The impact of a context switch and context instructions on the return of verbally conditioned fear

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Abstract

Background and Objectives: Repeated exposure to a conditioned stimulus can lead to a reduction of conditioned fear responses towards this stimulus (i.e., extinction). However, this reduction is often fragile and sensitive to contextual changes. In the current study, we investigated whether extinction of fear responses established through verbal threat instructions is also sensitive to contextual changes. We additionally examined whether verbal instructions can strengthen the effects of a context change.

Methods: Fifty-two participants were informed that one colored rectangle would be predictive of an electrocutaneous stimulus, while another colored rectangle was instructed to be safe. Half of these participants were additionally informed that this contingency would only hold when the background of the computer screen had a particular color but not when it had another color. After these instructions, the participants went through an unannounced extinction phase that was followed by a context switch.

Results: Results indicate that extinguished verbally conditioned fear responses can return after a context switch, although only as indexed by self-reported expectancy ratings. This effect was stronger when participants were told that CS-US contingency would depend on the background color, in which case a return of fear was also observed on physiological measures of fear.

Limitations: Extinction was not very pronounced in this study, possibly limiting the extent to which return of fear could be observed on physiological measures.

Conclusions: Contextual cues can impact the return of fear established via verbal instructions. Verbal instructions can further strengthen the contextual control of fear.

Keywords: Fear; Conditioning; Instructions; Context; Psychophysiology

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1. Introduction

Fear conditioning and extinction are considered to provide laboratory analogues for the acquisition of fear and phobias and the subsequent reduction of fear via exposure-based therapy (Field, 2006; Mineka & Zinbarg, 2006). Whereas fear conditioning refers to the acquisition of fear for a Conditioned Stimulus (CS) due to the pairing of the CS with an aversive Unconditioned Stimulus (US), extinction refers to the reduction of conditioned fear through the repeated unreinforced presentation of a CS after the CS-US pairings. Both phenomena have attracted widespread research interest because they allow to investigate complex phenomena such as anxiety disorders and therapeutic interventions in a safe and well controlled laboratory environment.

Despite being an extremely useful framework for understanding the pathogenesis of anxiety disorders and the development of therapeutic interventions, fear conditioning as a model of the development of anxiety disorders has attracted strong criticism as well (e.g., Beckers, Krypotos, Boddez, Effting, & Kindt, 2013; Field, 2006; Rachman, 1977). One important point of criticism is that fear conditioning in the lab nearly always relies on directly pairing a CS with an aversive US. In contrast to this standard practice in lab studies, retrospective studies with patients have found that it is often not possible to identify direct experience with a traumatic event as the etiology of anxiety disorders (for example, most people in Western countries will in general not have any experience with snakes, but may nevertheless develop phobias for them; e.g., Fredrikson, Annas, Fischer, & Wik, 1996; Oosterink, de Jongh, & Hoogstraten, 2009). Rachman (1977) and Field (2006) argue that, besides directly experiencing a traumatic event, acquisition of (maladaptive) fear can also be based on verbal instructions and social observation. This suggestion is supported by both laboratory research in which fear and avoidance responses have been established on the basis of verbal instructions and observation (Cameron, Roche, Schlund, & Dymond, 2016; Lovibond, 2003; Muris & Field, 2010; Olsson & Phelps, 2007) and retrospective reports of anxiety patients who identified verbal threats and social observation as the starting point of their psychopathology (e.g., King et al., 1998; Merckelbach, de Jong, Muris, & van den Hout, 1996). However, fear acquisition via verbal instructions and via observation remain relatively understudied phenomena compared to the large amount of research available on fear conditioning through direct CS-US pairings. Arguably, such a lack of research concerning two of the major pathways of fear acquisition hampers a full understanding of the development and treatment of fear and phobias. Therefore, the primary goal of our research was to further investigate the properties of fear acquired through verbal instructions.

Specifically, we wanted to investigate whether extinction of fear established through verbal instructions is similarly sensitive to contextual cues as fear established through direct experience of CS-US pairings. That is, research on extinction of fear (established through direct experience) has shown that extinction often results in a fragile reduction of the conditioned fearful reactions that can easily be overturned by a change in contextual cues. Based on laboratory research it has been suggested that extinction does not lead to unlearning of previously learned contingencies, but rather results in context-dependent inhibitory learning that suppresses the expression of previously learned contingencies within a certain context (Bouton, 2004). This context specificity of extinction is an important phenomenon to understand why relapse can occur after successful therapy (Bouton, 2002). That is, because extinction memory is more context specific than the original acquisition memory, confrontation with a fear-eliciting stimulus in a new context tends to preferentially activate the original acquisition memory rather than the extinction memory, resulting in a return of fear. So far, however, no study has investigated whether extinction of fear established through verbal information is similarly context-specific. Given that verbal instructions can be regarded as a major pathway to the development of maladaptive fears and phobias, it is important to investigate whether return of verbally acquired fear can occur under similar circumstances as for fear acquired through direct experience.

The context-specificity of extinction is most convincingly demonstrated by the renewal effect. In a typical renewal experiment, conditioned fear is established by pairing a CS with an aversive US during an acquisition phase in a certain context A. This phase is then followed by an extinction phase in a new context B, in which the CS is repeatedly presented without reinforcement. The renewal effect refers to a rapid return of the previously extinguished fear response that occurs when subjects are exposed to the CS in the original acquisition context A (ABA renewal) or in a new context C (ABC renewal), compared to a control condition where the context is not changed (ABB). This basic effect has been obtained both in animal studies (for a review see: Bouton, 2002) and more recently in human studies as well (e.g., Alvarez, Johnson, & Grillon, 2007; Milad, Orr, Pitman, & Rauch, 2005; Vansteenwegen et al., 2005).

