University of Reading

Modifying avoidance in social anxiety: The effects of a cognitive-behavioural instruction on extinction learning

Article

Published Version

Creative Commons: Attribution 4.0 (CC-BY)

Open Access

Sridhar, S., Biagi, N. ORCID: https://orcid.org/0000-0002-7119-0767 and Wake, S. ORCID: https://orcid.org/0000-0001-6202-7645 (2026) Modifying avoidance in social anxiety: The effects of a cognitive-behavioural instruction on extinction learning. Behaviour Research and Therapy, 203. 105088. ISSN 0005-7967 doi: 10.1016/j.brat.2026.105088 Available at https://centaur.reading.ac.uk/129977/

It is advisable to refer to the publisher's version if you intend to cite from the work. See Guidance on citing.

To link to this article DOI: http://dx.doi.org/10.1016/j.brat.2026.105088

Publisher: Elsevier

All outputs in CentAUR are protected by Intellectual Property Rights law, including copyright law. Copyright and IPR is retained by the creators or other copyright holders. Terms and conditions for use of this material are defined in the End User Agreement.

www.reading.ac.uk/centaur

University of Reading

CentAUR

Central Archive at the University of Reading

Reading's research outputs online

Behaviour Research and Therapy 203 (2026) 105088

Contents lists available at ScienceDirect

Behaviour Research and Therapy

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

Modifying avoidance in social anxiety: The effects of a cognitive-behavioural instruction on extinction learning

Sruthi Sridhar [a], Nicolo Biagi [b], Shannon Wake [a,*]

[a] School of Psychology and Clinical Language Sciences, University of Reading, Whiteknights, Reading, UK
[b] Henley Business School, University of Reading, Whiteknights, Reading, UK

ARTICLE INFO

Keywords:
Social anxiety
Avoidance
Conditioning
Extinction
Threat expectancy
CBT

ABSTRACT

Although cognitive-behavioural therapy (CBT) with exposure is the first-line treatment for Social Anxiety Disorder (SAD), its efficacy is lower for SAD than for other anxiety disorders. One possible reason is that CBT may not effectively target the key maintaining features of SAD: persistent avoidance and heightened threat expectancy. Experimental research shows that individuals with elevated social anxiety exhibit generalised avoidance and persistent threat beliefs in conditioning paradigms, yet it remains unclear whether brief cognitive-behavioural (CB) strategies can modify these fear responses. Clarifying which components of fear responding, behavioural, cognitive, and physiological, are amenable to brief CB-based instruction is critical for identifying the mechanisms through which CBT with exposure facilitates change and for improving the precision of treatment. This study examined the effect of a brief CB instruction on behavioural avoidance, threat expectancy, and autonomic arousal in individuals with elevated social anxiety. Eighty-eight adults were assigned to a CB-informed instruction (n = 44) or control instruction (n = 44) condition while completing a four-phase Pavlovian Conditioning paradigm: threat acquisition, US-avoidance acquisition, US-avoidance extinction, and extinction test. Social anxiety was modelled dimensionally using SPIN scores. Behavioural avoidance, skin conductance response (SCR; autonomic arousal), and US-expectancy ratings (cognitive threat prediction) were assessed throughout. Results showed that, higher social anxiety was associated with greater avoidance and persistent threat responding. Further, among individuals with elevated social anxiety, the CB instruction was associated with reduced avoidance behaviours during US-avoidance extinction but did not alter SCRs or threat expectancy during extinction testing. These findings suggest that a brief CB instruction can attenuate maladaptive avoidance without corresponding changes in autonomic or cognitive threat responses for individuals with higher social anxiety. This dissociation provides a novel, mechanistic account of how brief cognitive-behavioural strategies selectively modify components of fear responding, offering valuable insights for the development of more targeted and effective exposure-based interventions for SAD.

1. Introduction

Avoidance is a behavioural response aimed at preventing anticipated threat. While typically adaptive in genuinely threatening situations, avoidance becomes maladaptive when used inflexibly, particularly when it persists in the absence of threat or is disproportionate to the actual risk posed by the situation (Craske et al., 2017). Excessive avoidance behaviour is a defining feature of social anxiety disorder (SAD) (American Psychiatric Association, 2013), a condition characterised by persistent fear and avoidance of social or performance situations in which there is potential for scrutiny or negative evaluation by others. Cognitive behavioural therapy (CBT) is the first-line treatment for SAD (Pilling et al., 2013) and typically incorporates exposure-based techniques as a principal component (Chesham et al., 2018; Heimberg, 2002). However, a substantial proportion of individuals remain symptomatic or experience a return of fear-related symptoms following treatment (Craske & Mystkowski, 2006; Otto et al., 2000), highlighting the need to refine exposure-based interventions for SAD. As such, experimental approaches that serve as a laboratory-based model for exposure therapy offer a valuable framework for identifying targets to enhance treatment efficacy.

Pavlovian threat conditioning and extinction paradigms have been

* Corresponding author. School of Psychology and Clinical Language Sciences, University of Reading, Earley, Reading, RG6 6ET, UK.
E-mail address: shannon.wake@reading.ac.uk (S. Wake).

https://doi.org/10.1016/j.brat.2026.105088
Received 6 October 2025; Received in revised form 17 April 2026; Accepted 22 May 2026
Available online 25 May 2026
0005-7967/© 2026 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

extensively employed to investigate the relationship between elevated levels of anxiety and safety learning mechanisms (for review, see Lonsdorf & Merz, 2017) and serve as experimental analogues for exposure-based interventions (Dunsmoor et al., 2015; Milad & Quirk, 2012). Further, Pavlovian threat conditioning and extinction paradigms have been adapted to examine avoidance as a goal-directed response to conditioned threat and safety cues (Dymond, 2019; Dymond & Roche, 2009; Vervliet & Raes, 2013). Recent theoretical accounts of avoidance learning emphasise the role of action-outcome contingencies and expectancy-based processes in maintaining avoidance behaviour, even in the absence of threat (e.g., Leng et al., 2024). From this perspective, avoidance is not only a behavioural response to threat but also a mechanism that can interfere with extinction learning by reducing opportunities for expectancy violation and belief updating (Craske et al., 2014).

In threat conditioning, an initially neutral conditioned stimulus (CS) is associated with an aversive unconditioned stimulus (US), resulting in the emergence of a defensive response (Conditioned Response, CR) to the CS alone (CS+). During threat extinction, the CS+ is repeatedly presented in the absence of the US, allowing for the attenuation of the CR as the CS + loses its predictive value concerning the US (Milad & Quirk, 2012). In avoidance conditioning paradigms, participants are afforded the opportunity to execute a response (i.e., a button press) that prevents the occurrence of the US in the presence of the CS+. Although such responses may initially reflect adaptive threat regulation, persistent avoidance during extinction, when the CS + no longer predicts threat, has been found to maintain threat beliefs, i.e., the expectancy that threat will occur if avoidance is not carried out (Lovibond et al., 2009; Pittig, 2019). Specifically, the absence of the US is attributed to the avoidance response, thereby prohibiting the individual from learning that the CS no longer signals threat as the individual does not experience a mismatch between expected and actual outcomes (i.e., threat expectancy violation), which is considered critical for extinction learning (Craske et al., 2014). In this way, persistent avoidance may impair safety learning by preventing the updating of threat-related beliefs about the CS. From a clinical perspective, such findings suggest that continued availability of avoidance following treatment may undermine exposure-based learning and contribute to the renewal of fear. As such, experimental research aimed at identifying strategies to reduce avoidance may provide mechanistic insights relevant to optimising the efficacy of exposure-based interventions for social anxiety.

Despite the central role of avoidance in social anxiety, research investigating the learning mechanisms underlying the acquisition and maintenance of maladaptive avoidance in social anxiety remains sparse. To date, only two studies have examined the relationship between social anxiety and avoidance using Pavlovian differential conditioning paradigms (Ly & Roelofs, 2009; Wake, Van Reekum, & Dodd, 2021). Ly and Roelofs (2009) found that higher levels of social anxiety were associated with increased US expectancy during avoidance conditioning. Building on this finding, Wake, Van Reekum, and Dodd (2021) reported that elevated social anxiety predicted the generalisation of avoidance responses to safety cues (CS−) during avoidance conditioning. Notably, Wake, Van Reekum, and Dodd (2021) is the only study to date to examine the effect of social anxiety on the extinction of avoidance. The findings of this study demonstrated that when the opportunity to avoid was reintroduced following a threat extinction phase, individuals with higher social anxiety showed increased avoidance behaviour and heightened US expectancy to threat cues (CS+). These effects indicate that persistent avoidance after threat extinction disrupts safety learning in individuals with higher social anxiety and were specific to social anxiety over and above transdiagnostic factors such as intolerance of uncertainty (i.e., the propensity to find uncertainty aversive) and trait anxiety. Given the specificity of these findings, it could be speculated that persistent avoidance behaviour associated with social anxiety may contribute to the comparatively lower efficacy of exposure-based interventions observed in individuals with social anxiety relative to those living with other anxiety disorders (Loerinc et al., 2015).

