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Ruining the surprise: The effect of safety information before extinction on return of fear

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1. Introduction

Exposure therapy has demonstrated its efficacy for a variety of anxiety disorders (e.g., Hofmann & Smits; Norton & Price, 2007). During exposure the patient is encouraged to approach the stimulus that elicits anxiety. Despite its general efficacy, some patients refuse to engage in exposure-based treatments or quit in a later stage of treatment (e.g., Haby, Donelly, Corry, & Vos, 2006). Refusal and dropout rates for exposure-based treatment vary amongst anxiety disorders and range between 20% and 43% for obsessive-compulsive disorder (Foa et al., 2005; Stanley & Turner, 1995; Whittal, Thordarson, & McLean, 2005), 7% and 31% for panic disorder (Cox, Endler, Lee, & Swinson, 1992), 14% and 20% for posttraumatic stress disorder (Hembree et al., 2003; Van Etten & Taylor, 1998), 0% and 45% for specific phobias (Choy, Fyer, & Lipsitz, 2007), and 0% and 27% for social phobia (Feske & Chambless, 1995).

Providing patients with psychoeducation before the start of exposure can potentially reduce refusal and dropout rates by increasing the credibility and acceptability of treatment (e.g., Bluett, Landy, Twohig, & Arch, 2016). Importantly, psychoeducation can consist of different components that can either be provided separately or can be combined with each other, including explaining the treatment rationale (Arch, Twohig, Daecon, Landy, & Bluett, 2015), informing patients about the (physiological) components of anxiety (Norr, Norman, & Schmidt, 2017), and providing (objective) information about the feared object or situation. The latter component can more specifically target the tendency of anxiety patients to overestimate threat (i.e., the probability that a negative outcome would occur), which can subsequently lower the threshold to engage in a confrontation with the fear-eliciting situation (Vander Haegen & Etienne, 2016)[1]. For example, a patient with fear of flying who is afraid of

[1] Notably, this component of psychoeducation shows considerable overlap with cognitive interventions (Clark & Beck, 2010).

dying in a plane crash can be provided with objective information about the probability that a plane crashes. For other patients the feared outcome or expectancy can relate to 'unbearable' or endlessly increasing levels of anxiety (i.e., 'fear of fear'). Similar to providing safety information about a plane crash, safety information that it is unlikely that anxiety endlessly increases can be given before exposure.

However, a recent approach of exposure therapy with roots in the Inhibitory Learning Theory (ILT; Craske et al., 2008; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014), presumes that there might be disadvantages to providing information about the probability that the feared outcome would occur before the start of exposure. ILT relies heavily on a classical fear conditioning framework in which it is assumed that an excitatory association between a conditioned stimulus (CS; e.g., taking a plane) and an unconditioned stimulus (US; e.g., dying in a plane crash) is formed in memory in anxious individuals. During exposure, an additional inhibitory link with the CS would be formed (CS-noUS; taking a plane does not go together with dying in a plane crash; Bouton, 1993; Bouton & King, 1983). Since it is assumed that fear responding depends on the relative strength of the excitatory and inhibitory associations, the effects of exposure therapy can be maximized by strengthening inhibitory learning. In strengthening the inhibitory association, the concept of *expectancy violation* plays a crucial role. This refers to the mismatch between the expected outcome and the actual outcome. In line with the Recorla-Wagner model (1972), ILT assumes that more (inhibitory) learning can take place if the mismatch between the expected and experienced outcome is large.

Building on the assumptions of ILT, it has been suggested in the literature that providing patients with information about the (low) probability of the occurrence of a feared outcome, decreases the room for expectancy violation during exposure (Craske et al., 2014). If, in the fear of flying example, the expectancy of a plane crash decreases after having

received information about the extremely low odds of plane crashes, taking a plane without crashing would not evoke as much "surprise" or expectancy violation. Similarly, in the other example, providing information before exposure therapy that it is unlikely that anxiety endlessly increases might reduce the expectancy violation if fear does not endlessly increase during the actual session. As such, providing this type of psychoeducation or cognitive interventions before or during the exposure, has been argued to be deleterious to inhibitory learning and to the effectiveness of the exposure treatment (Craske et al., 2014).

