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Reappraisal facilitates extinction in healthy and socially anxious individuals

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ABSTRACT

Background and objectives: Cognitive behavioral therapy (CBT) combines cognitive restructuring with exposure to feared stimuli in the treatment of anxiety disorders. Due to the complexities of cognition–emotion interactions during ongoing CBT, the underlying mechanisms remain unclear, which hinders treatment optimization.
Methods: We created a laboratory analogue by combining reappraisal, a key ingredient of cognitive restructuring, with Pavlovian conditioning, a key ingredient in behavioral treatments. The novel differential Pavlovian acquisition and extinction task featured social stimuli as conditioned and unconditioned stimuli under unregulated and reappraisal instructions.
Results: Findings indicated that reappraising the conditioned stimuli attenuated acquisition (Study 1) and facilitated extinction (Study 2) of conditioned negative valence. In Study 3, highly socially anxious individuals showed deficient extinction learning relative to low socially anxious individuals but compensated for this by using reappraisal.
Limitations: Diagnostic status of participants was not assessed in structured clinical interviews.
Conclusions: Reappraisal of feared stimuli could be useful in prevention and treatment of social anxiety.

1. General introduction

Anxiety disorders are highly prevalent, severely debilitating, and involve considerable societal costs (e.g., Konnopka, Leichsenring, Leibing, & König, 2009). Cognitive behavioral therapy (CBT) has emerged as the treatment of choice for these disorders (e.g., Butler, Chapman, Forman, & Beck, 2006). Core components of CBT are cognitive techniques such as cognitive restructuring and behavioral techniques such as repeated exposure to feared stimuli. It is likely that cognitive and behavioral processes interact in a bidirectional fashion during CBT. Thus, experiences during successful exposures to feared stimuli may change phobic cognitions, and cognitive restructuring of phobic cognitions, in turn, may facilitate fear extinction during exposure.

A growing literature is trying to delineate the mechanisms behind these cognition–emotion interactions during ongoing CBT (e.g., Craske et al., 2008; Hofmann et al., 2007; Kleim et al., 2013; de Quervain et al., 2011; Salkovskis, Hackmann, Wells, Gelder, & Clark, 2007). However, the complexity of a dynamically unfolding therapeutic process makes the establishment of causality difficult. In this regard laboratory research can usefully complement naturalistic process research. Therefore, the present study series created a laboratory analogue of CBT by applying a key feature of cognitive restructuring, the cognitive emotion regulation strategy *reappraisal*, to the laboratory analogue of exposure therapy, Pavlovian conditioning (Bouton, Mineka, & Barlow, 2001).

1.1. Pavlovian conditioning theories of anxiety and exposure therapy

According to conditioning theories of anxiety disorders, etiology and maintenance of pathological anxiety results from a Pavlovian conditioning process, involving contingent pairing of aversive unconditioned stimuli (USs) such as initial panic attacks (as in panic disorder), social stress (as in social anxiety disorder, SAD), or traumatic events (as in posttraumatic stress disorder) with neutral CSs (stimuli, situations, people, see De Houwer, Barnes-Holmes, & Moors, 2013; for a revised definition of learning). After such

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acquisition of conditioned fear, CSs can later provoke aversive-defensive responding even in the absence of the USs, as evidenced during later *extinction* training, when CSs are no longer followed by USs. Failure to decrease such conditioned responding is referred to as *resistance to extinction*. This extinction deficit has been demonstrated in a range of anxiety disorders (Lissek et al., 2005) making it a key maintenance factor in clinical anxiety. Extinction is thought to underlie *exposure therapy*: patients are encouraged to expose themselves to their feared stimuli (the CSs) to realize that the feared consequences (the USs) do not occur, and to decrease their disliking and avoidance of these stimuli. Although exposure therapy is very successful overall, there is room for improvement (Craske et al., 2008; Hofmann & Smits, 2008). Therefore, much of the basic conditioning research has tried to understand the mechanisms underlying extinction, with the ultimate aim of developing novel strategies to improve it (e.g., Graham & Milad, 2011).

1.2. Integrating cognitive emotion regulation with Pavlovian conditioning

This search for ways to optimize exposure therapy has motivated researchers to investigate the role of cognitive emotion regulation in Pavlovian conditioning. In the first study on this topic, participants were conditioned to yellow or blue square-CSs using electric shocks as US under instructions of either attending to their feelings or of cognitively regulating their emotions (i.e. by imagining calming images from nature during CS presentation, Delgado, Nearing, Ledoux, & Phelps, 2008). Results revealed decreased differential skin conductance responding for reappraise vs. attend trials. Neurally, the dorsolateral prefrontal cortex (dlPFC), engaged by reappraisal, seemed to attenuate differential amygdala responding via the ventromedial PFC, suggesting that regulation takes a common final path as extinction learning (Delgado et al., 2008; Hartley & Phelps, 2010). More recently, Shurick et al. (2012) conditioned participants to images of snakes and spiders using electric US. After conditioning, participants were helped in cognitively restructuring negative thoughts and feelings experienced during conditioning. This procedure reduced differential fear and electrodermal responding during a second conditioning session 24 h later. These two studies demonstrated the influence of cognitive emotion regulation over differential fear conditioning. However, three important aspects remain unexplored.

First, the tasks employed by Delgado et al. (2008) and Shurick et al. (2012) did not distinguish an acquisition phase from an extinction phase. However, it would be useful to know *when* cognitive emotion regulation needs to be employed to be successful: during the acquisition phase and thus early during conditioning (analog to the original onset of fear in the course of clinical anxiety), or later during the extinction phase when already established associations need to be changed (analog to CBT treatment of chronic clinical anxiety).

Second, previous research did not examine regulation effects on valence ratings. Valence during Pavlovian conditioning is thought to arise from an *evaluative conditioning* (EC) process that evolves in parallel to the differential responses on autonomic electrodermal, or US-expectancy/fear ratings, both representing expectancy learning. EC has a number of characteristics that make it different from expectancy learning. EC is more resistant to extinction than expectancy learning (Blechert, Michael, Williams, Purkis, & Wilhelm, 2008; Hermans, Vansteenwegen, Crombez, Baeyens, & Eelen, 2002; Vansteenwegen, Crombez, Baeyens, & Eelen, 1998; Vansteenwegen, Francken, Vervliet, De Clercq, & Eelen, 2006). EC is also associated with reinstatement (Dirikx, Hermans, Vansteenwegen, Baeyens, & Eelen, 2004; Hermans et al., 2005; Zbozinek, Hermans, Prenoveau, Liao, & Craske, 2014), a laboratory analogue of the return of fear after an initially successful treatment (Rachman, 1989) which makes EC particularly relevant for the long term outcome of exposure therapies. In fact, EC is enhanced in clinical anxiety: patients with panic disorder and post-traumatic stress disorder show a deficit in extinguishing EC responses compared to healthy controls (Blechert, Michael, Vriends, Margraf, & Wilhelm, 2007; Michael, Blechert, Vriends, Margraf, & Wilhelm, 2007). Thus, enhanced EC conditioning might be why many anxiety patients are prone to experience a return of fear after successful exposure therapy.

Third, if adding cognitive emotion regulation to Pavlovian conditioning were clinically relevant, it should help to reduce the extinction deficit seen in several anxiety disorders. Might cognitive emotion regulation in fact reduce the extinction deficit in participants with elevated anxiety? The present study series aimed to answer these three open questions.

1.3. The present research

The present research started off by creating a suitable conditioning framework that would isolate acquisition from extinction, and that would generate reliable and persistent EC effects. Due to their high relevance to daily life social functioning, we chose social stimuli as CSs and USs. Research in social cognitive neuroscience moves away from using static emotional faces in isolation and starts to embed them in written emotional sentences (Davis, Johnstone, Mazzulla, Oler, & Whalen, 2010; Wieser et al., 2014), emotional voice recordings (Iidaka et al., 2010), nonverbal affective gestures (Wieser, Flaisch, & Pauli, 2014) or dynamic videos (Hermann, Keck, & Stark, 2014; Pejic, Hermann, Vaitl, & Stark, 2013) to determine how humans acquire and represent knowledge about unpleasant social encounters and to elucidate associated individual differences such as emotion regulation style (Hermann et al., 2014) or social anxiety (Pejic et al., 2013). Here, we used still images of neutral faces of actors as CSs which predicted aggressive/insulting exclamations of the same actors as USs. In this social conditioning task we expected to condition strong negative valence to the still images (assessed through subjective ratings), thereby modeling a prevalent process in social interactions in daily life. Translation of Pavlovian conditioning into the social domain would also allow us to study putative extinction deficits in individuals with social anxiety, who are particularly sensitive to negative social evaluation (Weeks et al., 2005; Winton, Clark, & Edelmann, 1995) and to test whether cognitive emotion regulation might ameliorate these deficits. We chose to focus on *reappraisal*, defined as changing the way one thinks about a situation to alter one's emotional response, as this is a particularly well studied and clinically relevant cognitive emotion regulation strategy (Gross, 2014). A series of three studies was carried out to address these research aims. Study 1 applied reappraisal during acquisition. Study 2 applied reappraisal during extinction. Study 3 assessed individuals with high social anxiety in the social conditioning task to test whether they would show an extinction deficit and whether reappraisal would help in reducing it.