Interventions for social anxiety typically combine CBT with exposure-based techniques (Dugas & Robichaud, 2007; Simos & Hofmann, 2013). A core aim of cognitive therapy is to support individuals with anxiety to re-evaluate their beliefs about the likelihood and consequences of their feared outcomes (Robichaud et al., 2019; Robichaud and Dugas, 2006). Exposure therapy complements this process as therapists instruct patients to refrain from avoidance and engage with feared situations to test whether their feared outcome occurs. This process is believed to initiate fear extinction by reducing avoidance in the first instance, thereby enabling the occurrence of a mismatch between threat expectancy and actual outcomes, consequently facilitating expectancy change and fear reduction (Craske et al., 2014; Pittig et al., 2016). Although these strategies are well established in clinical practice, experimental research is needed to isolate and examine the underlying mechanisms of change to better understand how instructions might reduce avoidance and promote extinction learning. Despite this need, only a few studies have incorporated CBT-based instructions into Pavlovian avoidance conditioning paradigms to examine whether higher-order cognitive processes can reduce avoidance behaviour and facilitate extinction learning (Pittig & Wong, 2021, 2022). This emerging evidence indicates that instructions to refrain from avoidance reduce both avoidance behaviour and conditioned responses, and decrease the long-term retention of avoidance, suggesting that such instructions enhance extinction learning. However, to the best of our knowledge, the effect of instruction on avoidance responses has not been examined in relation to individual differences in anxiety. Given the specific link between social anxiety and avoidance responses observed in prior research (Wake, Van Reekum, & Dodd, 2021), testing a laboratory model that integrates CBT and exposure-based principles has important clinical implications for enhancing the effectiveness of exposure therapy for social anxiety.

The current study had two primary objectives. First, we aimed to replicate and extend the findings of Wake, Van Reekum, and Dodd (2021) that indicate that social anxiety is associated with compromised conditioning and extinction of avoidance behaviours and threat expectancy. Second, we aimed to examine the effect of an instruction, based on cognitive behavioural principles, on the relationship between social anxiety and avoidance behaviour and threat expectancy. To address these aims, we developed a differential Pavlovian conditioning and extinction task based on the paradigms previously employed by Pittig and Wong (2021) and Wake, Van Reekum, and Dodd (2021). The task comprised of four phases: threat acquisition, US-avoidance acquisition, US-avoidance extinction, and extinction test. Only the instruction that participants received between the US-avoidance acquisition and US-avoidance extinction trials differed between groups. The CBT-instruction group was instructed to perform non-avoidance responses to test whether their US expectancy matched the actual outcome. In contrast, participants in the control-instruction group received no intervention and were simply asked to take a brief pause and remain attentive before continuing the task. Neutral facial expressions served as conditioned stimuli (CS), while an aversive vocal comment paired with an electric shock functioned as the unconditioned stimulus (US), as in Wake, Van Reekum, and Dodd (2021). A 50% reinforcement rate was used during threat acquisition. Throughout the US-avoidance acquisition phase, participants performed a goal-directed avoidance response in the presence of the CS (i.e., by pressing either the “avoid” or “don't avoid” button on the keyboard). During this phase, if participants pressed to avoid the US, the US would not be delivered in the presence of the CS+ and CS-, however, if participants pressed to not avoid the US, the US would be delivered during CS + trials. During the US-avoidance extinction phase, following the delivery of the instruction (CBT-instruction or control-instruction), avoidance responses remained available, however, the US was never presented with the CS+, regardless of avoidance behaviour. During the final extinction test phase, the CS+ and CS- were presented without the US and without the opportunity to

avoid. Skin conductance responses (SCR), US expectancy ratings, and behavioural avoidance, indexed by button presses, were recorded throughout the task. As the process of extinction is best observed across time, the extinction test phase was divided into 'early' and 'late' trials for the purpose of SCR analysis (Morriss et al., 2018).

We hypothesised that:

1) During threat acquisition, all participants, irrespective of their level of social anxiety, would exhibit greater conditioned responding to the CS + relative to the CS−, as indexed by elevated skin conductance responses (SCRs) and higher US expectancy ratings.
2) During the US-avoidance acquisition phase, higher levels of social anxiety would be associated with greater avoidance behaviour to both the CS+ and CS−, compared to lower levels of social anxiety.
3) In the control-instruction group, higher social anxiety, compared to lower social anxiety, would be associated with greater avoidance behaviour towards the CS+ during the US-avoidance extinction phase, indicating compromised extinction of avoidance.
4) If the cognitive behavioural instruction facilitates the attenuation of maladaptive avoidance in individuals with elevated social anxiety, higher social anxiety would be associated with reduced avoidance behaviour towards the CS+ and CS− in the CBT-instruction condition relative to the control-instruction condition during the US-avoidance extinction phase.
5) The availability of avoidance will alter the process of extinction learning, and all participants, regardless of level of social anxiety, would demonstrate significantly higher SCR and US expectancy ratings towards the CS + compared to the CS- during the extinction test phase. However, we expected that participants in the CBT-instruction condition would exhibit reduced conditioned responding, indexed by lower SCRs and US expectancy ratings to the CS + versus CS−, during the extinction test, compared to participants in the control-instruction condition.
6) Finally, we explored whether cognitive behavioural instruction would promote extinction learning among individuals with higher levels of social anxiety. Specifically, it was expected that participants with high social anxiety in the CBT-instruction condition would show attenuated conditioned responding (SCRs and US expectancy ratings) to both the CS+ and CS− relative to their low social anxiety counterparts in the control-instruction condition during the extinction test phase.

As in Wake, Van Reekum, and Dodd (2021), to test whether effects were related to social anxiety specifically and not the result shared variance with transdiagnostic processes that underpin anxiety more broadly, we carried out further analyses that controlled for trait anxiety and Intolerance of Uncertainty (IU), both of which have been linked to impaired extinction learning within previous work (Dunsmoor et al., 2015; Lucas et al., 2018; Morriss et al., 2016; Wake, Morriss, et al., 2021).

2. Methods

2.1. Participants

Eighty-eight participants (age: M = 20.22, SD = 1.80; Sex: 62 Female, 26 Male, 0 Non-Binary, 0 Not-Specified; Ethnicity: 45 White, 15 Black, 13 Middle Eastern/Arab, 9 Asian, 6 Mixed; Sexual Orientation: 66 Heterosexual, 13 Sexual Minorities, 9 Not Specified) took part in this study. Participants were recruited if they were between the ages of 18 and 40 and were free of psychotropic medication and without any previous history of traumatic brain injury. No other exclusion criteria were used for recruitment. The procedure was approved by the University of Reading Research Ethics Committee (UREC 19/62).

Power estimation was based on repeated-measures ANCOVA with a within–between interaction design, even though the study intended to conduct multilevel models, which can account for nested structures, missing data (Quené & Van den Bergh, 2004), and the entering of individual differences measures as continuous predictor variables. While there are methods to test for power in MLMs, such as those implemented in the R package *mlmpower* (Keller, 2024), they tend to rely on detailed simulation of ICCs, R^2 values, cluster sizes, and covariance structures. Given the complexity of simulation-based methods for MLM power, the study used an ANOVA-based power approximation as a conservative planning approach, a commonly accepted alternative (Peugh, 2010; Snijders, 2005).

The sample size for this experiment was determined using a priori power analysis that was conducted using G*Power 3.1.9.2 (Faul et al., 2007). The following parameters were used: f = 0.25, α error probability = 0.05, power (1 - β error probability) = 0.8, number of groups = 2 (CBT-instruction, control-instruction), number of measurements = 2 (CS+, CS-), correlation among repeated measures = 0.2. The effect size was based on that employed by similar previous work (Pittig & Wong, 2021). The total sample size required was n = 78.

