Behaviour Research and Therapy 174 (2024) 104490

Contents lists available at ScienceDirect

Behaviour Research and Therapy

journal homepage: www.elsevier.com/locate/brat

Positive mood induction does not reduce return of fear: A virtual reality exposure study for public speaking anxiety

Suzanne C. van Veen [a], Tomislav D. Zbozinek [b], Eva A.M. van Dis [a], Iris M. Engelhard [a,*], Michelle G. Craske [c]

[a] Department of Clinical Psychology, Utrecht University, the Netherlands
[b] Division of Humanities and Social Sciences, California Institute of Technology, Pasadena, CA, United States
[c] Department of Psychology, University of California, Los Angeles, CA, United States

ARTICLE INFO

Keywords:
Exposure
Positive mood
CS valence
Spontaneous recovery
Reinstatement
Virtual reality

ABSTRACT

Previous laboratory work has shown that induction of positive mood prior to fear extinction decreases the negative valence of the conditional stimulus (CS) and reduces reinstatement of fear. Before translating these insights to clinical practice, it is important to test this strategy in anxious individuals. Students with a high fear of public speaking ($N = 62$) were randomized to either a positive mood induction, a negative mood induction, or no induction control group. All participants performed two weekly sessions of virtual reality exposure and a 1-week follow-up test including a spontaneous recovery test and reinstatement test after a social rejection (unconditional stimulus). We used self-reported fear measures and skin conductance responses. We expected that the positive group, compared to the other groups, would evaluate the CS (i.e., speaking in front of an audience) as less negative following exposure and would show less spontaneous recovery and reinstatement of fear following a social rejection. Although mood was successfully manipulated, there were no group differences in CS valence following exposure. In all conditions, VR exposure successfully reduced public speaking fear, and these effects were stable at follow-up. In contrast with expectations, the positive group showed more spontaneous recovery of CS negative valence than the negative group. To conclude, we found no evidence that positive mood induction prior to exposure optimizes exposure effects for anxious individuals.

Anxiety disorders constitute the largest group of mental disorders in western society, with 12-month prevalence rates of 10–14 % (Baxter, Scott, Vos, & Whiteford, 2013; Wittchen et al., 2011). The most empirically supported psychological treatment for anxiety disorders is cognitive behavioral therapy (CBT), which includes a broad array of therapeutic techniques (Craske et al., 2017). One of its core techniques is exposure therapy: systematic and repeated encounters with cues (e.g., objects, situations, memories, thoughts) that individuals fear, avoid, or endure with dread (Craske, 2015; Craske, Treanor, Zbozinek, & Vervliet, 2022). Post-treatment response rates for CBT are about 45–55 % for individual anxiety disorders (Loerinc et al., 2015), but a considerable number of individuals (19–62 %) demonstrate a return of fear after successful exposure (see Craske & Mystkowski, 2006). Given the large burden of anxiety disorders and the limits on treatment effectiveness, there is a need to optimize the therapeutic strategies of CBT (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014).

Derived from principles of inhibitory learning and basic laboratory research, several strategies of preventing the return of fear after exposure therapy have been proposed (Craske, 2015; Craske et al., 2014, 2022). Most of these build upon the notion that it is necessary to maximally violate the expectation that the conditional stimulus (CS) predicts the unconditional stimulus (US) (Rescorla & Wagner, 1972). However, violation of CS/US expectancy learning often does not change evaluative learning (e.g., Dirikx, Hermans, Vansteenwegen, Baeyens, & Eelen, 2004; Engelhard, Leer, Lange, & Olatunji, 2014; Kang, Vervliet, Engelhard, van Dis, & Hagenaars, 2018; Luck & Lipp, 2015; Vansteenwegen, Francken, Vervliet, De Clercq, & Eelen, 2006). Evaluative learning is defined as the *(dis)liking* of the CS that results from the pairing of the CS with the US (de Houwer, Thomas, & Baeyens, 2001). For instance, if public speaking (CS) is met with humiliation from a disapproving audience (US), then dislike of presenting in front of an audience (i.e., CS negative valence), similar to the innate dislike of rejection (i.e., US negative valence), is likely to emerge. Several laboratory studies have found that the higher the remaining CS negative

* Corresponding author. Clinical Psychology, Utrecht University, PO Box 80140, 3508 TC, Utrecht, the Netherlands.
E-mail address: i.m.engelhard@uu.nl (I.M. Engelhard).

https://doi.org/10.1016/j.brat.2024.104490
Received 21 April 2023; Received in revised form 26 January 2024; Accepted 30 January 2024
Available online 1 February 2024

valence after extinction, the higher the subjective fear following (experimental) fear reinstatement (i.e., return of fear after the presentation of an unsignaled US; e.g., Dirikx et al., 2004; Hermans et al., 2005, Zbozinek, Hermans, Prenoveau, Liao, & Craske, 2015, but see Luck & Lipp, 2018). Subclinical studies have further shown that explicit residual CS negative valence after exposure to spiders predicts return of avoidance behavior at a two-month follow-up (Huijding & de Jong, 2005), and implicit residual CS negative valence after exposure to public speaking predicts return of fear at a one-month follow-up (Vasey, Harbaugh, Buffington, Jones, & Fazio, 2012).

Kerkhof et al. (2009) offered several explanations why CS negative valence may contribute to a return of fear. First, negative stimuli are simply more easily associated with aversive outcomes than positive or neutral stimuli (e.g., Hamm, Vaitl, & Lang, 1989). A CS that continues to possess a negative connotation therefore more strongly activates the excitatory association than does a CS with a neutral or positive meaning. Second, because negative valence is positively related to avoidance tendencies (Chen & Bargh, 1999; Phaf, Mohr, Rotteveel, & Wicherts, 2014), and the availability of avoidant behavior may cause a return of fear for the CS (van Uijen, Leer, & Engelhard, 2018; Vervliet & Indekeu, 2015), post-extinction CS negative valence may increase the risk of return of fear via avoidance. Third, Dirikx et al. (2004) explained the positive relation between CS negative valence and reinstatement by using the emotion typology of Lang (1995). According to this typology, emotions can be placed in a two-dimensional space of valence (positive vs. negative) and arousal (high vs. low). Fear is considered a negative and high arousal emotion. During reinstatement, the unpredicted US increases arousal related to that specific context. Introduction of a negatively valenced CS in this context might recombine or reinstate the previously extinguished CS-US association (Hermans et al., 2005).

In an attempt to reduce the return of fear, researchers have tested strategies to shift the CS valence from negative to positive during or following extinction/exposure. We (Zbozinek, Holmes, & Craske, 2015) evaluated whether positive mood induction prior to extinction training reduced CS negative valence. Participants either read or vividly imagined positive scripts for about 30 min. As expected, positive imagery, relative to reading scripts, led to greater positive mood, less negative CS valence at the end of extinction, and less reinstatement of subjective fear and startle responses. However, we did not test whether the effect of positive mood on reinstatement of fear was *mediated* by changes in CS positive valence.

Positive mood may improve the effects of extinction learning via various pathways (Zbozinek & Craske, 2017a). Laboratory studies have shown that individuals tend to use affective state as information to make evaluative judgments, resulting in more positive evaluations of stimuli during a positive affective state (e.g., Erez & Isen, 2002; Yeung & Wyer, 2004), and more negative evaluations of stimuli during a negative affective state (e.g., Clore & Huntsinger, 2007; Engelhard & Arntz, 2005). Following this argument, positive affective state may lead to positive CS evaluations after extinction (Zbozinek, Holmes, & Craske, 2015) and therefore reduce the return of fear. Alternatively, positive affective state can enhance encoding, rehearsal and retrieval of information (for a review, see Zbozinek & Craske, 2017a), thereby improving the effects of extinction learning and preventing the return of fear. A recent fear conditioning study showed that higher positive affective state, but not negative affective state, before and after extinction was associated with less reacquisition of conditional fear (Zbozinek & Craske, 2017b).

Inducing positive mood prior to exposure is not restricted to a specific CS and may therefore be used for a broad spectrum of fears. However, before translating these insights to clinical practice, a crucial next step is to test this new strategy on individuals with existing fears (Craske, Hermans, & Vervliet, 2018). Therefore, the aim of the present study was to conceptually replicate the study of Zbozinek, Holmes, and Craske (2015) in a subclinical group of participants with a high fear of public speaking. To correct for a general effect of arousal, we also added a negative group, in which the mood induction was matched to the positive group on levels of arousal. So, we tested three groups: positive mood induction ("positive"), negative mood induction ("negative"), and no mood induction ("control"). All participants received two weekly sessions of virtual reality (VR) exposure and were retested one week later. We expected that the positive group, compared to the negative group and the control group, would (1) start exposure with a more positive mood, (2) evaluate the CS (i.e., speaking in front of an audience) less negatively following exposure, (3) show less return of subjective CS negative valence, US expectancy, US aversiveness, subjective fear, skin conductance response (SCR) and startle reflex (SR) at a spontaneous recovery test, and (4) show less reinstatement on these outcome measures following an unsignaled US presentation (i.e., social rejection). We also expected that (5) the effects of mood on all indices of return of fear would be (partially) mediated by CS valence ratings. To minimize contextual changes between exposure and follow-up test, we tested participants in the same VR context. We did not specify any hypotheses about differences between the negative and control groups due to conflicting potential costs/benefits of valence and arousal.