In the current study, we investigated the effects of safety information on return of fear. Using an ABA contextual renewal paradigm as a model for return of fear, participants first learned in context A that one of the stimuli was always paired with an electric shock (i.e., danger cue; CS+) and the other stimulus was never paired with the shock (i.e., safe cue; CS-). Crucially, before the extinction phase, participants in the experimental group were presented with a verbal instruction about the low probability of US-occurrence. Participants in the control group did not receive this information. Subsequently, extinction took place in context B with both the CS+ and CS- presented in the absence of the electric shock. After extinction, we tested for contextual renewal by presenting the CS+ and CS- in context A again. It was predicted that the experimental group would show lower shock expectancies and skin-conductance responding (SCR) at the start of extinction compared to the control group. Therefore, we also predicted lower shock expectancies in the experimental group throughout extinction. In addition, we tested the prediction of ILT that the experimental group would display higher return of fear compared to the control group.

2. Method

2.1 Participants

Eighty-two first-year psychology students and community volunteers participated in the experiment in return for payment (8 euro) or course credit. Thirty-six participants were recruited for the control group and 46 for the experimental group. Participants in the experimental group who rated the psychoeducational message as "not believable" or "not very believable" were excluded from the data analysis (Mertens & De Houwer, 2016), leaving a total sample of 72 participants (M_{age} = 20.33; *SD* = 3.04; 57 females) or 36 participants per group. Exclusion criteria were pregnancy, cardio-pulmonary conditions, psychiatric or neurological disorders (e.g., epilepsy) and wrist pain. Before the start of the experiment, all participants gave informed consent. The study was approved by the ethical committee of the Faculty of Psychology and Educational Sciences of the University of Leuven.

2.2 Apparatus and Stimuli

2.2.1 Conditioned stimuli and contexts. Two geometrical shapes (i.e., a triangle and a square) were used as conditioned stimuli (CS). The triangle and square had a grey color with a black border and were presented on a 19-inch Dell monitor (type P1911, resolution: 1440 × 900 at 60 Hz). Which of the two geometrical shapes functioned as the CS+ and which one as the CS- was counterbalanced. The background colors of the computer screen served as contexts and were yellow (RGB 255, 255, 128) or blue (RGB 0. 255, 255).

2.2.2 Unconditioned stimuli. A 2 ms electrocutaneous stimulus served as the unconditioned stimulus (US). It was administered to the participant's right wrist by a Digitimer DS7A constant current stimulator (Hertfordshire, UK) through a pair of V91-01 8-mm reusable Bilaney Ag/AgCl electrodes. These electrodes were filled with K-Y jelly.

2.3 Measures

2.3.1 US-expectancy ratings. Participants rated their expectancy for the US on an eleven-point scale ranging from 0 = "certainly no shock" to 10 = "certainly shock". They

could register their response by a left mouse click on the position of the scale that corresponded to their expectancy. This was done on a trial-by-trial basis. The rating scale appeared onscreen 200 ms after stimulus onset and remained there for maximum 7 s or until participants gave their response.

2.3.2 Skin conductance response (SCR). A Coulbourn LabLinc V Isolated Skin Conductance coupler (model V71-23, Coulbourn Instruments, Allentown, PA) was used to measure electrodermal responding. This device applied a constant voltage of 0.5 Volts through a pair of disposable Biopac EL 507 electrodes (contact area = 95 mm^2). These electrodes were filled with isotonic paste and attached to the hypothenar site of the left-hand palm. Electrodermal activity was recorded from 2 s prior stimulus onset until 6 s after stimulus offset. The analog signal was digitized at 10 Hz by a NI PCI 3221 data acquisition card (National Instruments Corporation, Austin, Texas).

2.4 Procedure

After participants gave informed consent, the electrodes were attached. Using a standard work-up procedure, the intensity of the US was set to a level that was "definitely uncomfortable, but not painful". Before the start of the experimental task, participants were explained that they would be presented with two pictures of geometrical shapes and that one of these shapes could be followed by an electric shock. Participants were told that it was their task to predict the occurrence of the shock and that they could do this by using the rating scale. Subsequently, participants could practice using the rating scale in three practice trials after which they received feedback on whether they used the scale correctly. No CSs or USs were presented during these practice trials.

