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The development of an attentional bias for angry faces following Pavlovian fear conditioning☆

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ABSTRACT

Although it is well documented that fear responses develop following aversive Pavlovian conditioning, it is unclear whether fear learning also manifests in the form of attentional biases for fear-related stimuli. Boschen, Parker, and Neumann (Boschen, M. J., Parker, I., & Neumann, D. L. (2007). Changes in implicit associations do not occur simultaneously to Pavlovian conditioning of physiological anxiety responses. *Journal of Anxiety Disorders*, *21*, 788–803.) showed that despite the acquisition of differential skin conductance conditioned responses to angry faces paired (CS+) and unpaired (CS−) with an aversive shock, development of implicit associations was not subsequently observed on the Implicit Association Test. In the present study, participants ($N = 76$) were assigned either to a Shock or NoShock group and completed a similar aversive Pavlovian conditioning procedure with angry face CS+ and CS− stimuli. Participants next completed a visual probe task in which the angry face CS+ and CS− stimuli were paired with angry face control stimuli and neutral faces. Results confirmed that differential fear conditioning was observed in the Shock group but not in the NoShock group, and that the Shock group subsequently showed a selective attentional bias for the angry face CS+ compared with the CS− and control stimuli during the visual probe task. The findings confirm the interplay between learning-based mechanisms and cognitive processes, such as attentional biases, in models of fear acquisition and have implications for treatment of the anxiety disorders.

Introduction

Phobic responding in the anxiety disorders

Anxiety disorders are highly prevalent and represent the most common cluster of mental health disorders in the general population (Kessler, Chiu, Demler, & Walters, 2005). Fear responses are thought to be acquired through three (Rachman, 1977, 1978) or four (Lovibond, 2003) learning mechanisms, including Pavlovian conditioning which has been considered a central mechanism in the pathogenesis of anxiety disorders for almost 90 years (Davey, 1992; Lissek et al., 2005). A continued interest in the Pavlovian conditioning model of anxiety disorders has lead researchers to produce more complex conditioning models (e.g., Bouton, Mineka, & Barlow, 2001; Maren, 2001; Mineka & Öhman, 2002; Mineka & Zinbarg, 2006) and more recently, to consider the role that cognitive processes play in such learning (Boschen, Parker, & Neumann, 2007; Hofmann, 2008).

Many human fear learning studies employ a differential Pavlovian conditioning procedure in which the offset of one conditioned stimulus (CS), the CS+, coincides with an aversive stimulus such as an electric shock (UCS), and a second CS, the CS−, is presented alone without an accompanying shock (Öhman, Fredrikson, Hugdahl, & Rimmö, 1976; Öhman & Mineka, 2001). Conditioning is apparent by differential responding to the CS+ and CS−, and is usually found within four trials (Lipp, 2006). Despite extensive use of the differential conditioning paradigm, there is less evidence linking the acquisition of differential conditioned responses with the development of cognitive phenomena such as attentional biases.

Several researchers have suggested that a limitation of Pavlovian conditioning models of fear acquisition has been the failure to account for cognitive processes such as biases in the deployment and dwell of attention (Merckelbach, de Jong, Muris, & van den Hout, 1996; Öhman & Soares, 1993). Conditioning has been previously demonstrated to exert effects on numerous different outcome variables, beyond overt behavioural responding. Autonomic responses such as skin conductance have been repeatedly shown to change in response to conditioning procedures. Furthermore, cognitive variables such as subjective stimulus valence

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(e.g., Hermans, Vansteenwegen, Crombez, Baeyens, & Eelen, 2002) and implicit associations as measured by the affective priming task (e.g., Hermans et al., 2005) have also recently been demonstrated to be affected by classical conditioning procedures. Less well studied, however is whether aversive learning through Pavlovian conditioning produces attentional biases typically seen in anxiety and phobic responses (Öhman & Soares, 1993).

The attentional bias phenomena

According to cognitive models of anxiety, individuals with elevated anxiety levels show a preferential allocation of attention to fear-relevant stimuli (Mogg & Bradley, 1998; Öhman & Mineka, 2001; Williams, Watts, MacLeod, & Mathews, 1997). It has been suggested that biased attention may maintain hypervigilance for threat, which in turn elevates an individual's fear level, thereby serving to maintain the anxious state (Davey, 2006; Merckelbach, van Hout, de Jong, & van den Hout, 1990).

While it is acknowledged that various paradigms can detect attentional biases (e.g., dichotic listening and spatial orienting tasks; Kelly & Forsyth, 2007), the emotional Stroop task and the dot probe task (DPT) have been two of the more commonly applied techniques for studying attentional biases to threat (McNally, 1998). To overcome methodological problems with earlier tasks such as Stroop-type procedures, MacLeod, Mathews, and Tata (1986) designed the dot probe attention task. This task isolates attentional processes through the assessment of spatial attention as measured by reaction times to visual probes (Logan & Goetsch, 1993; Mogg & Bradley, 1999). Using this task, MacLeod et al. (1986) found that anxious individuals responded faster when probes appear in the location of threat stimuli, compared with when probes appeared in the location of neutral stimuli. Similar results have been documented in numerous subsequent studies, and the consistency of these findings has been demonstrated in a recent meta-analysis of the attentional bias phenomenon (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007).