In the current study we investigated whether renewal effects can be obtained for verbally conditioned fear (see Dieussaert, Vansteenwegen, & Van Assche, 2005, 2006, for related studies in the context of human contingency learning). We therefore told participants that a certain CS (CS+) would be predictive of an electrocutaneous stimulus (the US) while another CS was said to be safe (CS-). Subsequently, these participants underwent an unannounced extinction phase that was followed by a context switch by changing the background color of the computer screen (e.g., Dibbets, Havermans, & Arntz, 2008; Haesen & Vervliet, 2014)[1]. We expected that the context switch would lead to a return of conditioned fear reactions similar to what has been observed in fear conditioning studies with direct CS-US pairings, even though the CS-US contingency was never directly experienced but merely instructed. We assessed conditioned fear reactions by collecting US expectancy ratings, fear potentiated startle reactions and skin conductance responses on every trial.

A second aim of our study was to investigate whether verbal instructions could modulate the renewal effect. Several models of human associative learning argue that the acquisition and expression of fear is a function of cognitive expectancies about the occurrence of harmful events (Lovibond, 2004; Mitchell, De Houwer, & Lovibond, 2009; Reiss, 1980). These expectancies can be strongly influenced by verbal instructions (e.g., Lovibond, 2003; McNally, 1981). Furthermore, verbal instructions not only allow to communicate whether two stimuli are related, but also allow to specify how they are related and under which conditions the relationship is valid (De Houwer, 2014). Hence, based on these models and studies, we expect that verbal instructions about the relevance of the context for the CS-US relationship could strongly impact the contextual expectancies of encountering an aversive event and hence strongly influence the magnitude of the renewal effect. So far, only one study has addressed the impact of verbal instructions on the renewal effect. In four studies, Neumann (2007) found that verbal instructions that informed the participant that the context was irrelevant for the CS-US contingency was

[1] To control for time related changes which may explain the renewal effect (i.e., spontaneous recovery) usually a second group is included in which the extinction context is not changed (ABB group). However, in the current study the extinction phase was immediately followed by the context switch which reduces the likelihood that time related changes cause context switch effects. Previous studies with a short delay between the extinction and the renewal phase did not find evidence for time related changes that could explain the renewal effect (Alvarez et al., 2007; Vansteenwegen et al., 2005).

ineffective in attenuating the renewal effect. However, while instructing participants that the context is irrelevant for the CS-US contingency seems to be ineffective in influencing the renewal effect, it cannot be excluded that making the context explicitly relevant for the CS-US contingency via verbal instructions could potentially strengthen the renewal effect. To test for this possibility, we included a second group of participants (context instructions, CI, group) who were informed that the previously instructed CS-US contingency would be instantiated only when the background of the computer screen had a particular color but not when the background of the computer screen had another color. We expected that the effect of the context switch would be particularly pronounced for this group compared to the group that did not receive these context instructions (no context instructions, NCI, group).

Finally, we measured startle reactions during noise alone trials to determine whether the obtained renewal effects could be explained by context conditioning (Alvarez et al., 2007). Specifically, while the renewal effect is usually explained by the context gated expression of a learned inhibitory CS-noUS relationship (Bouton, 2004), an alternative explanation is that participants learn that the context itself is a cue for the presence or absence of the US (context conditiong; see: Vervliet, Baeyens, Van den Bergh, & Hermans, 2013 for an overview of explanations for the renewal effect)[2]. If renewal in our study is explained by context conditioning, startle reactions should be potentiated in the context predicting the US (or in any other context not predicting the absence of a US), even in the absence of a CS (Alvarez et al.,

[2] Because we established conditioned fear via verbal instructions (and hence, the US was never presented), little or no excitatory conditioning will take place between the context and the US. Nevertheless, inhibitory context conditioning can still take place in our design during the unannounced extinction phase. In fact, inhibitory context conditioning is a more likely alternative account to the Bouton (2004) retrieval model than excitatory context conditioning because it can account for all the different types of renewal (e.g., ABA, ABC and AAB renewal; see Vervliet et al., 2013).

2007; Vansteenwegen, Iberico, Vervliet, Marescau, & Hermans, 2008). Hence, including startle probes in the absence of CSs allowed us to test whether the renewal effect could be explained by context conditioning, both in the CI and the NCI group.

2. Method

2.1 Participants

Fifty-two right-handed students at Ghent University participated in the experiment in exchange for €8. Eight of these participants were excluded from analyses because they did not remember the instructions correctly after the experiment (5), because they reported not to believe the instructions (2), or because of a technical failure (headphones were unplugged; 1). Half of the participants were assigned to the CI condition and the other half to the NCI condition. Detailed information about each group is provided in Table 1. Even though there was an imbalance between the two groups in the sex distribution, the results remained similar when the analyses were restricted to include only female participants. We therefore report the results for the full sample.

Table 1. Detailed information for the two experimental groups (standard deviation between brackets).

	Context instructions group (N = 22)	No context instruction group (N = 22)	Difference between groups
Age	23.18 (5.43)	21.27 (2.00)	$t(42) = 1.55$
Sex	6 male	1 male	$\chi^2(1) = 4.25$*
Final US intensity (mA)	17.30 (12.29)	17.93 (14.46)	$t(42) < 1$
Final US painfulness rating	7.84 (0.66)	7.57 (1.81)	$t(42) < 1$
STAI-T	36.59 (7.18)	36.72 (7.37)	$t(42) < 1$

*$p < .05$

Note: US = Unconditioned Stimulus (an electrocutaneous stimulation); STAI-T = State-Trait Anxiety Inventory – Trait version (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).