2.2. Procedure

Upon arrival, participants were welcomed to the laboratory and provided information about the study protocol before they provided written informed consent. They were then seated in the testing booth and completed a battery of questionnaires (see "Questionnaires" for details). Once the questionnaires were complete, participants were asked to wash their hands (without soap) and return to the testing booth. At this point, to ensure that an even number of participants with high and low SPIN scores were allocated to each experimental group (CBT-instruction; control-instruction), a second research assistant assigned each participant to a condition based on their SPIN score. The researcher running the experimental session was blind to the participant's SPIN score and group allocation.

Headphones were placed on the participant's head, and physiological sensors were attached to the participant's index, middle and ring fingers on the left hand. The stimulator electrode was placed on the little finger of the left hand, and each participant's shock level was set following procedures outlined in Delgado et al. (2008). An initial shock was delivered at a very low level (0.5 mV) and was gradually increased in steps of 0.5 mV. After the delivery of each shock, participants rated the sensation on a scale of 1 ("not painful at all") to 10 ("extremely painful"). Once a rating of "8" was reported, the intensity of the shock was decreased by one step to establish the final stimulation level, which remained constant throughout the experiment. Participants received both verbal and on-screen instructions outlining the task. They were informed: (1) that the task would involve viewing faces and occasionally hearing an audio statement and receiving a mild electric stimulation; (2) that a red dot would appear in the top left corner of the screen on some trials, indicating that they could press the "avoid" button (left arrow key) or "don't avoid" button (right arrow key) to potentially prevent the statement and stimulation; (3) that they would receive an on-screen instruction partway through the task; (4) that they would be asked to provide ratings using the number keys with their right hand following each trial block; and (5) to remain as still as possible during the task. No information was given regarding CS-US contingencies. The Avoidance Conditioning Task (see "The Avoidance Conditioning Task" below for details) was then presented on the screen. Electrodermal activity, pulse, avoidance response, and US expectancy ratings were recorded throughout the task. Following completion of the task, participants were asked to rate how anxious and unpleasant the stimulation and audio statement made them feel on a scale of 1 ("not at all") to 9 ("extremely"). The entire session lasted approximately 45 min.

2.3. Electric stimulation build-up procedure

Stimulation was delivered via a PowerLab 26 T Isolated Stimulator

(AD Instruments) using a MLADDF30 (AD Instruments) stimulating bar electrode that was attached to the little finger of the left hand.

The researcher explained the procedure to the participant verbally. Participants were informed that "the intensity of the stimulation would be set by you" and were instructed to determine a level that was "highly unpleasant, but not painful."

During the build-up procedure, the participants received a mild stimulation (Repeat rate of 20 Hz, repeats 10, pulse width of 0.2 ms, starting at 1 mA), which was gradually increased according to the participant's self-report of the unpleasantness of the stimulation. The research assistant confirmed with the participant that they were willing to increase the level before each stimulation was delivered. The researcher then prompted the participant to rate the intensity and unpleasantness of the stimulation on a scale from 0 to 10 verbally, where 0 was "not unpleasant at all" and 10 was "extremely unpleasant" (M = 7.01; SD = 1.02). Once the participant reached a suitable level, the stimulation was set for the duration of the experiment (M = 6.81 mA; SD = 5.66 mA).

2.4. The Avoidance Conditioning Task

The conditioning task was designed using E-Prime 2.0 software (Psychology Software Tools Ltd, Pittsburgh, PA). The visual and auditory stimuli used as CS and US in the current avoidance conditioning task were identical to those employed in the task developed by Wake, Van Reekum, and Dodd (2021) (see Wake, Van Reekum, and Dodd (2021) for more details).

The task comprised of four sequential phases: threat acquisition, US-avoidance acquisition, US-avoidance extinction, and the extinction test phase (Fig. 1a). During threat acquisition, one of the female identities (blonde or brunette) was paired with the electric shock and critical statement 50% of the time (CS+), whilst the other identity (brunette or blonde) was always presented alone (CS-). The 50% pairing rate was designed to sustain the effect of conditioning into the US-avoidance acquisition phase (Leonard, 1975; Livneh & Paz, 2012), and to allow the examination of the conditioned response during threat acquisition without the confound of the US. The electric shock and auditory statement were paired as US to make the US more aversive (Wake, Van Reekum, & Dodd, 2021). Following threat acquisition, the US-avoidance acquisition phase took place, during which the CS+ and CS- were presented in the same manner as in threat acquisition, however, a red square acted as an avoidance cue and was presented with the CS during the trial. When the red square was presented, participants had to choose to press the "avoid" or "don't avoid" button on the keyboard. If participants pressed the "don't avoid" button, they would always receive the US during CS + trials. However, if they chose the "avoid" button when presented with the CS+, the US would not be administered. Regardless of avoidance behaviour, the US was never presented during CS- trials (Fig. 1b). The red dot remained on screen until a response was made, after which it disappeared, and the CS remained for a further 4000 ms. Before the US-avoidance extinction phase, all participants received instructions that differed between groups. Participants in the CBT-instruction group were encouraged to perform non-avoidance responses via the instruction "Please press the non-avoidance button to test your expectancy of whether the noise and electrical stimulus will occur" (see Pittig & Wong, 2021). Participants in the control-instruction

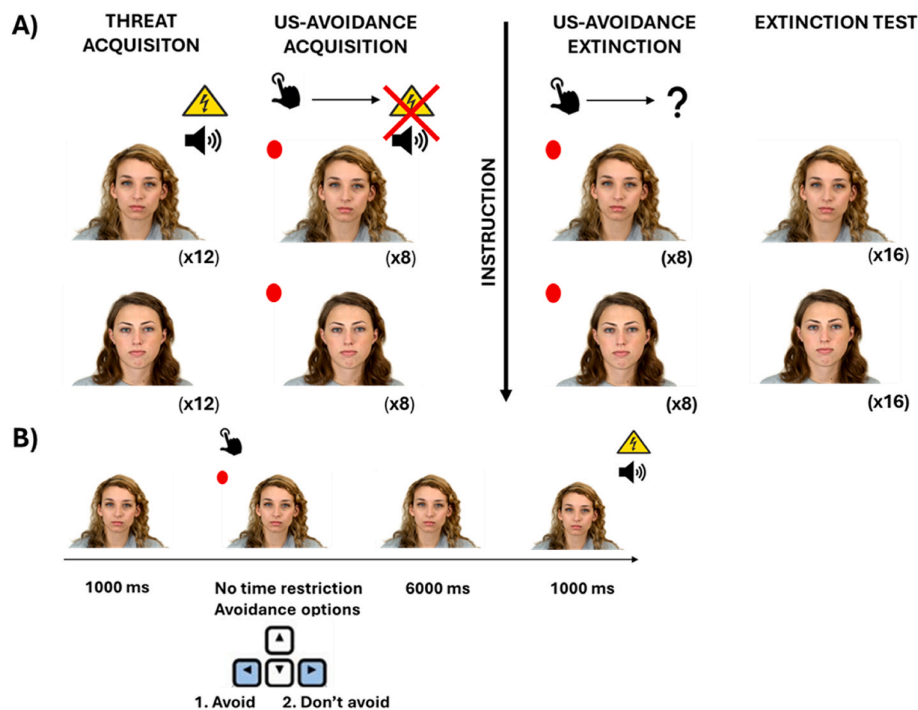

Fig. 1. (A): Overview of the experimental phases. During threat acquisition, one of the identities was associated with an electric stimulation and an aversive statement in 50% of trials (i.e., six trials). During the US-avoidance acquisition phase, participants had to choose to press the "avoid" or "don't avoid" button on the keyboard when the red dot appeared on the screen. Pressing the "avoid" button cancelled the presentation of the electric stimulation and aversive statement during CS + trials. Before the US-avoidance extinction phase, all participants received instructions (CBT-Instruction or Control Instruction) that differed between groups. During US-avoidance extinction, the opportunity to avoid remained present, but the electric stimulation and aversive statement were never presented, regardless of avoidance behaviour. During the extinction test phase, the opportunity to avoid was removed, and the electric shock and aversive statement were never presented. **(B):** Timeline of a US-avoidance acquisition trial. The identity was presented alone for 1000 ms. A red dot then appeared in the corner of the screen to inform participants that they were required to make an "avoid" or "don't avoid" response by pressing either the left or right arrow key on the keyboard. Once the participants responded, the red dot disappeared, and the identity was presented for 7000 ms. During the US-Avoidance Acquisition phase, if the participant chose not to avoid, the aversive statement was presented during the final 1000 ms of the trial and co-terminated with the trial. The electric stimulation had a duration of 200 ms and also co-terminated with the trial.

group were instructed that "you may take a short break and continue when you are ready. When you continue with the task, please keep paying attention". The US-avoidance extinction phase then took place, during which participants were still provided with the opportunity to avoid, or not, by pressing the "avoid" and "don't avoid" buttons when the red dot was on the screen with the CS. However, regardless of avoidance behaviour, the US was never administered. During the extinction test phase, the CS+ and CS- were displayed with no opportunity to avoid and no presentation of the US.

