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One for all: The effect of extinction stimulus typicality on return of fear

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ABSTRACT

Background and objectives: During exposure therapy, patients are encouraged to approach the feared stimulus, so they can experience that this stimulus is not followed by the anticipated aversive outcome. However, patients might treat the absence of the aversive outcome as an 'exception to the rule'. This could hamper the generalization of fear reduction when the patient is confronted with similar stimuli not used in therapy. We examined the effect of providing information about the typicality of the extinction stimulus on the generalization of extinction to a new but similar stimulus.
Methods: In a differential fear conditioning procedure, an animal-like figure was paired with a brief electric shock to the wrist. In a subsequent extinction phase, a different but perceptually similar animal-like figure was presented without the shock. Before testing the generalization of extinction with a third animal-like figure, participants were either instructed that the extinction stimulus was a typical or an atypical member of the animal family.
Results: The typicality instruction effectively impacted the generalization of extinction; the third animal-like figure elicited lower shock expectancies in the typical relative to the atypical group.
Limitations: Skin conductance data mirrored these results, but did not reach significance.
Conclusion: These findings suggest that verbal information about stimulus typicality can be a promising adjunctive to standard exposure treatments.

Exposure therapy involves the repeated confrontation with a fear-provoking stimulus and is the treatment of choice for anxiety disorders (e.g., Norton & Price, 2007; Wolitzky-Taylor, Horowitz, Powers, & Telch, 2008). Nevertheless, some clients experience a re-emergence of fear symptoms after completing treatment (Craske & Mystkowski, 2006). One pathway for return of fear is the limited generalization of treatment effects when the client is confronted with a new stimulus from the feared category (Boddez et al., 2012; Rowe & Craske, 1998; Vervliet, Vansteenwegen, Baeyens, Hermans, & Eelen, 2005). For instance, a client suffering from dog phobia who has been successfully exposed to a German shepherd might experience a return of fear upon seeing an Airedale terrier. An important goal for clinical and translational research is, therefore, to enhance the generalization of exposure treatment to other exemplars of the feared category.

Extinction provides an elegant laboratory paradigm to tackle this type of question. In extinction, either a conditioned stimulus (CS; e.g., a geometrical figure) that was initially paired with an aversive unconditioned stimulus (US; e.g., electrical shock), or a stimulus that resembles this CS (i.e., a generalization stimulus; GS), is presented without the US (Hermans, Craske, Mineka, & Lovibond, 2006; Scheveneels, Boddez, Vervliet, & Hermans, 2016). This results in a decrease in the previously acquired (fear) responses. However, just like after initially successful exposure therapy, fear can return due to a variety of manipulations including confrontation with a stimulus different from the one used during extinction training (Vervliet, Craske, & Hermans, 2013; Vervoort, Vervliet, Bennett, & Baeyens, 2014). For example, in a study of Barry and colleagues (Barry, Griffith, Vervliet, & Hermans, 2016), a CS was paired with a US in the acquisition phase, so that it came to elicit fear responding. In the subsequent extinction phase, a perceptually similar GS was presented without the US. This GS elicited a high amount of fear responding at the beginning of the extinction phase, which, as

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expected, gradually decreased throughout the extinction phase. However, Barry et al. demonstrated that this successful extinction learning did not generalize to other stimuli: the presentation of yet another GS elicited fear responding again.

Existing extinction research already suggests one potential strategy to attenuate such return of fear after stimulus change in situations where fear is acquired via Pavlovian conditioning[1]: exposure to the stimulus to which fear was originally established (i.e., the CS) eliminates fear responding to other exemplars more effectively than exposure to a GS (Boddez et al., 2012; Dubin & Levis, 1975; Vervliet, Vansteenwegen, & Eelen, 2006; Vervliet et al., 2005). However, in clinical practice this original acquisition stimulus cannot always be identified or used (e.g., because of ethical considerations) and there is often no other option but to use a GS that more or less resembles the CS. In a study with spider phobics, Rowe and Craske (1998) therefore tested whether exposure to not just one but to multiple GSs (i.c. spiders) would enhance generalization of the observed reductions in fear responding to a new GS. As this did not turn out to be the case, we here propose another strategy to overcome this lack of transfer.

More precisely, we examined the effect of providing information about the typicality of the extinction stimulus on the generalization of extinction to a new GS. Indeed, principles of category-based induction suggest that properties of exemplars that are more representative or typical of the overall category are more likely to transfer to other category exemplars (i.e., GSs; Osherson, Smith, Wilkie, Lopez, & Shafir, 1990). If a certain property holds for a typical bird (e.g., a sparrow), for example, then this property will be judged more likely to hold for other birds than if it holds for an atypical bird (e.g., a penguin). Recently, Dunsmoor and Murphy (2014) tested this in a conditioning procedure and showed that fear acquisition with a typical exemplar generalizes more broadly than fear acquisition with an atypical exemplar. We investigated whether enhancing the perceived categorical typicality of the extinction stimulus enhances the transfer of the reduction in fear responses to other exemplars.