1. Methods

1.1. Sample size calculation

We based our sample size calculation on the findings of Zbozinek, Holmes, and Craske (2015) and Niles, Craske, Lieberman, and Hur (2015). The latter study also involved individuals with fear of public speaking and a strategy to optimize exposure (i.e., affect labeling). Based on these studies, we expected to find a difference between conditions with a small to medium effect size. The sample size was determined with Gpower (F test, repeated measures, within-between interaction) with a correlation among repeated measures of 0.5, a nonsphericity correction of 1, and an effect size specification of 'as in GPower 3.0' (with 3 groups, 4 time points, f = 0.17, power = .80; α = 0.05). The minimum total sample size was 63. Taking potential drop-out into account, we included 24 participants per condition (72 participants in total). However, after data collection but before analyses were conducted, we decided to conduct a set of 3 x 2 factorial ANOVAs to assess treatment effect, and spontaneous recovery and reinstatement effects separately, because they address the specific hypotheses and are easier to interpret. With the current sample size (N = 62), for a power of .80, an alpha level of 0.05, 3 groups, 2 measurements, correlation between measures of 0.1, and a non-sphericity correction ε of 1, we were able to detect a minimum effect size of around Cohen's f = 0.21.

1.2. Participants

We recruited 72 students from two sites: the University of California Los Angeles (UCLA; n = 20; no drop-outs) and Utrecht University (UU; n = 52) through flyers around campus, a Psychology Subject Pool, and social media. From the UU sample, nine participants dropped out after the first session and one dropped out after the second session (positive group: n = 2; negative group: n = 5; control group: n = 3). Those who dropped out from the study did not differ significantly on the Personal Report of Public Speaking Anxiety (PRPSA) at baseline ($M = 128.70$; $SD = 14.05$) from those who completed it ($M = 134.79$; $SD = 12.47$), $t(70) = 0.735$, $p = 465$. Within the negative group, participants who dropped out of the study ($n = 5$) did not significantly differ from the completers ($n = 19$) on baseline PRPSA scores (drop-outs: $M = 131.60$, $SD = 15.18$; completers: $M = 130.58$, $SD = 9.61$).

The final sample consisted of 62 students (positive group: n = 23; negative group: n = 19; control group: n = 20). Participants in the UCLA sample (16 female, 4 male) had a mean age of 20.70 ($SD = 5.51$); were 40 % Asian, 25 % Caucasian, 20 % Hispanic/Latino, 5 % African American, and 10 % reported another ethnicity. Participants in the UU sample (30 female, 11 male, 1 non-binary gender identity) had a mean age of 21.57 ($SD = 2.49$). Most (91.5 %) were Caucasian and 9.5 %

reported another ethnicity.

On a 2-item screening instrument (see Niles et al., 2015), eligible participants reported 6 or higher on anxiety ("How anxious would you feel giving a formal speech before a live audience?" 0 = *not at all anxious*, 8 = *extremely anxious*) and a 5 or higher on avoidance ("How likely would it be for you to avoid taking a class that requires an oral presentation?" 0 = *I would never avoid*, 8 = *I would always avoid*). Furthermore, they were 18–30 years of age, fluent in English or Dutch, and free of any self-reported heart, neurological or respiratory conditions; visual or hearing impairment; physician recommendation to avoid stressful situations; current treatment for public speaking anxiety; medication for an emotional problem; elevated depressive symptoms (score >18 on the Beck Depression Inventory-II, Beck, Steer, & Brown, 1996); active suicidal ideation; or sickness from watching 3D movies. The study was approved by the UCLA Institutional Review Board (IRB16-1025) and by the UU faculty Ethical Committee (FETC17-58). Participants received course credits or financial compensation for their participation.

1.3. Design

We randomly assigned participants to the positive, negative, or control groups. Participants attended three sessions approximately one week in between. Day 1 included a pre-test (Behavioral Approach Test; BAT1, (no) mood induction, and the first exposure session (seven 1min speeches). Day 8 consisted of (no) mood induction, the second exposure session (seven 1min speeches), and post-test (BAT2). Day 15 started with a spontaneous recovery test (BAT3), after which participants completed a social media task in which they received a social rejection (i.e., reinstatement) and then performed the reinstatement test (BAT4). BATs were identical to the speeches during exposure and took place in the same VR context. See Fig. 1 for an overview of the experimental design.

2. Materials and apparatus

Physiological measures. All physiological activity was recorded using a BIOPAC MP150 hardware unit and AcqKnowledge version 4.4.0 software (BIOPAC Systems, Inc).

Skin conductance Response (SCR). SCR (31.25 Hz sampling rate) was our measure of arousal, recorded using EL507 Ag/AgCl electrodes attached to the distal phalanges of the index and middle fingers of the non-dominant hand. A GSR100C amplifier and two LEAD110A to the electrodes were used. Data were filtered using an FIR low pass filter with a frequency cut-off fixed at 2 Hz. SCR were calculated by taking the difference between the mean skin conductance value of the last 2 s of the speech preparation phase and the maximum skin conductance level 1–6 s following the confrontation with the audience (CS). In total, there were 18 speeches over 3 days. T-scores were calculated within each participant over these 18 speeches, which corrects for inter-individual variance (see Lonsdorf et al., 2017). On the first BAT of the experiment, there were two outliers in the positive condition and one outlier in the negative condition. To reduce the influence of outliers, we standardized values.

Eye blink startle reflex (SR). Eye blink SR was measured by exposing participants to one startle probe of 82 dB for 50m during each phase (i.e. speech preparation, speech delivery and rest phase) of the BATs and exposure speeches. Participants wore headphones on top of the VR headset, because it was not possible to build the startle probes in the VR environment. Due to this construction, 82 dB was the highest intensity that was possible. Resultant change in electromyography orbicularis oculi activity under the left eye was recorded (Blumenthal et al., 2005). However, because participants wore their VR headset on top of the electrodes, the data suffered from substantial noise and were therefore not analyzed.

2.1. Self-report measures

2.1.1. Personal report of public speaking anxiety (PRPSA; McCroskey, 1970)

The PRPSA measures public speaking anxiety and consists of 34 statements (e.g., "I feel anxious while waiting to give my speech") that are rated on a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*). We back-translated the PRPSA to Dutch (van Veen & van Schie, in preparation) for participants at the UU site. In the current study, the reliability at pre-test was $\alpha = 0.88$ at the UCLA site and $\alpha = 0.83$ at the UU site. Based on the total score, participants can be classified as high anxiety (>131), moderate anxiety (98–131), or low anxiety (<98).

Self-Assessment Manikins (SAMs; Bradley & Lang, 1994***).*** As a manipulation check of the mood induction procedures, participants rated the valence and arousal of their current mood by SAMs on a scale from 1 to 9, with 1 = *extremely unpleasant* or *low arousal*, 5 = *neutral*, and 9 = *extremely pleasant* or *high arousal*.

Positive and Negative Affect Scale – Expanded form (PANAS-X; Watson, Clark, & Tellegen, 1988; Watson & Clark, 1999***).*** The 33-item PANAS-X involves a 21-item positive affect scale and a 12-item negative affect scale. We administered the PANAS-X with state instructions to capture immediate fluctuations in mood. Participants rated to which degree they currently experienced each feeling or emotion on a scale from 0 = *not at all* to 5 = *extremely*. The reliability range was $\alpha = 0.91–0.96$ for the positive subscale and $\alpha = 0.83–0.91$ for the negative subscale. Since positive mood was our primary focus, we only used the positive subscale for the analyses.