2.2 Material

2.2.1 Psychophysiology.

Recording and scoring of the psychophysiological measures was done in accordance with standard procedures in our lab that have been published before. For the sake of brevity, we refer readers to Raes, De Houwer, De Schryver, Brass and Kalisch (2014) regarding the collection and scoring of skin conductance responses (SCR) and to Verschuere, Crombez, Koster, Van Bockstaele and De Clercq (2007) regarding the collection of the startle response.

2.2.2 US expectancy ratings.

US expectancy ratings were collected on each trial using a 9-point Likert scale presented below the CSs with 5 anchor points: 1 = “not at all”, 3 = “rather not”, 5 = “uncertain”, 7 = “to some extent”, 9 = “certainly”. Above the CSs the question: “To what extent do you expect the shock?” was presented. Participants indicated their answer by clicking one of the response options of the Likert scale with the computer mouse using their dominant hand.

2.2.3 Stimuli.

CSs were a blue and a green rectangle (500 by 400 pixels). Assignment of these rectangles as the CS+ and the CS- was counterbalanced over participants.

The US was an electrocutaneous stimulus of 300 ms administered by two lubricated Fukuda standard Ag/AgCl electrodes (1-cm diameter) to the left leg over the retromalleolar course of the sural nerve. The stimulus was generated by a constant current stimulator (DS7A, Digitimer, Hertfordshire, UK). The intensity of this stimulus was determined for each participant individually to be unpleasant but not painful using a stepwise work-up procedure. Note however that this stimulus was never administered during the experiment, but only during the work-up procedure.

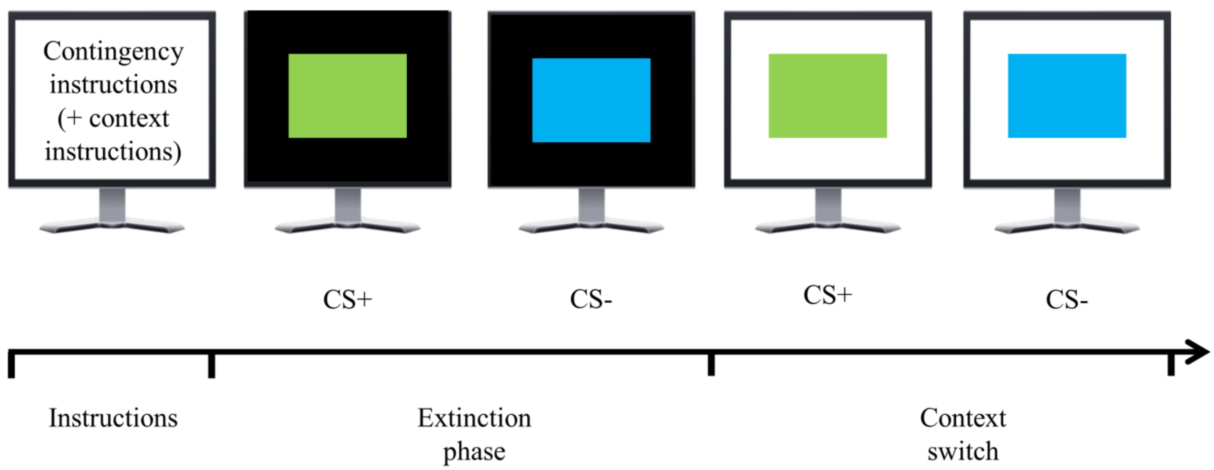

Figure 1. Schematic overview of the experiment. Note that the assignment of background color and CS colors were counterbalanced over participants. Only the CI group received additional context instructions.

2.3 Procedure

At the start of the experiment, participants had to complete an informed consent that instructed them about the presence of an unpleasant but unharmful electrical stimulus and informed them that they could interrupt the experiment at any time without negative consequences.

Next, participants went through a work-up procedure to determine an appropriate intensity level of the electrocutaneous stimulus. Participants were exposed to gradually increasing levels of intensity of the electrocutaneous stimulus and were asked to select an unpleasant but not painful stimulus. After a final intensity level had been determined (see Table 1), participants were told that this would be the stimulus intensity that they could expect during the experiment. Participants were asked to give a verbal rating between zero and ten of the experienced painfulness of the stimulation (see Table 1). Subsequently, physiology recording electrodes were applied and the experiment was launched on the test computer.

In the first part of the experiment, participants received on the computer screen instructions about the contingencies between the colored rectangle and the electrocutaneous stimulus. This can be considered to be the “acquisition” phase because participants learned the contingencies at this point but were never directly exposed to these instructed contingencies at any point during the experiment (see Figure 1 for a schematic overview of the experiment). The instructions (in Dutch) informed participants that they would see two colored rectangles during the experiment. One colored rectangle (green or blue, counterbalanced) was instructed to sometimes be followed by the electrocutaneous stimulus while the other colored rectangle was instructed to never be followed by the electrocutaneous stimulus. One half of the participants (CI group) was also informed that this rule would be valid only when the background of the screen is white (or black, counterbalanced) and that when the background of the screen is black (or white) no electrocutaneous stimuli would be applied. The other half of the participants did not receive these additional instructions (NCI, group; see Appendix A for a translation of the instructions). Participants were further informed that their task was to indicate to what extent they expect the electrocutaneous stimulus each time a rectangle appears by clicking one of the response options on the scale below the rectangle. They were asked to provide their ratings quickly after the appearance of the rectangle. The background color of the computer screen during the instructions was either black or white (counterbalanced) and was always the same as the background color of the renewal phase, but different from the background color in the extinction phase. Hence, the procedure resembled an ABA renewal design, with this difference that the first phase involved only instructions that referred to events on the second phase or third phase. Because we did not have an acquisition phase in which CS-US pairings were presented, it was not possible to return to the original acquisition context (and hence have a standard ABA renewal design).