2.. Study 1: reappraisal during acquisition

Study 1 explored the suitability of the social conditioning task for generating reliable and durable EC effects, and for examining reappraisal. Three conditions were repeatedly presented within participants (explained in more detail below). Two conditions, termed CS_Neg and CS_Neu, simulated the CS+ (the CS that predicts the US during acquisition) and the CS− (the CS that is never paired with the US) of conventional conditioning designs. The difference in negative valence between CS_Neg and CS_Neu after acquisition was

taken to represent differential EC acquisition. A third condition – the CS_Rea condition – represents a second CS+ (predicting the US) presented under reappraisal conditions. The difference in valence ratings between CS_Rea and CS_Neg was taken as an index of reappraisal strength. Based on previous research, we hypothesized that reliable EC effects would be observed (CS_Neg > CS_Neu, Lissek et al., 2008; Pejic et al., 2013). We further expected reappraisal to reduce or slow acquisition (CS_Neg > CS_Rea, Shurick et al., 2012). These effects during acquisition were expected to carry over into the extinction phase. Due to the known effects of gender during emotion reactivity and regulation tasks (e.g., Domes et al., 2009; Mcrae, Ochsner, Mauss, Gabrieli, & Gross, 2008), this factor was considered in the analyses.

2.1. Method

2.1.1. Participants

Participants were $n = 33$ ($n = 26$ female, $n = 7$ male) undergraduate students from Northern California (66.7% Caucasian, 24.2% Asian, 9.1% other) aged 33.4 (SD = 9.15) years. None reported a history of psychiatric or neurological disorders.

2.1.2. Procedure

An LCD projector (1600 × 1200 pixel resolution) was used to display stimuli onto a white board 10 ft in front of participants sitting in the front row of a college classroom. Participants were tested in three approximately equally sized groups on the same day and in the same classroom.

Pre-task instructions informed participants that they would be presented with photos of three individuals and asked to imagine a real world situation in which they interacted with each of them (e.g., meeting a remote acquaintance in a classroom or on the hallway in the dorm). No information about possible stimulus contingencies (CS-US pairings) was given. As illustrated in Fig. 1A, in each of the three conditions, still images of the faces of three male actors displaying neutral expressions were used as CSs which were immediately followed by videos of the same actors (same field of view and camera settings) as USs during acquisition. Specifically, each acquisition trial of the *CS_Neu condition* (equivalent to a CS-) presented a still image for 6 s, that was replaced by a one of four different neutral videographic statements (2 s each, “Sorry I'm late”, “What time is it?”, “I lost my key”, “Its 4 o'clock”). Each acquisition trial of the *CS_Neg condition* (equivalent to a CS+) presented the still image of another actor, replaced by one of four videographic negative statements (“You're a complete failure”, “You are ridiculous”, “You disgust me”, “I hate you”). The *CS_Rea condition* was equivalent to the CS_Neg condition (different actor, same four statements) but instructions prompted participants to *reappraise* their emotional response to the still image of this actor to ‘decrease negative thoughts and feelings about that person’. The

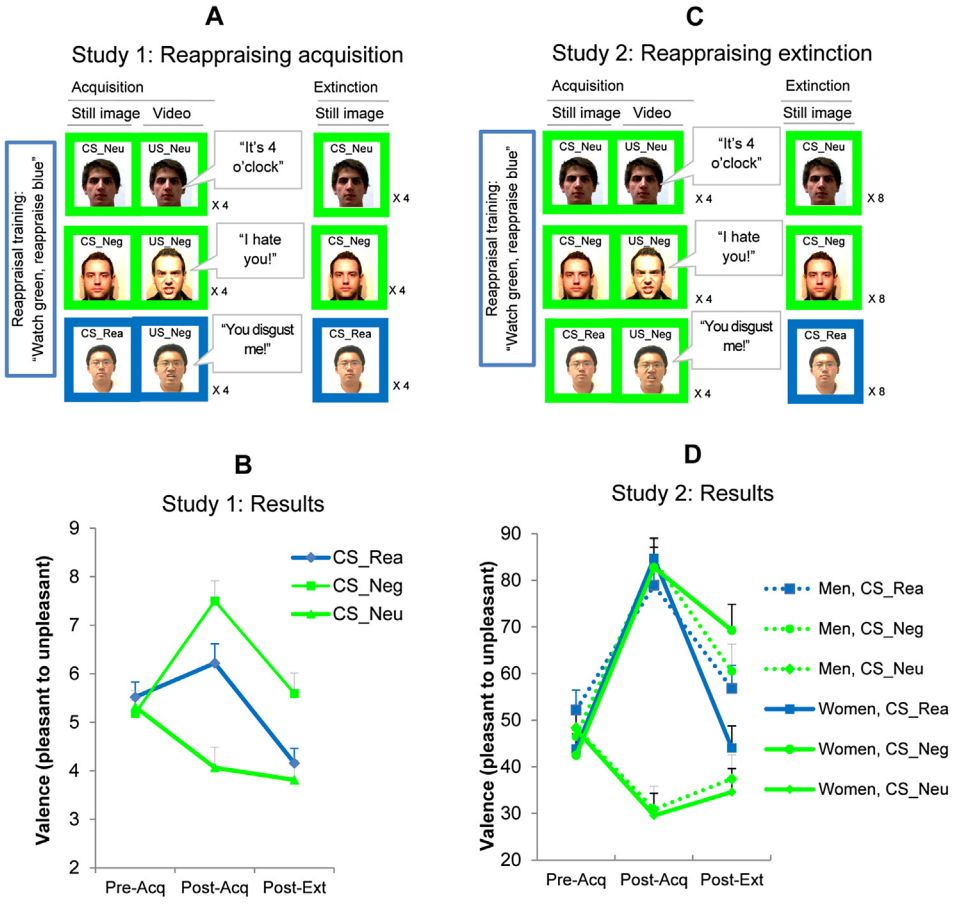

Fig. 1. The social conditioning and reappraisal procedures: actors in blue frames are to be reappraised, actors in green frames are to be watched naturally. Study 1 introduced reappraisal during acquisition (CS_Rea framed in blue from the start, A). Negative valence ratings (means, standard errors) as a function of condition and time in Study 1, B). Study 2 introduced reappraisal during extinction (CS_Rea framed in blue only during extinction, C). Negative valence ratings (means, standard errors) as a function of condition, time and Gender in Study 2 (D). See text for details. Acq, Acquisition; Ext, Extinction; CS_Rea, negatively conditioned stimulus that is reappraised; CS_Neg, negatively conditioned stimulus (not reappraised); CS_Neu, conditioned stimulus followed by neutral videos. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

experimenter explained reappraisal as "a way of changing how one thinks about a situation in a different way to change ones emotions" and provided two reappraisal examples ("this person is just practicing for a play, so his anger is not directed at you", "This person is just having a bad day so it's understandable that he is upset") and left it to the participant to adopt a reappraisal strategy that worked best for him/her. Training duration was around 5 min. Colored frames reminded participants of when to reappraise (CS_Rea) and when to watch without changing their natural response (CS_Neg, CS_Neu, blue = reappraise in Fig. 1A, color counterbalanced across participants). Four trials per condition were shown during acquisition. Actor-condition assignment was counterbalanced across the three testing groups.

The *extinction* phase that directly followed acquisition comprised another four presentations of the still images of CS_Neg, CS_Rea and CS_Neu, without accompanying US videos. No additional instructions were given before or during this phase.

CS-valence ratings were completed on paper handouts, displaying the neutral still images of each of the three actors along with a visual analogue rating scale ranging from pleasant to unpleasant (converted to values 1–10). Ratings were given pre-, mid- and post-acquisition and mid- and post-extinction (cf. Blechert et al., 2008). To simplify the analyses, mid-acquisition and mid-extinction ratings were omitted from statistical analyses.

2.1.3. Statistical analysis

To test for differential acquisition of negative valence, a CS-Type (CS_Neg, CS_Neu) × Time (pre, post-acquisition) × Gender (male, female) analysis of variance (ANOVA) with repeated measures on CS-Type and Time was run (SPSS, version 19). Successful differential acquisition would give rise to CS-Type × Time interactions due to more negative ratings of the CS_Neg relative to the CS_Neu at post-acquisition. Similarly, to test for effects of reappraisal, a CS-Type (CS_Neg, CS_Rea) × Time (pre, post-acquisition) × Gender ANOVA was computed. Again, successful reappraisal would result in a CS-Type × Time interaction with lower values for the CS_Rea compared to the CS_Neg post-acquisition. Effects of extinction were evaluated in relation to acquisition strength, that is, extinction analysis included post-acquisition values in a CS-Type (CS_Neg, CS_Neu) × Time (post-acquisition, post-extinction) × Gender analysis.

