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# Fear conditioning with film clips: A complex associative learning paradigm

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ABSTRACT

*Background and objectives:* We argue that the stimuli used in traditional fear conditioning paradigms are too simple to model the learning and unlearning of complex fear memories. We therefore developed and tested an adapted fear conditioning paradigm, specifically designed for the study of complex associative memories. Second, we explored whether manipulating the meaning and complexity of the CS-UCS association strengthened the learned fear association.
*Methods:* In a two-day differential fear conditioning study, participants were randomly assigned to two experimental conditions. All participants were subjected to the same CSs (i.e., pictures) and UCS (i.e., 3 s film clip) during fear conditioning. However, in one of the conditions (negative-relevant context), the reinforced CS and UCS were meaningfully connected to each other by a 12 min aversive film clip presented prior to fear acquisition. Participants in the other condition (neutral context) were not able to make such meaningful connection between these stimuli, as they viewed a neutral film clip.
*Results:* Fear learning and unlearning were observed on fear-potentiated startle data and distress ratings within the adapted paradigm. Moreover, several group differences on these measures indicated increased UCS valence and enhanced associative memory strength in the negative-relevant context condition compared to the neutral context condition.
*Limitations:* Due to technical equipment failure, skin conductance data could not be interpreted.
*Conclusions:* The fear conditioning paradigm as presented in the negative-relevant context condition holds considerable promise for the study of complex associative fear memories and therapeutic interventions for such memories.



## 1. Introduction

Pavlovian fear conditioning has been proven to be an invaluable tool to investigate the learning and unlearning of fear and is considered among the most successful paradigms in the history of experimental psychopathology (Beckers, Krypotos, Boddez, Effting, & Kindt, 2013). It offers an analogue model to study processes that play a role in the pathogenesis and treatment of anxiety disorders (Mineka & Zinbarg, 2006). Over the past decennia, fear conditioning research in animals and humans has unraveled key processes involved in the formation, consolidation and expression of associative fear memories (e.g., see Craske, Hermans, & Vansteenwegen, 2006; Fanselow & Poulos, 2005; LeDoux, 2000), which are supposed to lie at the root of anxiety disorders.

In traditional human fear conditioning research, previously neutral or ambiguous stimuli such as pictures, referred to as the conditioned stimulus (CS), acquire the ability to elicit fear responses (conditioned response, CR), after they have been paired with an intrinsically aversive event (unconditioned stimulus, UCS), like an electric stimulus or airblast. Subsequent re-exposure to the CS in the absence of the UCS decreases the CR as a result of a newly formed extinction memory (Bouton, 2002). While fear conditioning studies have undoubtedly provided us with unique knowledge about the etiology and treatment of anxiety disorders, we argue that traditional fear conditioning models also have serious drawbacks: First, when a specific stimulus (e.g., picture) is associated with a single aversive event (e.g., electric shock), a relatively simple CS-UCS association is induced. Yet, many fear memories such as

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traumatic memories, refer to much more complex fear networks (Foa & Kozak, 1986; Foa, Steketee, & Rothbaum, 1989), as they are provoked by the pairing of a multitude of stimuli (CSs) with an aversive event (UCS), in the context of meaningful relationships. Such composite networks have been modeled with cue competition or selective learning paradigms (see Beckers et al., 2013), where several CSs or combinations of such stimuli are used in order to increase the ambiguity of the learning situation. Moreover, in an attempt to enhance the meaning of artificially induced fear associations, some classical conditioning experiments use fear-relevant CSs (e.g., spiders, guns), which seem to provoke qualitatively different CRs than fear-irrelevant stimuli (e.g., flowers, geometric figures; for reviews, see Öhman & Mineka, 2001; Mineka & Öhman, 2002). However, traumatic fear memories differ from the associations induced by traditional fear learning paradigms not only in terms of their ambiguity and/or evolutionary relevance, but also in other important characteristics. That is, the stimuli involved in trauma formation are of great complexity, in the sense that the aversiveness and emotional impact of the UCS is defined by various (inter-) personal and situational factors, as well as the subjective meaning of the aversive event. Thus, most stimuli used in traditional fear conditioning paradigms do not seem sufficiently representative of the multifaceted and subjectively meaningful stimuli usually involved in the formation of complex fear memories.