After these instructions, the extinction phase started. The background of the computer screen during the extinction phase changed to either black or white (counterbalanced; see Figure 1) and was in the color that was instructed to be safe for the CI group. The extinction phase started with 5 habituation startle probes with an interval of 7 seconds. Next, both colored rectangles were each presented 10 times during 8 seconds without reinforcement, preceded by a fixation cross during 2 seconds. On each trial, a startle probe occurred 7 seconds after CS onset (Sevenster, Beckers, & Kindt, 2012). The inter-trial interval between the stimuli was either 6, 8 or 12 seconds, randomly determined. Furthermore, 10 startle probes were presented throughout the extinction phase in the absence of a CS (noise alone, NA, trials) with the same inter-trial interval. The sequence of trials was randomly determined with the exception that no more than two identical trials could occur in sequence.

The extinction phase was immediately followed by an unannounced change in the background color of the screen (context switch; from black to white or vice versa). A short 5 seconds interval followed the context switch to avoid that SCRs on the first trial in the new context would be influenced by the orienting response. This new background color was always the instructed threatened background color for the CI group. Three unreinforced presentations of each colored rectangle and three additional NA trials were presented within this new context with the same trial procedure as during the extinction phase. The first trial after the context switch was experimentally controlled: half of the participants saw the CS+ first while the other half saw the CS- first.

At the end of the experiment, participants were asked to retrospectively rate the believability of the instructions at the moment they received them by selecting one of four options from a dropdown list: “not believable”, “not very believable”, “very believable” and “completely believable”. Two participants who selected “not believable” were excluded from the analyses. Finally, participants were asked to indicate which of the two colored rectangles would be followed by the electrocutaneous stimulation according to the instructions by selecting one of three response options from a dropdown list: “the green rectangle”, “the blue rectangle” or “I don’t know”. Five participants who did not correctly identify the CS+ were excluded from the analyses.

3. Results

The different measures of conditioned fear (US expectancy, SCR and startle) were analyzed separately. For each measure, two mixed ANOVAs were conducted. First, the data obtained during the extinction phase were analyzed using an ANOVA with the within-subjects factors CS (US expectancy ratings and SCR: CS+, CS-; startle: CS+, CS-, NA) and Trial (1 to 10), and the between-subjects factor Group (CI or NCI group). Second, the effect of the context switch was assessed by comparing the responses from the last trial of the extinction phase with the responses from the first trial of the switch phase (factor Phase). Additional factors in this second analyses were the factors CS (CS+, CS-) and Group (CI or NCI group).

Greenhouse-Geisser corrections were applied when the sphericity assumption was violated and *p*-values below .05 were considered significant.

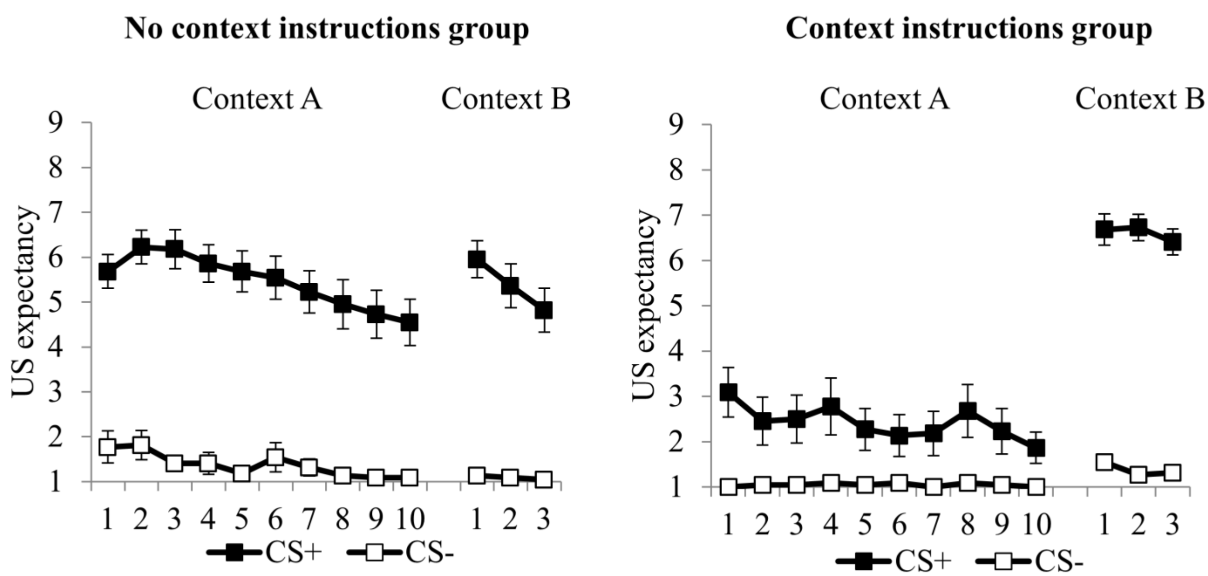

Figure 2. US expectancy ratings throughout the experiment for the two experimental groups. Error bars represent standard error.