The acquisition phase consisted of 24 trials (6 CS + paired, 6 CS + unpaired and 12 CS-), the US-avoidance acquisition phase 16 trials (8 CS+ and 8 CS-), the US-avoidance extinction phase 16 trials (8 CS+ and 8 CS-) and the extinction test 32 trials (16 CS+ and 16 CS-). There were 12 trials in threat acquisition, 8 trials in US-avoidance acquisition and US-avoidance extinction phases, and 16 trials during the extinction test phase (Fig. 1a). Experimental trials throughout the task were pseudo-randomised. The first trial of the acquisition phase was always a CS + paired trial, and there was always an equal number of CS+ and CS- trials in each block. Trials within blocks were randomised. Conditioning contingencies were counterbalanced across participants, with half of the participants receiving the blonde identity as the CS+ and the other half receiving the brunette identity as the CS+.

During threat acquisition, the CS was presented for 4000 ms. During reinforced trials, the statement (duration 1000 ms) was presented 3000 ms after CS onset. The shock was presented 3800 ms after CS onset, and both the statement and the shock co-terminated with the trial. During US-avoidance trials, the CS was presented alone for 1000 ms, followed by the presentation of the avoidance cue. The avoidance cue consisted of a red dot displayed in the top left-hand corner of the screen. When the avoidance cue was presented on the screen, participants had to respond by pressing the "avoid" or "don't avoid" button. There was no time restriction, and the avoidance cue remained on the screen until the participant had made a response. Once the participant had made a response, the avoidance cue disappeared, and the CS was presented alone for a further 4000 ms. During US-avoidance acquisition, if the participant pressed the "don't avoid" button, the statement (duration 1000 ms) and shock (duration 200 ms) were presented during CS + trials and co-terminated with the trial. The CS was presented alone for 4000 ms during the extinction test trials. A jittered ITI, ranging between 8000 ms and 10,000 ms, consisted of a blank black screen and followed each stimulus presentation throughout the task (Fig. 1b).

Participants were asked to rate on a 9-point scale their expectancy of hearing the statement and receiving the stimulation (0 = "do not expect", 9 = "do expect") at the following points: before threat acquisition, before US-avoidance acquisition, before US-avoidance extinction, before extinction test, mid-extinction test, and post-extinction test.

2.5. Questionnaires

Descriptive statistics for all individual differences' measures are presented in Table 1.

The Social Phobia Inventory (SPIN; Connor et al., 2000) was administered to assess social anxiety symptoms. The questionnaire contains 17 items rated on a 5-point Likert scale (0 = "not at all"; 4 = "extremely"). Higher scores on the scale indicate greater social anxiety. A cutoff score of 19 is used to determine clinical levels of social phobia (Connor et al., 2000). Overall, sixty participants (68.2%) exceeded this clinical cut-off (score >19; control condition: $n = 31$ and instruction condition: $n = 29$), mean SPIN scores by condition are presented in Table 1. The internal reliability of SPIN was $\alpha = .91$.

Table 1
Descriptive statistics for individual difference measures.

Measure	Condition					
	Control			Instruction		
	Mean	SD	Range	Mean	SD	Range
SPIN	26.59	12.40	5 – 53	26.45	12.76	0 – 50
IUS	69.91	18.81	40 – 119	67.77	20.25	33 – 115
STAI-T	46.93	9.35	27 – 70	49.34	10.11	30 – 73

Note. $N = 88$ with 44 participants in each condition; SPIN = Social Phobia Inventory; IUS = Intolerance of Uncertainty Scale; STAI-T = State-Trait Anxiety Inventory — Trait version.

To test for the specificity of effects of social anxiety over and above transdiagnostic measures of anxiety, we also administered the Intolerance of Uncertainty Scale (IUS; Freeston et al., 1994) and the Trait scale of the State and Trait Anxiety Inventory (STAI-T; Spielberger et al., 1983). The IUS contains 27 items rated on a 5-point Likert scale, and the Trait section of the STAI is made up of 20 items rated on a 4-point Likert scale. Cronbach's alphas for the IUS and STAI-T were $\alpha > .90$.

SPIN scores, IUS scores, and STAI-T scores were significantly positively correlated with one another, with the smallest correlation between SPIN and STAI-T scores, r (88) = 0.45, and the largest correlation between SPIN and IUS, r (88) = 0.66. The correlation between IUS scores and STAI-T scores was r (88) = 0.57. All correlations between questionnaire measures were at the $p < .001$ level.

SPIN, IUS, and STAI-T scores were not significantly associated with any of the following demographic variables: Age [SPIN, r (88) = 0.08, p = .45; IUS, r (88) = 0.08, p = .47; STAI-T, r (88) = 0.11, p = .32], ethnicity (white, non-white, not specified) [SPIN, F (88) = 0.41, p = .53; IUS, F (88) = 2.10, p = .15; STAI-T, F (88) = 0.14, p = .71], sexual orientation (heterosexual, sexual minority, non-specified) [SPIN, F (88) = 0.03, p = .87; IUS, F (88) = 0.32, p = .58; STAI-T, F (88) = 0.71, p = .40]. There was a significant difference in SPIN scores between males and females [t (86) = 2.07, p = .04], where females (M = 28.27, SD = 12.85) displayed significantly higher SPIN scores compared to males (M = 22.35, SD = 10.77). This finding is consistent with prevalence rates that demonstrate that social anxiety is more prevalent in females compared to males (Remes et al., 2016; Sosic et al., 2008). There were no significant differences between males and females for IU [t (86) = 0.52, p = .60] or STAI-T scores [t (86) = 1.17, p = .25].

There were no significant differences between groups (CBT-Instruction, Control-Instruction) for SPIN [t (86) = 0.24, p = .82], IU [t (86) = 0.30, p = .76], or STAI-T scores [t (86) = 0.85, p = .40].

2.6. Data acquisition, reduction and scoring

2.6.1. Avoidance behaviour

Avoidance responses were coded as 1 (avoidance response) and 0 (non-avoidance response). For each participant, a proportion score was calculated separately for the CS+ and CS- during both the US-avoidance acquisition and US-avoidance extinction phases. This score, ranging from 0 to 1, represents the proportion of trials during which the participant chose to avoid divided by the total number of CS + or CS- trials (i.e., 4 avoided trials out of 8 CS + trials = 0.50).

2.6.2. US expectancy ratings

US expectancy ratings data towards the CS+ and CS- were extracted for each participant at the following timepoints throughout the task: before threat acquisition, after threat acquisition, after US-avoidance acquisition (pre-instruction), after US-avoidance extinction, midway through threat extinction, and after the extinction test phase. Participants were asked to rate on a 9-point Likert scale their expectancy of hearing the statement and receiving the stimulation when presented with each identity (1 = "do not expect", 9 = "do expect"). US expectancy ratings data were extracted using the E-Data Aid tool in E-Prime (Psychology Software Tools Ltd, Pittsburgh, PA).

2.6.3. Skin conductance response

Physiological recordings were obtained using AD Instruments (AD Instruments Ltd, Chalgrove, Oxfordshire) hardware and software. Electrodermal activity was measured with dry MLT118F stainless steel

bipolar finger electrodes attached to the distal phalanges of the index and middle fingers of the non-dominant hand. A low constant-voltage AC excitation of 22 mVrms at 75 Hz was passed through the electrodes, which were connected to a PowerLab 8/35, and converted to DC before being digitised and stored. The electrodermal signal was converted from volts to microSiemens using AD Instruments software (AD Instruments Ltd, Chalgrove, Oxfordshire). An ML138 Bio Amp connected to a ML870 PowerLab Unit Model 8/30 amplified the electrodermal and IBI signals, which were digitised through a 16-bit A/D converter at 1000 Hz. IBI signals were used only to identify movement artefacts and were not analysed. The electrodermal signal was converted from volts to microSiemens using AD Instruments software (AD Instruments Ltd, Chalgrove, Oxfordshire).

