Neurobiology of Learning and Memory 131 (2016) 109–116

Contents lists available at ScienceDirect

Neurobiology of Learning and Memory

journal homepage: www.elsevier.com/locate/ynlme

Immediate extinction promotes the return of fear

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ARTICLE INFO

Article history:
Received 24 November 2015
Revised 4 March 2016
Accepted 16 March 2016
Available online 16 March 2016

Keywords:
Context
Delayed extinction
Fear conditioning
Learning
Renewal
Retrieval

ABSTRACT

Accumulating evidence indicates that immediate extinction is less effective than delayed extinction in attenuating the return of fear. This line of fear conditioning research impacts the proposed onset of psychological interventions after threatening situations. In the present study, forty healthy men were investigated in a differential fear conditioning paradigm with fear acquisition in context A, extinction in context B, followed by retrieval testing in both contexts 24 h later to test fear renewal. Differently coloured lights served as conditioned stimuli (CS): two CS (CS+) were paired with an electrical stimulation that served as unconditioned stimulus, the third CS was never paired (CS−). Extinction took place immediately after fear acquisition or 24 h later. One CS+ was extinguished whereas the second CS+ remained unextinguished to control for different time intervals between fear acquisition and retrieval testing. Immediate extinction led to larger skin conductance responses during fear retrieval to both the extinguished and unextinguished CS relative to the CS−, indicating a stronger return of fear compared to delayed extinction. Taken together, immediate extinction is less potent than delayed extinction and is associated with a stronger renewal effect. Thus, the time-point of psychological interventions relative to the offset of threatening situations needs to be carefully considered to prevent relapses.

1. Introduction

Being confronted with a life-threatening situation such as a car accident or a rape which can be considered as traumatic events as defined by DSM-V (American Psychiatric Association, 2013), the time-point of intervention might be critical to treatment outcome. Such a process can be investigated in the laboratory using fear conditioning paradigms with a varying temporal delay between fear acquisition (threatening situation) and extinction learning (intervention). Indeed, rodent and human work suggests that immediate vs. delayed extinction influences the persistence and the time-course of extinction by aiming at recent or more remote fear memories (for a review see Maren, 2014).

Initially, a promising study reported resistance to return of fear phenomena such as spontaneous recovery, renewal, and reinstatement after rats underwent extinction training 10 min to 1 h after fear conditioning but not when they received extinction training after 24–72 h (Myers, Ressler, & Davis, 2006). These results suggested that immediate extinction might be an especially effective means of preventing relapses after extinction and could even be capable of erasing the initial fear from memory. Besides, these findings are in agreement with the consolidation theory proposing memory to be labile shortly after initial encoding (McGaugh, 2000). However, the majority of animal studies which followed up on this topic was unable to replicate this result and, in contrast, frequently observed that immediate extinction is less effective than delayed extinction in preventing the return of fear, a pattern which has been termed the "immediate extinction deficit" (Chang, Berke, & Maren, 2010; Chang & Maren, 2009, 2011; Kim, Jo, Kim, Kim, & Choi, 2010; Long & Fanselow, 2012; Maren & Chang, 2006; Stafford, Maughan, Ilioi, & Lattal, 2013; Woods & Bouton, 2008; cf. Maren, 2014; but see Archbold, Bouton, & Nader, 2010). Additionally, immediate extinction is characterized by slower and incomplete within-session extinction due to the temporal proximity to fear acquisition and the partial reinforcement extinction effect (Archbold et al., 2010; Chang & Maren, 2009; Kim et al., 2010).

Although few human experiments report that immediate extinction does not erase fear memories, these studies were in most cases not designed to address the question as to whether immediate extinction is more, less, or equally effective as delayed extinction and thus did not include a delayed extinction group for comparison (Alvarez, Johnson, & Grillon, 2007; Schiller et al., 2008). So far, only a few studies in humans directly investigated this issue by comparing the efficacy of immediate and delayed extinction in attenuating the return of fear. Norrholm et al.

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http://dx.doi.org/10.1016/j.nlm.2016.03.013
1074-7427/

(2008) obtained ambiguous results in fear-potentiated startle and shock expectancy ratings, concluding that the immediate extinction deficit "may or may not be present in humans" (p. 1029). Huff, Hernandez, Blanding, and LaBar (2009) conducted extinction either in the acquisition context or in a new context and tested for renewal in the acquisition context 24 h after extinction. In line with the immediate extinction deficit hypothesis, they observed spontaneous recovery of conditioned skin conductance responses (SCRs) only in the immediate extinction group, while the delayed extinction group did not show an increase in SCRs from the end of extinction to the beginning of the retention test. In contrast, Golkar and Öhman (2012) obtained conflicting findings, observing less reinstatement of fear-potentiated startle in immediate extinction compared to delayed extinction (note, however, that shock expectancy ratings at test did not differ between conditions). In sum, the majority of animal studies agree that immediate extinction does not prevent the return of fear, but the few human experiments revealed rather mixed findings.