It is of note that the dominant theory about extinction learning postulates that return of fear after extinction can be understood by assuming that subjects treat the omission of the US during extinction as a mere 'exception to the rule' that the US generally does follow the CS (Bouton, 2002, p. 982). If a GS is extinguished, for example, people might attribute the absence of the US to the fact that a stimulus other than the original CS was presented. From this perspective as well, informing people that the GS used during extinction is a typical exemplar might be a potentially promising strategy to violate this status of extinction learning as an 'exception to the rule'.

In the present study, we used a differential fear conditioning procedure in which a stimulus (CS) was paired with an electric shock (US). In a subsequent extinction phase, a perceptually similar GS from the same category-type (GS1) was presented without shock, after which another exemplar or GS from this category-type (GS2) was used to test the generalization of extinction. It was predicted that participants who received instructions about the extinction stimulus being a typical exemplar (i.e., the typical group) would show better generalization of extinction learning to the test stimulus compared to participants who were instructed that the extinction stimulus is an atypical exemplar (i.e., the atypical group). US-expectancy ratings and skin conductance were measured as indices of fear.

[1] We refer the interested reader to McNally (2016) for a discussion of non-Pavlovian pathways to fear acquisition.

1. Method

1.1. Participants

Sixty-nine undergraduate students at the University of Leuven (M_{age} = 21.30; SD = 4.18; 50 females) participated in exchange for course credits or payment (€ 8.00). This sample size was chosen in order to exceed the sample size that is typically reported in related fear conditioning studies (e.g., Barry et al., 2016; Boddez, Bennett, van Esch, & Beckers, 2016; Dunsmoor & Murphy, 2014). Participants were allocated in an alternating manner to the typical (n = 35) or atypical (n = 34) group: the first participant was assigned to the typical group, the second participant to the atypical group, the third participant again to the typical group, etc. All participants gave informed consent before starting the experiment and were aware that they could withdraw at any time. The standing ethical committee of the Faculty of Psychology and Educational Sciences approved the study.

1.2. Apparatus

1.2.1. Conditioned stimuli

Two separate families of artificial animal-like objects, known as 'Fribbles', served as experimental (CS + family) and control (CS− family) stimuli (Barry, Griffith, De Rossi, & Hermans, 2014). Whether a particular family of Fribbles served as experimental or control stimuli was counterbalanced across participants. Six different Fribbles were used; one exemplar per family in each experimental phase (see Fig. 1). All exemplars within a family had the same central body part but differed across phases with regard to their peripheral features (i.e., legs, head and tail). In particular, GS2 (used during test) shared two features with GS1 (used during extinction) and two features with the CS (used during acquisition; Barry et al., 2016). This overlap between exemplars in acquisition, extinction and test was analogous for stimuli in the CS+ and in the CS− family. With regard to notation, we use '+' and '-' to denote whether or not a US followed the CS in acquisition. In the extinction and test phase, we use CS+_GS1 and CS+_GS2 to indicate GSs from the CS + family, and CS−_GS1 and CS−_GS2 to indicate GSs from the CS− family. Fribbles were approximately 8.45 cm wide and 6.35 cm high and were presented against a black background on a 19 inch Dell monitor (type P1911, resolution: 1440 × 900 at 60 Hz).

1.2.2. Unconditioned stimulus

The US was a 2 ms electrocutaneous stimulus administered to the participant's right wrist by a Digitimer DS7A constant current stimulator (Hertfordshire, UK). Electrical stimulation was delivered via a pair of V91-01 8-mm reusable Bilaney Ag/AgCl electrodes filled with K-Y Jelly.

1.2.3. US-expectancy ratings

Participants rated their US-expectancy on a trial-by-trial basis on an 11-point scale, ranging from 0 = "certainly no shock" to 10 = "certainly shock". The scale was presented 200 ms after stimulus onset and remained onscreen for maximum 7 s. Responses were made via a mouse-click and the scale disappeared once participants clicked a position on the scale.

1.2.4. Skin conductance response (SCR)

Electrodermal responding was recorded by a Coulbourn LabLinc V Isolated Skin Conductance coupler (model V71-23, manufactured by Coulbourn Instruments, Allentown, PA) using the exosomatic method with alternating current excitation. The coupler applied a constant voltage of 0.5 V through a pair of disposable Biopac EL 507 electrodes (contact area = 95 mm^2) filled with isotonic paste. The