SCRs were calculated by subtracting the mean value of a baseline period (2 s before CS onset) from the highest peak during the 1–7 s interval post CS onset (Pineles et al., 2009). Thereafter, skin conductance values were range corrected using the largest response for each participant (Dawson et al., 2007). A minimum response criterion was set at 0.02 μS. Values lower than the 0.02 μS cutoff were set to 0. Trials with no discernible SCRs were scored as zero. SCR magnitudes were square root transformed to reduce skew and z-scored within-subjects across all trials to control for interindividual differences in skin conductance responsiveness (Ben-Shakhar, 1985). SCR magnitudes were calculated from remaining trials by averaging SCR-transformed values and zeros for each condition. SCR was not analysed during avoidance conditioning and avoidance test trials due to confounds created by movement during avoidance responses. CS + non-reinforced and CS- trials were included in the analysis during acquisition, but CS + reinforced trials were discarded to avoid confounds from the sound and electric shock.

2.7. Data analysis

Analyses were conducted using the mixed procedure in SPSS 29.0.2.0 (SPSS, Inc.; Chicago, Illinois). In all analyses, individual differences in social anxiety (SPIN scores) were treated as a continuous predictor and entered at the between-subject level (Level 2) of the multilevel models. The dependent variables were avoidance responses, US expectancy ratings, and SCR. This approach allows for the examination of how variation in social anxiety is associated with behavioural, cognitive, and physiological responses, and how these relationships interact with experimentally manipulated within-subject factors (e.g., Stimulus, Instruction Type).

Separate Multilevel Models (MLMs) were conducted for each dependent variable (avoidance response, US expectancy ratings and SCR) during threat acquisition, US-avoidance acquisition, US-avoidance extinction and extinction test phases in line with hypotheses. For SCR and US expectancy ratings during threat acquisition, we entered Stimulus (CS+, CS-) into the model at level 1 and individual subjects at level 2. For avoidance responses during the US-avoidance acquisition phase, we entered Simulus (CS+, CS-) at level 1 and individual subjects at level 2. For avoidance responses during the US-avoidance extinction phase, we entered Stimulus (CS+, CS-) and Instruction Type (CBT-Instruction, Control-Instruction) at level 1 and individual subjects at level 2. For SCR magnitude during the extinction test phase, we entered Stimulus (CS+, CS-), Time (Early, Late extinction) and Instruction Type (CBT-Instruction, Control-Instruction) at level 1 and individual subjects at level 2. For the analysis of US expectancy ratings, Stimulus (CS+, CS-) and Block (after threat acquisition, after US-avoidance acquisition, after US-avoidance extinction, midway through extinction test, and after extinction test) were entered into the model at level 1 and individual subjects were entered at level 2. In all of the above MLMs, SPIN scores were entered into the models first to examine the main effects of social anxiety, and its interactions with stimulus type, instruction condition, and time/block. Subsequently, to examine the specificity of SPIN findings, IU and STAI-T scores were entered into the models with SPIN scores as main effects and interacting with manipulated variables (i.e., Stimulus Type, Instruction Type, Time/Block). In the MLMs that included the three predictor variables (SPIN, IU, STAI-T), a significant main effect or interaction between conditions of interest and one individual difference variable, but not the others, suggests specificity.

Fixed effects included Stimulus, Instruction Type, and Time. All models used a diagonal covariance matrix for level 1. A random intercept for each participant was included as random effect, using a variance components structure. We used a maximum likelihood estimator for the MLMs and corrected post-hoc tests for multiple comparisons using the Benjamini-Hochberg False Discovery Rate procedure (Benjamini & Hochberg, 1995).

Where a significant main effect or interaction with SPIN was observed, follow-up pairwise comparisons were performed on the estimated marginal means of the relevant conditions at specific at values corresponding to one standard deviation above and below the mean SPIN score (±1 SD), to aid interpretation of main effects and interactions involving continuous predictors. These values are estimated from the multilevel model of the complete sample, which is not unlike performing a simple slopes analysis in a multiple regression analysis. Similar analyses have been published elsewhere (Morriss et al., 2020; Wake, Van Reekum, & Dodd, 2021). In addition, in cases where a significant main effect of SPIN was observed, exploratory descriptive analyses were conducted to aid interpretation by estimating model-derived values at ±1 SD of the mean SPIN score. These analyses were not used to test differential effects across conditions and should be interpreted as descriptive.

3. Results

3.1. Self-reported reactions to unconditioned stimuli

Participants rated the electric stimulation ($M = 5.76$, $SD = 1.27$) and critical vocal statement ($M = 6.72$, $SD = 1.20$) as making them feel anxious (where 1 = "not at all", 9 = "extremely") after completing the task. A paired samples *t*-test indicated that participants rated the critical statement as making them feel significantly more anxious compared to the electrical stimulation, $t\ (86) = 5.24$, $p < .001$. Individual differences in social anxiety were not significantly associated with ratings of anxiety elicited by the critical statement, $r\ (88) = 0.10$, $p = .365$.

3.2. Main effects of the task

3.2.1. Threat acquisition

SCR was significantly larger for CS + compared to CS- during the threat acquisition phase [Stimulus, $F\ (1, 88) = 27.78$, $p < .001$], see Fig. 2.

There was no significant difference in US expectancy ratings between the CS+ and CS- before acquisition, $p = .965$ however after acquisition, US expectancy ratings were significantly higher towards the CS + compared to the CS-, $p < .001$, [Stimulus, $F\ (1, 264) = 140.15$, $p < .001$; Time, $F\ (1, 264) = 45.58$, $p < .001$; Stimulus x Time, $F\ (1, 264) = 141.64$, $p < .001$, see Table 2; Fig. 3]. These findings indicate that conditioning was effective during the acquisition phase.

3.2.2. US-avoidance acquisition

During the US-avoidance acquisition phase, participants avoided the CS+ ($M = 0.60$, $SE = 0.04$) significantly more than the CS- ($M = 0.16$, $SE = 0.03$), [Stimulus, $F\ (1, 88) = 121.83$, $p < .001$, see Table 2, Fig. 4].

3.2.3. US-avoidance extinction

During the US-avoidance extinction phase, participants avoided the CS+ ($M = 0.42$, $SE = 0.05$) significantly more than the CS- ($M = 0.15$, $SE = 0.03$), [Stimulus, $F\ (1, 88) = 45.92$, $p < .001$]. There was not a significant main effect of instruction type (CBT-instruction vs control-instruction) or a significant Stimulus x Instruction Type interaction for avoidance responses during the avoidance test phase, [Instruction Type,

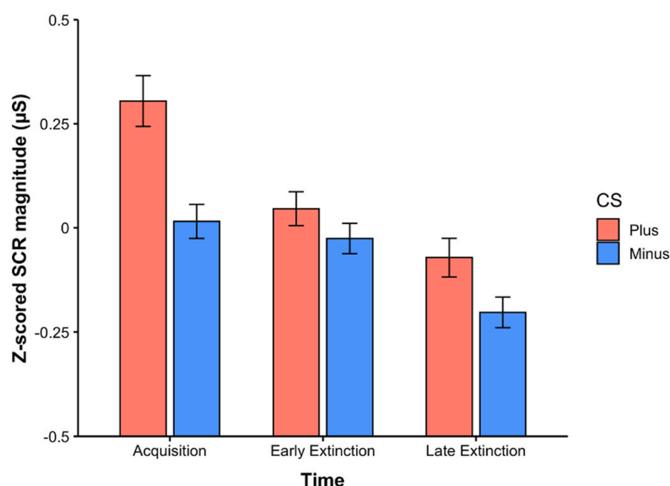

Fig. 2. Z-Scored Skin Conductance Response (SCR) Magnitude (μS) across Conditioned Stimulus (CS) and Time. Bar graphs depict mean square-root transformed and z-scored skin conductance response (SCR) magnitude measured in microSiemens during Acquisition, Early Extinction, and Late Extinction for CS+ and CS− trials. Error bars represent ±1 standard error of the mean. Z-scoring was performed within subjects across acquisition and extinction phases, explaining the negative values. SCR was significantly greater during CS + trials compared to CS- trials during threat acquisition, early threat extinction, and late threat extinction.