Table 1 displays a schematic overview of the experimental phases. The experimental task started with one non-reinforced presentation of the CS+ and one CS- presentation to

weaken orienting responses in the skin-conductance measures (pre-exposure phase). This phase was immediately followed by an acquisition phase that consisted of four presentations of the CS+ that was always followed by the US and four CS- presentations in absence of the US. During acquisition, all stimuli were presented against a blue background of the computer screen (context A).

After acquisition, both groups were presented with the following information: "*You will now continue with the experiment. It is still your task to indicate on the rating scale to what extent you expect that the shock will follow the geometrical shapes*".

Participants in the experimental group received additional safety information. Specifically, this information stated the following: "*At the start of the experiment it was mentioned that one of the geometrical shapes could be followed by the electric shock. For the remainder of the experiment, however, the probability that an electric shock will follow this shape is extremely small (1/1000).*" All information was presented against a white background, similar to the instructions at the start of the experiment.

Subsequently, the CS+ and CS- were presented eight times in the absence of shock during the extinction phase. Notably, during extinction the color of the background screen switched to yellow (context B). Extinction was immediately followed by an ABA-renewal test phase in which the CS+ and CS- were presented three times against the blue acquisition context (context A).

After the test phase for contextual renewal, participants in the experimental group rated to what extent the safety information was believable. They could select one of four options: "not believable", "not very believable", "very believable", and "completely believable".

In order to measure a baseline for the skin conductance, all trials started with a 2 s blank screen. CSs stayed on screen for 8 s and intertrial intervals (ITI) were on average 10 s (range 8-12 s). On US-present trials, the US was delivered 7.5 s after CS onset. For half of the participants the CS+ was presented during the first trial of all experimental phases, for the other half the CS- was presented first. This way we aimed to control for order-effects or the impact of (un)reinforced CS+ presentations on subsequent ratings (Lovibond, 2003; Vervliet, Vansteenwegen, Baeyens, Hermans, & Eelen, 2005). Trial order, stimulus presentation, ITI and registration of the dependent variables were controlled by Affect 4.0 (Spruyt, Clarysse, Vansteenwegen, Baeyens, & Hermans, 2010).

Table 1

Overview of the experimental phases

	Pre exposure	Acquisition		Extinction	Test
Experimental group	CS+ (1) CS- (1)	CS+ (4) CS- (4)	**Safety information**	CS+ (8) CS- (8)	CS+ (4) CS- (4)
Control group	CS+ (1) CS- (1)	CS+ (4) CS- (4)		CS+ (8) CS- (8)	CS+ (4) CS- (4)

Note. CSs are pictures of geometrical shapes (counterbalanced). During acquisition '+' refers to the administration of the US and '-' to the absence of the US. During the other phases no USs are administered. The number of trials is indicated between parentheses. The background coloring refers to the context, operationalized as the background of the computer screen.

3. Results

Only the results of the US-expectancy ratings are reported, since the skin-conductance measure failed to show differential acquisition which is a prerequisite for assessing its extinction and later return (e.g., Boddez, Baeyens, Hermans, & Beckers, 2013; Boddez,

Baeyens, Hermans, Van der Oord, & Beckers, 2013). As discussed earlier, only participants in the experimental group who indicated that the experimental instruction was believable were included in the analyses[2].

Figure 1 displays the mean US-expectancy ratings throughout the experiment per CS in the experimental and control groups. A Greenhouse-Geisser correction was applied when the assumption of sphericity was violated.

