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A novel perceptual discrimination training task: Reducing fear overgeneralization in the context of fear learning

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Generalization is an adaptive learning mechanism, but it can be maladaptive when it occurs in excess. A novel perceptual discrimination training task was therefore designed to moderate fear overgeneralization. We hypothesized that improvement in basic perceptual discrimination would translate into lower fear overgeneralization in affective cues. Seventy adults completed a fear-conditioning task prior to being allocated into training or placebo groups. Predesignated geometric shape pairs were constructed for the training task. A target shape from each pair was presented. Thereafter, participants in the training group were shown both shapes and asked to identify the image that differed from the target. Placebo task participants only indicated the location of each shape on the screen. All participants then viewed new geometric pairs and indicated whether they were identical or different. Finally, participants completed a fear generalization test consisting of perceptual morphs ranging from the CS + to the CS-. Fear-conditioning was observed through physiological and behavioural measures. Furthermore, the training group performed better than the placebo group on the assessment task and exhibited decreased fear generalization in response to threat/safety cues. The findings offer evidence for the effectiveness of the novel discrimination training task, setting the stage for future research with clinical populations.

1. Introduction

Generalization occurs when the characteristics of a known stimulus extend onto an unfamiliar stimulus on the basis of shared characteristics. While generalization is often an adaptive learning mechanism, it can be maladaptive when it occurs in excess. One such example is the overgeneralization of fear, which characterizes anxiety disorders (e.g., Lissek et al., 2005; Lissek, 2012). Exposure therapy is the leading treatment for this class of disorders. However, though it has proven to be effective, many individuals remain symptomatic or experience relapse following treatment (Loerinc et al., 2015; Olatunji, Cisler, & Deacon, 2010; Walkup et al., 2008). The aim of the current study is therefore to examine a novel perceptual discrimination training task designed to reduce fear overgeneralization, with the long-term goal of improving treatment effectiveness for anxiety-related psychopathology.

Fear conditioning paradigms are often used to assess mechanisms related to fear learning in a laboratory setting. In a classical fear conditioning task, a neutral stimulus (Conditional Stimulus, CS) is repeatedly paired with a naturally aversive stimulus (Unconditional Stimulus, US) until a CS-US association is formed (CS+). In this way, the CS + becomes a threat cue that elicits a fear response even when presented without the US. In differential conditioning paradigms, a second neutral stimulus is added, which is repeatedly presented without the US pairing (CS-). In this way the CS- becomes a safety cue. Conditioning paradigms are highly controlled, allow for the rapid induction of fear, and can be used to examine fear generalization with relative ease (J. LeDoux, 2003; Shechner, Hong, Britton, Pine, & Fox, 2014).

In the last decade a number of studies have sought to better understand the mechanisms of fear overgeneralization using fear conditioning paradigms (for a review, see Dymond, Dunsmoor, Vervliet, Roche, & Hermans, 2015). To this end, generalization is often divided into two categories: perceptual and non-perceptual (i.e., conceptual or symbolic) generalization. Because the focus of the current study is on perceptual generalization, it alone will be discussed. Perceptual learning has been extensively studied in both animals and humans (for a comprehensive review see: Mitchell & Hall, 2014), providing a rich foundation for the investigation of

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perceptual generalization effects. Measuring perceptual similarities offer a means to accurately quantify the distance between stimuli along a continuum (Dunsmoor & Paz, 2015). For example, recent studies have used geometric rings of increasing sizes (Lissek et al., 2008, 2014; Torrents-Rodas et al., 2013), a range of neutral to angry faces (Haddad, Pritchett, Lissek, & Lau, 2012), and colour shape gradients (Dunsmoor & LaBar, 2013) to measure perceptual generalization. A common feature of these studies is the use of generalization gradients consisting of figures ranging in perceptual similarity to the CS+.

The majority of human studies assessing fear overgeneralization have been conducted with healthy participants. Very few studies have directly examined fear overgeneralization in clinical populations (e.g., Panic Disorder: Lissek et al., 2010; PTSD: Lissek & Grillon, 2012; GAD: Lissek et al., 2014). Most of these studies have used a fear generalization paradigm of varying sized rings (see Lissek et al., 2008). Following conditioning, in the generalization test phase of the experiment, participants are presented with generalization stimuli (GSs) that vary in parametrical similarity on a continuum from the CS- to the CS+. Plotted fear responses create a generalization gradient, with the CS + producing the highest fear response, followed by a gradual decrease of such responses to GSs that are decreasingly similar to the CS+. In all of the studies cited above, significant differences between healthy and clinical populations emerged, with clinical participants displaying a higher tendency to generalize between perceptual stimuli than did their healthy counterparts. This finding manifested in a quadratic trend in the responses of healthy participants, who only displayed fear towards GSs that were closely related perceptually to the CS+, thus demonstrating adaptive fear responses. In contrast, participants with psychopathology exhibited a linear trend in their responses, displaying more fear towards intermediary GSs, which could be due to a lower ability to perceptually discriminate between morphs. These trends were illustrated in electromyography (EMG) responses, where, for example, patients with panic disorder generalized up to three units of dissimilarity to the conditioned threat cue (CS+), whereas in the healthy comparison group generalization was restricted to rings with only one unit of dissimilarity (Lissek et al., 2010).