Continued reappraisal effects were evaluated in a CS-Type (CS_Neg, CS_Rea) × Time (post-acquisition, post-extinction) × Gender ANOVA. Significant interactions involving CS-Type were followed by *T*-tests between CS-Types (e.g. *differential acquisition/extinction*: CS_Neg vs. CS_Neu, *reappraisal*: CS_Neg vs. CS_Rea) or between time points (e.g. post-acquisition vs. post-extinction), as appropriate. Due to our interest in the final 'outcome' of conditioning and reappraisal, *T*-tests were planned for post-extinction ratings between the three CS-types.

Preliminary analyses showed that the Gender factor did not reach significance in any of the analyses, all $Fs < 3.23$, $ps > .082$, and Gender was therefore dropped from the analyses (and data combined across male and female participants). Similarly, the factor Testing Group (first, second, third group tested in classroom setting) did not modulate CS-Type effects, all $Fs < 1.00$ and was therefore dropped from all analyses. The alpha level was set to .05. Partial eta-squared (η_p^2) and Cohen's *d* (with pooled SDs) are reported as measures of effect size.

2.2. Results

2.2.1. Acquisition phase

The CS-Type × Time (pre, post-acquisition) ANOVA testing for differential *acquisition* of valence (CS_Neg vs. CS_Neu) yielded a main effect of CS-Type, $F(1, 32) = 29.0$, $p < .001$, $\eta_p^2 = .476$, as well as a CS-Type × Time interaction effect, $F(1, 31) = 16.2$, $p < .001$, $\eta_p^2 = .337$. *T*-tests revealed equivalent ratings pre-acquisition, $t < 1.0$, but more negative valence for the CS_Neg relative to the CS_Neu post-acquisition, $t(32) = 5.83$, $p < .001$, $d = 1.01$. The CS-Type × Time (pre, post-acquisition) ANOVA testing for effects of *reappraisal* (CS_Rea vs. CS_Neg) yielded main effects of Time, $F(1, 32) = 15.2$, $p < .001$, $\eta_p^2 = .322$, and CS-Type $F(1, 32) = 5.76$, $p = .022$, $\eta_p^2 = .152$, as well as a CS-Type × Time interaction, $F(1, 31) = 4.86$, $p = .035$, $\eta_p^2 = .132$. *T*-tests revealed equivalent ratings pre-acquisition, $t < 1.0$ whereas at the end of acquisition, CS_Rea was less negative than CS_Neg, $t(32) = 3.27$, $p = .003$, $d = .57$ (Fig. 1B).

2.2.2. Extinction phase

The CS-Type × Time (post-acquisition, post-extinction) ANOVA testing for *extinction* of conditioned negative valence yielded a main effect of Time $F(1, 31) = 11.4$, $p = .002$, $\eta_p^2 = .268$, and CS-Type, $F(1, 31) = 27.3$, $p < .001$, $\eta_p^2 = .468$, as well as a Time × CS-Type interaction, $F(1, 31) = 15.2$, $p < .001$, $\eta_p^2 = .329$. To follow up on this interaction, *T*-tests compared post-acquisition with post-extinction values of CS_Neg and CS_Neu. *T*-tests confirmed a loss of conditioned negative valence across extinction for the CS_Neg, $t(31) = 4.56$, $p < .001$, $d = .81$, but not for the CS_Neu, $t < 1.00$, however, the CS_Neg remained more negative than the CS_Neu, $t(31) = 3.54$, $p < .001$,$d = .63$, post-extinction.

The CS-Type × Time (post-acquisition, post-extinction) ANOVA testing for continuation of *reappraisal* effects on negative valence yielded a main effect of Time, $F(1, 31) = 27.3$, $p < .001$, $\eta_p^2 = .468$, and CS-Type, $F(1, 31) = 13.3$, $p < .001$, $\eta_p^2 = .300$. *Reappraisal* effects were maintained; by the end of extinction the CS_Rea was still lower than the CS_Neg, $t(31) = 3.08$, $p = .004$, $d = .56$ and no longer differed from CS_Neu, $t(31) < 1.00$.

2.3. Discussion

Study 1 demonstrated several key properties of the social conditioning task. First, large differential acquisition (EC conditioning) effects were found (CS_Neg > CS_Neu on negative valence): At the end of acquisition a neutral image of an actor that was followed by negative sentences of that actor (CS_Neg) was evaluated more negatively than a neutral image of another actor that was followed by neutral sentences (CS_Neu). Despite reductions in "absolute" negative valence, this EC effect was largely retained throughout extinction (i.e. CS_Neg > CS_Neu, "relative" resistance to extinction), suggesting that the social conditioning task is suitable for inducing relatively durable EC effects at least with this short extinction phase of 4 trials. Second, significant and substantial reappraisal effects were evident at the end of acquisition and were maintained throughout extinction. This indicates that engaging in reappraisal early during first encounters with a feared situation in combination with subsequent extinction episodes can reverse the effect of conditioning.

However, Study 1 had several limitations. First, reappraisal effects during extinction could simply be carry-over effects of changes that had taken place during acquisition. Likewise, during acquisition there is some ambiguity whether reappraisal is applied toward the CSs (still images, as instructed) or to the USs (video clips). If primarily US films were reappraised (Goldin, McRae, Ramel, & Gross, 2008), then the reduced negativity of the CSs would be a 'downstream' consequence and acquisition of negative valence to the CS would be incomplete. Applying reappraisal during extinction would provide more conceptual clarity here. Second, Study 1 further featured only a short extinction phase (4 trials per CS), thereby occluding the subsequent trajectory of conditioning and reappraisal effects. Third, Study 1 was conducted in a mass

testing setting and thus was under relatively low experimental control. Fourth, the small number of men in the sample precluded a solid test of gender differences. Last, being based on self-report, the question of demand and social desirability bias arises with regard to the observed effects.

3. Study 2: reappraisal during extinction

Despite the significance of the modulating role of reappraisal during acquisition, as shown in Study 1, much higher practical importance is attributed to the extinction phase, considered the laboratory analogue of exposure therapy, which is typically undertaken long after the original acquisition of fear. In addition, to address limitations of Study 1, Study 2 used tighter control, with individual sessions in the laboratory, doubled the number of extinction trials, balanced participant gender, and included a measure of social desirability.

We expected to replicate differential EC effects during acquisition and extinction in the controlled setting of Study 2. We further hypothesized that reappraisal would speed extinction even when applied after acquisition.

3.1. Method

3.1.1. Participants

Participants were $n = 31$ ($n = 16$ female, $n = 15$ male) undergraduate students from Northern California. Mean age was 19.6 (SD = 4.82, no data on race obtained). None reported a history of psychiatric or neurological disorders.

3.1.2. Procedure

Stimulus presentation was the same as in Study 1 but in Study 2, participants came to the psychophysiology laboratory for individual sessions, and stimuli were presented via monitor and calibrated speakers ([1]).

Due to the focus on extinction, the following procedural changes were made. First, extinction trial numbers per condition were doubled to eight to follow the trajectory of conditioned responses and reappraisal for an extended period. Importantly, although reappraisal training was conducted prior to acquisition, the blue color frame (as a marker of which actor to reappraise) only came on starting with the first extinction trial, therefore precluding any differences between CS_Rea and CS_Neg or any differential application of reappraisal to the USs prior to extinction (see Fig. 1C).

Valence ratings were made on-screen with the mouse, using a visual analogue scale ranging from 1 (pleasant) to 100 (unpleasant) at pre-, mid, and post-acquisition time points as well as 4 times during extinction (after every second presentation of each condition). Again, only the last extinction rating was included in the analyses. A *contingency awareness measure* after extinction asked for each of the three still images/conditions whether the displayed person had expressed "negative or neutral sentences early in the task" (yes/no) ([2]). Only participants correctly answering these three items were considered contingency aware. However, due to the unclear role of contingency awareness in EC (Baeyens, Eelen, & Van den Bergh, 1990; Field, 2000; Hutter, Sweldens, Stahl, Unkelbach, & Klauer, 2012), non-aware participants were not excluded.

Last, to assess the possibility that obtained results reflect social desirability, the 13-item short form of the Marlowe-Crowne Scale, which possesses good psychometric properties (Loo & Thorpe, 2000; Reynolds, 1982), was added.

3.1.3. Statistical analysis

Statistical analysis of the acquisition and extinction phases was identical to Study 1, except that the Marlowe–Crowne scores were added as covariate in a separate set of analyses.