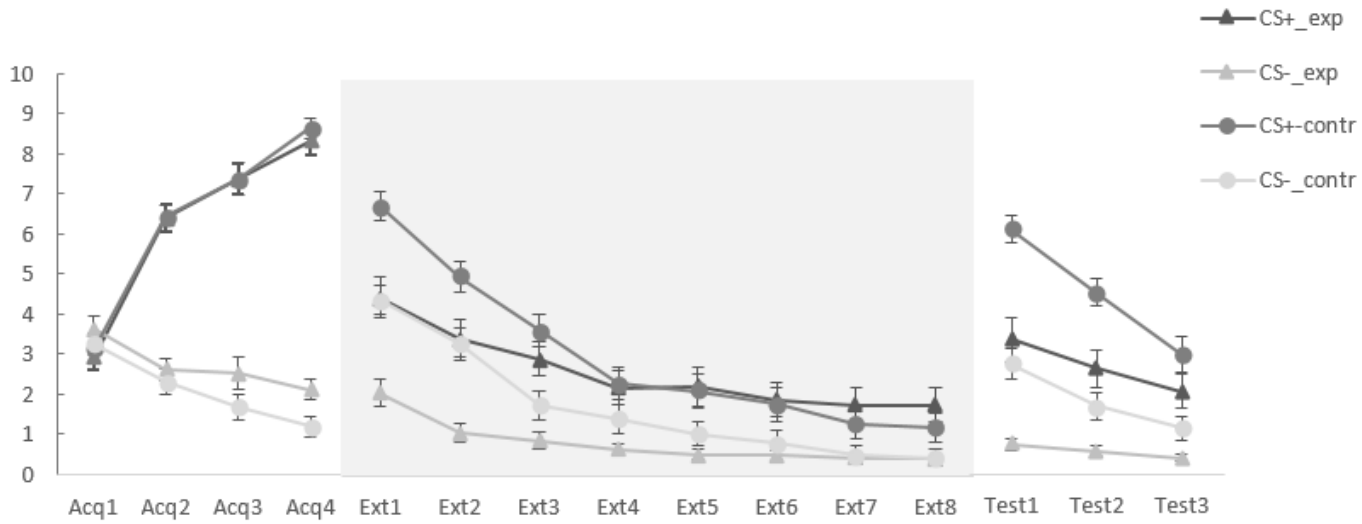

Figure 1. Mean US-expectancy ratings for the four acquisition trials, eight extinction trials and three test trials per CS in the experimental group (exp) and control group (contr). Background colors represent the experimental contexts. Error bars represent standard error of the means.

3.1 Acquisition phase

The left panel of Figure 1 suggests in both groups an increase in US-expectancies from the first to the last acquisition trial for the CS+ and a decrease for the CS-. This was confirmed by

[2] Notably, the conclusions remain the same when conducting the analyses including the 10 participants of the experimental group who indicated that the instruction was not (very) believable.

a 2 (Stimulus) × 2 (Trial) × 2 (Group) repeated measures Analysis of Variance (rmANOVA) comparing the first and last acquisition trial. This analysis revealed a main effect of Stimulus, $F(1, 70) = 173.65$, $p < .001$, $\eta^2_p = 0.71$, a main effect of Trial, $F(1, 70) = 85.51$, $p < .001$, $\eta^2_p = 0.55$, and most importantly a significant Stimulus × Trial interaction, $F(1, 70) = 315.80$, $p < .001$, $\eta^2_p = 0.82$. No effects of Group were found. These results indicate successful acquisition learning which was similar in both groups.

3.2 First extinction trial

The middle panel of Figure 1 suggests higher overall US-expectancy ratings in the control group compared to the experimental group on the first extinction trial but no differences between both groups in CS+/CS- discrimination. A 2 (Stimulus) × 2 (Group) rmANOVA on the first extinction trial revealed a significant main effect of Stimulus, $F(1, 70) = 34.10$, $p < .001$, $\eta^2_p = 0.33$, but no Stimulus × Group interaction, $F(1, 70) = 0.01$, $p = .973$, $\eta^2_p = 0$. These results suggest generalization of the CS+/CS- discrimination to the new context, which was not different between both groups. However, the main effect of Group was significant, $F(1, 70) = 35.33$, $p < .001$, $\eta^2_p = 0.34$, suggesting that the overall US-expectancies are higher in the control group than in the group that received the safety information.