F (1, 88) = 1.46, p = .230, Instruction Type x Stimulus, F (1, 88) = 0.21, p = .646].

3.2.4. *Extinction test*

During the extinction test phase, SCR was significantly higher for the CS+ (M = −0.01, SE = 0.03) compared to the CS- (M = −0.11, SE = 0.03), [Stimulus, F (1, 256.07) = 7.13, p = .008, see Table 3]. Further, SCR significantly reduced between early (M = 0.01, SE = 0.03) and late (M = −0.01, SE = 0.03) threat extinction towards the CS+, p = .046, and the CS-, p < .001 [Time, F (1, 256.07) = 15.00, p < .001, see Table 3; see Fig. 2]. There was not a significant main effect of Instruction Type on SCR during the extinction test phase [Instruction Type, F (1, 92.23) = 0.28, p = .600, see Table 3]. Neither were there any other significant interactions between Stimulus, Instruction Type and Time [max F: Stimulus x Time, F (1, 256.07) = 0.62, p = .431].

3.3. *US expectancy ratings throughout the task*

Higher expectancy ratings of the US paired with the CS + versus the CS- were found at every post-acquisition timepoint of the task (i.e, after threat acquisition, after US-avoidance acquisition, after US-avoidance extinction, mid extinction test, after extinction test), [Stimulus, F (1, 633.96) = 631.34, p < .001, Block, F (4, 242.62) = 38.46, p < .001, Stimulus x Block, F (4, 242.62) = 45.46, p < .001], see Table 2. A second model was run to examine the effect of Instruction Type, only including US expectancy ratings collected after the delivery of the CBT- or Control-instruction. This model did not demonstrate any significant main effects of or interactions with Instruction Type on US expectancy ratings [max F = 0.48, min p = .617].

3.4. *The effects and specificity of individual differences in social anxiety*

3.4.1. *Threat acquisition*

During threat acquisition, there were no significant interactions with

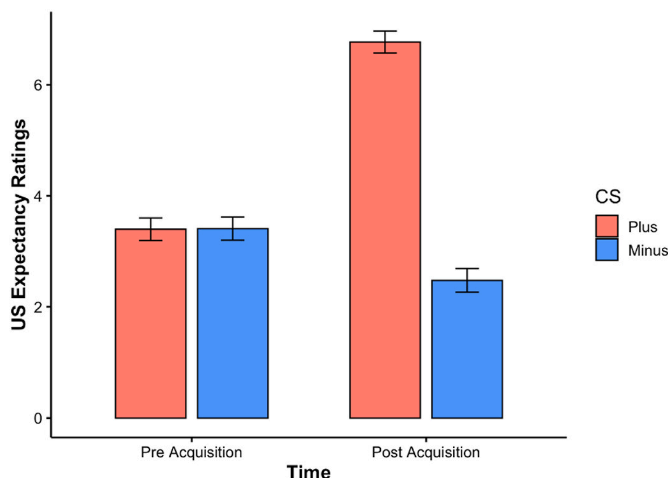

Fig. 3. US expectancy ratings for CS+ and CS- across Acquisition phases. Bar graph depicting mean US expectancy ratings towards the CS+ and CS- across Pre-Acquisition and Post-Acquisition phases. Error bars represent ±1 standard error of the mean. Participants provided CS+ with a higher expectancy rating post-acquisition compared to pre-acquisition, indicating that conditioning was successful.

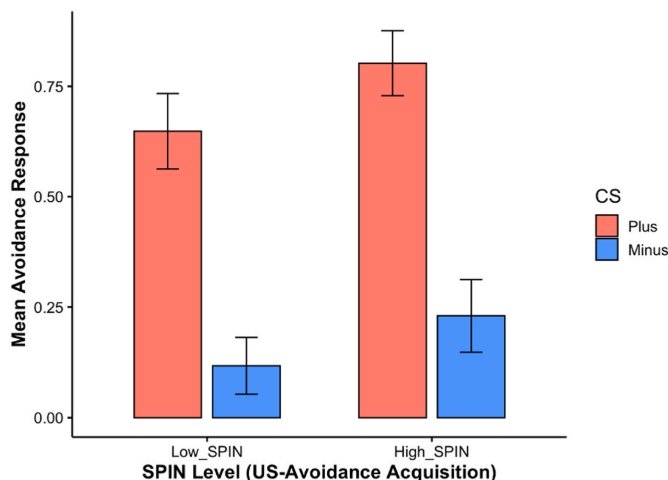

Fig. 4. Avoidance response during US-Avoidance acquisition by SPIN Level and conditioned stimulus (CS). Bar graph depicting mean avoidance responses towards the CS+ and CS- during the US-avoidance acquisition phase with lower (−1 SD) and higher (+1 SD) Social Phobia Inventory (SPIN) scores. Error bars represent ±1 standard error of the mean. Participants avoided CS + significantly more than CS- across both high and low SPIN scores. Although avoidance of CS+ was consistently high, participants with higher SPIN scores displayed increased avoidance of CS- during avoidance acquisition.

Table 2
Summary of Means (SD) for US Expectancy Ratings and Avoidance Responses as a function of condition (CS+ and CS-), separately for Pre- and Post Threat Acquisition, US-Avoidance Acquisition, US-Avoidance Extinction, and Post-Extinction Test.

Measure	Pre-Threat Acquisition		Post-Threat Acquisition		US-Avoidance Acquisition		US-Avoidance Extinction		Post-Extinction Test	
	CS+	CS-	CS+	CS-	CS+	CS-	CS+	CS-	CS+	CS-
US Expectancy Rating	3.40 (1.92)	3.41 (1.95)	6.78 (1.87)	2.48 (2.00)	7.31 (2.21)	1.81 (1.55)	5.10 (2.59)	2.22 (2.06)	3.28 (2.38)	2.24 (2.21)
Avoidance Responses					0.60 (0.38)	0.16 (0.28)	0.42 (0.43)	0.15 (0.30)		

Table 3
Summary of Means (SD) for SCR Magnitude ($\sqrt{\mu s}$) as a function of condition (CS+ and CS-), separately for Acquisition, Early Extinction and Late Extinction.

Measure	Acquisition		Early Extinction		Late Extinction	
	CS+	CS-	CS+	CS-	CS+	CS-
SCR Magnitude	0.31 (0.57)	0.02 (0.38)	0.04 (0.38)	−0.03 (0.34)	−0.07 (0.44)	−0.20 (0.34)

Note: SCR magnitude ($\sqrt{\mu S}$), square root transformed, and z-scored skin conductance magnitude measured in microSiemens.

or main effects of social anxiety on SCR magnitude [max $F = 2.68$], or US expectancy ratings [max $F = 2.81$].

3.4.2. US-avoidance acquisition

Individual differences in social anxiety were associated with avoidance responses during the US-avoidance acquisition phase. There was no significant Stimulus x Social Anxiety interaction, [Stimulus x SPIN, F (1, 88) = 0.11, p = .743]. However, there was a significant main effect of social anxiety on avoidance responses, [SPIN, F (1, 88) = 4.80, p = .031], suggesting increased overall avoidance behaviour at higher SPIN scores (CS+: M = 0.66, SE = 0.05; CS-: M = 0.21, SE = 0.04) compared to lower SPIN scores (CS+: M = 0.54, SE = 0.05; CS-: M = 0.11, SE = 0.04).

In the model that included IU and trait anxiety scores with social anxiety scores (as well as their individual interactions with stimulus), the above main effect of SPIN was no longer significant, [SPIN, F (1, 88) = 1.95, p = .167]. This suggests that the above effect is not specific to social anxiety when controlling for anxiety traits captured by IU and STAI-T. However, there were no significant interactions with, or main effects of IU and STAI-T, for avoidance behaviour during US-avoidance acquisition in the above analysis, max $F = 0.86$, or when IU and STAI-T scores were entered into the model alone, max $F = 2.98$.

3.4.3. US-avoidance extinction

When entered in to the model alone, individual differences in social anxiety were not significantly related to avoidance responses during the US-avoidance extinction phase, and no significant interactions with Stimulus or Instruction Type were observed, [SPIN, F (1, 88) = 2.37, p = .127, Stimulus x SPIN, F (1, 88) = 2.18, p = .144, Instruction Type x SPIN, F (1, 88) = 1.14, p = .288, Stimulus x Instruction Type x SPIN, F (1, 88) = 1.38, p = .244].