Speech ratings. Participants were first interviewed to personalize their US for the speech ratings (see Procedure). Right before and after each speech, participants were asked to rate: (1) US expectancy ("How

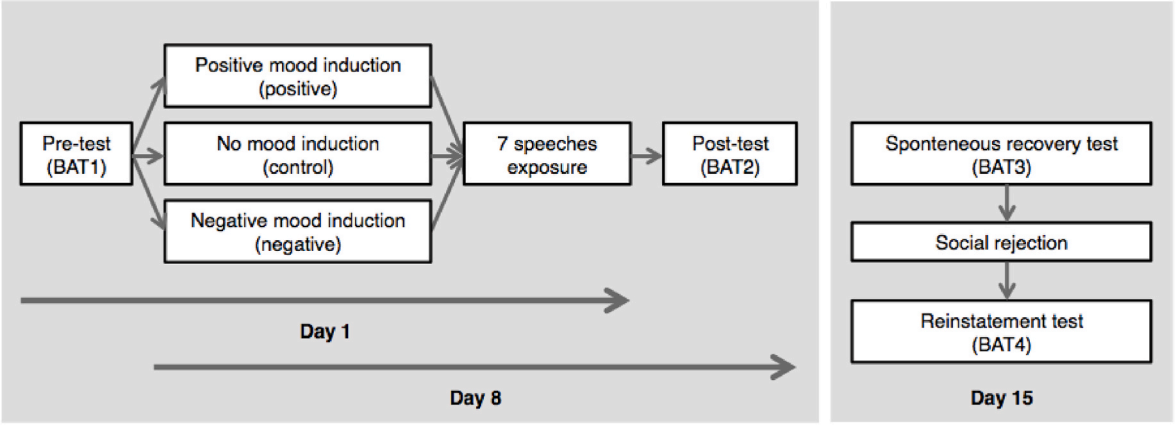

Fig. 1. Timeline of experimental procedure.

likely is it that the thing you are most worried about will occur?"; with any value between 0 and 100 with 0 = *certain it will not occur*, 50 = *uncertain*, 100 = *certain it will occur*), (2) US aversiveness ("How bad would it be if the thing you are most worried about did occur?"; with any value between 0 and 100 with 0 = *not bad at all*, 50 = *moderately bad*, 100 = *extremely bad*), (3) CS valence ("How much do you like or dislike speaking in front of an audience?"; with any value between 0 and 100 with 0 = *dislike very much*, 50 = *neutral*, 100 = *like very much*), and (4) current fear level ("What is your fear rating right now?"; with any value between 0 and 100 with 0 = *not fearful at all*, 50 = *moderately fearful*, 100 = *extremely fearful*). These questions always referred to their *next* speech and can therefore be considered as anticipation (i.e., right before the upcoming speech) and future prospect (i.e., potential future speech) ratings. The anticipation ratings are our measure of interest and we included the future prospect ratings for exploratory purposes. The latter ratings will not be presented in this article.

Mood and Need for Threat Questionnaire (**MNTQ**; ***van Beest & Williams, 2006)*****.** The 28-item MNTQ was used to assess feelings of ostracism after a social rejection in the laboratory. Participants scored all items on a 5-point scale (1 = *not at all*, 5 = *extremely*). The reliability was $\alpha = 0.92$ in the current study.

Post-experimental questionnaire. Participants indicated to which degree they followed the instructions on a 0–100 Visual Analogue Scale (*0 = not at all, 100 = very well*). Furthermore, the rated the feeling of immersion in the VR environment on a 0–100 Visual Analogue Scale (0 = *not at all immersed*, 100 = *totally immersed*).

2.1.2. Manipulations

Mood induction (Zhang, Hui, & Barrett, 2014***).*** The positive and negative mood induction consisted of 36 evocative images that were each displayed for 5 s, resulting in a 3 min presentation. The images differed in valence and were selected by Zhang et al. (2014) from the International Affective Picture System (Lang, Bradley, & Cuthbert, 1997) or gathered online. During display, participants in the positive condition listened to "Arrival of the Queen of Sheba" (Händel, 1715), whereas participants in the negative condition listened to "Battle on the Ice" (Prokofiev, 1938). Participants were instructed to immerse themselves, use their imagination to make the images more personal, and be carried away by the mood of the music and pictures (Zhang et al., 2014).

Virtual Reality (VR) speech environment and apparatus. BATs and exposure sessions took place in the Oxford Room (Virtual Speech, freely available at http://virtualspeech.com). See Appendix A for a screenshot of the room. An Oculus Rift headset presented a 360° video of a real audience of 11 individuals (mixed gender and ethnic background), with neutral-to-positive facial expressions and different levels of attentiveness. The room involves background noise to increase the feeling of immersion.

Behavioral Approach Test (BAT). All instructions for the speech ratings and BATs were programmed in E-prime version 2.0. Each BAT consisted of three phases: speech preparation phase (30 s), speech delivery phase (1 min) and rest phase (i.e., inter-trial-interval, ITI; 2 min). The beginning and end of each phase was signaled by a 1 s bell sound. The experimenter provided the speech topic right before the speech preparation phase. Speech topics for the four BATs were: health care, global warming, immigration and home schooling. The order of the topics was counterbalanced across participants. Participants looked away from the audience during the speech preparation and rest phases and only faced the audience during the speech delivery phase. Before and after each speech, they completed the four speech ratings. Participants faced the audience during the anticipation ratings and faced a sculpture during the future prospect ratings. This shift in perspective was done by turning the swivel office chair that participants were sitting on to the right-hand side. By turning right, participants no longer saw the audience and faced a neutral sculpture in front of a wall. Because of this continuous shift in perspective, participants performed the exposure sessions while they were sitting. They were told that their speeches would be videotaped so that observers could evaluate them later. We gave this false instruction to further induce discomfort during the task (see Niles et al., 2015).

Exposure speeches. The only difference between the BATs and exposure speeches was that participants in the positive and negative conditions received three 1-min reminders of the music from the mood induction manipulation per exposure session (i.e., prior to their third, fifth and seventh speeches). We cut the music piece in three parts of 1-min and used this in chronological order. The duration of the rest phase prior to these reminders was adjusted so that the total length of the exposure session remained the same for all three conditions. We created two lists of speech topics (see Appendix B for list 1 and list 2) that were balanced on number of personal (e.g., favorite book), mildly controversial (e.g., smoking in public) and highly controversial (e.g., death penalty) topics. The order of lists was counterbalanced cross participants and the order of speech topics per list was randomized.

Ostracism online (Wolf et al., 2015***).*** As a reinstatement manipulation, a social media ostracism task was used to expose participants to a social rejection (US) in the laboratory. Ostracism online mimics the procedures of the Cyberball paradigm (Williams & Jarvis, 2006) and has been validated as equally effective (Wolf et al., 2015). Participants start the task by creating a personal profile consisting of an avatar and a short description of themselves. They received the instruction that for a period of 3 min they would be introduced to the profiles of 11 other players and asked to form an impression of all the other group members. They were stimulated to give a "like" (similar to likes on Facebook) to profiles they favored. Wolf et al. (2015) created profiles for the group members that differed in age, gender and background, and were free of stereotypes and indicators of social or financial status. Participants received one like in the first minute and no likes in the following 2 min. For the other players, the number of likes increased over time and was normally distributed with an average of 5.5 likes (Wolf et al., 2015).

2.1.3. Procedures

On Day 1, participants signed the informed consent form and completed the BDI-II for screening purposes. If eligible, they also completed a brief demographics questionnaire and the PRPSA. Next, the experimenter interviewed the participant to personalize their US (i.e., "With regard to speaking in front of an audience, what are you most worried will happen?"). When a clear US was defined (e.g., "That the audience thinks I'm dumb"), the experimenter explained the four speech ratings to the participant. The experimenter then attached the electrodes monitoring SCR and SR and participants underwent a 3-min startle habituation phase consisting of 12 startle probes. Thereafter, participants wore the VR headset and viewed a short neutral VR video (i.e., "Cliffs of Moher" in Discovery), to reduce a possible novelty effect of the VR. Directly after this video, participants completed the BAT1 (pre-test). In accordance with their condition, they then received the positive or negative mood induction or were given a 3-min break without further instructions. Before and after the mood induction or brief break, participants rated the valence and arousal of their current mood and filled out the PANAS-X (i.e., "mood ratings"). Next, all participants underwent the first exposure session comprised of seven speeches. After these speeches, they again completed the mood ratings.

Day 8 began with a 3-min startle habituation phase, followed by the same mood induction or brief break used on Day 1. Again, this mood induction or break was preceded and followed by mood ratings. Participants underwent the second exposure session of seven speeches, directly followed by the BAT2 (post-test) and final mood ratings.

On Day 15, no mood inductions were used. Participants completed the PRPSA, mood ratings, and a 3-min startle habituation phase, immediately followed by the BAT3 (spontaneous recovery test). They were then told that they would engage in an online group task (i.e., Ostracism online) and had to wait for the others players to come online. All participants performed the ostracism online task in English. Directly after the ostracism task, participants underwent the BAT4

(reinstatement test). Lastly, they filled out the MNTQ, answered some final questions about task compliance and were debriefed.

3. Results

3.1. Sample characteristics

UCLA and UU samples did not significantly differ on mean PRPSA scores at baseline, $t(60) = -0.67$, $p = .50$; therefore, participants were analyzed as one sample. The mean PRPSA score of the full sample was 134.79 ($SD = 12.47$, range = 116–162), with 54.8 % in the high public speaking anxiety range, 45.2 % in the moderate anxiety range, and 0 % in the low anxiety range.