3.3 Course of extinction

The middle panel of Figure 1 suggests a decrease in CS+/CS- discrimination from the first to the last extinction trial in both groups with a steeper decline in the control group. A 2 (Stimulus) × 2 (Trial) × 2 (Group) rmANOVA comparing the first and last extinction trial revealed a main effect of Stimulus, $F(1, 70) = 36.94$, $p < .001$, $\eta^2_p = 35$, and a main effect of Trial, $F(1, 70) = 232.74$, $p < .001$, $\eta^2_p = 0.77$. In addition, a significant Stimulus × Trial interaction was found, $F(1, 70) = 12.40$, $p = .001$, $\eta^2_p = 0.15$, but the Stimulus × Trial × Group interaction was not significant, $F(1, 70) = 0.54$, $p = .466$, $\eta^2_p = 0.01$. These results indicate

that there was a decrease in CS+/CS- discrimination from the first to the last extinction trial, with no differences between the groups. The Trial × Group interaction was, however, significant, $F(1, 70) = 32.38$, $p < .001$, $\eta^2_p = 0.32$, suggesting that irrespective of CS+/CS- discrimination, a steeper decline from the first to the last extinction trial is observed in the control group compared to the experimental group. Moreover, there was a significant main effect of Group, $F(1, 70) = 12.82$, $p = .001$, $\eta^2_p = 0.16$, indicating lower US-expectancy ratings in the experimental group than in the control group.

3.4 Return of fear

To test for group differences in return of fear, a 2 (Stimulus) × 2 (Trial) × 2 (Group) rmANOVA was performed comparing the last extinction trial with the first test trial. This analysis revealed a main effect of Stimulus, $F(1, 70) = 52.69$, $p < .001$, $\eta^2_p = 0.43$, and a main effect of Trial, $F(1, 70) = 125.61$, $p < .001$, $\eta^2_p = 0.64$. The significant Stimulus × Trial interaction, $F(1, 70) = 34.29$, $p < .001$, $\eta^2_p = 0.33$, indicates that there was an increase in CS+/CS- discrimination between the last extinction trial and the first test trial. Moreover, the Stimulus × Trial × Group interaction was significant, $F(1, 70) = 4.03$, $p = .049$, $\eta^2_p = 0.05$, suggesting more return of fear in the control group compared to the experimental group. In addition, there was a significant Trial × Group interaction, $F(1, 70) = 42.01$, $p < .001$, $\eta^2_p = 0.38$. This result indicates that participants who received the safety information, irrespective of CS+/CS- discrimination, showed a smaller increase in US-expectancies from the last extinction to the first test trial compared to participants in the control group.

3.5 Course of the test phase

Group differences in the course of the test phase were tested by a 2 (Stimulus) × 3 (Trial) × 2 (Group) rmANOVA including the three test trials. This resulted in a main effect of Stimulus, $F(1, 70) = 64.68$, $p < .001$, $\eta^2_p = 0.48$, and a main effect of Trial, $F(2, 140) = 41.92$, $p < .001$,

η^2_p = 0.38. The significant Stimulus × Trial interaction suggests that there was re-extinction during the test phase, $F(2, 140) = 10.40$, $p < .001$, $\eta^2_p = 0.13$. The Stimulus × Trial × Group interaction was not significant, indicating that both groups did not differ in the course of extinction during the test phase, $F(2, 140) = 0.72$, $p = .449$, $\eta^2_p = 0.01$. However, when looking at the overall US-expectancies and not taking into account CS+/CS- discrimination, the decrease throughout test is steeper in the control group compared to the experimental group, as indicated by a significant Trial × Group interaction, $F(2, 140) = 9.96$, $p < .001$, $\eta^2_p = 0.13$.

4. Conclusion and Discussion

In clinical practice, patients sometimes receive (objective) information about the probability of the occurrence of their feared outcome as a part of psychoeducation and to lower the threshold to engage in exposure therapy. It has, however, been proposed that giving this type of information might be deleterious to inhibitory learning and to the effectiveness of exposure because it interferes with the possibility to maximally violate expectancies about the occurrence of the aversive outcome during the exposure (Craske et al., 2014). In the present study, we investigated the effect of safety information given between acquisition and extinction training on the return of conditioned fear.

Using an ABA-renewal paradigm, half of the participants (i.e., the experimental group) received between acquisition and extinction the information that the probability of US-occurrence would be extremely small in the remainder of the experiment. The control group did not receive this information. We tested the prediction of ILT that that participants in the experimental group would show higher return of fear in the US-expectancy ratings and skin-conductance response (SCR) compared to the control group.