However, when controlling for variance accounted for by IU and STAI-T, a significant main effect of SPIN was observed [SPIN, F (1, 88) = 4.09, p = .046], suggesting that higher levels of social anxiety were specifically associated with greater overall avoidance responding during this phase, irrespective of stimulus type or instruction condition.

To further characterise the main effect of SPIN in the context of the Instruction Type manipulation, exploratory follow-up analyses were conducted by estimating effects at + and – 1 SD above and below the mean SPIN score between instruction conditions. At higher levels of SPIN, there was no significant difference in avoidance between instruction conditions (p = .066), although estimated means suggests lower avoidance in the CBT-instruction compared to the control-instruction condition (see Fig. 5). No difference between instruction conditions was observed at lower levels of SPIN (p = .991). Given the absence of significant interactions involving SPIN, this follow-up analyses are interpreted as exploratory.

Exploratory correlation analyses, conducted separately by stimulus type and instruction condition, indicated a positive association between SPIN scores and avoidance response to the CS+ in the control condition (r (44) = 0.32, p = .034). No other significant correlations were observed, max $r = 0.10$.

In the model that included IU and STAI-T scores, no significant interactions with or main effects of IU or STAI-T were observed for avoidance behaviour during the US-avoidance extinction phase, max F = 1.96.

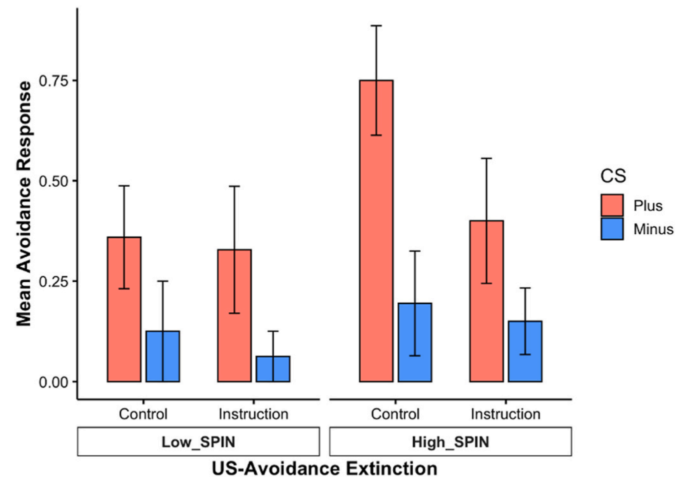

Fig. 5. Avoidance response during US-avoidance extinction by instruction type, SPIN Level, and conditioned stimulus (CS). Bar graph depicting mean avoidance responses towards the CS+ and CS- during the avoidance extinction phase with lower (−1 SD) and higher (+1 SD) Social Phobia Inventory (SPIN) scores and by Instruction type (Control vs CBT-Instruction). Error bars represent ±1 standard error of the mean. Participants avoided the CS + more than the CS− across conditions. At higher SPIN scores, there was a marginal reduction in CS + avoidance in the instruction group compared to the control group.

3.4.4. Extinction test

There were no significant interactions that included Instruction Type between Social Anxiety, Stimulus, and Time for SCR during the extinction test phase (i.e., Instruction Type x SPIN, Instruction Type x Stimulus x SPIN, Instruction Type x Time x SPIN, Instruction Type x Stimulus x Time x SPIN, max F = 1.20, min p = .273). There Stimulus x Time x Social Anxiety interaction was not significant when SPIN scores were entered into the model alone [Stimulus x Time x Social Anxiety, F (1, 255.84) = 3.45, p = .064]. This interaction reached significance when IU and STAI-T scores were entered into the model with SPIN scores, suggesting specificity [Stimulus x Time x Social Anxiety, F (1, 256.11) = 4.87, p = .028], see Fig. 6. To follow up on this interaction, the effect of Stimulus and Time at higher and lower levels of SPIN was examined at + and – 1 SD above and below the mean SPIN score. There was no significant differences between SCR towards the CS+ and CS- during early extinction at higher SPIN scores (CS+: M = −0.00, SE = 0.06; CS-: M = −0.01, SE = 0.05), p = .934, however, during late extinction, SCR towards the CS+ was significant greater compared to SCR towards the CS- for individuals with higher SPIN scores (CS+: M = −0.07, SE = 0.06; CS-: M = −0.28, SE = 0.05), p = .009. Further, individuals with higher SPIN scores demonstrated a significant reduction in SCR towards the CS- between early and late extinction, p < .001, but not the CS+, p = .395. Individuals with lower SPIN scores, did not demonstrate a significant difference in SCR towards the CS+ and CS- during early extinction (CS+: M = 0.09, SE = 0.06; CS-: M = −0.43, SE = 0.05) or late extinction (CS+: M = −0.07, SE = 0.06; CS-: M = −0.13, SE = 0.05). Further, at lower SPIN, there was a significant reduction in SCR towards the CS+, p = .047, but not the CS-, p = .215, between early and late extinction. No other significant interactions with or main effects of IU or STAI-T were observed for SCR during the extinction test phase, max F = 3.41.

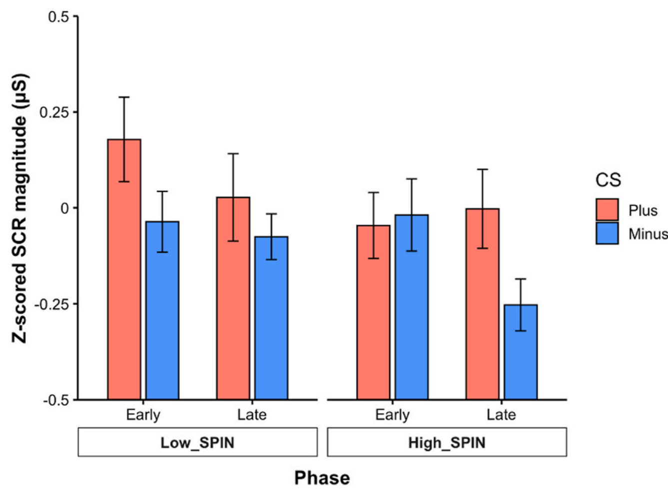

Fig. 6. Z-Scored skin conductance response (SCR) magnitude (μS) across early and late extinction phase by SPIN scores and conditioned stimulus (CS). Bar graphs depict mean square-root transformed and z-scored skin conductance response (SCR) magnitude measured in microSiemens during early and late extinction phases, shown separately for lower (−1 SD) and higher (+1 SD) Social Phobia Inventory (SPIN) scores and by Conditioned Stimulus (CS + vs. CS−). Error bars represent ±1 standard error of the mean. Z-scoring was performed within subjects across acquisition and extinction phases, explaining the negative values. During late extinction, participants with higher SPIN scores displayed significant SCR differentiation between CS+ and CS- due to reduced response to CS-. In contrast, individuals with lower SPIN scores showed reduced SCR to the CS + over time, resulting in no differential response by late extinction.

3.4.5. US expectancy ratings throughout the task

When SPIN scores were entered into the model alone, there were not significant Stimulus x Block x Social Anxiety or Stimulus × SPIN interactions for US expectancy throughout the task, [Stimulus x Block x SPIN, F (4, 244.55) = 1.21, p = .308; Stimulus x SPIN, F (1, 638.47) = 2.97, p = .085]. However, there was a significant main effect of SPIN, a significant Block x SPIN and a, [SPIN, F (1, 87.58) = 7.00, p = .010, Block x SPIN, F (4, 244.55) = 4.73, p = .001]. Individuals with higher SPIN scores tended to have greater expectancy of the US with the CS+ and CS- relative to individuals with lower SPIN scores, after US-avoidance extinction, midway through the extinction test and after the extinction test phase, see Fig. 7.

The above analysis was repeated, with IUS and STAI-T scores included in the model alongside SPIN scores, and again there was not a significant Stimulus x Block x Social Anxiety interaction, [Stimulus x Block x SPIN, F (4, 245.90) = 1.10, p = .358]. But, the main effect of SPIN and the Block × SPIN interaction remained significant, [SPIN, F (1, 87.71) = 4.91, p = .029, Block x SPIN, F (4, 245.90) = 3.99, p = .004]. Further, the Stimulus × SPIN interaction became significant [Stimulus x SPIN, F (1, 639.43) = 9.78, p = .002]. There was also a significant Stimulus × IU interaction for US expectancy ratings throughout the task [Stimulus x IU, F (1, 639.43) = 9.99, p = .002], suggesting that the Stimulus × SPIN interaction was not specific to social anxiety. No other interactions or main effects of IU or STAI-T were observed, max F = 1.09.