3.2. Manipulation check

Task compliance was high (M = 87.6; SD = 10.7) and did not differ between conditions ($p = .721$). Participants rated the feeling of immersion in the VR environment on average as 58.20 ($SD = 24.07$), with no difference between conditions ($p = .817$). Their scores on the MNTQ were comparable (i.e., less than 1 SD difference) to the scores for the Ostracism condition in the original validation study (Wolf et al., 2015). For the reinstatement analyses, participants were excluded who were unable to read the descriptions of the other players (n = 1), or estimated the number of likes they received relative to the rest of the group as "above average" (n = 1; Wolf et al., 2015).

3.3. Randomization check

Means and standard deviations for speech ratings and SCR by Group over Time are displayed in Table 1. One-way ANOVAs revealed no significant differences between groups on age, mean baseline PRPSA, pre-induction mood valence and arousal, positive affect, SCR, or any of the speech ratings at the pre-test. Therefore, these baseline variables were not covaried in the main analyses. A chi-square test revealed a significant difference in gender proportion between groups ($\chi 2 = 11.44$, $p = .02$). However, considering the small samples (e.g., 1, 5, and 9 for the neutral, positive and negative condition, respectively), gender was not included as covariate in the analyses.

3.4. Mood valence, positive affect and arousal (Day 1 and day 8)

Group (positive, negative, control) x Time (pre-induction, post-induction) mixed ANOVAs were conducted with mood valence, positive affect or arousal as the dependent variables for Day 1 and 8 (see Fig. 2a-d for mood valence and arousal scores). For Day 1, the Group × Time interaction was significant for mood valence, $F(2, 59) = 27.72$, $p < .001$, $\eta p2 = 0.48$, positive affect, $F(2, 59) = 6.87$, $p = .002$, $\eta p2 = 0.19$, and arousal, $F(2, 59) = 6.57$, $p = .003$, $\eta p2 = 0.18$. In line with expectations, general mood became more positive in the positive group, $t(21) = -5.75$, $p < .001$, more negative in the negative group, $t(18) = 4.28$, $p < .001$, and did not change in the control group, $t(20) = -1.16$, $p = .26$. All groups significantly differed in mood valence at post-induction test: $F(2, 59) = 48.76$, $p = .004$, $\eta p2 = 0.62$; independent t-tests $ps < .001$. As expected, paired t-tests showed that positive affect significantly increased in the positive group, $t(21) = -3.73$, $p = .001$, and did not change in the negative group or control group ($ps > .072$). Arousal significantly decreased after the 3-min waiting time in the control group, $t(20) = 6.71$, $p < .001$, but did not change after the 3-min positive and negative inductions ($ps > .440$).

For Day 8, a significant Group × Time interaction was found for mood valence, $F(2, 59) = 20.47$, $p < .001$, $\eta p2 = 0.41$, and positive affect, $F(2, 59) = 7.78$, $p = .001$, $\eta p2 = 0.21$, but not for arousal, $F(2, 59) = 1.01$, $p = .371$, $\eta p2 = 0.03$. Paired t-tests revealed that general mood became more negative in the negative group, $t(18) = 6.09$, $p < .001$, but did not significantly change in the positive or control group ($ps > .095$). Nevertheless, all groups differed significantly from each other in the expected directions on mood valence ratings at post-induction test: $F(2, 59) = 29.47$, $p < .001$, $\eta p2 = 0.50$; independent t-tests $ps < .006$. Similar to Day 1, paired t-tests showed that positive affect significantly increased in the positive group, $t(21) = -2.79$, $p = .011$, and did not change in the negative group or control group ($ps > .101$).

For explorative purposes, the same analyses were conducted with pre-induction and end of session as within-subjects Time variables. This revealed no significant Group × Time interactions for mood valence, positive affect or arousal at Day 1 or 8 ($ps > .312$). Hence, mood valence, positive affect and arousal were successfully manipulated on Day 1 and 8, but these effects were no longer present at the end of the exposure sessions. Furthermore, a one-way ANOVA showed that at the beginning of Day 15, participants did not differ in positive affect ($p = .084$) or arousal ($p = .678$). The negative group (M = 5.53, SD = 1.61) seemed to start Day 15 with a less positive mood than the positive group (M = 6.36, SD = 1.05) and control group (M = 6.24, SD = 0.89), but the one-way ANOVA was not significant ($p = .069$).

3.5. The effect of pre-exposure mood induction on post-exposure CS valence

CS valence ratings over time are displayed in Fig. 3a. A Group x Time (BAT1 Day 1, BAT2 Day 8) mixed ANOVA with self-report CS valence as the dependent variable showed that, in contrast to expectations, the Group × Time interaction effect was not significant, $F(2, 59) = 1.21$, $p = .305$, $\eta p2 = 0.04$. There was a significant main effect for Time, $F(2, 59) = 5.12$, $p = .027$, $\eta p2 = 0.08$: the CS was rated as more positive at BAT2 ($M = 29.35$, $SD = 18.16$) than at BAT1 ($M = 22.71$, $SD = 19.00$), with 0 = *dislike very much*, 50 = *neutral*, 100 = *like very much*. Thus, participants liked speaking in front of an audience more after two exposure sessions than before, but this was not affected by the mood inductions.

3.6. Exposure effectiveness

Group x Time (BAT1 Day 1, BAT 2 Da y 8) mixed ANOVAs revealed no significant Group × Time interactions for subjective fear, US expectancy, US aversiveness or SCR ($ps > .084$). As expected, there were significant main effects for Time in subjective fear, $F(2, 59) = 92.33$, $p < .001$, $\eta p2 = 0.61$, US expectancy, $F(2, 59) = 59.83$, $p < .001$, $\eta p2 = 0.50$, US aversiveness, $F(2, 59) = 65.61$, $p < .001$, $\eta p2 = 0.53$, and SCR, $F(2, 56) = 8.73$, $p = .005$, $\eta p2 = 0.14$. Scores on all these outcome variables decreased from BAT1 to BAT2, indicating the effectiveness of exposure. Likewise, a Group x Time (Baseline Day 1, Follow-up Day 15) mixed ANOVA with mean PRPSA score as dependent variable revealed no significant Group × Time interaction effect ($p = .206$) and a significant main effect for Time, $F(2, 59) = 55.81$, $p < .001$, $\eta p2 = 0.49$. Public speaking anxiety was, on average, lower at follow-up ($M = 122.94$, $SD = 13.87$) than at baseline ($M = 134.79$, $SD = 12.47$). Unexpectedly, the main Group effect was also significant, $F(2, 59) = 4.54$, $p = .015$, $\eta p2 = 0.13$. Post-hoc tests showed that the average PRPSA score was higher in the positive group ($M = 134.39$, $SE = 2.34$) than in the negative group ($Mdif = 9.73$, $SE = 3.43$, $p = .006$) and control group ($Mdif = 7.51$, SE = 3.34, $p = .028$).

3.7. Spontaneous recovery test

The hypothesis that positive mood induction would decrease

Table 1
Mean and SD self-report speech ratings and SCR for all BATs per condition.

Measure	Condition	Day 1 BAT1		Day 8 BAT2		Day 15 BAT3		Day 15 BAT4	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
CS valence	Positive	16.55	13.07	27.95	16.88	22.55	13.35	23.18	13.76
	Negative	30.68	25.16	31.58	23.75	37.58	23.75	39.00	22.87
	Control	21.95	15.78	29.05	19.66	31.14	19.04	31.67	19.51
US expectancy	Positive	69.23	17.23	44.41	27.34	52.18	20.59	47.14	24.54
	Negative	64.58	21.83	44.16	27.78	39.00	26.01	36.94	29.90
	Control	65.71	27.17	31.67	23.94	37.71	23.22	39.29	24.46
US aversiveness	Positive	67.50	21.70	40.09	26.63	44.18	19.42	42.32	23.86
	Negative	58.32	23.44	32.53	22.60	34.21	25.00	27.06	20.92
	Control	56.90	27.73	28.43	23.04	30.38	25.98	32.14	22.11
Fear	Positive	66.09	19.15	32.32	23.53	40.41	21.51	35.73	23.04
	Negative	53.68	21.07	33.68	26.10	32.58	23.17	24.29	19.16
	Control	62.86	24.22	26.19	19.55	29.57	23.56	30.95	21.77
SCR	Positive	.70	1.35	.12	.22	.42	.80	.25	.50
	Negative	.39	.89	.15	.57	.29	.58	.13	.36
	Control	.34	.59	.07	.36	.41	.48	.17	.30

Note. BAT = Behavioral Approach Task; CS = Conditioned stimulus; US = Unconditioned stimulus; SCR = Skin Conductance Response. BAT1 = pre-test on Day 1; BAT2 = post-test on Day 8; BAT3 = spontaneous recovery test on Day 15; BAT4 = reinstatement test on Day 15. For BAT4, we excluded two participants who did not see the stimuli correctly.

spontaneous recovery compared to negative and control was analyzed using Group x Time (BAT2 Day 8, BAT3 Day 15) mixed ANOVAs with subjective and psychophysiological indices as dependent variables. A significant Group × Time interaction effect was found for CS valence, $F(2, 59) = 6.82$, $p = .002$, $\eta p2 = 0.19$[1] (see Fig. 3a). In contrast with predictions, paired *t*-test showed that from BAT2 to BAT3, CS valence became *more negative* in the positive group, $t(21) = 2.95$, $p = .008$, *more positive* in the negative group, $t(18) = -2.50$, $p = .022$, and did not change in the control condition, $t(20) = -0.85$, $p = .406$. Moreover, a one-way ANOVA revealed that groups significantly differed on CS valence at BAT3, $F(2, 59) = 3.27$, $p = .045$, $\eta p2 = 0.10$: the negative group liked speaking in front of an audience more than the positive group did, $t(39) = -2.54$, $p = .015$. The negative and positive groups did not differ from the control group (*ps* > .092).