3.2. Results

3.2.1. Acquisition phase

The CS-Type × Time (pre, post-acquisition) × Gender ANOVA testing for differential *acquisition* of valence (CS_Neg vs. CS_Neu) yielded a main effect of CS-Type, $F(1, 29) = 62.6$, $p < .001$, $\eta_p^2 = .684$, as well as a CS-Type × Time interaction, $F(1, 29) = 53.4$, $p < .001$, $\eta_p^2 = .648$. Similar to Study 1, *t*-tests revealed equivalent ratings pre-acquisition, $t < 1.0$, but more negative valence for the CS_Neg relative to the CS_Neu post-acquisition, $t(30) = 10.7$, $p < .001$, $d = 2.14$. The CS-Type × Time (pre, post-acquisition) × Gender ANOVA testing for whether the CS which was to be reappraised during extinction (CS_Rea) differed from the CS_Neg showed no main effect or interactions involving CS-Type, all Fs < 1.13, ps > .296, confirming equivalent acquisition of negative valence in both conditions (Fig. 1D).

3.2.2. Extinction phase

The CS-Type × Time (post-acquisition, post-extinction) × Gender ANOVA testing for *extinction* of conditioned negative valence yielded a main effect of Time, $F(1, 29) = 23.6$, $p < .001$, $\eta_p^2 = .449$, and CS-Type, $F(1, 29) = 75.5$, $p < .001$, $\eta_p^2 = .772$, as well as a CS-Type × Time interaction, $F(1, 29) = 14.2$, $p < .001$, $\eta_p^2 = .328$. The CS-Type × Time interaction was due to a decrease in negative valence across extinction for the CS_Neg, $t(30) = 4.40$, $p < .001$, $d = .78$ (absolute extinction), which contrasted with a slight increase for the CS_Neu, $t(30) = 2.18$, $p = .038$, $d = .39$. However, the CS_Neg remained more negative than the CS_Neu, $t(30) = 4.70$, $p < .001$, $d = 1.17$ post-extinction (relative resistance to extinction).

The CS-Type × Time (post-acquisition, post-extinction) × Gender ANOVA testing for *reappraisal* effects during extinction yielded main effects of Time, $F(1, 29) = 54.3$, $p < .001$, $\eta_p^2 = .652$, and CS-Type, $F(1, 29) = 7.83$, $p = .009$, $\eta_p^2 = .213$, as well as a CS-Type × Time, $F(1, 29) = 6.00$, $p = .021$, $\eta_p^2 = .172$ and a CS-Type × Time × Gender interaction, $F(1,29) = 7.66$, $p = .010$, $\eta_p^2 = .209$. *T*-tests showed no gender differences post-acquisition, ts < 1.26, ps > .228. However, post-extinction, women showed a reappraisal effect and rated the CS_Rea lower than the CS_Neg, $t(15) = 3.89$, $p = .001$, $d = .98$. Men did not show a reappraisal effect post-extinction, $t(14) < 1.00$. As a result of successful reappraisal, at post-extinction females rated the CS_Rea no different than the CS_Neu, $t(15) = 1.26$, $p = .228$, whereas males rated the CS_Rea as more negative than the CS_Neu, $t(14) = 2.46$, $p = .027$, $d = .88$.

3.2.3. Contingency awareness & social desirability

Descriptively, 29 participants (93.5%) were classified as contingency aware. In an additional set of analyses, the Marlowe–Crowne score was treated as covariate (centered) during acquisition and extinction. No significant main effects or interaction effects involving this covariate were observed, all Fs < 1.00.

[1] We also measured skin conductance and heart rate throughout the task but no significant differential conditioning was observed (see Pejic et al., 2013; for similar results) and results are therefore not reported.

[2] Participants also rated the likelihood of presentation of a video-clip subsequent to the still image (US-expectancy; "How likely is it that a picture of this person will be followed by a video on the next trial?", rating given directly after the valence rating) on a 1 (very unlikely) to 100 (very likely) scale. This wording was used to be consistent across CS_Rea and CS_Neg (both followed by negative videos during acquisition) and CS_Neu (being followed by neutral videos during acquisition) but it deviates from typical US-expectancy ratings (e.g. likelihood of a shock or no shock, corresponding to expectancy of a *negative* video here), which is why we omitted these data from the present report.

3.3. Discussion

In line with our expectations, Study 2 replicated Study 1 with regard to differential EC in the social fear conditioning task, however, it did so in individual testing sessions in a controlled laboratory setting. Study 2 further showed that reappraisal effectively reduced conditioned negative valence during the extinction phase in females. In fact, as a result of reappraisal, conditioning effects could be reversed (i.e. CS_Rea was no different from the CS_Neu). This finding is clinically relevant since it suggests that exposure therapy could be augmented with reappraisal to reduce negative evaluations of stimuli associated with aversive encounters, at least in women. This finding also shows that reappraisal does not need to be engaged early during conditioning, but can modulate CS-valence after acquisition has occurred. At the same time, it became clear that reappraisal does not operate primarily on the US (videos, shown during acquisition) but on the CSs (still images, shown during extinction). It should be noted that US-revaluation can occur also after conditioning, i.e. a reduction in US aversiveness after acquisition can lead to reduced conditioned responding (Davey, 1989; Walther, Gawronski, Blank, & Langer, 2009). Thus, both reappraisal of CS-valence and US revaluation provide putative mechanisms here. Interestingly, reappraisal during extinction was not effective in men. The literature on gender differences has mostly focused on emotion reactivity with only a few findings with regard to emotion regulation. Emotional clarity, the ability to identify, describe, and understand one's own emotional experiences (Gohm & Clore, 2000), has been suggested to be higher in women (Barrett, Lane, Sechrest, & Schwartz, 2000), which might aid them in applying reappraisal. Also neural activations differ by gender (Domes et al., 2009; Mcrae et al., 2008), however, so far without a consistent functional interpretation. Last, social desirability did not explain or modulate the obtained effects, which is an important assurance for interpreting such self-report data during conditioning straightforwardly.

4. Study 3: conditioning and reappraisal in social anxiety

Building on these findings, in Study 3 we asked whether reappraisal would facilitate extinction learning in individuals with social anxiety. In particular, we examined whether individuals with elevated social anxiety would show an extinction deficit in the present social conditioning task, and whether reappraisal would help in compensating for this deficit. With regard to extinction learning in social anxiety, we predicted elevated negative valence ratings in the CS_Neg condition relative to the CS_Neu in individuals with high relative to low social anxiety based on similar previous findings (Lissek et al., 2008; Pejic et al., 2013). Previous research does not permit strong predictions with regard to the effect of reappraisal in socially anxious individuals: Goldin, Manber, Hakimi, Canli, and Gross (2009) found no difference between SAD patients and controls in their ability to reappraise harsh looking faces but identified neural group differences whereas another study found lower perceived self-efficacy in reappraisal in this patient group (Werner, Goldin, Ball, Heimberg, & Gross, 2011). However, a recent study showed that improvements in reappraisal self-efficacy mediated CBT success in SAD suggesting that training reappraisal might be beneficial in social anxiety (Goldin et al., 2012). Either result would be interesting with regard to therapeutic avenues for this prevalent condition. Thus, we recruited participants with high and low levels of social anxiety, exposed them to the social conditioning task used in Study 2 and focused our comparisons on group differences in reappraisal after extinction.

4.1. Method

A total of $N = 270$ undergraduate students from Northern California were screened with the self-report version of the Liebowitz Social Anxiety Scale, LSAS-SR and high (HSA) and low (LSA) scorers (top and bottom 15%) were invited to the laboratory. The LSAS-SR is a reliable and valid measure of social anxiety (Fresco et al., 2001). The State-Trait-Anxiety Inventory (STAI, Spielberger, Gorsuch, & Luchene, 1970), trait version, and the Beck Depression Inventory (BDI, Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) were used to characterize the sample. Again, the Marlowe-Crowne Scale was administered to assess social desirability. As shown in Table 1, individuals classified into the LSA vs. HSA groups ($ns = 38/33$ actually showed up in the laboratory, respectively) differed significantly on LSAS total score but not on age or sex ratio (no data on race obtained). The HSA group also had higher scores on the STAI-T and the BDI but lower scores on social desirability (Marlowe-Crowne scale). Participants received $20 for their participation.

Participants underwent the identical procedure in the same setting as used in Study 2. The between participants factor Group was added to the statistical analyses (in addition to the Gender factor).

4.2. Results

4.2.1. Acquisition phase

The Group × Gender × CS-Type × Time repeated measures ANOVA testing for differential *acquisition* yielded a CS-Type effect, $F(1, 68) = 66.0$, $p < .001$, $\eta_p^2 = .493$, as well as a CS-Type × Time interaction, $F(1, 68) = 148$, $p < .001$, $\eta_p^2 = .686$. No significant effects involving Group, $Fs < 1.40$, $ps > .240$ or Gender, $Fs < 3.60$, $ps > .062$, were found. Collapsed across groups and Gender and similar to Studies 1 and 2, *t*-tests revealed equivalent ratings pre-acquisition, $t < 1.0$, but more negative valence for the CS_Neg relative to the CS_Neu post-acquisition, $t(70) = 11.6$, $p < .001$, $d = 2.50$.

The Group × Gender × CS-Type × Time (pre, post-acquisition) ANOVA testing for whether the CS which was to be reappraised during extinction (CS_Rea) differed from the CS_Neg showed no main effect or interactions involving CS-Type, all $Fs < 1.00$, Group, $Fs < 1.11$, $ps > .296$ or Gender, $Fs < 2.30$, $ps > .134$, confirming equivalent acquisition of negative valence in both conditions, groups and genders (Fig. 2).

