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## Review

## A review on the effects of verbal instructions in human fear conditioning: Empirical findings, theoretical considerations, and future directions

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## ABSTRACT

Fear learning reflects the adaptive ability to learn to anticipate aversive events and to display preparatory fear reactions based on prior experiences. Usually, these learning experiences are modeled in the lab with pairings between a neutral conditioned stimulus (CS) and an aversive unconditioned stimulus (US) (i.e., fear conditioning via CS-US pairings). Nevertheless, for humans, fear learning can also be based on verbal instructions. In this review, we consider the role of verbal instructions in laboratory fear learning. Specifically, we consider both the effects of verbal instructions on fear responses in the absence of CS-US pairings as well as the way in which verbal instructions moderate fear established via CS-US pairings. We first focus on the available empirical findings about both types of effects. More specifically, we consider how these effects are moderated by elements of the fear conditioning procedure (i.e., the stimuli, the outcome measures, the relationship between the stimuli, the participants, and the broader context). Thereafter, we discuss how well different mental-process models of fear learning account for these empirical findings. Finally, we conclude the review with a discussion of open questions and opportunities for future research.

## 1. Introduction

Fear conditioning is a relatively simple procedure that is often used in different research areas such as experimental psychopathology, animal behavior, behavioral neuroscience, and psychopharmacology. In this procedure, a conditioned stimulus, CS, is repeatedly paired with an aversive unconditioned stimulus, US, which results in the establishment of conditioned fear responses to the CS. In humans, this procedure is usually implemented by pairing a visual CS (e.g., a blue square) with a mildly aversive US (e.g., a calibrated electric shock), and presenting another CS (e.g., a yellow square) that is not followed by the shock. As a result of this acquisition phase, the first CS (referred to as the CS+) typically evokes more fear than the second CS (referred to as the CS-). The conditioned fear response is assumed to involve subjective, physiological, and behavioral components that can be assessed using self-reports (e.g., of subjective fear or US expectancy), physiological responses (e.g., skin conductance), and behavioral responses (e.g., approach-avoid responses such as pressing a button to avoid the US). The fear acquisition phase can be supplemented with other phases, for instance, an extinction phase during which the CS+ is presented in the

absence of the US. Many factors have been varied in fear conditioning research, including the type of CSs (e.g., evolutionary relevant stimuli, such as pictures of snakes), the context in which stimuli are presented (e.g., the color of a background screen), or the type of population (e.g., anxiety patients; see [Lonsdorf et al., 2017](#), for an extensive overview of relevant factors in fear conditioning). Fear conditioning research is important because it provides insight into the adaptive capacity of humans and other animals to learn which cues predict the occurrence of aversive and potentially dangerous events (that is, the fear conditioning procedure provides an important insight into the process of fear learning; for a further clarification regarding the difference between procedures and processes see [LeDoux, 2014](#)).

In the current review, we will address the role of verbal instructions in human fear conditioning. On the one hand, we review evidence about the effects of conditioning instructions, that is, instructions about CS-US relations (e.g., telling people that a blue square will be followed by a mild shock). On the other hand, we consider the way in which instructions about various elements of a conditioning procedure (e.g., the nature of the CSs) moderate the impact of actual CS-US pairings on conditioned fear responses (see below for more information about the

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specific procedural elements that we will focus on). Understanding the effects of instructions in human fear conditioning research is important for a number of reasons. First, it has already been known for a long time that verbal instructions about CS-US contingencies can result in fear for the CS (Cook & Harris, 1937). However, this capacity of verbal instructions about CS-US contingencies to install fear has only received little consideration in the fear conditioning literature, until recently. Second, verbal instructions can moderate the effects of CS-US pairings on fear. They might even influence the nature of the processes via which CS-US pairings lead to fear (Lonsdorf et al., 2017). Third, from a practical and ethical point of view, it is not possible to avoid instructions altogether in fear conditioning research with humans, because participants have to be informed about the procedures to know what is expected of them and to provide informed consent to participate in the studies. Given these considerations, we think it is important to further our understanding of the effects of verbal instructions in human fear conditioning and the implications of these studies on theories about fear learning. Such a review has in part been undertaken before (Field, 2006; Fuhrer & Baer, 1969; Grings, 1973; Luck & Lipp, 2016a; Muris & Field, 2010). However, these reviews did not attempt to provide a comprehensive overview of the effects of verbal instructions in fear conditioning but mostly focused on specific topics (such as the role of instructions on the extinction of conditioned fear, Luck & Lipp, 2016a, or the effects of verbal threatening instructions in children, Muris & Field, 2010). Moreover, during the last few years, there has been a stark increase in the number of research articles focusing on this topic. Therefore, we think that an updated and more comprehensive review of studies investigating the role of verbal instructions in fear conditioning is due. In this paper, we aim to provide such a review.