Likewise, the Group × Time interaction was significant for US expectancy, $F(2, 59) = 3.96$, $p = .024$, $\eta p2 = 0.12$. Observation of the data (Fig. 3b) indicated a decrease in US expectancy for the negative group and an increase in US expectancy for the positive and control groups, but paired *t*-tests per group were not significant (*ps* > .052). The one-way ANOVA for the BAT3 scores was also not significant, $F(2, 59) = 2.54$, $p = .088$, $\eta p2 = 0.08$.

There were no significant Group × Time interaction effects for subjective fear, US aversiveness, or SCR (*ps* > .117). The main effects for Time were non-significant for all outcome measures except for SCR: it increased from BAT2 to BAT3, $F(2, 57) = 7.99$, $p = .006$, $\eta p2 = 0.12$, indicating spontaneous recovery.

For exploration purposes, mixed Group x Time ANOVAs were conducted for all outcome variables with the last speech of Day 1 and the first speech of Day 8 as Time factor. This revealed no significant Group × Time interaction effects for any outcome measure (*ps* > .081). However, there were significant main effects for Time for subjective fear, $F(2, 59) = 16.53$, $p < .001$, $\eta p2 = 0.22$, US expectancy, $F(2, 59) = 13.341$, $p = .001$, $\eta p2 = 0.18$, US aversiveness, $F(2, 59) = 9.33$, $p = .003$, $\eta p2 = 0.14$ and SCR, $F(2, 54) = 9.10$, $p = .004$, $\eta p2 = 0.14$. Scores on all these outcome measures increased from Day 1 to Day 8, indicating a general spontaneous recovery regardless of the mood induction prior to the first speech of Day 8.

3.8. Reinstatement test

The hypothesis that positive mood induction would decrease reinstatement effects compared to negative and control was analyzed using Group x Time (BAT3 Day 15, BAT4 Day 15) mixed models with subjective and physiological indices as dependent variables. Only for subjective fear, the Group × Time interaction was significant, $F(2, 57) = 3.19$, $p = .049$, $\eta p2 = 0.10$. Additional paired *t*-tests showed that fear decreased in the negative group, $t(16) = 2.93$, $p = .010$, and did not change in the positive group, $t(21) = 1.76$, $p = .093$, or control condition, $t(20) = -0.93$, $p = .363$. For SCR, the main effect for Time was significant, $F(2, 57) = 7.72$, $p = .007$, $\eta p2 = 0.12$, with scores decreasing from BAT3 to BAT4. For CS valence, the main effect of Group was significant, $F(2, 57) = 3.70$, $p = .031$, $\eta p2 = 0.12$. A one-way ANOVA for the BAT4 scores was also significant, $F(2, 57) = 3.47$, $p = .038$, $\eta p2 = 0.11$, and additional group comparisons showed participants in the positive group, compared to the negative group, still disliked public speaking more, $t(37) = -2.68$ $p = .011$. None of the other Group x Time, Time, or Group effects were significant(*ps* > .097).

3.9. Regression analysis with CS valence and return of fear

Because groups did not differ in CS valence scores at post-test, the hypothesis regarding a CS valence mediation effect between group and return of fear could not be tested. Nevertheless, the relationship between post-exposure CS valence and follow-up tests was explored using linear regressions with CS valence at BAT2 (post-test) as independent variable and difference scores between BAT2 and BAT3 for spontaneous recovery as dependent variable for all outcome variables. These analyses yielded no significant effects (*ps* > .300). The same analyses with differences scores between BAT3 and BAT4 for reinstatement effects also showed no significant effects (*ps* > .283). Finally, regression analyses with CS

[1] Although groups did not significantly differ on CS valence scores at pre-test ($F(2, 59) = 3.04$, $p = .055$, $\eta 2 = 0.09$), we visually observed pre-test differences (see Fig. 3a). We therefore also conducted an ANCOVA with CS valence pre-test scores as covariate. This revealed a significant effect for the covariate, $F(2, 59) = 5.84$, $p = .019$, $\eta 2 = 0.09$, but the crucial Group × Time interaction effect was still significant, $F(2, 59) = 5.63$, $p = .006$, $\eta 2 = 0.16$.

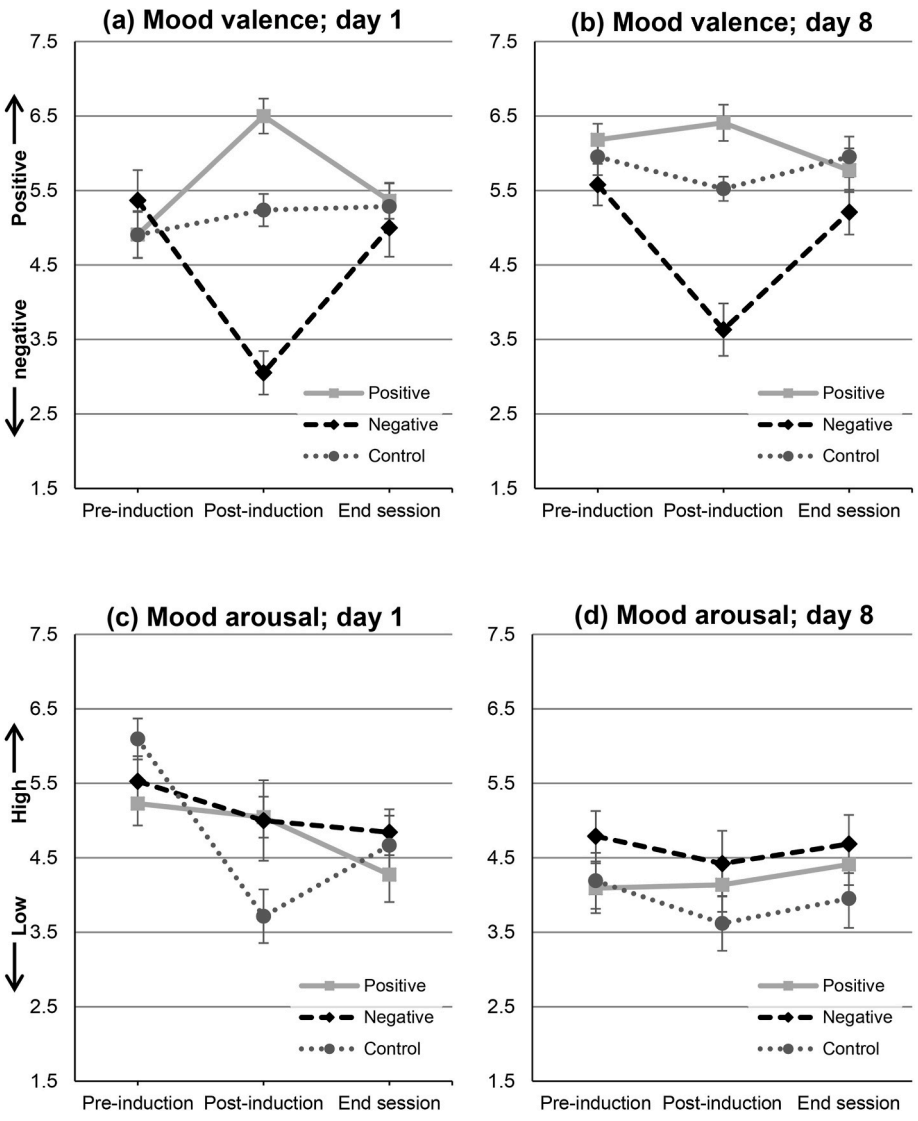

Fig. 2. (a–d). Mood valence and arousal ratings per group (positive, negative, control) over time (pre-induction, post-induction, end session) for Day 1 and 8. Error bars are standard errors.

valence at the last speech of Day 1 as independent variable and difference scores between the last speech of Day 1 and the first speech of Day 8 as dependent variable showed no significant effects for any of the outcome measures (*ps* > .170).