3.1 US expectancy ratings.

Successful conditioning was obtained on the basis of verbal instructions as evidenced by significantly higher US expectancy ratings for the CS+ (M = 3.94, SE = 0.30) than for the CS-

(M = 1.21, SE = 0.07) during the extinction phase, main effect of CS: $F(1, 42) = 80.24$, $p < .001$, $\eta^2_p = .66$. Conditioning during the extinction phase was more pronounced for the NCI group (M = 4.09, SD = 1.93, $t(21) = 9.94$, $p < .001$, $d = 2.12$) than for the CI group (M = 1.37, SD = 2.11, $t(21) = 3.05$, $p = .006$, $d = 0.65$; see Figure 2), interaction between CS and group: $F(1, 42) = 19.83$, $p < .001$, $\eta^2_p = .32$. This result demonstrates that our context instructions (i.e., no USs would be applied during the extinction context for the CI group) successfully reduced US expectancy ratings. Furthermore, US expectancy ratings tended to decrease throughout the extinction phase (see Figure 2), main effect of trial: $F(3.81, 160.21) = 6.46$, $p < .001$, $\eta^2_p = .32$. There was a marginally significant interaction between CS and trial, indicating that US expectancies tended to decrease more for the CS+ than for the CS- during the extinction phase, $F(3.68, 154.61) = 2.42$, $p = .056$, $\eta^2_p = .05$. The three way interaction between CS, trial and group was not significant, $F(3.68, 154.61) = 1.32$, $p = .267$, $\eta^2_p = .03$, suggesting that the extinction tendency was comparable for the CI and NCI group.

The context switch led to a significant increase in US expectancy ratings after the context switch (M = 3.83, SE = 0.14) compared to before the context switch (M = 2.13, SE = 0.16), main effect of phase: $F(1, 42) = 237.20$, $p < .001$, $\eta^2_p = .85$. This effect was more pronounced for the CS+ (see Figure 2), interaction between CS and phase: $F(1, 42) = 87.36$, $p < .001$, $\eta^2_p = .65$. Importantly, this specific renewal effect was especially pronounced for the CI group (increase in differential conditioning = 4.27, $SD = 2.39$, $t(21) = 8.37$, $p < .001$, $d = 1.79$) compared to the NCI group (increase in differential conditioning = 1.36, $SD = 1.84$, $t(21) = 3.48$, $p = .002$, $d = 0.74$; see Figure 2), three-way interaction between CS, phase and group: $F(1, 42) = 20.42$, $p < .001$, $\eta^2_p = .33$. This result demonstrates that the context instructions strengthened the renewal effect. Note that the difference in the renewal effect was driven mainly by differences between the two groups in the extinction phase. That is, an interaction between CS and group was observed only at the end of the extinction phase, $F(1, 42) = 17.23$, $p < .001$, $\eta^2_p = .29$, but not at the first trial of the renewal phase, $F(1, 42) < 1$. Thus, the greater renewal effect of the CI group was mainly due to reduced differential US expectancy ratings in the extinction phase, rather than larger differential US expectancy ratings in the renewal phase (see Figure 2)[3].

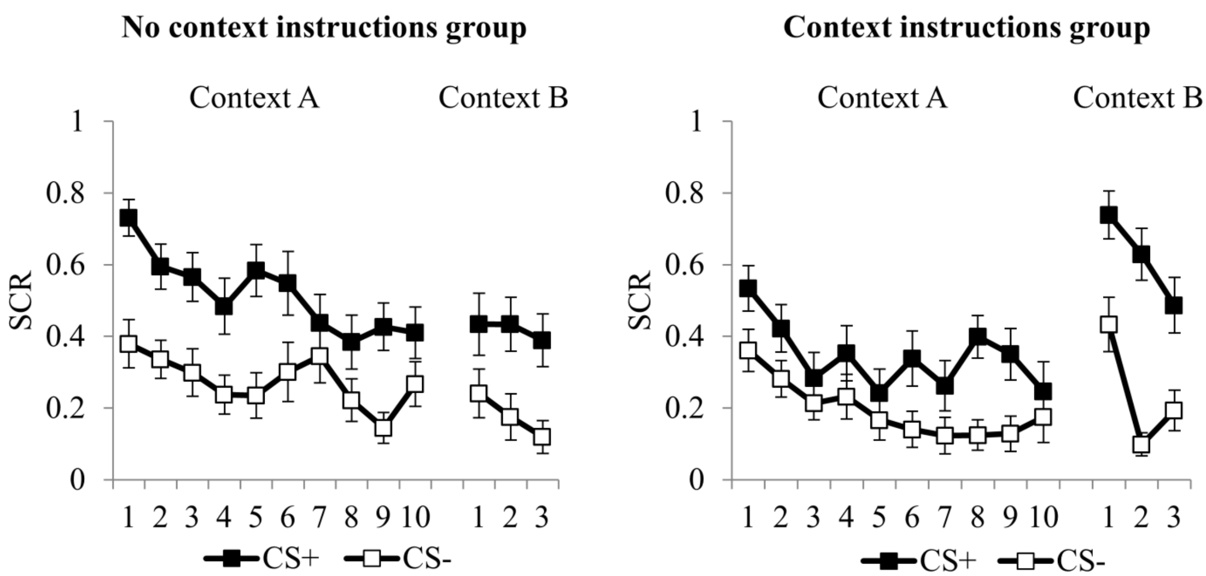

Figure 3. Skin conductance responses throughout the experiment for the two experimental groups. Error bars represent standard error.

[3] However, note that when we included all three trial of the renewal phase to compare the CI and NCI group, we did obtain a trend for larger differential US expectancy ratings for the CI group, $F(1, 42) = 3.24$, $p = .079$, $\eta^2_p = .07$.