One critical component to consider when investigating the effects of immediate vs. delayed extinction comprises the time interval between acquisition and retrieval, which is e.g. 24 h for immediate extinction but 48 h for delayed extinction. The additional time elapsing in delayed extinction compared to immediate extinction might be partly responsible for the reduced return of fear in delayed extinction experiments. We addressed this issue in the current study by investigating an additional CS+ which is presented during acquisition and retrieval, but not during extinction.

Taken together, given the relatively scarce and inconclusive findings obtained from human studies, our aim is to gain more insight into the ambiguous data published to date regarding the (in)efficacy of immediate extinction compared to delayed extinction in preventing the return of fear in a renewal design. Two CSs were paired with a shock (CS+) and one was not paired (CS−) in context A. One of the CSs was presented during extinction (CS+E) in context B, whereas the other CS was not shown (CS+U) to compare the impact of immediate vs. delayed extinction between an extinguished and an unextinguished CS at a separate test session 24 h later in context A and B. Extinction took place either immediately or 24 h after fear acquisition. We predicted an immediate extinction deficit to be assessed in differential SCRs and shock expectancy; slower extinction learning and a higher renewal effect (comparing the CSs between contexts) should occur in the immediate compared to the delayed extinction group. The comparison of the conditioned responses towards the CS+E and the CS+U at the retrieval session should shed light into the question whether the different time intervals between fear acquisition and retrieval accounts for between group differences in the return of fear.

2. Material and methods

2.1. Participants and general procedure

For the purpose of comparing the effects of immediate and delayed extinction, data of the control groups of two previously published studies were re-analyzed and compared (Hamacher-Dang, Merz, & Wolf, 2015; Merz, Hamacher-Dang, & Wolf, 2014). The control groups were tested in the same laboratory using the same experimental procedures, with the exception that in the immediate extinction group (n = 20 men), fear extinction immediately followed fear acquisition, whereas in the delayed extinction group (n = 20 men), extinction was conducted 24 h (±2 h) after fear acquisition. In both groups, fear retrieval was tested 24 h (±2 h) after extinction. All men participated in a non-stressful control condition, during which they immersed their right hand in body-temperature water (37 °C) for three minutes. This served as a standard control procedure to mimic procedural components of the socially evaluated cold pressor test (Schwabe, Haddad, & Schächinger, 2008) while neither being aversive nor eliciting a stress response. The socially evaluated cold pressor test had been used as a means of stress induction in the experimental groups of the two studies (data not reported here; see Hamacher-Dang et al., 2015; Merz et al., 2014). The control condition took place either before fear retrieval (immediate extinction group) or after fear extinction (delayed extinction group).

Participants were healthy male students recruited via advertisement and flyers at the Ruhr-University Bochum. Students were screened via a standardized telephone interview in order to check whether they met any of the pre-defined exclusion criteria. The exclusion criteria included age below 18 or above 40 years, colour blindness, chronic or acute illnesses, current psychological treatment, smoking, drug use, and regular medication (e.g. intake of glucocorticoids for treatment of asthma or beta-blockers).

All test sessions were conducted in the afternoons. For each individual participant, test sessions were arranged so that there was an interval of 24 h ± 2 h between each person's sessions. During all days of testing, participants were instructed not to consume alcohol. They were also advised to abstain from physical exercise, eating, and drinking anything except water within 90 min before the test sessions started.

Upon arrival at the laboratory, participants provided written informed consent and subsequently underwent a brief screening for colour blindness (based on four Ishihara plates selected from Ishihara, 1990). Then, they completed a short demographic questionnaire, provided ratings on two 20-item scales regarding their state and trait anxiety (State-Trait Anxiety Inventory, STAI; Laux, Glanzmann, Schaffner, & Spielberger, 1981) and participated in the fear acquisition phase of the experiment. In the immediate extinction group, the extinction phase followed after a break of approximately three minutes. In the delayed extinction group, the extinction phase was conducted approximately 24 h (±2 h) after fear acquisition. Twenty-four hours (±2 h) after the extinction phase, participants were tested for retrieval and afterwards completed a questionnaire to indicate shock expectancies. At the end of the last day of testing, participants received financial reimbursement and were given the opportunity to ask further questions about the experiment. The studies were approved by the ethics committee of the Faculty of Psychology at the Ruhr-University Bochum and conducted in accordance with the Declaration of Helsinki.

2.2. Fear acquisition, extinction, and retrieval test

The experimental paradigm was completely identical for the immediate and delayed extinction group; thus, any differences between the two groups cannot be attributed to a diverging methodology. In the fear conditioning paradigm, two different contexts were used, provided by photos of two different rooms (office, library) presented on a standard 19-in. computer screen (stimulus material and design were adopted from Milad et al., 2007, 2009). Both contexts contained a desk lamp, which indicated absence and presence of the CS by turning its lamplight on in one of three different colours (blue, red, yellow; assignment of colours to the CSs was counterbalanced across participants). In each trial, the context was presented alone for three seconds. Then, the CS (lamplight) was presented for six seconds. Duration of intertrial intervals varied randomly between six to eight seconds, during which a black screen with a white fixation cross was shown. The fear acquisition phase (duration: 530 s) took place in one context (A), extinction in the other context (B), and retrieval was tested in both contexts (the order of CS-context presentations was counterbalanced across participants). In the fear acquisition phase, two out