4. Discussion

The goal of this study was to test whether pre-exposure positive mood induction, compared to pre-exposure negative mood induction and no mood induction, would decrease post-exposure CS negative valence and reduce spontaneous recovery and reinstatement of fear in individuals with high fear of public speaking. Although the mood induction procedure successfully affected mood, the mood induction groups did not differ significantly in terms of CS valence (i.e., (dis)liking of speaking in front of an audience) at the end of two weekly exposure sessions. For all groups, VR exposure was associated with a decrease in public speaking anxiety, as measured via US expectancy, US aversiveness, subjective fear and SCR, and this effect was maintained at the 1-week follow-up test. There were several unexpected findings in terms of return. First, at the spontaneous recovery test, relative to the control group, the positive group reported more *dislike* of speaking in front of an audience and more expectancy to experience rejection, while the negative group reported the opposite effects. Second, for only the negative mood induction condition, subjective fear decreased from before to after reinstatement. Finally, post-exposure CS valence ratings did not significantly predict spontaneous recovery or reinstatement of fear.

In line with human aversive conditioning studies (e.g., Dirikx et al., 2004; Engelhard et al., 2014; Hermans et al., 2005; Vansteenwegen et al., 2006), we found that exposure led to large changes in expectancy learning, but small changes in evaluative learning. That is, individuals greatly reduced their expectation of social rejection from the audience, accompanied by large reductions of fear, but continued to report strong dislike for speaking in front of an audience. Evaluative learning is resistant to change during extinction (see de Houwer et al., 2001), and previous studies have found that residual CS negative valence predicted spontaneous recovery and reinstatement of fear (Dirikx et al., 2004; Hermans et al., 2005; Vasey et al., 2012; Zbozinek, Hermans, et al., 2015). In contrast, and similar to one other study by Luck and Lipp (2018), we did not find evidence for this predictive relationship. One explanation for this discrepancy may be that the robustness of the exposure effects in the current study limited the magnitude of spontaneous recovery effects. A second explanation may be the way CS valence was assessed. Evaluative learning works through implicit and explicit

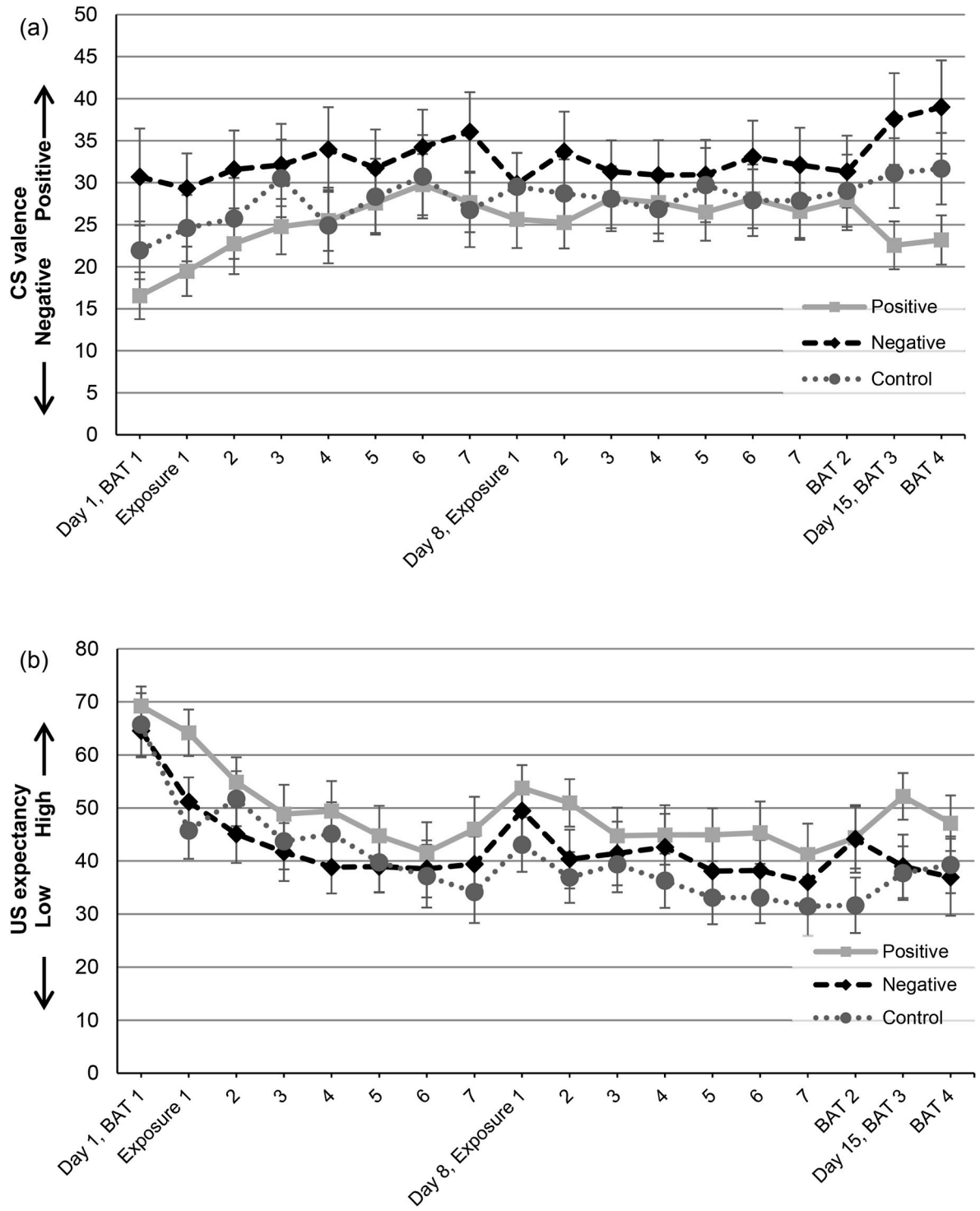

Fig. 3. *(a-b)*. CS valence and US expectancy ratings at BAT1 (Day 1, pre-test), exposure 1–7 (Day 1), exposure 1–7 (Day 8), BAT2 (Day 8, post-test), BAT3 (Day 15, sponteneous recovery test) and BAT4 (Day 15, reinstatement test) for the positive, negative and control groups. Error bars are standard errors.

pathways (Jones, Olson, & Fazio, 2010), but we only used an explicit measurement to assess CS valence. Implicit measures (e.g., affective priming tasks; Engelhard et al., 2014) are relatively more difficult to control and are therefore believed to assess more automatic attitudes (see de Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009). Third, most studies that found a positive relationship between negative CS valence and the return of fear involved de novo fears, whereas we tested phobic fears. The attitude formation in a (sub)clinical sample may be a predictor of avoidance behavior (i.e., "I dislike it, therefore I avoid it"), which then could lead to a return of fear. Participants in the current study did not have the option to avoid giving a speech. Future studies would benefit from: (1) extending the duration between post-test and follow-up test to increase the probability and magnitude of spontaneous recovery, (2) including implicit measures as index for CS valence (e.g., affective priming, Engelhard et al., 2014; fear-specific Implicit Association Test, Vasey et al., 2012), and (3) including measures of avoidance (e.g., optional access to online speech training).

Previously, we (Zbozinek, Hermans, et al., 2015) argued that

strategies that target evaluative learning may improve the long-term effects of exposure therapy based on the results of our fear conditioning study, in which pre-extinction positive mood induction decreased post-extinction CS negative valence and reduced reinstatement of fear (Zbozinek, Holmes, & Craske, 2015). The current study represented an attempt to replicate and extend our earlier study. As we had found in our fear conditioning study, the effects of the mood induction procedure did not last until the end of the exposure session. Furthermore, the current findings suggest that enhancing positive mood before a confrontation with the CS may have the paradoxical effect of *reducing* the effects of exposure therapy for anxiety, given the reversed interaction pattern for CS valence and – to a smaller degree – for US expectancy at the last assessment.

How can we explain these reversed findings? A plausible explanation is that mood in the positive group functioned as a conditional inhibitor (Bouton, 2006): participants may have concluded that the audience did not reject them *because* they felt positive or less anxious while giving the speeches. They could have partially contributed the success of exposure to their enhanced positive state, which was absent at the follow-test. Removal of this conditional inhibitor may have increased the dislike of speaking in front of an audience and increased the expectancy of a rejection. Indeed, from an inhibitory learning perspective, it is argued that change of context (e.g., internal state, time of the day, external context) is important to strengthen inhibitory associations during exposure therapy (Craske et al., 2014). Future studies could include questions about the interpretation of the learning effects in exposure that are general ("what did you learn from this exposure session?") or more specific about the absence of the US ("how would you interpret the absence of your feared outcome?"). The explanation of mood as a conditional inhibitor does, however, not explain why the negative group liked speaking in front of an audience *more* at the re-test.