4.2.2. Extinction phase

The Group × Gender × CS-Type × Time ANOVA testing for *extinction* of conditioned negative valence ratings yielded effects of CS-Type, $F(1, 68) = 152$, $p < .001$, $\eta_p^2 = 691$, and Time, $F(1, 68) = 19.7$, $p < .001$, $\eta_p^2 = .225$, as well the expected CS-Type × Group

Table 1
Participant characteristics in study 3: means (SD) of low vs. high socially anxious participants and group comparisons.

	Low socially anxious (LSA) ($n = 38$)	High socially anxious (HSA) ($n = 33$)	Statistic
Age (years)	20.1 (3.10)	20.3 (4.35)	$t < 1.00$
Male/female	18/20	10/23	$\chi^2(71) = 2.15$, $p = .110$
LSAS	13.2 (5.04) range = 1–21	59.2 (14.4) range = 44–90	$t(69) = 18.4$, $p < .001$, $d = 4.74$
STAI-T	32.4 (8.93)	45.5 (10.2)	$t(67) = 5.67$, $p < .001$, $d = 1.37$
BDI	3.71 (6.50)	11.6 (7.61)	$t(67) = 4.44$, $p < .001$, $d = 1.18$
Marlowe-Crowne scale	5.37 (2.49)	4.06 (2.07)	$t(67) = 2.34$, $p = .023$, $d = .58$

Note. LSAS, Liebowitz Social Anxiety Scale – self report; STAI-T, State Trait Anxiety Inventory – Trait version; BDI, Beck Depression Inventory.

interaction, $F(1, 68) = 4.72$, $p = .033$, $\eta_p^2 = .065$, and no effects involving Gender, $Fs < 2.62$, $ps > .110$. To follow up on the CS-Type × Group interaction, ratings were collapsed across Time (post-acquisition and post-extinction values averaged) and compared by between group *t*-tests. HSA participants gave more negative valence ratings for the CS_Neg than LSA participants, $t(69) = 2.43$, $p = .018$, $d = .59$, whereas group differences for the CS_Neu did not reach significance, $t(69) = 1.62$, $p = .111$. Thus, HSA participants showed enhanced conditionability. To follow up on the CS-Type × Time interaction, within participant *t*-tests compared post-acquisition with post-extinction values of CS_Neg and CS_Neu. Values for the CS_Neg decreased, $t(70) = 4.53$, $p < .001$, $d = .54$, but remained constant for the CS_Neu, $t < 1.00$, demonstrating a partial loss of conditioned negative valence (absolute extinction). However, by the end of extinction, the CS_Neg was still more negative than the CS_Neu, $t(70) = 9.93$, $p < .001$, $d = 1.37$ (relative resistance to extinction).

The Group × Gender × CS-Type × Time ANOVA testing for *reappraisal* effects during extinction revealed main effects of Time, $F(1, 68) = 54.3$, $p < .001$, $\eta_p^2 = .444$, and CS-Type, $F(1, 68) = 26.6$, $p < .001$, $\eta_p^2 = .282$, as well as a CS-Type × Time interaction, $F(1, 68) = 33.7$, $p < .001$, $\eta_p^2 = .331$. The interactions of Group × CS-Type and Group × CS-Type × Time only approached significance, $F(1,68) = 3.72$, $p = .058$, $\eta_p^2 = .052$ and $F(1, 68) = 3.71$, $p = .058$, $\eta_p^2 = .052$, respectively. No effects involving Gender reached significance, $Fs < 3.17$, $ps > .079$. The CS-type × Time interaction was due to lower ratings for the CS_Rea compared to the CS_Neg post-extinction, $t(70) = 6.21$, $p < .001$, $d = .74$, despite equivalent values post-acquisition, $t < 1.00$. However, CS_Rea ratings did not drop to the levels of the CS_Neu, $t(70) = 5.01$, $p < .001$, $d = .60$. Due to our *a-priori* interest in the question of reappraisal success in the two groups, CS_Rea ratings were compared between LSA and HSA groups post-extinction. Values were numerically almost identical and the between group *t*-test was not significant, $t < 1.00$.

4.2.3. Contingency awareness & social desirability

Sixty-eight participants (95.8%) were classified as contingency aware (no difference between groups, all participants included in analyses). No effects involving the covariate Marlowe–Crowne (centered) scores reached significance during Acquisition, $Fs < 2.86$, $ps > .096$, or Extinction analyses $Fs < 1.86$, $ps > .177$.

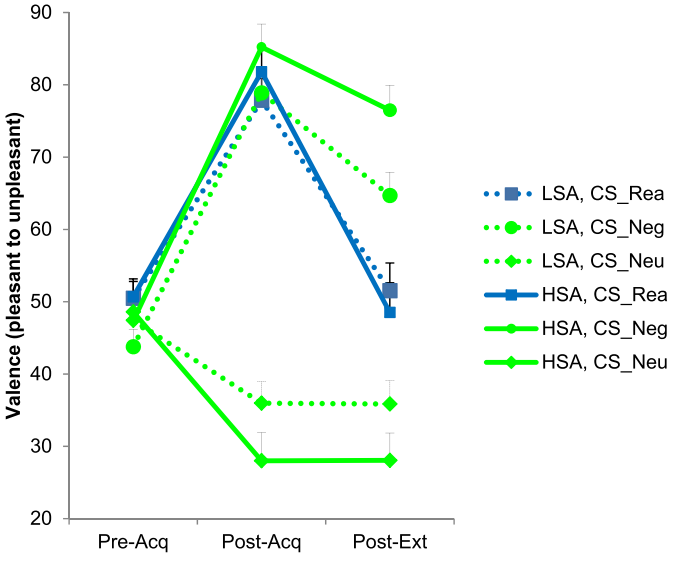

Fig. 2. Means (standard errors) for negative valence as a function of conditioning phase (Acquisition, Extinction) and social anxiety group (low social anxiety, LSA; high social anxiety, HSA) in Study 3. See Fig. 1 legend for other abbreviations.

4.3. Discussion

In addition to replicating the conditioning and reappraisal effects of Studies 1 and 2, Study 3 demonstrated the clinical relevance of the social conditioning task: enhanced resistance to extinction was found in the high social anxiety group. HSA individuals experienced elevated negative valence for the actor that had been conditioned negatively, and did so throughout extinction. The fact that no CS-Type × Time and no 3-way interaction was present suggests that parts of these group differences were already partially present post-acquisition (most clearly seen for the CS_Neu in Fig. 2). Thus, this finding should be considered evidence for enhanced conditionability, a concept entailing both acquisition and extinction (Orr et al., 2000) rather than a selective deficit in extinction. Importantly, despite starting from equivalent post-acquisition levels, reappraisal worked to reduce this enhanced conditionability, with the result that post-extinction values in the LSA and HSA groups applying reappraisal during extinction were indistinguishable between these groups. Thus, one could argue that reappraisal *compensated* for the enhanced conditionability.

5. General discussion

The present research sought to examine the interaction of reappraisal, representing a core process in cognitive therapy, with Pavlovian conditioning, representing a core process in behavioral exposure therapy. To integrate these different processes in a meaningful, externally valid way, we created a specific experimental context: a social conditioning task using social stimuli as CSs and USs that we expected to generate strong and durable evaluative conditioning (EC) effects.

Results revealed that despite reductions of the negative valence conditioned to the CS_Neg across extinction (termed "absolute" extinction), the difference relative to the non-conditioned CS_Neu remained significant (termed "relative extinction"). In fact, in none of the three studies did the CS_Neg (equivalent of CS+ in other differential conditioning designs) reach levels of the CS_Neu (~CS-) by the end of the extinction phase, even in the more extended extinction procedures in Studies 2 and 3. This is consistent with previous research on the persistence of EC (e.g., Vansteenwegen et al., 1998; Vansteenwegen et al., 2006) and makes it an important target for extinction research.

Using this task, we addressed several questions left open by prior research. Study 1 tested whether reappraisal could modify conditioned negative valence (EC) during the acquisition. Study 2 applied reappraisal during extinction and addressed several limitations of Study 1. Study 3 examined individuals with high social anxiety to test whether they would show an extinction deficit and, if so, whether reappraisal would help in reducing it.

5.1. Reappraisal attenuates acquisition

Study 1 showed that the social conditioning task generated robust differential EC effects during acquisition, which carried over into extinction. Given this context, it is noteworthy that reappraisal slowed the differential acquisition of negative valence, resulting in about 40% lower negative valence ratings in the CS_Rea condition (equivalent of the CS+, plus reappraisal) by the end of acquisition. This reappraisal effect carried over into the extinction phase and led to a complete extinction of conditioned negative valence by the end of extinction. This is generally in line with research showing the power of reappraisal to decrease negative valence as it has been

shown in a range of paradigms, including social stimuli (Blechert, Sheppes, Di Tella, Williams, & Gross, 2012; Goldin et al., 2009). Recently, Hermann and coworkers found dispositional reappraisal frequency negatively correlated with insula and hippocampus activity during acquisition (Hermann et al., 2014), pointing to the possibility that not only instructed reappraisal but also habitual emotion regulation styles impact Pavlovian acquisition and to a potential neural basis of the present effects.

