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# The renewal of extinguished conditioned fear with fear-relevant and fear-irrelevant stimuli by a context change after extinction

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**Abstract**

The acquisition, extinction, and subsequent recovery of conditioned fear can be influenced by the nature of the conditional stimulus (CS) and the context in which the CS is presented. The combined effects of these factors were examined in a differential fear-conditioning procedure with humans. Fear-relevant or fear-irrelevant CSs were followed by a shock unconditional stimulus (US) during acquisition and presented alone during extinction. The CSs were images presented upon different background contexts. Half the participants received the same context during acquisition and extinction and the remaining received different contexts. All participants received test trials in the same context as acquisition. In Experiment 1 ($N = 64$), a renewal of shock expectancy and skin conductance responses was found during test for fear-relevant and fear-irrelevant CSs when extinction was given in a different context. In Experiment 2 ($N = 72$), renewal for fear-relevant stimuli was enhanced when acquisition and test was given in an indoor office context and extinction in an outdoor bush context. The opposite context configuration produced the strongest renewal for fear-irrelevant stimuli. The return of extinguished conditioned fear can occur to fear-relevant stimuli that are commonly associated with clinical fears and its strength may be enhanced when the stimuli are encountered in certain contexts after extinction.


*Keywords:* Conditioned fear; Fear renewal; Extinction; Context

## Introduction

Pavlovian conditioning has provided a useful framework for understanding the origin and treatment of phobias (Field, 2006). This framework has continued to undergo revision ever since Watson and Rayner's (1920) demonstration that fear behavior to a white rat could be acquired by pairing it with an aversive loud noise. In this example, the white rat functioned as the conditional stimulus (CS) and was associated with an aversive unconditional stimulus (US). Although organisms are readily able to acquire conditioned fear, the extinction of fear behaviors appears to be more difficult. Extinction can be produced by repeatedly presenting the feared CS on its own. However, extinction can be retarded in certain stimuli that seem particularly potent

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to be associated with fear (Mineka & Öhman, 2002; Öhman & Mineka, 2001; Seligman, 1971). According to the notion of preparedness, humans have inherited a genetic predisposition to associate some CS–US combinations more readily than others (see Mineka & Öhman, 2002; Öhman & Mineka, 2001 for reviews). When applied to the acquisition of phobias, humans are more likely to associate certain *fear-relevant* stimuli with aversive stimuli. As such, fear-relevant stimuli that threatened our ancestors, such as predatory or poisonous animals, may explain why phobias to threatening organisms, such as spiders and snakes, are more common than phobias to modern stimuli, such as cars and electrical outlets (Hugdahl & Johnsen, 1989).

Evidence in support of preparedness theory comes from laboratory research employing different types of stimuli as the CS. Such experiments have compared fear-relevant stimuli (e.g., images of spiders or snakes) with fear-irrelevant stimuli (e.g., images of flowers or mushrooms). A finding that corroborates preparedness theory is resistance to extinction in that fear-relevant stimuli show a slower rate in the extinction of conditioned fear than fear-irrelevant stimuli (Fredrikson, Hugdahl, & Öhman, 1976; Hugdahl, Fredrikson, & Öhman, 1977; Öhman, Fredrikson, Hugdahl, & Rimmö, 1976). The phenomenon of resistance to extinction suggests that following acquisition, fear-relevant stimuli are slower to enter into an association that predicts the absence of the US than are fear-irrelevant stimuli. Even though complete extinction can still occur to both stimuli provided that a sufficient number of trials are made, the different rate of extinction in fear-relevant and fear-irrelevant stimuli potentially reflects different underlying processes of extinction. The fear relevance of the CS may also influence other characteristics of extinction such as its permanency across contexts.

Research has shown that extinction does not necessarily result in a permanent loss of conditioned responses, but that it can return under certain circumstances (Bouton, Westbrook, Corcoran, & Maren, 2006). For instance, the renewal effect suggests that extinction learning is modulated by the context in which extinction treatment has been implemented. Bouton and Bolles (1979) demonstrated ABA renewal by exposing rats to pairings of a CS and a footshock US in one context (Context A), followed by extinction in a second context (Context B). Following extinction, the CS no longer evoked a conditioned fear response. When the rats were returned to the original learning context (Context A), they exhibited a renewal of conditioned fear to the CS. In comparison, low levels of conditioned fear were observed in rats that were tested in the same context that had been used for extinction (Bouton & Bolles, 1979; see also Bouton & King, 1983; Thomas & Ayres, 2004). Variations of the renewal procedure have indicated that extinction behavior is restricted to the environmental context in which it takes place (Bouton & Bolles, 1979; Bouton & Ricker, 1994). One explanation of renewal is that following extinction, the CS has become ambiguous because it is associated with the US in two ways, a CS–US and a CS–noUS association. The CS will elicit a conditioned response whenever the contextual cues do not match those experienced during extinction (Bouton, 2002; Bouton et al., 2006).

Renewal has clinical implications in that contextual cues may undermine the effectiveness of extinction-based behavioral treatments for fears and anxiety (Bouton, 2002). Phobic individuals may learn that the feared stimulus is safe only sometimes; that is, in the contexts in which the extinction treatment was implemented (Vansteenwegen et al., 2005). However, a return of fear may occur when the individual subsequently confronts the stimulus alone, in a different context. The observation of a renewal effect in a variety of human laboratory preparations, such as a conditioned suppression task (Havermans, Keuker, Lataster, & Jansen, 2005; Neumann, 2006, 2007) and a fear-conditioning task (Alvarez, Johnson, & Grillon, 2007; Effting & Kindt, 2007; Neumann, Lipp, & Cory, 2007; Vansteenwegen et al., 2005; Vervliet, Vansteenwegen, Baeyens, Hermans, & Eelen, 2005) supports the relevance of renewal to clinical treatments. However, a notable aspect of this research has been the use of neutral CSs, such as images of geometric shapes (Neumann et al., 2007; Neumann, 2006; Vervliet et al., 2005). It is not known whether renewal can be observed for fear-relevant stimuli under the same conditions as when neutral stimuli are used. This question is particularly relevant given that clinical fears are typically found in response to fear-relevant stimuli such as spiders, snakes, and open spaces. Some research has demonstrated a return of fear within a clinical setting by examining spider fear (e.g., Mineka, Mystkowski, Hladek, & Rodriquez, 1999; Mystkowski, Craske, & Echiverri, 2002; Rodriguez, Craske, Mineka, & Hladek, 1999). However, as no direct comparisons between fear-relevant and fear-irrelevant stimuli were possible in these studies it remains to be specified whether the nature of the CS can impact upon the return of fear. The present research was conducted with the primary aim of examining this question.