The SCR measure did not produce usable data, because during acquisition no differentiation in skin responding between the CS+ and CS- was found, which makes interpretation of the extinction and return of fear data impossible. It is of note that relatively less clear patterns in skin conductance responding are reported often despite following conventional procedures and are regularly attributed to large measurement error in this measure (e.g., Boddez, et al., 2013; Haesen & Vervliet, 2015; Schultz, Balderston, Geiger, & Helmstetter, 2013). Our conclusions therefore solely depend on the US-expectancy measure. However, a systematic evaluation by Boddez et al. (2013) suggests that US-expectancy is a robust and valid measure in human fear conditioning research. In particular, fear conditioning research relying on the US-expectancy measure has shown sufficient face validity, diagnostic validity, predictive validity and construct validity with respect to anxiety disorders.

In the US-expectancy ratings, lower return of fear was observed in the experimental group compared to the control group. The same result was found when taking into account the overall US-expectancy ratings, irrespective of CS+/CS- discrimination. In addition, whereas it was predicted that the information about US-occurrence would immediately affect US-expectancy ratings, results indicate no group differences in CS+/CS- discrimination on the first extinction trial. However, the information about US-occurrence had the intended effect on the overall US-expectancy ratings (irrespective of CS+/CS- discrimination), with significantly lower ratings on the first extinction trial in the experimental group compared to the control group[3].

Translating these results to clinical practice, we did not find evidence for a deleterious effect of providing information about the (low) probability of the feared outcome on the

[3] Notably, results indicate that the safety information also had an effect on the CS- ratings. Whereas, similar to other renewal studies (e.g., Haesen & Vervliet, 2014), an increase in CS- ratings is observed after context change in the control group, this does not seem to be the case in the experimental group.

effectiveness of exposure. Our results even point towards beneficial effects of this type of psychoeducation and suggest that it could attenuate return of fear. Notably, this is opposite to what is predicted by ILT. Arguably, US-expectancies during extinction can be used as a measure for expectancy violation, since the US does not occur. However, it is possible that the subjective feeling of surprise after US-omission is a more proximal measure of expectancy violation. To test more specifically whether the instruction results in less surprise after US-omission and whether this mediates the outcome of the exposure, another manipulation check might be informative in future research on this topic. For instance, after each extinction trial the degree of surprise that the US did not occur can be assessed (Craske et al., 2014).

There are two accounts of fear learning at the mental level: dual-process models and single-process models (Mertens, Boddez, Sevenster, Engelhard, & De Houwer, 2018). Arguably, ILT and its predictions regarding the effects of safety information before exposure (implicitly) depart from a dual-process account on fear learning. In particular, ILT seems to consider learning via direct experience as opposed and superior to learning via instruction in the sense that their recommendations are focused on preventing that learning via instruction (psychoeducation about US-occurrence) can interfere with the opportunity to subsequently learn via experience in exposure therapy. Such dual-process perspective is at contrast with single-process theories according to which fear learning through verbal instructions and through CS-(no)US pairings are mediated by the same mental process (Mertens et al., 2018). For example, according to propositional learning theory, it does not matter whether information about (the absence of) contingencies is gained by actual experience, instructions or still other pathways (Boddez, De Houwer, & Beckers, 2017; Mitchell, De Houwer, & Lovibond, 2009). More precisely, this theory holds that information from different learning pathways is continuously integrated into one learning process and therefore has no problem in

accounting for our observation that verbally transmitted safety information enhances (rather than impedes) extinction learning and reduces return of fear.

Although our findings are at odds with the predictions of ILT, they are in line with previous empirical findings. In a study with a different research question, different instruction, and a different test for return of fear, Sevenster, Beckers, and Kindt (2012) instructed half of their participants after fear acquisition that the CS would no longer be followed by the US, whereas the other participants did not receive these instructions. Both groups then underwent extinction and were tested the next day for return of fear using a reinstatement procedure. Similar to the findings of the current study, the group that received information about the absence of the US showed lower return of fear in the US-expectancy ratings than the control group.

In conclusion, the current study did not find evidence that information about the (low) probability of US-occurrence has deleterious effects on return of fear. These results suggest that in clinical practice providing psychoeducation about the occurrence of the feared outcome does not have negative consequences for the effectiveness of exposure. An important next step is to test this question in a clinical trial.

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