Increasingly, visual stimuli such as human faces have been used instead of the word stimuli employed in earlier versions of the DPT (e.g., Bradley et al., 1997). Emotional faces are considered to be more ecologically valid than words, and address other limitations of earlier versions of the DPT highlighted by previous authors such as the relatively limited threat value of words, and their inability to assess attentional bias across the entire time course of the orienting process (Bar-Haim et al., 2007; Bradley, Mogg, Falla, & Hamilton, 1998; Bradley et al., 1997; McNally, Kaspi, Reimann, & Zeitlin, 1990; Mogg & Bradley, 1999; Mogg, Millar, & Bradley, 2000).

Most studies that have studied attentional biases have preselected individuals from clinically anxious populations or individuals with low and high trait anxiety. Very few studies have experimentally induced phobic-like responding in unselected non-anxious participants and measured an attentional bias to threat stimuli (Dawson, Schell, Beers, & Kelly, 1982; Merckelbach et al., 1990). Furthermore, human experiments that have utilised Pavlovian conditioning procedures have often only considered participants' physiological responses (and not the role of cognitive biases) to various fear-relevant stimuli that have been paired with a mild electric shock (Öhman & Mineka, 2001). Thus, the aim of the current study was to investigate whether unselected non-clinical participants would show an attentional bias towards a stimulus they had been conditioned to fear.

Conditioning-induced attentional biases

Hermans et al. (2005) reported on a study in which attention bias was assessed using a reaction time task based on that used by Dawson et al. (1982). In this study, the researchers paired a stimulus of one human face (the CS+) with an electric shock, while presenting another human facial stimulus (the CS−) consistently without a shock. This resulted in significantly slower reaction times to a tone probe when it was later presented during a period when the CS+ was visible, as opposed to the CS−, suggesting an attention bias for the CS+. Similar results have also been reported previously by Dawson et al. (1982) and Lipp, Siddle, and Dall (1993) using similar methods, by Hermans et al. (2002) using an affective priming task and by Van Damme, Crombez, Hermans, Koster, and Eccleston (2006) using a spatial cueing paradigm.

One previous study has attempted to assess the acquisition of attention biases using the dot probe task (DPT). Beaver, Mogg, and Bradley (2005) used a differential conditioning procedure, conditioning an association between photographs of snakes and spiders with a loud burst of white noise. In this study the authors did find a preferential allocation of attention to pictures paired with the aversive noise. They also reported, however, that the attention bias was dependent on the level of aversiveness of the noise. The authors also suggested that stimuli that are generally perceived as more aversive, such as electrical shock, may demonstrate more powerful attention bias effects.

Boschen et al. (2007) recently investigated whether an attentional bias for angry faces can arise from aversive Pavlovian conditioning. Specifically, Boschen et al. (2007) contrasted skin conductance conditioned responses with a measure of cognitive change: changes in implicit associations. The concept of implicit associations arose out of social psychology research, and has since been applied in several studies of psychopathology. An implicit association is an unconscious association of two or more concepts in memory. Results showed that while it was possible to elicit conditioned skin conductance responses (SCR) when an angry face stimulus was paired with a mild electric shock, a subsequent Implicit Association Test (IAT) did not detect changes in implicit concept associations. However, it was unclear whether this was due to failure of the conditioning task to lead to changes in information processing, or whether the IAT was not sufficiently sensitive to these changes.

Aims, overview and hypotheses

The current study was designed to further develop and extend the research findings of Boschen et al. (2007) by replacing the IAT with a more sensitive measure of cognitive change, the DPT. For both the fear conditioning paradigm and the DPT, pictorial stimuli of angry and neutral human facial expressions were used. Similarly to Boschen et al. (2007), this study used a differential conditioning procedure whereby participants were exposed to images of neutral and angry faces. For half the participants (Shock group), one of the angry faces was paired with a shock (CS+) and the other angry face was not (CS−) (Öhman & Mineka, 2001). The remaining participants (NoShock group) received presentations of the angry face CS+ and CS− stimuli without any shock stimulus. Directly following the conditioning procedure, participants in both groups completed the DPT to test for the presence of an attentional bias for the angry face CS+ that had been paired with the shock. The present experiment thus employed both within and between-subject controls to assess conditioning and attentional bias effects.

This investigation posited a series of a priori hypotheses. Firstly, it was hypothesised that during the acquisition phase, Pavlovian fear conditioning would occur, as demonstrated by differential skin conductance responses between the angry face CS+ and angry face CS−, in the Shock group only. In contrast, there would be no differences in skin conductance activity between the CS+ and CS− for the NoShock group. Secondly, it was expected that participants in the Shock group only, would preferentially allocate attention