Another plausible explanation for the unexpected benefit of negative mood inductions is that participants in the negative mood induction may have experienced higher stress prior to exposure, which may result in less context-dependent memory consolidation and, hence, a lower return of fear (Drexler, Merz, Jentsch, & Wolf, 2019). There are two other potential explanations. Mood induction could have served as a negative occasion setter (Ahlers & Richardson, 1985; Bouton, Kenney, & Rosengard, 1990; Trask, Thrailkill, & Bouton, 2017) that predicted the absence of rejection during exposure. In this case, participants would have learned that mood induction (positive or negative) signaled a particular response from the audience. However, fear would then increase when mood induction procedures are absent during the test phase for both positive and negative mood induction groups. Finally, the positive group could have experienced greater negative emotion (e.g., feelings of disappointment or pessimism) after noticing that the speech at the follow-up test was not preceded by the mood induction procedure, and the negative group experienced greater positive emotion (e.g., feelings of relief or optimism). This contrast may have resulted in differences in CS evaluation because affective state is often used as information to make evaluative judgments (Zbozinek & Craske, 2017a). In a future study, this element of disappointment/pessimism vs. relief/optimism could be operationalized by asking participants to rank the likelihood of the feared outcome in presence of certain members in the audience (e.g., peers, authority figures, members of the opposite sex) and manipulate their appearance in the (VR) audience.

Our study has several limitations. First, individuals may differ in music preferences, which may limit the utility of using standardized music (Zhang et al., 2014). Second, there were differences between the conditions in the distribution of gender, but sample sizes were too small to conduct analyses on gender. Third, we did not measure levels of positive mood/affect *during* the exposure sessions. The effect of the mood induction may already have faded away before the first exposure speech trial, due to anticipation anxiety for the speech task (Hinrichsen & Clark, 2003). Fourth, anticipation anxiety may also have affected the baseline SCR scores during the preparation time (seconds before giving a speech). Nevertheless, we found significant decreases in SCR over time due to exposure sessions. Fifth, although the social media ostracism task produced the expected feelings of rejection, its intensity may have been too low to produce a reinstatement effect. In fear conditioning studies, researchers typically use the same US for the acquisition and reinstatement phase and still a reinstatement effect is not always found (Haaker, Golkar, Hermans, & Lonsdorf, 2014). More studies are needed that test the effect of an ecologically valid US (e.g., personal negative feedback; LeBeau, 2014) to provoke a reinstatement effect in subclinical samples. Current developments in VR technology and artificial intelligence enable the possibility to tailor feedback or outcomes in the VR environment. In fact, Virtual Speech (the program used in this study) now offers the option receive AI-powered feedback on your performance and practice roleplays with ChatGPT.

To conclude, there was no evidence that pre-exposure positive mood improves persisting effects of exposure therapy for public speaking anxiety. Instead, the results suggest that pre-exposure negative mood induction may reduce spontaneous recovery and reinstatement. This study underlines the importance of conducting translational research in the field of fear and anxiety research (Craske et al., 2018). New discoveries in fear conditioning studies should first be tested in subclinical samples before conducting treatment studies with clinical samples or implementing these insights into daily clinical practice.

CRediT authorship contribution statement

Suzanne C. van Veen: Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Tomislav D. Zbozinek:** Writing – review & editing, Writing – original draft, Methodology. **Eva A.M. van Dis:** Writing – review & editing, Writing – original draft, Methodology. **Iris M. Engelhard:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Conceptualization. **Michelle G. Craske:** Writing – review & editing, Writing – original draft, Resources, Methodology.

Declaration of competing interest

There is no conflict of interest in the present study for any of the authors. This research was funded by a TOP-grant (40-00812-98-12030) from the Netherlands Organization for Health Research and Development (ZonMw) awarded to MAvdH and IME. SCvV was supported by a Fulbright Scholarship for Ph.D. students from the Fulbright Center to visit the research group of MGC at UCLA for six months. IME is supported with a Vici grant (453-15-005) from the Netherlands Organization for Scientific Research (NWO).

Data availability

Data will be made available on request.

Acknowledgements

We thank Thomas Brouwers, Ilse van de Groep, Parnian Kazemi and Andrea Cervantes for their assistance in the data collection. We thank Virtual Speech for adjusting the Oxford room to the Oculus Rift for the purpose of this study.

Appendix A

A screenshot of the Oxford room. Free available at http://virtualspeech.com.

Appendix B

BAT Speech topics	List 1 Speech topics	List 2 Speech topics
Health care	Favorite fast food	Favorite book
Global warming	Academic weakness	Career goals
Immigration	Violent video games	Cosmetic surgery
Home schooling	Gay marriage	Hunting
	Abortion	Death penalty
	Internet dating	Smoking in public
	Favorite sport to play	Favorite subject in school

References

Ahlers, S. T., & Richardson, R. (1985). Administration of dexamethasone prior to training blocks ACTH-induced recovery of an extinguished avoidance response. *Behavioral Neuroscience, 99*(4), 760.

Baxter, A. J., Scott, K. M., Vos, T., & Whiteford, H. A. (2013). Global prevalence of anxiety disorders: A systematic review and meta-regression. *Psychological Medicine, 43*(5), 897–910. https://doi.org/10.1017/S003329171200147X

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Beck depression inventory-II. San Antonio, 78*(2), 490–498.

Blumenthal, T. D., Cuthbert, B. N., Filion, D. L., Hackley, S., Lipp, O. V., & VanBoxtel, A. (2005). Committee report: Guidelines for human startle eyeblink electromyographic studies. *Psychophysiology, 42*(1), 1–15. https://doi.org/10.1111/j.1469-8986.2005.00271.x

Bouton, M. E. (2006). *Learning and behavior: A contemporary synthesis*. Sunderland, MA: Sinauer Associates, Inc, 2nd ed.

Bouton, M. E., Kenney, F. A., & Rosengard, C. (1990). State-dependent fear extinction with two benzodiazepine tranquilizers. *Behavioral Neuroscience, 104*(1), 44.

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry, 25*(1), 49–59. https://doi.org/10.1016/0005-7916(94)90063-9

Chen, M., & Bargh, J. A. (1999). Consequences of automatic evaluation: Immediate behavioral predispositions to approach or avoid the stimulus. *Personality and Social Psychology Bulletin, 25*(2), 215–224. https://doi.org/10.1177/0146167299025002007

Clore, G. L., & Huntsinger, J. R. (2007). How emotions inform judgment and regulate thought. *Trends in Cognitive Sciences, 11*(9), 393–399. https://doi.org/10.1016/j.tics.2007.08.005

Craske, M. G. (2015). Optimizing exposure therapy for anxiety disorders: An inhibitory learning and inhibitory regulation approach. *Verhaltenstherapie, 25*(2), 134–143. https://doi.org/10.1159/000381574

Craske, M. G., Hermans, D., & Vervliet, B. (2018). State-of-the-art and future directions for extinction as a translational model for fear and anxiety. *Philosophical Transactions of the Royal Society B: Biological Sciences, 373*(1742), Article 20170025. https://doi.org/10.1098/rstb.2017.0025

Craske, M. G., & Mystkowski, J. L. (2006). Exposure therapy and extinction: Clinical studies. In M. G. Craske, D. Hermans, & D. Vansteenwegen (Eds.), *Fear and learning: From basic processes to clinical implications* (pp. 217–233). Washington, DC: American Psychiatric Association.

Craske, M. G., Stein, M. B., Eley, T. C., Milad, M. R., Holmes, A., Rapee, R. M., et al. (2017). Anxiety disorders. *Nature Reviews Disease Primers, 3*, Article 17024. https://doi.org/10.1038/nrdp.2017.24

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. https://doi.org/10.1016/j.brat.2014.04.006

Craske, M. G., Treanor, M., Zbozinek, T. D., & Vervliet, B. (2022). Optimizing exposure therapy with an inhibitory retrieval approach and the OptEx Nexus. *Behaviour Research and Therapy, 152*. https://doi.org/10.1016/j.brat.2022.104069

de Houwer, J., Teige-Mocigemba, S., Spruyt, A., & Moors, A. (2009). Implicit measures: A normative analysis and review. *Psychological Bulletin, 135*(3), 347. https://doi.org/10.1037/a0014211

de Houwer, J., Thomas, S., & Baeyens, F. (2001). Association learning of likes and dislikes: A review of 25 years of research on human evaluative conditioning. *Psychological Bulletin, 127*(6), 853. https://doi.org/10.1037/0033-2909.127.6.853

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 & Memory, 11*(5), 549–554. https://doi.org/10.1101/lm.78004

Drexler, S. M., Merz, C. J., Jentsch, V. L., & Wolf, O. T. (2019). How stress and glucocorticoids timing-dependently affect extinction and relapse. *Neuroscience & Biobehavioral Reviews, 98*, 145–153.

Engelhard, I. M., & Arntz, A. (2005). The Ex-consequentia reasoning fallacy and the persistence of PTSD. *Journal of Behavior Therapy and Experimental Psychiatry, 36*, 35–42.