3.2 SCR.

Similar to the US expectancy ratings, there was a significant difference in SCR between the CS+ (M = 0.43, SE = 0.03) compared to the CS- (M = 0.24, SE = 0.02), demonstrating conditioning on the basis of verbal instructions, main effect of CS: $F(1, 42) = 66.70$, $p < .001$, $\eta^2_p = .61$. Furthermore, there was a significant effect of the factor trial, $F(9, 378) = 6.72$, $p < .001$, $\eta^2_p = .14$, but this did not interact with CS, $F < 1$, indicating that the extinction procedure led to a reduction of the SCRs, but not differently so for the two CSs (see Figure 3). Finally, the interaction effect between CS and group was marginally significant, $F(1, 42) = 3.70$, $p = .061$, $\eta^2_p = .08$, due to less differential conditioning in the CI group ($M = 0.15$, $SD = 0.16$, $t(21) = 4.24$, $p < .001$, $d = .94$) than in the NCI group ($M = 0.24$, $SD = 0.15$, $t(21) = 7.45$, $p < .001$, $d = 1.60$; see Figure 3), suggesting that our instructions were successful to reduce conditioned reactions for the CI group during the extinction phase on SCRs as well. The other interaction effects did not reach significance, *F*-values < 1.

The context switch led to a significant increase in SCRs (see Figure 3), main effect of phase: $F(1, 42) = 14.86$, $p < .001$, $\eta^2_p = .26$. However, there was no significant difference in the context switch effect between the CS+ and the CS-, interaction between phase and CS: $F(1, 42) = 1.92$, $p = .173$, $\eta^2_p = .04$. This indicates that the context switch led to a general increase of fear for both the CS+ and CS-, rather than a specific increase of fear for the CS+. This is a commonly observed effect in studies on return of fear (Vervliet et al., 2013). Importantly, the interaction effect between the factor phase and group was significant, $F(1, 42) = 15.06$, $p < .001$, $\eta^2_p = .26$, demonstrating that the effect of the context switch (a general increase in SCRs) was larger for the CI group ($M = 0.38$, $SD = 0.35$, $t(21) = 4.97$, $p < .001$, $d = 1.09$) than for the NCI group (M = -

0.001, *SD* = 0.29, *t*(21) = -0.02, *p* = .984, *d* ≈ 0; see Figure 3). This greater non-specific renewal effect for the CI group was mainly explained by larger SCRs in the CI group at the first trial of the renewal phase, $F(1, 42) = 13.15$, $p = .001$, $\eta^2_p = .24$, rather than smaller SCRs in the CI group at the last trial of the extinction phase, $F(1, 42) = 2.45$, $p = .125$, $\eta^2_p = .06$. Thus, the verbal instructions increased SCRs to both the CS- and CS+ after a context switch, rather than reduced SCRs in the instructed safe context (see Figure 3). However, note that this does not apply for the whole extinction phase. When all trials of the extinction phase were considered, we did see evidence for a reduction of differential SCRs for the CI group (see the results of the extinction phase). Finally, there was no significant three-way interaction between phase, CS and group, $F(1, 42) < 1$.

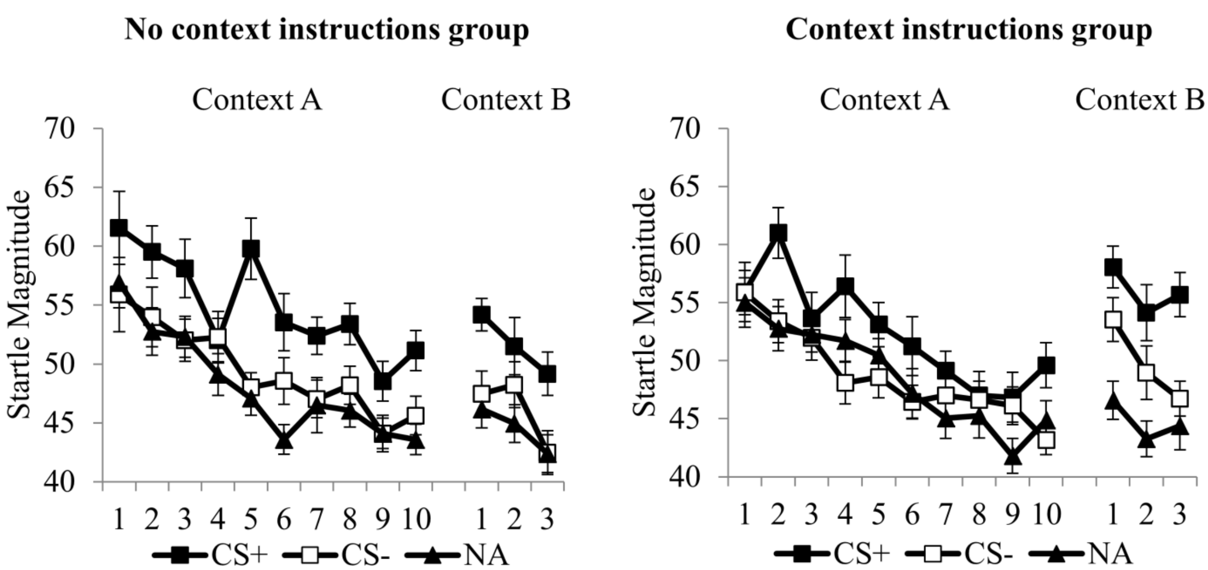

Figure 4. Startle responses throughout the experiment for the two experimental groups. Error bars represent standard error.