Second, by modeling exposure-based treatment methods for anxiety disorders and PTSD, the traditional fear conditioning paradigms tap at contingency-dependent learning processes during extinction (i.e., CS-noUCS association during extinction). Even though such lab-procedures seem to adequately mimic exposure-based treatments, other promising treatment methods for anxiety disorders and PTSD are thought to act via dissimilar mechanisms. For example, cognitive therapies, eye movement desensitization and reprocessing (EMDR), and imagery rescripting, might at least partly work through UCS-devaluation (Davey, 1989), a process where fear memories are degraded in such a way that the conditioned fear response eventually decreases. These methods are thought to change the meaning of a stimulus independently of any experience explicitly aimed at affecting the CS-UCS association (e.g., any further CS-UCS pairings). Thus, a new experimental fear conditioning method is needed, which would enable studying various learning processes of complex UCSs as well as the underlying processes of therapeutic techniques that do not solely focus on contingency learning, but rather on changing the meaning of aversive events.

Inspired by a recent study conducted by Dibbets, Poort, and Arntz (2012), we adapted the traditional fear conditioning paradigm by replacing the simple CSs and UCSs with more complex and meaningful stimuli. While Dibbets and colleagues used pictures and imaginative aversive events during fear learning, we introduce film clips for this purpose. Film clips are among the most powerful stimuli to elicit affective responses in experimental settings (Schaefer, Nils, Sanchez, & Philippot, 2010; Westermann, Spies, Stahl, & Hesse, 1996), and they have increasingly been used to study emotional memories and trauma-analog symptoms such as intrusive memories (for a review on the trauma film paradigm, see Hagenaars & Arntz, 2012; Holmes & Bourne, 2008). Moreover, aversive film clips provide multimodal input (i.e., visual, auditory), thereby inducing an extended associative network of a variety of stimuli. Lastly, film clips are also capable to depict complex interpersonal meanings of traumatic events.

In a two-day differential fear conditioning procedure, participants were subjected to fear acquisition, extinction, and reinstatement. Pictures were used as CSs and the auditory and visual presentation of a short aversive film clip (3 s) served as UCS in two experimental conditions. To increase the complexity of the induced CS-UCS association, before fear acquisition, half of the participants viewed a film clip (12 min) that created a meaningful and complex connection between the reinforced CS and UCS (negative-relevant context). A control group watched a neutral film clip (12 min) that was entirely unrelated to these stimuli (neutral context). Thus, while participants in both conditions were subjected to the same stimuli during fear conditioning, for participants in the negative-relevant context condition the CS and UCS had an associated and rich meaning, while participants in the neutral context condition were confronted with the CS and UCS as 'simple' stimuli.

The aim of the present study was twofold: First, in order to validate the adapted procedure for the study of complex fear memories, we tested whether fear acquisition, extinction, and reinstatement could be observed on psychophysiological (fear-potentiated startle and skin conductance responses) and self-report measures (online distress ratings) within the negative-relevant context condition. Second, we explored whether pre-exposure to an aversive stimulus (film clip) resulted in enhanced fear learning and memory (Rescorla & Wagner, 1972). Given that fear associations high in belongingness (i.e., the extent to which two stimuli are viewed as being related) usually result in stronger fear responding than CS-UCS associations low in belongingness (Hamm, Vaitl, & Lang, 1989), we tested whether pre-exposure to a meaningful film clip increased the associability of the stimuli during fear learning. In the present study, evidence for such effects might be reflected in enhanced fear acquisition, impaired extinction learning, and/or enhanced fear reinstatement in the negative-relevant context compared to the neutral context condition.

## 2. Material and methods

### 2.1. Participants

Fifty-three healthy undergraduate students participated in the study (42 female), which was approved by the department's Ethics Committee. All participants were screened for exclusion criteria (history of physical and/or sexual abuse, current mental and/or physical illness, and (prescribed) medication and/or drug intake at the time of testing). Participants received either partial course credit or monetary compensation (21 Euro) for their participation. Prior to testing, participants were randomly assigned to either the negative-relevant context condition ($n = 26$) or the neutral context condition ($n = 27$; groups were stratified by gender). Written informed consent was obtained from all participants.

### 2.2. Physiological measures

#### 2.2.1. Fear-potentiated startle (FPS)

The conditioned fear response was measured by means of electromyography of the left obicularis oculi muscle. The startle probe eliciting the eye blink reflex was a 104 db, 40 ms burst of broadband white noise with near instantaneous rise time (e.g., Kindt, Soeter, & Vervliet, 2009; Sevenster, Beckers, & Kindt, 2013; Van Ast, Vervliet, & Kindt, 2012), delivered binaurally through headphones (Sennheider, HD 25-1 II). For technical details about the FPS measurement, see Supplementary Material section 1.1.

#### 2.2.2. Electrodermal activity

Due to equipment failure, electrodermal activity could not reliably be recorded during testing. Therefore, the skin conductance results are not further presented (for technical details, see Supplementary Material section 1.2).