To organize the research on the effects of verbal instructions in fear conditioning, we identify five core procedural elements of fear conditioning procedures (for papers that use a similar framework see: De Houwer, 2011; Lipp, 2006; Lonsdorf et al., 2017). Any conditioning experiment involves pairing a CS and a US that elicits a specific unconditioned reaction (UR). These pairings between the CS and the US result in the establishment of conditioned responses (CR) to the CS. This description highlights the three first core elements of the conditioning procedure: The stimuli (CS and US), the outcome measures (UR and CR) and the relationship between the stimuli (e.g., the number of pairings, the statistical contingency between the stimuli, the temporal relationship between the stimuli). Furthermore, these pairings are not administered in a void, but are presented to a specific participant (with certain characteristics) in a broader context with certain task demands and distractors. We will use these five elements of a conditioning procedure (the stimuli used, the outcome measures, the relationship between stimuli, the characteristics of the participant and the distractors and task demands of the broader context) to discuss both the effects of instructions when there are no CS-US pairings as well as the way in which verbal instructions moderate the effects of CS-US pairings on fear. In our review, we only include studies that: (1) used an aversive US (or verbally implied the presence of such a US; see Section 2.1.3), (2) provided explicit instructions about one of the elements of a fear conditioning procedure, and (3) measured one or more behavioral or physiological outcome measure of conditioned fear (see Section 2.2). As such, we will not consider studies that exclusively deal with non-aversive USs and include only measures of liking or contingency ratings (i.e., studies that exclusively deal with contingency or evaluative learning). Furthermore, we will not consider subtle instructional effects of procedural elements other than direct verbal instructions (e.g., the possibility that participants might experience the request to rate their expectancy of the US as an instruction to learn about CS-US contingencies). Finally, in order to limit the scope of our review, we do not consider the effects of instructions on neural activity in brain regions such as the amygdala, and the cingulate and insular cortex (e.g., Büchel et al., 1998; see Mechias et al., 2010, for a review and meta-analysis of that literature).

After considering the procedural knowledge (i.e., the way in which effects depend on specific elements of the procedure) about the effect of verbal instructions on fear conditioning, we discuss how these effects relate to several mental-process theories that attempt to explain how fear learning takes place. Specifically, we consider theories that propose that learned fear is the result of conscious expectations about the presence of an aversive event in the presence of certain antecedent stimuli (Davey, 1992; Lovibond, 2011; Reiss, 1980) and compare those with theories that propose that learned fear is the result of automatic associative learning processes (LeDoux, 2014; Öhman & Mineka, 2001; Olsson & Phelps, 2007). Finally, we conclude our paper with an overview of open questions and avenues for future research.

## 2. Effects of verbal instructions in the absence of CS-US pairings: fear conditioning via verbal instructions<sup>1</sup>

Ever since the work by Cook and Harris (1937), we know that verbal instructions about the contingency between a CS and an aversive US (e.g., “this green light will be followed by an electric shock”), in the absence of any actual CS-US pairings, can result in conditioned fear responses towards the CS. In line with the original terminology of Cook and Harris, we refer to this procedure (i.e., verbally specifying a spatio-temporal contingency between a CS and a US) as ‘fear conditioning via verbal instructions’.<sup>2</sup> Here, we review the effects of the stimuli, the outcome measures, the relationship between stimuli, the characteristics of the participant and the broader context on fear conditioning via verbal instructions. An overview of this section can be found in Table 1.

### 2.1. Effects of stimuli

#### 2.1.1. Type of CS

Fear conditioning via verbal instructions has been demonstrated with various types of visual conditioned stimuli, such as geometric shapes (Costa et al., 2015; Mertens & De Houwer, 2016a), colored lights (Cook & Harris, 1937; Grillon et al., 1993), pictures of unknown animals (Field & Storksen-Coulson, 2007; Uglund et al., 2013), pictures of faces (Olsson & Phelps, 2004) and nonsense words (Bennett et al., 2015). These studies indicate that fear conditioning via verbal instructions is a quite general phenomenon. However, to our knowledge, fear conditioning via verbal instructions has not been demonstrated with stimuli in other sensory modalities, such as auditory or tactile stimuli.

#### 2.1.2. Stimulus preparedness

One specific case concerns stimuli that are thought to be evolutionary prepared to elicit fear (Öhman & Mineka, 2001; Seligman, 1971). Previous studies using CS-US pairings to establish conditioned

<sup>1</sup> Note that we will specify from here on which specific procedure was used to install conditioned fear: verbal instructions (i.e., verbally specifying a contingency between a CS and a US, or implying such a contingency, in the absence of any CS-US pairings, see Section 2.1.3) or CS-US pairings.

<sup>2</sup> In a strict sense, ‘fear conditioning via verbal instructions’ might be an inappropriate usage of the term conditioning. Conditioning refers to the effects of the spatio-temporal pairing of (conditioned and unconditioned) stimuli. Hence, unless it is assumed that the co-occurrence of words referring to a conditioned stimulus and an unconditioned stimulus in a sentence constitutes a stimulus pairing and that the effects of the verbal instructions are due to this spatio-temporal pairing of words (see Field, 2006; Gast & De Houwer, 2012 for such an argument), it seems inappropriate to talk about ‘fear conditioning via verbal instructions’. Rather, it seems likely that verbal instructions produce their effects because of their symbolic meaning rather than because of their spatio-temporal properties (see De Houwer & Hughes, 2016). Thus, strictly speaking it would be more correct to talk about ‘the effects of conditioning instructions on fear’. However, because ‘fear conditioning via verbal instructions’ is more common terminology and because the meaning of this terminology is generally clear, we decided to use this more conventional phrasing (see De Houwer & Hughes, 2016, for a more extended discussion).

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