3.3 Startle.

For the analysis of the extinction phase, startle responses were averaged per two trials to reduce the impact of missing observations on the results. Startle responses were stronger to the CS+ probes (M = 53.75, SE = 0.56) than towards the CS- (M = 49.19, SE = 0.47) or the NA probes (M = 48.42, SE = 0.46), main effect of CS: $F(2, 82) = 25.09$, $p < .001$, $\eta^2_p = .38$, demonstrating conditioning on the basis of verbal instructions for startle as well. Startle magnitude tended to decrease throughout the extinction phase, main effect of trial, $F(3.33, 136.47) = 48.11$, $p < .001$, $\eta^2_p = .54$, but this effect did not interact with CS, $F < 1$. Descriptively, conditioning effects were larger in the NCI ($M = 5.56$, $SD = 5.08$, $t(21) = 5.14$, $p < .001$, $d = 1.09$) than in the CI group ($M = 3.64$, $SD = 5.83$, $t(21) = 2.93$, $p = .008$, $d = 0.62$; see Figure 4), which would be expected on the basis of our instructions, but this effect failed to reach significance; interaction between CS and group: $F(2, 82) = 1.87$, $p = .161$, $\eta^2_p = .04$. All the other interaction effects were not significant, *F*-values < 1.

The context switch led to stronger startle responses after the context switch (M = 50.95, SE = 0.67) compared to before (M = 46.31, SE = 0.68); main effect of phase: $F(1, 39) = 20.44$, $p < .001$, $\eta^2_p = .34$. This effect of phase did not interact with CS, $F < 1$, indicating that the context switch led to a general increase in startle responses (see Figure 4). Importantly, the interaction effect between phase and group approached significance, $F(1, 39) = 4.01$, $p = .052$, $\eta^2_p = .09$, due to larger effects of the context switch (a general increase in startle responses) for the CI group ($M = 6.99$, $SD = 6.28$, $t(21) = 5.22$, $p < .001$, $d = 1.11$) than for the NCI group ($M = 2.60$, $SD = 6.56$, $t(21) = 1.86$, $p = .077$, $d = 0.40$; see Figure 4). As for SCRs, this non-specific renewal effect was mainly due to stronger startle responses in the CI group at the first trial of the renewal phase, *F*(1, 41) = 7.01, *p* = .011, η^2_p = .15, rather than weaker startle responses in the CI group at the end of the extinction phase, *F*(1, 40) < 1 (see Figure 4). The three way interaction between phase, CS and group did not reach significance, *F*(2, 78) = 2.13, *p* = .126, η^2_p = .05.

Finally, we did not observe a significant increase in NA startle reaction after compared to before the context switch for the NCI group, *t*(21) = 1.34, *p* = .194, Cohen's *d* = .29, or the CI group, *t*(20) < 1, *p* = .370, Cohen's *d* = .20. Also, there was no difference between the two groups in the increase in context conditioning as measured by NA startle reactions going from the extinction phase to the renewal phase, *F*(1, 41) < 1, suggesting that differences in context switch effects between the two groups cannot be explained by differences in context conditioning.

4. Discussion

The main aim of the current study was to investigate whether extinguished fear reactions that were initially established on the basis of verbal instructions are sensitive to a change in context. To this end, participants were verbally informed about the contingencies between two CSs and a US. After these instructions, participants were subjected to an unannounced extinction phase which was immediately followed by a context switch. US expectancy ratings, skin conductance responses and startle responses were measured throughout the experiment. In addition, a second group of participants was included who were explicitly informed about the two contexts in the experiment (i.e., a safe context and a second context in which CS-US pairings would occur). We report three main findings: First, a context switch after an unannounced extinction phase led to a selective return of conditioned responding (i.e., stronger for CS+ than for CS-) as measured by US expectancy ratings. However, this was not accompanied by a comparable selective return of fear on SCRs or startle responses. Instead, for startle (but not for SCR) we observed a trend for a general return of fear (i.e., not different for CS+ than for CS-). Second, verbal instructions about the relevance of the context for the CS-US contingency resulted in stronger context switch effects on all measures. Third, no evidence was obtained that the context switch effects could be explained by context conditioning as measured by NA startle reactions. These three findings will be discussed in greater detail below.

First, evidence for a selective renewal effect was obtained on US expectancy ratings even though conditioning was established on the basis of verbal instructions (see left panel Figure 2). That is, US expectancy ratings, especially for the CS+, increased after the context switch relative to the last trial of the extinction phase. Furthermore, a trend for a general increase of fear (both for the CS+ and the CS-) was observed for startle responses after the context switch, which can also be considered to be an indication of renewal (Vervliet et al., 2013). However, the fact that we found specific renewal only for the US expectancy ratings but not for the psychophysiological measures calls for caution when interpreting the results. Previous studies in which conditioning was established through direct experience revealed specific renewal on psychophysiological measures as well (e.g., Alvarez et al., 2007; Milad et al., 2005; Vansteenwegen et al., 2005). One explanation for the absence of specific renewal effects on the psychophysiological measures in the current experiment might be because extinction, despite 10 extinction trials, was quite limited in magnitude. This weak extinction, in turn, limits the likelihood of finding strong renewal effects both statistically (less room for a return of conditioned fear reactions) and mechanistically (less inhibition learning). Alternatively, it is possible that uninstructed fear conditioning, relative to instructed fear conditioning, leads to either more context-independent acquisition learning or more context-dependent inhibitory learning, therefore resulting in stronger renewal effects that are also observed on psychophysiological measures. It would be interesting for future studies to directly study the impact of including contingency instructions on the renewal effect. Nevertheless, the specific renewal effect on US expectancy ratings and the general return of fear on startle in the current study provide reasonable evidence that contextual cues are important for the return of fear, also when this fear was initially established on the basis of verbal instructions.