On a practical level Study 1 findings imply that reappraisal could be used as a preventive strategy: some anxiety disorders are thought to develop partially through strong coupling of conditioned responses to neutral stimuli which predict or accompany an aversive or traumatic event (acquisition). Applying reappraisal during such initial conditioning stages might slow or decrease the development of strong negative evaluations of involved CSs. Conditioning-inspired prevention approaches are being developed for posttraumatic stress disorder (reviewed in Hourani, Council, Hubal, & Strange, 2011) but are less studied in other anxiety disorders. Study 1 results point to the utility of reappraisal training for preventing buildup of social anxiety during aversive social encounters.

5.2. Reappraisal facilitates extinction

Study 2, featuring reappraisal during an extended extinction phase added several additional findings to this picture. *First*, and most importantly, reappraisal, applied during extinction, substantially reduced conditioned negative valence, making it an interesting add-on tool for exposure therapy (see below) which typically occurs long after fear acquisition. Reappraisal did not abolish conditioning altogether, though (as in Study 1), as evident in the remaining difference between CS_Rea and CS_Neu post-extinction. Full extinction might have required more extinction trials under concurrent reappraisal. Applying reappraisal during extinction in Study 2 also showed that the presence of USs is not necessary for obtaining CS reappraisal effects; reappraisal can thus operate on CS valence directly, or possibly change CS valence indirectly through US revaluation. Previous studies had used distraction-like reappraisal (imagining calming nature images, Delgado et al., 2008) and multiple cognitive restructuring interventions focusing on emotions during electric shock conditioning (Shurick et al., 2012). The present research extends this research toward social contexts which could arguably be considered as more representative of everyday life stressors. Consistent with the present results, the above mentioned study by Hermann et al. (2014) found dispositional reappraisal frequency associated with stronger extinction of fear ratings as well as with reduced insular and enhanced rostral anterior cingulate cortex activity, suggesting higher top-down control over emotion generative centers.

A second insight from Study 2 was that only women showed significant reappraisal effects. This is in line with several studies demonstrating gender differences during emotion reactivity and regulation tasks and could be due to the reasons discussed in Study 2 above. However, in Studies 1 and 3, gender differences were not found. Sample 1 did not reveal gender differences, however, possible due to lack of power (few men in sample). Sample 3, comprised of individuals with high and low scores on social anxiety and reasonable sample sizes for each gender did not show them either. Thus, in unselected samples as in Study 2 gender differences are to be expected. It should be noted that our stimuli featured male actors only and a full examination of gender differences would have to fully cross participant and stimulus gender. Also, as indicated above, additional questionnaire data (e.g. emotional awareness) are needed to determine possible sources of gender differences during reappraisal.

A third important insight came from the Marlowe–Crowne social desirability scale, demonstrating that the obtained self-report effects were likely not simple demand effects imposed by the experimental setup or the experimenters. In fact, our previous research has demonstrated that self-reported valence reductions during reappraisal of social stimuli was accompanied by parallel reductions of implicit, reaction time-based valence assessments and reductions of emotion-sensitive event related potentials (Blechert et al., 2012), suggesting involvement of several response systems and robustness of valence ratings against social desirability effects in well-designed reappraisal studies.

5.3. Reappraisal facilitates extinction in individuals with social anxiety

Extinction deficits are documented in several anxiety disorders, including social anxiety disorder and its subclinical forms, raising the question whether these effects would be observed in the present social conditioning task. If so, would socially anxious individuals be able to engage in reappraisal during extinction to counter this effect, or would they fail to do so? Results of Study 3 revealed an enhanced conditionability of negative valence in socially anxious participants. This is generally consistent with previous research, although the precise 'profile' of group differences differed across studies: Hermann, Ziegler, Birbaumer, and Flor (2002) demonstrated slowed extinction of electrodermal responding and enhanced US-expectancy for the CS- in SAD patients compared to controls whereas Lissek et al. (2008) found enhanced acquisition of differential eye-blink startle responding. Pejic et al. (2013) found correlations of differential amygdala responding with social anxiety measures during both acquisition and extinction and a correlation of social anxiety with the increase of unpleasantness across conditioning.

Clinically most interesting is the role of reappraisal in socially anxious individuals. Previous research had either demonstrated reduced habitual reappraisal efficacy in SAD (Werner et al., 2011) or no differences between patients and controls in valence ratings in experimental reappraisal tasks (Goldin et al., 2009). In the present research, HSA individuals reached comparably low negative valence levels as their LSA counterparts by the end of extinction. Thus, this effect 'countered' their extinction deficit. This suggests that training socially anxious individuals in reappraisal techniques would help them to compensate for their deficit in extinction learning in anxiety-provoking social situations. Translated to social exposure treatment in CBT, an explicit focus on CS valence reappraisal could mean helping the patient to develop a deeper understanding of motives of disliked interaction partners ("he/she is having a bad day, so it's not about me"). Such reattribution-like reappraisal could reduce anticipatory anxiety and lessen the impact of (perceived) signs of interpersonal rejection that might occur during exposure exercises (e.g. giving a speech, talking to strangers) and might reduce avoidance of social contacts. In fact recent evidence shows that improvements in perceived reappraisal efficacy mediated the success of CBT treatment for SAD (Goldin et al., 2012), possibly due to enhanced recruitment of dorsolateral and dorsomedial prefrontal cortices (Goldin et al., 2013), justifying a more explicit focus on this skill during treatment. As mentioned above, explicit efforts are being made recently to translate findings of basic conditioning research into exposure therapies (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014) but reappraisal has not been given much consideration yet in this approach.

5.4. Limitations and future directions

Several limitations of the present studies bear noting. First, although we have little reason to believe that social desirability is responsible for the present results, some aspects of social

conditioning and reappraisal might not be fully represented in the experiential variables assessed. Although we did not observe reliable conditioning on autonomic measures, additional evidence from other psychophysiological measures might be helpful in this regard. Eye-blink startle, for example, might be more sensitive to valence effects in addition to the social threat elicited in such tasks (Lissek et al., 2008) and neurocognitive, or implicit measures might be helpful in complementing the rating data reported here (e.g., affective priming, Blechert et al., 2012; Hermans et al., 2002). A recent study showed that facial electromyographic responses and long latency event related potentials are sensitive to negative videos similar to the US videos used here (Wiggert, Wilhelm, Reichenberger, & Blechert, submitted for publication). Furthermore, despite almost perfect contingency awareness in all samples, evidence from US-expectancy ratings would be informative and tap into the more cognitive aspects of Pavlovian conditioning (see [2] for methodological problems of US-expectancy ratings in the present task). A recent review attested high validity to US-expectancy ratings in fear conditioning (Boddez et al., 2013). The type of reappraisal used here should mainly operate on valence and leave the more cognitive aspects of conditioning intact. Fear ratings might be useful, too, especially in clinical populations.

Second, in Study 3, we recruited individuals with high and low scores on the LSAS without standardized diagnostic interviewing. Thus, on the one hand we do not know whether some of our participants were actually clinically socially anxious. On the other hand, we cannot ascertain that our sample is merely at risk for SAD. Given the recommended clinical cutoff scores for the LSAS-SR of 60 (Rytwinski et al., 2009) and the scores in the present sample, about 40% of our HSA sample may have fulfilled a diagnosis of SAD. Consequently our results pertain to differences on a social anxiety continuum rather than to a high-risk status or full-blown SAD. Future research could explore the present task in patients diagnosed with SAD or other mental disorders with known interpersonal difficulties such as borderline personality disorder or major depressive disorder.

Third, we focused on reappraisal, but the repertoire of cognitive restructuring interventions available during extinction is large. For example, other emotion regulation strategies such as distraction and acceptance affect stimulus processing and shock anticipation (e.g., Braams, Blechert, Boden, & Gross, 2012; Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross, 2011) and might therefore work well during extinction. Introducing a second, active condition would also control for non-specific effects (such as effort or cognitive load) possibly confounded with the reappraisal strategy here. Furthermore, by characterizing these strategies or pitting them against each other in healthy or clinically anxious groups, basic research using face-valid, more naturalistic conditioning procedures such as the one described here could help in clarifying the exact cognitive mechanisms involved in CBT research on exposure treatment and fear extinction.

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References

Baeyens, F., Eelen, P., & Van den Bergh, O. (1990). Contingency awareness in evaluative conditioning: a case for unaware affective-evaluative learning. *Cognition and Emotion, 4*(1), 3–18.

Barrett, L. F., Lane, R. D., Sechrest, L., & Schwartz, G. E. (2000). Sex differences in emotional awareness. *Personality and Social Psychology Bulletin, 26*(9), 1027–1035. http://dx.doi.org/10.1177/01461672002611001.

