

## Fear conditioning in posttraumatic stress disorder: Evidence for delayed extinction of autonomic, experiential, and behavioural responses

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### Abstract

Aversive conditioning has been proposed as an important factor involved in the etiology of posttraumatic stress disorder (PTSD). However, it is not yet fully understood exactly which learning mechanisms are characteristic for PTSD.

PTSD patients ( $n = 36$ ), and healthy individuals with and without trauma exposure (TE group,  $n = 21$ ; nTE group,  $n = 34$ ), underwent a differential fear conditioning experiment consisting of habituation, acquisition, and extinction phases. An electrical stimulus served as the unconditioned stimulus (US), and two neutral pictures as conditioned stimuli (CS+, paired; CS-, unpaired). Conditioned responses were quantified by skin conductance responses (SCRs), subjective ratings of CS valence and US-expectancy, and a behavioural test.

In contrast to the nTE group, PTSD patients showed delayed extinction of SCRs to the CS+. Online ratings of valence and US-expectancy as well as the behavioural test confirmed this pattern. These findings point to a deficit in extinction learning and highlight the role of affective valence appraisals and cognitive biases in PTSD. In addition, there was some evidence that a subgroup of PTSD patients had difficulties in learning the CS–US contingency, thereby providing preliminary evidence of reduced discrimination learning.

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### Introduction

Posttraumatic stress disorder (PTSD) is a pervasive psychiatric condition characterised, inter alia, by symptoms of persistent re-experiencing of the traumatic event (DSM-IV, [American Psychiatric Association, 1994](#)). Contemporary theories of PTSD concur in assuming that memory and learning processes like perceptual priming and fear conditioning underlie these re-experiencing symptoms ([Michael et al., 2005](#); [Pitman, 1989](#); [Rothbaum & Davis, 2003](#)). According to the fear conditioning approach, the traumatic event

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(unconditioned stimulus, US) triggers an unconditioned response (UR) which is characterised by strong arousal and intense fear. This UR becomes associated with cues, such as smells, voices, or sights (conditioned stimuli, CSs) which were present during the traumatic event. As a result of this pairing, these cues can trigger similar responses (conditioned responses, CRs) even in the absence of the US. Thus, re-experiencing symptoms can be understood as CRs, which remain persistent, even a long time after the trauma.

As such, the fear conditioning account cannot explain why these symptoms disappear in the aftermath of a traumatic event in most individuals, but persist in those who develop PTSD. Within the conditioning framework, three accounts have been put forward to answer this question: enhanced conditionability, reduced conditioned inhibition, and reduced discrimination learning.

The concept of *enhanced conditionability* refers to a hypothetical trait predisposing to the development of stronger CRs to a traumatic event, and/or to a reduced ability to extinguish these CRs (Orr et al., 2000). Experimentally, conditionability is typically assessed in a differential fear conditioning paradigm in which one CS is paired with the US during the acquisition phase (the CS+) and another CS is not (the CS−). During a subsequent extinction phase, both CSs are presented without the US. The difference between reactions to the CS+ and the CS− (also called differential or discriminative learning) during acquisition and/or extinction indexes conditionability. An individual high on conditionability is thought to be at risk for the development of PTSD subsequent to trauma exposure since particularly strong CRs develop and persist.

However, conditionability, as assessed by differential fear conditioning, actually confounds two processes: excitatory conditioning and inhibitory conditioning (assessed by responses to the CS+ and the CS−, respectively) which each may be informative in its own right (Lissek et al., 2005). In fact, it has been suggested that the inability to inhibit fear in the presence of safety cues (i.e. the CS−) causes excessive fear responses in PTSD patients (Davis, Falls, & Gewirtz, 2000; Grillon & Morgan, 1999; Rothbaum & Davis, 2003). Thus, it is proposed that PTSD patients should differ from controls mainly because of poor inhibitory processes, i.e. they should show heightened responding to the CS−. In the following we will refer to this account as *conditioned inhibition account*.<sup>1</sup>

In line with the enhanced conditionability account, Orr and coworkers found stronger differential responding during acquisition and extinction in PTSD in comparison to trauma exposed controls (Orr et al., 2000). Similarly, Peri and colleagues found enhanced differential responses during the extinction phase in PTSD patients in contrast to healthy and traumatised controls (Peri, Ben-Shakhar, Orr, & Shalev, 2000). However, Peri and colleagues also found heightened reactions in PTSD with respect to the CS− during acquisition and extinction. Although these two studies interpreted their findings to support enhanced conditionability in PTSD, they are also partially consistent with the conditioned inhibition account.

In addition to these two accounts, a third conceptualisation of *reduced discrimination learning* has received support in the clinical conditioning literature. Investigating eye blink conditioning<sup>2</sup> in combat veterans with and without PTSD and control participants, Ayers, White, and Powell (2003) found differential responding to the CSs only in control participants. They attributed this to impaired discriminative learning in combat veterans, possibly due to general memory deficits. Grillon and Morgan (1999) measured the fear potentiated startle reactions in a differential fear conditioning paradigm in two separate sessions separated by one week. In contrast to trauma exposed controls, PTSD patients failed to acquire differential conditioning during the first session. Only during the second conditioning session did they show differential startle responses similar to controls. In opposition to the enhanced conditionability account, the reduced discriminative learning account conceptualises this type of learning as a highly functional process by which participants learn to distinguish between threat and safety cues (Grillon, 2002a).

At this stage, research has yielded partial support for the enhanced conditionability account of PTSD. While some studies were supportive of this view (Orr et al., 2000; Peri et al., 2000) at least two others found

<sup>1</sup>Although it is more of a suggestion rather than a formal theory, the conditioned inhibition account is an interesting complementary approach to the heightened conditionability account (S. Lissek, personal communication). In addition, a differential fear conditioning paradigm cannot be expected to produce equally strong inhibitory effects as obtained in studies using A + /AB− procedures (Rescorla, 1969). In the latter, one stimulus is followed by the US (A+ trials), except when accompanied by a second stimulus B (AB− trials, e.g. Chan & Lovibond, 1996).

<sup>2</sup>While eye blink conditioning is also a form of Pavlovian discriminative learning it might differ on a number of aspects from the present design, i.e. it is less dependent on contingency awareness (Clark & Squire, 1998).

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