Fear overgeneralization is a defining characteristic of clinical anxiety, whereby the focus of fear excessively transfers onto neutral individuals, objects or contexts. Numerous researchers therefore view studies on fear generalization as a window through which more effective treatment methods for this class of disorders may be developed (see Dymond et al., 2015). Indeed, the potential therapeutic benefit of improving an individual's ability to discriminate between threat and safety cues in treatment settings has been highlighted both in laboratory studies (Boddez, Baeyens, Hermans, Van der Oord, & Beckers, 2013) and in a unique cognitive therapy program developed for posttraumatic stress disorder (Ehlers, Clark, Hackmann, McManus, & Fennell, 2005).

To date, no tasks have been specifically designed to improve individuals' ability to discriminate between perceptual stimuli so as to reduce fear overgeneralization. The aim of the current study is therefore to train individuals to be better able to differentiate perceptually between threat (i.e., CS+) and safety (i.e., CS-) cues following a differential conditioning task. This training involves the use of a novel perceptual discrimination training task wherein individuals will be asked to distinguish between neutral stimuli of increasing similarity. The objective of the training is to use neutral and unfamiliar stimuli to moderate the overgeneralization of fear by improving perceptual discrimination. Neutral as opposed to affective stimuli were specifically chosen for the discrimination training based on the supposition that improvement in this basic mechanism would translate into more adaptive fear expression.

As the current study is the first to assess this novel paradigm, the perceptual discrimination task was tested in a sample of healthy adults. In contrast to those with anxiety-related symptoms, healthy individuals are expected to exhibit adaptive fear generalization. Empirically this would emerge in a quadratic trend in their response data during the fear generalization test phase. That being said, it is hypothesized that participants who complete the discrimination training task will be able to discriminate to a higher degree of accuracy between GSs (i.e., as indicated by enhanced quadratic trends in their response data) than will participants who complete a placebo task. If successful, the perceptual discrimination training could be used to decrease the overgeneralization of fear in clinical populations suffering from anxiety-related psychopathology.

2. Method

2.1. Participants

Seventy healthy adult volunteers participated in this study (age range: 21–41 years, $M = 26.71$, $SD = 3.8$; 63% female) and received either modest monetary compensation or course credit in return for their participation. The study procedure was approved by the local Institutional Review Board. All participants signed written consent forms and were verbally informed that they could leave the study at any time without penalty. Participants were randomly assigned to the training or control conditions using Research Randomizer (Urbaniak & Plous, 2013), with 35 participants in each group.

2.2. Instruments and measurements

Physiological data were collected during the fear conditioning and fear generalization test phases of the experiment using an 8 Slot Bionex system (MindWare Technologies Ltd., www.mindwaretech.com) and were recorded using MindWare acquisition software (Version 3.0.13, MindWare Technologies Ltd.). Fear potentiated startle (FPS) data were measured during both stages through use of electromyography (EMG) and were collected by placing two electrodes filled with standard electrolyte gel on the cheekbone of each participant, directly under the left eye. EMG was recorded at a sampling rate of 2000 hz, and was filtered using an amplifier bandwidth of 30–500 Hz. Skin conductance response (SCR) was measured during the fear conditioning stage of the experiment by placing two isotonic gel electrodes on each participant's left palm (on the hypothenar and thenar muscles), and was recorded at a sampling rate of 25 hz. In addition, a ground electrode was placed on each participant's left forearm.

2.3. Behavioural measures

Self-report questionnaires were administered before and after fear conditioning. Participants were asked to rate level of fear in response to each CS (i.e., "how afraid are you of this bell?) using a Likert scale ranging from 1 to 10. In addition, following conditioning participants were asked to assess the likelihood that each of the CSs would ring (0–100%) in order to assess participants' understanding of the CS-US contingency. At this stage, participants were also asked to rate how unpleasant they had found the ringing of the bell (US) on a scale ranging from 1 (not at all) to 10 (extremely). The State subscale of the State-Trait Anxiety Inventory (STAI: Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) and the Brief Symptom Inventory (BSI: Derogatis & Melisaratos, 1983) were both administered following the discrimination assessment task using an online platform (Qualtrics, Provo, UT). These self-report