

An increasing body of literature demonstrates that the startle reflex is enhanced during aversive emotional states. This effect has proved especially robust with fear manipulations,

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and is generally referred to as fear-potentiated startle (FPS, e.g., Davis, 1992). In humans, FPS has been demonstrated as a result of aversive conditioning (e.g., Hamm and Vaitl, 1996; Lipp et al., 1994; Lipp et al., 1997; Lipp et al., 1998) or by instructed threat of shock (Grillon et al., 1991; Grillon et al., 1993). Furthermore, Lang et al. (1995) developed a procedure to induce negative affect by presenting intrinsically aversive lead stimuli, such as pictures showing mutilated bodies (International Affective Picture System or IAPS). Presentation of aversive pictures also leads to startle facilitation (see e.g., Lang et al., 1997, for a review).

However, startle magnitude can also be modulated by attention (e.g., Filion et al., 1998). Initially, attentional startle modulation has been regarded as modality specific. Eye blink startle is facilitated when the startle probes and the attended lead stimuli are in the same modality, but is inhibited when they are in different modalities (e.g., Putnam, 1990). More recently, it was demonstrated that attention can modulate startle in a modality-nonspecific way. A number of studies reported larger auditory startle response during task-relevant than during task-irrelevant lead stimuli, regardless of lead stimulus modality (Lipp et al., 1997, 1998; Lipp, 2002; Böhmelt et al., 1999). This suggests the possibility that emotional processing indirectly affects startle by engaging attention. In this paper, we address this issue by comparing startle modulation during threat of shock with startle modulation in an attentional task.

Behavioral research based on a cognitive-motivational approach to anxiety has indeed demonstrated the existence of an attentional bias towards threatening stimuli (Mogg and Bradley, 1998). Subjects who reported relatively high state anxiety in the experimental situation were faster to react to dot probes at locations where a threatening word had been shown just before (Mogg et al., 1997). In non-anxious subjects, event-related potentials (ERPs) measured in an instructed threat of shock procedure indicated selective attention to threat cues from 60 ms onwards (Baas et al., 2002a).

In previous studies that compared FPS and attentional startle modulation, occurrence of the latter depended on the nature of the attention task. In the attention tasks, the lead stimuli were associated with a non-aversive target stimulus, instead of the aversive stimulus used in FPS (usually an electrical shock). When the target stimulus called for a motor response findings were equivocal. In earlier studies, no startle modulation was observed (Hamm and Vaitl, 1996; Lipp et al., 1994). In later studies, that used performance feedback combined with monetary reward, attentional startle facilitation has been observed (Lipp, 2002; Lipp et al., 2003b). Feedback has been reported to increase attentional startle modulation, at least with easy tasks (Lipp, 2002; Lipp and Hardwick, 2003). In other studies, the attentional task was to count occurrences of certain stimuli in a series of sequentially presented stimuli, but only when presented with a slight increase in duration (first introduced by Filion et al., 1993). This task requires participants to detect the occurrence of stimuli with the relevant features, and to pay attention to the duration of those relevant stimuli to count the number of longer-than-usual occurrences (discrimination and counting task). In these studies, that used acoustic startle probes, attentional startle facilitation was observed with auditory and visual lead stimuli (Lipp et al., 1997, 1998), but not with somatosensory lead stimuli (Lipp et al., 1998). Because FPS was observed in all three modalities, it was concluded from the lack of attentional facilitation in the somatosensory data that FPS could not be reduced to attentional facilitation (Lipp et al., 1998; consult Lipp et al., 1997 for additional considerations). This result is especially relevant for the present purposes because it involved relevant stimuli

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