Our results have both clinically and theoretically interesting implications. Clinically, they suggests that fears acquired on the basis of verbal instructions can quickly return when the context changes. This is an important finding because previous research has demonstrated that verbal instructions can be an important pathway through which fear and phobias are acquired (e.g., Muris & Field, 2010). Given that the renewal effect can be a source of relapse after successful therapy (Bouton, 2002), our results suggest that fear acquired through verbal instructions might pose similar challenges for successful therapy as fears established through direct conditioning. Therefore, it would be interesting for future studies to test whether procedures that seem to be effective in preventing or reducing renewal, such as extinction training in multiple context (e.g., Gunther, Denniston, & Miller, 1998) or including extra extinction cues in the extinction training and the renewal phase (e.g., Dibbets et al., 2008), are effective to reduce the renewal effect after verbally instructed fear conditioning as well. Theoretically, our results suggest that conditioning via verbal instructions also competes for expression with contingencies subsequently learned in an extinction phase and that the context can gate this expression of learned information (Bouton, 2004). More generally, our findings once again highlight the similarities between learning via instructions and via direct experience (Grings, 1973; Lovibond, 2003). Hence, they advocate a model of fear conditioning and learning that allows for strong similarities between learning via instructions and learning via direct experience.

Second, informing a group of participants about the presence of two contexts and its relevance for the CS-US contingencies strengthened the context switch effects on all collected measures for this group. This finding demonstrates that verbal information about the context can strongly modulate the impact of a context switch on the expression of fear. However, the effect of the context instructions was differently expressed on the different measures of fear. For US expectancy, the context instructions primarily reduced US expectancy ratings for the CS+ in the extinction phase, but did not reliably increase differential US expectancy ratings after the context switch. For the physiological measures, on the other hand, the context instructions resulted in larger fear responses to both the CS+ and the CS- after the context switch, but did not reduce psychophysiological responses before the context switch (see Figures 2, 3 and 4). These results may suggest that our instructions differently affected self-report ratings and psychophysiological measures of conditioned fear. However, when all the trials of the extinction and renewal phase were considered, similar trends were observed for both types of measures. That is, increased differential and non-differential US expectancy ratings were obtained when all trials of the renewal phase were considered, and differential fear reactions tended to be reduced for SCRs and startle when all trials of the extinction phase were taken into account. Hence, there was some evidence in our data for similar effects of verbal instructions on psychophysiological and self-report measures. This may suggest that our study may have lacked sufficient power to reliably detect certain, more subtle, effects of the verbal instructions on self-report ratings and psychophysiological measures. Context-specific inflation and reduction of differential fear responses on both psychophysiological and self-report measures through verbal instructions may be obtained when a sufficient amount of observations are considered. Nevertheless, regardless of these considerations about the differences between the psychophysiological measures and the US expectancy ratings, our study does provide an important proof-of-principle that verbal instructions about the relevance of the context for the CS-US contingency can strengthen contextual control of fear, on both self-report and psychophysiological measures.

Our results are complementary to the only other study that has investigated the impact of verbal instructions on the renewal effect. Whereas we found that instructions can strengthen the renewal effect, Neumann (2007) observed that verbal instructions cannot attenuate the renewal effect. The combination of our own results with these of Neumann (2007) may suggest that verbal instructions are successful in strengthening the renewal effect, but not in attenuating it. However, the way conditioned reactions were measured differed between our own study (physiological and self-report measures) and the studies of Neumann (withholding a response in a videogame). Furthermore, conditioning was established by directly experiencing the contingencies in the studies by Neumann (2007) rather than via verbal instructions in our own study. Further research will need to clarify exactly under which conditions verbal instructions can impact the contextual expression of fear.

More generally, the effects of context instructions that we observed in our study are in correspondence with the aforementioned expectancy models of associative learning and fear conditioning (De Houwer, 2009; Lovibond, 2004; Mitchell et al., 2009; Reiss, 1980) by showing that the expression of learned fear reactions is strongly influenced by verbal instructions about when the CS-US contingency applies. That is, our CS-US contingency instructions strengthened fear reaction within a certain context in which they were instructed to apply, and reduced fear reactions in a context in which they were instructed not to apply. Such a result cannot easily be explained by the formation of simple associations when receiving instructions (e.g., Field, 2006; Ugland, Dyson, & Field, 2013) because these associations do not offer a way to encode validity information. Rather, it shows that our instructions are encoded and expressed in a conditional format, which seems to fit better with the idea of learning through the formation of propositions about the relationship between the CS and the US as proposed by propositional models of associative learning (De Houwer, 2009; Mitchell et al., 2009).

Finally, we did not find evidence for context conditioning as measured by startle reactions during NA trials, neither for the CI group nor the NCI group. This result suggests that the effect of the context switch cannot be explained by context conditioning in either group. This result fits with the results from Alvarez et al. (2007) who did not find any evidence either that context conditioning, as measured by NA startle reactions, could explain the renewal effect.

In conclusion, our study demonstrates that extinction after conditioning via verbal instructions is sensitive to contextual cues. In addition, we provide evidence that verbal instructions can strengthen the contextual control of fear.

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Appendix A

Dutch version of the instructions

No context instructions group. Welcome to this experiment! During this experiment you will see two colored rectangles repeatedly being presented on the screen. The blue rectangle can sometimes be followed by an electrical stimulation. The green rectangle will NEVER be followed by an electrical stimulation. Your task is to indicate to what extent you expect the electrical stimulation each time a rectangle appears by clicking one of the options on the scale below the rectangle. It is important to indicate to what extent you expect the electrical stimulation quickly after the presentation of a rectangle.

Context instructions group. Welcome to this experiment! During this experiment you will see two colored rectangles repeatedly being presented on the screen. The blue rectangle can sometimes be followed by an electrical stimulation. The green rectangle will NEVER be followed by an electrical stimulation. Watch out: this rule is only applicable when the background of the screen is white. When the background of the screen is black, no electrical stimulations will be applied. Your task is to indicate to what extent you expect the electrical stimulation each time a rectangle appears by clicking one of the options on the scale below the square. It is important to indicate to what extent you expect the electrical stimulation quickly after the presentation of a rectangle.