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The Impact of Instructions on Generalization of Conditioned Fear in Humans

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Generalization of conditioned fear has been implicated in the maintenance and proliferation of fear in anxiety disorders. The role of cognitive processes in generalization of conditioning is an important yet understudied issue. Vervliet et al. (2010) tested generalization of fear to a visual stimulus of a particular color and shape paired with electric shock. Test stimuli shared either the color or shape of the CS+. Prior to conditioning, participants were instructed that either color or shape would be predictive of shock. Generalization was stronger to the stimulus containing the instructed feature, suggesting that instructions impacted generalization of fear. However, the result may also reflect the impact of instructions on attention and learning during the conditioning phase. In the present study, the instructional manipulation was given after the conditioning phase to control for any impact of instructions on learning. A similar result to that reported by Vervliet et al. was observed. On self-reported expectancy of shock, generalization was greater to the test stimulus that included the instructed stimulus feature. The same pattern was observed on skin conductance, although it did not reach statistical significance. The findings indicate that explicitly instructed information affected generalization of conditioned fear independently of any impact on learning, pointing to the role of cognitive processes in human fear generalization. They also support the utility of cognitive therapy approaches, which are employed after fear has already developed, in addressing clinical overgeneralization.

Keywords: generalization; fear learning; classical conditioning; cognitive processes

Anxiety disorders are among the most prevalent and debilitating of the psychological disorders (Andrews, Henderson, & Hall, 2001; Kessler, Chiu, Demler, & Walters, 2005). For many years, classically conditioned fear has been used to model and explore the learning thought to be involved in the development and maintenance of anxiety. Classical conditioning involves the pairing of an initially neutral stimulus (the conditioned stimulus; CS) with an outcome of interest (the unconditioned stimulus; US). Learning of the CS-US relationship is reflected in the development of an anticipatory response (the conditioned response; CR), which is produced when the CS is presented. If the US is aversive or anxiety-provoking, presentation of the CS will come to evoke a fear-appropriate CR aimed at preparing for or avoiding the occurrence of the US.

Experimental investigations into conditioned fear have indicated that conditioning models not only capture the behavioral and emotional components of anxiety, but also the cognitive aspects which dominant theories of emotional disorders have long emphasized (Beck, 1976). In particular, evidence suggests that fear conditioning is closely related to the development of participants' explicit expectancies regarding the likelihood of US occurrence (Lovibond, Saunders, Weidemann, & Mitchell, 2008). As such, fear conditioning provides a useful model for the investigation of the processes involved in anxiety disorders. It is arguably most appropriately applied to

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the processes of learning thought to be involved in posttraumatic stress disorder (PTSD). In PTSD the pairing of cues available at the time of the trauma (the CSs) with the traumatic experience itself (the US) is known to be a central feature of the development of the disorder (Ehlers & Clark, 2000).

There is now a large body of literature investigating the behavioral and neural mechanisms that underlie the acquisition of fear conditioning (Delgado, Olsson, & Phelps, 2006). In addition, much empirical work has been conducted into the process of extinction of fear when the CS is no longer followed by the US (Lissek et al., 2005). Crucially, this growing understanding of fear learning and extinction has allowed for the development of effective behavioral and pharmacological interventions for anxiety disorders (Mineka & Zinbarg, 2006; Lynch, 2004). Continuing to develop our empirical understanding of conditioned fear will potentially allow for the improvement of existing treatments for anxiety.

One aspect of fear conditioning that is relatively less well understood is the process of generalization. Generalization occurs when, following conditioning, the CR is seen to transfer to stimuli that are related to the original CS but never previously paired with the US (Mackintosh, 1974). In the context of fear conditioning, generalization would support fear responding in contexts or in response to stimuli never directly paired with the fear-evoking US. While such a process is potentially adaptive if it allows for more efficient responding to novel or ambiguous aspects of one's environment, it also has the potential to be detrimental if it becomes excessive. Overgeneralization of learning would result in false alarms, repeated instances in which the outcome is expected but does not occur. In the context of conditioned fear, repeated false alarms would support the development of an excessively pervasive sense of threat and therefore heightened levels of anxiety.

The deleterious role of overgeneralization of fear learning is empirically supported in PTSD in particular. Evidence indicates that generalization of conditioned fear to stimuli that resemble trauma cues (which were never themselves associated with the traumatic event) contributes to the heightening and maintenance of perceived threat observed in PTSD (American Psychiatric Association, 2000; Ehlers & Clark, 2000). This stimulus generalization is seen to further the impact of the trauma on the individual's daily life by producing a proliferation in fear-triggering cues in the environment (Feldner, Monson, & Friedman, 2007). Furthermore, several recent studies have suggested that clinically anxious individuals overgeneralize conditioned fear learning under experimental conditions when compared with nonanxious controls. This has been shown in both PTSD (Grillon & Morgan, 1999) and panic disorder samples (Lissek et al., 2010). Evidence such as this points to the importance of better understanding the mechanisms underlying generalization of fear conditioning.

Traditionally, generalization of conditioning has been considered to be largely determined by the perceptual similarity between novel generalization stimuli and those previously encountered. For example, an individual who learns to associate a specific stimulus with the experience of a traumatic event (e.g., a warning siren) would be expected to generalize fear learning most strongly to perceptually similar stimuli (e.g., a sound with similar properties to the warning siren). The role of perceptual similarity in generalization of learning is empirically supported by studies showing a strong relationship between stimulus similarity and strength of generalization. Such studies have typically investigated generalization in nonhuman animals using appetitive conditioning paradigms where the US is a positive or desirable outcome (Guttman & Kalish, 1956). Generalization of responding is tested by presenting a range of stimuli that vary in similarity to the trained stimulus and subsequently plotting strength of responding at the various values. The replicable finding is that responding follows a gradient with a peak at (or near) the CS value with progressively weaker responding as stimuli become increasingly dissimilar to the CS.

Several different theoretical accounts developed out of the early learning literature (Hull, 1949; Pavlov, 1927; Spence 1937), all of which emphasized the role of stimulus similarity in guiding the spread of learning to novel stimuli. More recently, extensions of dominant associative learning theories further developed the theoretical account of the role of stimulus similarity (Blough, 1975; McLaren & Mackintosh, 2002; Pearce, 1987). Although they differ in several key claims, these associative accounts of generalization all posit that associative strength develops through the pairing of CS and US. This associative strength spreads to novel stimuli that contain perceptual elements in common with the original CS, and since stimuli that are most perpetually similar to the CS are likely to have the most perceptual elements in common with it, they should receive the most transfer of associative strength. As such, stimuli never previously paired with the US come to support conditioned responding, the strength of which is dependent upon the similarity of the given stimulus to the original CS.

While the empirical predictions of associative accounts of generalization are well supported in nonhuman animal studies, reproducible inconsistencies have been recorded in human generalization