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J. E., & Erbaugh, J. K. (1961). An inventory for measuring depression. *Archives of General Psychiatry, 4*, 561–571.

Blechert, J., Michael, T., Vriends, N., Margraf, J., & Wilhelm, F. H. (2007). Fear conditioning in posttraumatic stress disorder: evidence for delayed extinction of autonomic, experiential, and behavioural responses. *Behaviour Research and Therapy, 45*(9), 2019–2033. http://dx.doi.org/10.1016/j.brat.2007.02.012. S0005-7967(07)00041-1 [pii].

Blechert, J., Michael, T., Williams, L. S., Purkis, H. M., & Wilhelm, F. H. (2008). When two paradigms meet: does evaluative learning extinguish in differential fear conditioning? *Learning and Motivation, 39*, 58–70.

Blechert, J., Sheppes, G., Di Tella, C., Williams, H., & Gross, J. J. (2012). See what you think: reappraisal modulates behavioral and neural responses to social stimuli. *Psychological Science, 23*(4), 346–353. http://dx.doi.org/10.1177/0956797612438559.

Boddez, Y., Baeyens, F., Luyten, L., Vansteenwegen, D., Hermans, D., & Beckers, T. (2013). Rating data are underrated: validity of US expectancy in human fear conditioning. *Journal of Behavior Therapy and Experimental Psychiatry, 44*(2), 201–206. http://dx.doi.org/10.1016/j.jbtep.2012.08.003.

Bouton, M. E., Mineka, S., & Barlow, D. H. (2001). A modern learning theory perspective on the etiology of panic disorder. *Psychological Review, 108*, 4–32.

Braams, B. R., Blechert, J., Boden, M. T., & Gross, J. J. (2012). The effects of acceptance and suppression on anticipation and receipt of painful stimulation. *Journal of Behavior Therapy and Experimental Psychiatry, 43*(4), 1014–1018. http://dx.doi.org/10.1016/j.jbtep.2012.04.001. S0005-7916(12)00026-2 [pii].

Butler, A. C., Chapman, J. E., Forman, E. M., & Beck, A. T. (2006). The empirical status of cognitive-behavioral therapy: a review of meta-analyses. *Clinical Psychology Review, 26*(1), 17–31. http://dx.doi.org/10.1016/j.cpr.2005.07.003. S0272-7358(05)00100-5 [pii].

Craske, M. G., Kircanski, K., Zelikowsky, M., Mystkowski, J., Chowdhury, N., & Baker, A. (2008). Optimizing inhibitory learning during exposure therapy. *Behaviour Research and Therapy, 46*(1), 5–27. http://dx.doi.org/10.1016/j.brat.2007.10.003.

Craske, M. G., Treanor, M., Conway, C. C., Zbozinek, T., & Vervliet, B. (2014). Maximizing exposure therapy: an inhibitory learning approach. *Behaviour Research and Therapy, 58*, 10–23. http://dx.doi.org/10.1016/j.brat.2014.04.006.

Davey, G. C. (1989). UCS revaluation and conditioning models of acquired fears. *Behaviour Research and Therapy, 27*(5), 521–528, 0005-7967(89)90086-7 [pii].

Davis, F. C., Johnstone, T., Mazzulla, E. C., Oler, J. A., & Whalen, P. J. (2010). Regional response differences across the human amygdaloid complex during social conditioning. *Cerebral Cortex, 20*(3), 612–621. http://dx.doi.org/10.1093/cercor/bhp126. bhp.126 [pii].

De Houwer, J., Barnes-Holmes, D., & Moors, A. (2013). What is learning? on the nature and merits of a functional definition of learning. *Psychonomic Bulletin & Review, 20*(4), 631–642.

Delgado, M. R., Nearing, K. I., Ledoux, J. E., & Phelps, E. A. (2008). Neural circuitry underlying the regulation of conditioned fear and its relation to extinction. *Neuron, 59*(5), 829–838. http://dx.doi.org/10.1016/j.neuron.2008.06.029. S0896-6273(08)00579-5 [pii].

Dirikx, T., Hermans, D., Vansteenwegen, D., Baeyens, F., & Eelen, P. (2004). Reinstatement of extinguished conditioned responses and negative stimulus valence as a pathway to return of fear in humans. *Learning and Memory, 11*(5), 549–554.

Domes, G., Schulze, L., Bottger, M., Grossmann, A., Hauenstein, K., Wirtz, P. H., et al. (2009). The neural correlates of sex differences in emotional reactivity and emotion regulation. *Human Brain Mapping*. http://dx.doi.org/10.1002/hbm.20903.

Field, A. P. (2000). I like it, but I'm not sure why: can evaluative conditioning occur without conscious awareness? *Consciousness and Cognition, 9*(1), 13–36.

Fresco, D. M., Coles, M. E., Heimberg, R. G., Liebowitz, M. R., Hami, S., Stein, M. B., et al. (2001). The Liebowitz Social Anxiety Scale: a comparison of the psychometric properties of self-report and clinician-administered formats. *Psychological Medicine, 31*(6), 1025–1035.

Gohm, C. L., & Clore, G. L. (2000). Individual differences in emotional experience: mapping available scales to processes. *Personality and Social Psychology Bulletin, 26*(6), 679–697.

Goldin, P. R., Manber, T., Hakimi, S., Canli, T., & Gross, J. J. (2009). Neural bases of social anxiety disorder: emotional reactivity and cognitive regulation during social and physical threat. *Archives of General Psychiatry, 66*(2), 170–180. http://dx.doi.org/10.1001/archgenpsychiatry.2008.525, 66/2/170 [pii].

Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The neural bases of emotion regulation: reappraisal and suppression of negative emotion. *Biological Psychiatry, 63*(6), 577–586. http://dx.doi.org/10.1016/j.biopsych.2007.05.031. S0006-3223(07)00592-6 [pii].

Goldin, P. R., Ziv, M., Jazaieri, H., Hahn, K., Heimberg, R., & Gross, J. J. (2013). Impact of cognitive behavioral therapy for social anxiety disorder on the neural dynamics of cognitive reappraisal of negative self-beliefs: randomized clinical trial. *JAMA Psychiatry*. http://dx.doi.org/10.1001/jamapsychiatry.2013.234.

Goldin, P. R., Ziv, M., Jazaieri, H., Werner, K., Kraemer, H., Heimberg, R. G., et al. (2012). Cognitive reappraisal self-efficacy mediates the effects of individual cognitive-behavioral therapy for social anxiety disorder. *Journal of Consulting and Clinical Psychology, 80*(6), 1034–1040. http://dx.doi.org/10.1037/a0028555, 2012-12666-001 [pii].