Engelhard, I. M., Leer, A., Lange, E., & Olatunji, B. O. (2014). Shaking that icky feeling: Effects of extinction and counterconditioning on disgust-related evaluative learning. *Behavior Therapy, 45*(5), 708–719. https://doi.org/10.1016/j.beth.2014.04.003

Erez, A., & Isen, A. M. (2002). The influence of positive affect on the components of expectancy motivation. *Journal of Applied Psychology, 87*(6), 1055–1067. https://doi.org/10.1037//0021-9010.87.6.1055

Haaker, J., Golkar, A., Hermans, D., & Lonsdorf, T. B. (2014). A review on human reinstatement studies: An overview and methodological challenges. *Learning & Memory, 21*(9), 424–440. https://doi.org/10.1101/lm.036053.114

Hamm, A. O., Vaitl, D., & Lang, P. J. (1989). Fear conditioning, meaning, and belongingness: A selective association analysis. *Journal of Abnormal Psychology, 98*(4), 395. https://doi.org/10.1037/0021-843X.98.4.395

Hermans, D., Dirikx, T., Vansteenwegen, 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. https://doi.org/10.1016/j.brat.2004.03.013

Hinrichsen, H., & Clark, D. M. (2003). Anticipatory processing in social anxiety: Two pilot studies. *Journal of Behavior Therapy and Experimental Psychiatry, 34*(3–4), 205–218. https://doi.org/10.1016/S0005-7916(03)00050-8

Huijding, J., & de Jong, P. J. (2005). A pictorial version of the Extrinsic Affective Simon Task: Sensitivity to generally affective and phobia-relevant stimuli in high and low spider fearful individuals. *Experimental Psychology, 52*(4), 289–295. https://doi.org/10.1027/1618-3169.52.4.289

Jones, C. R., Olson, M. A., & Fazio, R. H. (2010). Evaluative conditioning: The "how" question. In M. P. Zanna, & J. M. Olson (Eds.), *Advances in experimental social psychology* (Vol. 43, pp. 205–255). New York: Academic Press.

Kang, S., Vervliet, B., Engelhard, I. M., van Dis, E. A., & Hagenaars, M. A. (2018). Reduced return of threat expectancy after counterconditioning verus extinction. *Behaviour Research and Therapy, 108*, 78–84. https://doi.org/10.1016/j.brat.2018.06.009

Kerkhof, I., Vansteenwegen, D., Beckers, T., Dirikx, T., Baeyens, F., D'Hooge, R., et al. (2009). The role of negative affective valence in the return of fear. In H. D. Friedman, & P. K. Revera (Eds.), *Abnormal Psychology: New research* (pp. 121–138). New York: Nova Science Publishers, Inc.

Lang, P. J. (1995). The emotion probe: Studies of motivation and attention. *American Psychologist, 50*(5), 372. https://doi.org/10.1037/0003-066X.50.5.372

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). *International affective picture System: Technical manual and affective ratings*. Gainesville, FL: University of Florida.

LeBeau, R. T. (2014). *Social pain and the onset of social anxiety disorder*. Doctoral dissertation, UCLA).

Loerinc, A. G., Meuret, A. E., Twohig, M. P., Rosenfield, D., Bluett, E. J., & Craske, M. G. (2015). Response rates for CBT for anxiety disorders: Need for standardized criteria. *Clinical Psychology Review, 42*, 72–82. https://doi.org/10.1016/j.cpr.2015.08.004

Lonsdorf, T. B., Menz, M. M., Andreatta, M., Fullana, M. A., Golkar, A., Haaker, J., … Merz, C. J. (2017). Don't fear 'fear conditioning': Methodological considerations for the design and analysis of studies on human fear acquisition, extinction, and return of fear. *Neuroscience & Biobehavioral Reviews, 77*, 247–285. https://doi.org/10.1016/j.neubiorev.2017.02.026

Luck, C. C., & Lipp, O. V. (2015). A potential pathway to the relapse of fear? Conditioned negative stimulus evaluation (but not physiological responding) resists instructed extinction. *Behaviour Research and Therapy, 66*, 18–31. https://doi.org/10.1016/j.brat.2015.01.001

Luck, C. C., & Lipp, O. V. (2018). Verbal instructions targeting valence alter negative conditional stimulus evaluations (but do not affect reinstatement rates). *Cognition & Emotion, 32*(1), 61–80. https://doi.org/10.1080/02699931.2017.1280449

McCroskey, J. C. (1970). Measures of communication-bound anxiety. *Speech Monographs, 37*, 269–277.

Niles, A. N., Craske, M. G., Lieberman, M. D., & Hur, C. (2015). Affect labeling enhances exposure effectiveness for public speaking anxiety. *Behaviour Research and Therapy, 68*, 27–36. https://doi.org/10.1016/j.brat.2015.03.004

Phaf, R. H., Mohr, S. E., Rotteveel, M., & Wicherts, J. M. (2014). Approach, avoidance, and affect: A meta-analysis of approach-avoidance tendencies in manual reaction time tasks. *Frontiers in Psychology, 5*. https://doi.org/10.3389/fpsyg.2014.00378

Rescorla, R. A., & Wagner, A. R. (1972). A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement. *Classical conditioning II: Current research and theory, 2*, 64–99.

Trask, S., Thrailkill, E. A., & Bouton, M. E. (2017). Occasion setting, inhibition, and the contextual control of extinction in Pavlovian and instrumental (operant) learning. *Behavioural Processes, 137*, 64–72. https://doi.org/10.1016/j.beproc.2016.10.003

van Beest, I., & Williams, K. D. (2006). When inclusion costs and ostracism pays, ostracism still hurts. *Journal of Personality and Social Psychology, 91*(5), 918. https://doi.org/10.1037/0022-3514.91.5.918

van Uijen, S. L., Leer, A., & Engelhard, I. M. (2018). Safety behavior after extinction triggers a return of threat expectancy. *Behavior Therapy, 49*(3), 450–458. https://doi.org/10.1016/j.beth.2017.08.005

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. https://doi.org/10.1037/0097-7403.32.1.71

Vasey, M. W., Harbaugh, C. N., Buffington, A. G., Jones, C. R., & Fazio, R. H. (2012). Predicting return of fear following exposure therapy with an implicit measure of attitudes. *Behaviour Research and Therapy, 50*(12), 767–774. https://doi.org/10.1016/j.brat.2012.08.007

Vervliet, B., & Indekeu, E. (2015). Low-cost avoidance behaviors are resistant to fear extinction in humans. *Frontiers in Behavioral Neuroscience, 9*. https://doi.org/10.3389/fnbeh.2015.00351

Watson, D., & Clark, L. A. (1999). *The PANAS-X: Manual for the positive and negative affect schedule-expanded form*.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063. https://doi.org/10.1037/0022-3514.54.6.1063

Williams, K. D., & Jarvis, B. (2006). Cyberball: A program for use in research on interpersonal ostracism and acceptance. *Behavior Research Methods, 38*(1), 174–180.

Wittchen, H. U., Jacobi, F., Rehm, J., Gustavsson, A., Svensson, M., Jönsson, B., et al. (2011). The size and burden of mental disorders and other disorders of the brain in Europe 2010. *European Neuropsychopharmacology, 21*(9), 655–679. https://doi.org/10.1016/j.euroneuro.2011.07.018

Wolf, W., Levordashka, A., Ruff, J. R., Kraaijeveld, S., Lueckmann, J. M., & Williams, K. D. (2015). Ostracism online: A social media ostracism paradigm. *Behavior Research Methods, 47*(2), 361–373. https://doi.org/10.3758/s13428-014-0475-x

Yeung, C. W., & Wyer, R. S. (2004). Affect, appraisal, and consumer judgment. *Journal of Consumer Research, 31*(2), 412–424. https://doi.org/10.1086/422119

Zbozinek, T. D., & Craske, M. G. (2017a). The role of positive affect in enhancing extinction learning and exposure therapy for anxiety disorders. *Journal of Experimental Psychopathology, 8*(1), Article 052615. https://doi.org/10.5127/jep.052615. jep.

Zbozinek, T. D., & Craske, M. G. (2017b). Positive affect predicts less reacquisition of fear: Relevance for long-term outcomes of exposure therapy. *Cognition & Emotion, 31*(4), 712–725. https://doi.org/10.1080/02699931.2016.1142428

Zbozinek, T. D., Hermans, D., Prenoveau, J. M., Liao, B., & Craske, M. G. (2015). Post-extinction conditional stimulus valence predicts reinstatement fear: Relevance for long-term outcomes of exposure therapy. *Cognition & Emotion, 29*(4), 654–667. https://doi.org/10.1080/02699931.2014.930421

Zbozinek, T. D., Holmes, E. A., & Craske, M. G. (2015). The effect of positive mood induction on reducing reinstatement fear: Relevance for long term outcomes of exposure therapy. *Behaviour Research and Therapy, 71*, 65–75. https://doi.org/10.1016/j.brat.2015.05.016

Zhang, X., Hui, W. Y., & Barrett, L. F. (2014). How does this make you feel? A comparison of four affect induction procedures. *Frontiers in Psychology, 5*. https://doi.org/10.3389/fpsyg.2014.00689