Graham, B. M., & Milad, M. R. (2011). The study of fear extinction: implications for anxiety disorders. *American Journal of Psychiatry, 168*(12), 1255–1265.
Gross, J. J. (2014). Emotion regulation: conceptual and empirical foundations. In J. J. Gross (Ed.), *Handbook of emotion regulation* (2nd ed.). (pp. 3–20). New York: Guliford.
Hartley, C. A., & Phelps, E. A. (2010). Changing fear: the neurocircuitry of emotion regulation. *Neuropsychopharmacology, 35*(1), 136–146. http://dx.doi.org/10.1038/npp.2009.121. npp2009121 [pii].
Hermann, A., Keck, T., & Stark, R. (2014). Dispositional cognitive reappraisal modulates the neural correlates of fear acquisition and extinction. *Neurobiology of Learning and Memory, 113*, 115–124. http://dx.doi.org/10.1016/j.nlm.2014.03.008.
Hermann, C., Ziegler, S., Birbaumer, N., & Flor, H. (2002). Psychophysiological and subjective indicators of aversive pavlovian conditioning in generalized social phobia. *Biological Psychiatry, 52*, 328–337.
Hermans, D., Dirikx, T., Vansteenwegenin, D., Baeyens, F., Van den Bergh, O., & Eelen, P. (2005). Reinstatement of fear responses in human aversive conditioning. *Behaviour Research and Therapy, 43*(4), 533–551.
Hermans, D., Vansteenwegen, D., Crombez, G., Baeyens, F., & Eelen, P. (2002). Expectancy-learning and evaluative learning in human classical conditioning: affective priming as an indirect and unobtrusive measure of conditioned stimulus valence. *Behaviour Research and Therapy, 40*(3), 217–234.
Hofmann, S. G., Meuret, A. E., Rosenfield, D., Suvak, M. K., Barlow, D. H., Gorman, J. M., et al. (2007). Preliminary evidence for cognitive mediation during cognitive-behavioral therapy of panic disorder. *Journal of Consulting and Clinical Psychology, 75*(3), 374–379. http://dx.doi.org/10.1037/0022-006X.75.3.374, 2007-07856-003 [pii].
Hofmann, S. G., & Smits, J. A. (2008). Cognitive-behavioral therapy for adult anxiety disorders: a meta-analysis of randomized placebo-controlled trials. *The Journal of clinical psychiatry, 69*(4), 621.
Hourani, L. L., Council, C. L., Hubal, R. C., & Strange, L. B. (2011). Approaches to the primary prevention of posttraumatic stress disorder in the military: a review of the stress control literature. *Military Medicine, 176*(7), 721–730.
Hutter, M., Sweldens, S., Stahl, C., Unkelbach, C., & Klauer, K. C. (2012). Dissociating contingency awareness and conditioned attitudes: evidence of contingency-unaware evaluative conditioning. *Journal of Experimental Psychology: General, 141*(3), 539–557. http://dx.doi.org/10.1037/a0026477, 2011-29870-001 [pii].
Iidaka, T., Saito, D. N., Komeda, H., Mano, Y., Kanayama, N., Osumi, T., et al. (2010). Transient neural activation in human amygdala involved in aversive conditioning of face and voice. *Journal of Cognitive Neuroscience, 22*(9), 2074–2085.
Kleim, B., Grey, N., Wild, J., Nussbeck, F. W., Stott, R., Hackmann, A., et al. (2013). Cognitive change predicts symptom reduction with cognitive therapy for posttraumatic stress disorder. *Journal of Consulting and Clinical Psychology, 81*(3), 383–393. http://dx.doi.org/10.1037/a0031290, 2012-34987-001 [pii].
Konnopka, A., Leichsenring, F., Leibing, E., & König, H. (2009). Cost-of-illness studies and cost-effectiveness analyses in anxiety disorders: a systematic review. *Journal of Affective Disorders, 114*(1), 14–31.
Lissek, S., Levenson, J., Biggs, A. L., Johnson, L. L., Ameli, R., Pine, D. S., et al. (2008). Elevated fear conditioning to socially relevant unconditioned stimuli in social anxiety disorder. *American Journal of Psychiatry, 165*(1), 124–132. http://dx.doi.org/10.1176/appi.ajp.2007.06091513. appi.ajp.2007.06091513 [pii].
Lissek, S., Powers, A. S., McClure, E. B., Phelps, E. A., Woldehawariat, G., Grillon, C., et al. (2005). Classical fear conditioning in the anxiety disorders: a meta-analysis. *Behaviour Research and Therapy, 43*(11), 1391–1424.
Loo, R., & Thorpe, K. (2000). Confirmatory factor analyses of the full and short versions of the Marlowe-Crowne Social Desirability Scale. *Journal of Social Psychology, 140*(5), 628–635. http://dx.doi.org/10.1080/00224540009600503.
Mcrae, K., Ochsner, K. N., Mauss, I. B., Gabrieli, J. J. D., & Gross, J. J. (2008). Gender differences in emotion regulation: an fMRI study of cognitive reappraisal. *Group Processes & Intergroup Relations, 11*(2), 143–162. http://dx.doi.org/10.1177/1368430207088035.
Michael, T., Blechert, J., Vriends, N., Margraf, J., & Wilhelm, F. H. (2007). Fear conditioning in panic disorder: enhanced resistance to extinction. *Journal of Abnormal Psychology, 116*(3), 612–617. http://dx.doi.org/10.1037/0021-843X.116.3.612, 2007-11737-018 [pii].
Orr, S. P., Metzger, L. J., Lasko, N. B., Macklin, M. L., Peri, T., & Pitman, R. K. (2000). De novo conditioning in trauma-exposed individuals with and without post-traumatic stress disorder. *Journal of Abnormal Psychology, 109*, 290–298.
Pejic, T., Hermann, A., Vaitl, D., & Stark, R. (2013). Social anxiety modulates amygdala activation during social conditioning. *Social Cognitive and Affective Neuroscience, 8*(3), 267–276. http://dx.doi.org/10.1093/scan/nsr095. nsr095 [pii].
de Quervain, D. J., Bentz, D., Michael, T., Bolt, O. C., Wiederhold, B. K., Margraf, J., et al. (2011). Glucocorticoids enhance extinction-based psychotherapy. *Proceedings of the National Academy of Sciences of the United States of America, 108*(16), 6621–6625. http://dx.doi.org/10.1073/pnas.1018214108.
Rachman, S. (1989). The return of fear: review and prospect. *Clinical Psychology Review, 9*, 147–168.
Reynolds, W. M. (1982). Development of reliable and valid short forms of the Marlowe-Crowne social desirability scale. *Journal of Clinical Psychology, 38*(1), 119–125. http://dx.doi.org/10.1002/1097-4679(198201)38:1<119::Aid-Jclp2270380118>3.0.Co;2-I.
Rytwinski, N. K., Fresco, D. M., Heimberg, R. G., Coles, M. E., Liebowitz, M. R., Cissell, S., et al. (2009). Screening for social anxiety disorder with the self-report version of the Liebowitz Social Anxiety Scale. *Depression and Anxiety, 26*(1), 34–38. http://dx.doi.org/10.1002/da.20503.
Salkovskis, P. M., Hackmann, A., Wells, A., Gelder, M. G., & Clark, D. M. (2007). Belief disconfirmation versus habituation approaches to situational exposure in panic disorder with agoraphobia: a pilot study. *Behaviour Research and Therapy, 45*(5), 877–885. http://dx.doi.org/10.1016/j.brat.2006.02.008. S0005-7967(06)00050-7 [pii].
Shurick, A. A., Hamilton, J. R., Harris, L. T., Roy, A. K., Gross, J. J., & Phelps, E. A. (2012). Durable effects of cognitive restructuring on conditioned fear. *Emotion, 12*(6), 1393–1397. http://dx.doi.org/10.1037/a0029143, 2012-18064-001 [pii].
Spielberger, C. D., Gorsuch, R. L., & Luchene, R. E. (1970). *State-trait anxiety inventory.* Palo Alto: Consulting Psychology Press.
Thiruchselvam, R., Blechert, J., Sheppes, G., Rydstrom, A., & Gross, J. J. (2011). The temporal dynamics of emotion regulation: an EEG study of distraction and reappraisal. *Biological Psychology, 87*(1), 84–92. http://dx.doi.org/10.1016/j.biopsycho.2011.02.009. S0301-0511(11)00039-1 [pii].
Vansteenwegen, D., Crombez, G., Baeyens, F., & Eelen, P. (1998). Extinction in fear conditioning: effects on startle modulation and evaluative self-reports. *Psychophysiology, 35*, 729–736.
Vansteenwegen, D., Francken, G., Vervliet, B., De Clercq, A., & Eelen, P. (2006). Resistance to extinction in evaluative conditioning. *Journal of Experimental Psychology: Animal Behavior Processes, 32*(1), 71–79.
Walther, E., Gawronski, B., Blank, H., & Langer, T. (2009). Changing likes and dislikes through the back door: the US-revaluation effect. *Cognition and Emotion, 23*(5), 889–917.
Weeks, J. W., Heimberg, R. G., Fresco, D. M., Hart, T. A., Turk, C. L., Schneier, F. R., et al. (2005). Empirical validation and psychometric evaluation of the Brief Fear of Negative Evaluation Scale in patients with social anxiety disorder. *Psychological Assessment, 17*(2), 179–190. http://dx.doi.org/10.1037/1040-3590.17.2.179, 2005-07704-006 [pii].
Werner, K. H., Goldin, P. R., Ball, T. M., Heimberg, R. G., & Gross, J. J. (2011). Assessing emotion regulation in social anxiety disorder: the emotion regulation interview. *Journal of Psychopathology and Behavioral Assessment, 33*(3), 346–354. http://dx.doi.org/10.1007/s10862-011-9225-x.
Wieser, M. J., Flaisch, T., & Pauli, P. (2014a). Raised middle-finger: electrocortical correlates of social conditioning with nonverbal affective gestures. *PLoS One, 9*(7), e102937. http://dx.doi.org/10.1371/journal.pone.0102937.
Wieser, M. J., Gerdes, A. B. M., Büngel, I., Schwarz, K. A., Mühlberger, A., & Pauli, P. (2014b). Not so harmless anymore: how context impacts the perception and electrocortical processing of neutral faces. *Neuroimage, 92*(0), 74–82. http://dx.doi.org/10.1016/j.neuroimage.2014.01.022.
Wiggert, N., Wilhelm, F. H., Reichenberger, J., & Blechert, B. (2014). Neural, behavioral and experiential responses to social-evaluative video clips. *Social Cognitive and Affective Neuroscience* (submitted for publication).
Winton, E. C., Clark, D. M., & Edelmann, R. J. (1995). Social anxiety, fear of negative evaluation and the detection of negative emotion in others. *Behaviour Research and Therapy, 33*(2), 193–196.
Zbozinek, T. D., Hermans, D., Prenoveau, J. M., Liao, B., & Craske, M. G. (2014). Post-extinction conditional stimulus valence predicts reinstatement fear: relevance for long-term outcomes of exposure therapy. *Cognition and Emotion*, 1–14. http://dx.doi.org/10.1080/02699931.2014.930421.