To examine the between-group effect of Instruction Type on US expectancy ratings, we examined US expectancy ratings towards the CS+ and CS- after the instruction had been presented to participants (i.e., after US-avoidance extinction, mid-extinction test and post-extinction test ratings). There was not a significant main effect or interaction with Instruction Type for US expectancy ratings [Instruction Type, F (1, 92.38) = 0.07, p = .788, Stimulus x Instruction Type, F (1, 290.40) = 0.00, p = .980, Block x Instruction Type, F (2, 237.69) = 0.48, p = .617, Stimulus x Block x Instruction Type, F (2, 237.69) = 0.35, p = .702]. Further, there were no significant interactions including SPIN and Instruction Type when SPIN was entered into the model alone, max F = 0.83, or with IU and STAI-T, max F = 1.69.

4. Discussion

The present study had two primary aims. First, we aimed to replicate the findings of Wake, Van Reekum, and Dodd (2021) that demonstrated that social anxiety is associated with compromised conditioning and extinction of avoidance behaviours and threat expectancy. A second aim was to examine the effect of an instruction, based on cognitive behavioural principles, on the relationship between social anxiety and avoidance behaviour and extinction learning. As such, the findings of the study are twofold. First, we replicated the results of previous work that demonstrated that individual differences in social anxiety are associated with increased avoidance behaviour and threat expectancy during a US-avoidance acquisition and US-avoidance extinction phase (Ly & Roelofs, 2009; Wake, Van Reekum, & Dodd, 2021). Second, there was no clear evidence that the CBT-based instruction enhanced extinction learning; however, exploratory analyses suggested lower avoidance in the CBT-instruction condition at higher levels of social anxiety.

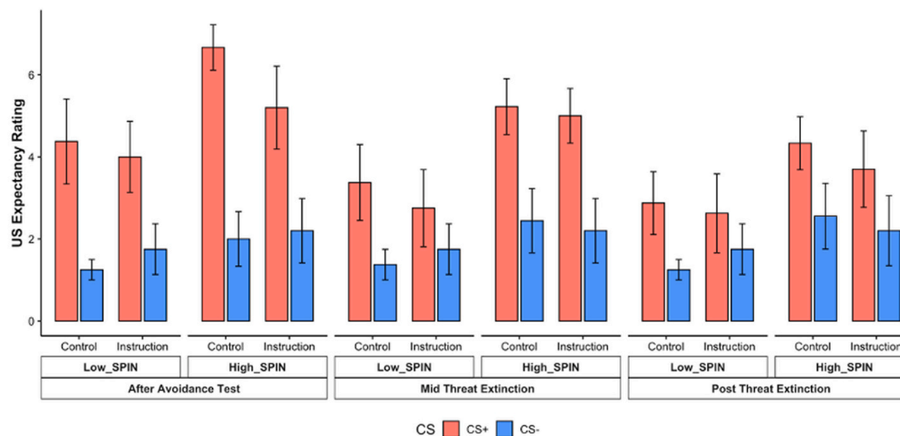

Fig. 7. US expectancy ratings for CS+ and CS- across avoidance and extinction phases by SPIN level and Instruction Type. Bar graph depicting US expectancy ratings towards the CS+ and CS- after the avoidance test, mid-threat extinction, and post-threat extinction phases with lower (−1 SD) and higher (+1 SD) Social Phobia Inventory (SPIN) scores by instruction type (Control-instruction vs. CBT-instruction). Error bars represent ±1 standard error of the mean. Participants expected CS + significantly more than CS- across high and low SPIN scores. Participants with higher SPIN scores had greater expectancies of the US with the CS+ and CS- compared to those with lower SPIN scores across all three phases.

During the US-avoidance acquisition phase, higher SPIN scores were associated with greater overall avoidance responding when social anxiety was entered alone into the model. This pattern is consistent with an increased tendency for individuals with higher social anxiety to avoid cues previously associated with threat, as well as safety cues, during initial avoidance learning. However, this association was no longer significant when IU and trait anxiety were included in the model, suggesting that avoidance during acquisition may reflect variance shared with broader transdiagnostic vulnerability factors rather than variance uniquely attributable to social anxiety. These findings are consistent with Wake, Van Reekum, and Dodd (2021), who similarly reported that associations between social anxiety and avoidance during acquisition were reduced when accounting for related individual difference variables.

During the US-avoidance extinction phase, we did not observe evidence that social anxiety differentially influenced avoidance behaviour as a function of stimulus type or instruction condition. Specifically, there were no significant interactions between SPIN and Stimulus or Instruction Type. However, when controlling for variance associated with IU and trait anxiety, a significant main effect of social anxiety emerged, suggesting that higher levels of social anxiety were associated with greater overall avoidance responding during this phase of the task. These findings replicate those reported by Wake, Van Reekum, and Dodd (2021), in that higher levels of social anxiety were associated with greater persistence of avoidance behaviour. This pattern suggests that elevated social anxiety may be linked to a general tendency to persist in avoidance behaviour, even when avoidance is no longer reinforced. Exploratory follow-up analyses provided some indication that this association may vary across conditions. Estimated means suggest lower avoidance in the CBT-instruction condition at higher levels of social anxiety, and a positive association between social anxiety and avoidance to the CS+ in the control condition. However, in the absence of significant higher-order interactions, these patterns should be interpreted with caution. Taken together, these findings point to a more general relationship between social anxiety and persistent avoidance responding during the US-avoidance extinction phase.

As predicted, during the extinction test phase, participants exhibited sustained differential responding to conditioned threat (CS+) versus safety (CS−) cues, as reflected in both US expectancy ratings and skin conductance responses (SCRs). These findings provide further evidence that avoidance behaviour interferes with extinction learning, resulting in extinction resistance to learned threat cues (Vervliet & Indekeu, 2015; Wake, Van Reekum, & Dodd, 2021). Further, we did not find a significant main effect of instruction type on US expectancy ratings and SCRs during the extinction test phase. Such a result suggests that, irrespective of individual differences in social anxiety, the CBT-based instruction did not facilitate extinction learning across all participants.

Finally, the present study examined whether a cognitive-behavioural instruction would facilitate extinction learning among individuals with elevated social anxiety. It was hypothesised that, compared to their high-social anxiety counterparts in the control-instruction condition, participants with higher social anxiety in the CBT-instruction group would exhibit reduced conditioned responding, as indexed by lower US expectancy ratings and SCRs to both the CS+ and CS−. Contrary to this exploratory hypothesis, no significant effect of instruction type on conditioned responses was observed during the extinction test phase at higher levels of social anxiety. Instead, across both instruction conditions, individuals with elevated social anxiety displayed a generalised conditioned SCR to both threat and safety cues during the early extinction test phase. During the later part of the extinction test phase, individuals with increased social anxiety continued to exhibit elevated SCRs to the CS + relative to the CS−, suggesting sustained conditioned responding. In contrast, individuals with lower social anxiety demonstrated differential SCRs to the CS+ and CS− during early extinction testing, and no significant differentiation during the later phase, indicative of successful extinction learning at lower social anxiety in both instruction groups. Furthermore, across all phases of the task, participants with higher social anxiety reported greater US expectancy to both the CS+ and CS− compared to those with lower social anxiety, regardless of instruction condition. Collectively, these findings suggest that, following the opportunity to avoid, elevated social anxiety is associated with a generalised and persistent conditioned threat response during extinction testing, and that this pattern was not reliably modified by the brief CBT-based instructional interventions. The present findings can also be considered in light of contemporary models of avoidance learning, which emphasise the role of expectancy violation and action-outcome learning in shaping avoidance behaviour (Leng et al., 2024). In line with these accounts, persistent avoidance may limit opportunities for updating threat-related beliefs by preventing individuals from experiencing the absence of expected outcomes.

The findings outlined above replicate those of Wake, Van Reekum, and Dodd (2021) and contribute to an emerging body of research that highlights the relationship between social anxiety and maladaptive avoidance and threat expectancy. Specifically, consistent with Wake, Van Reekum, and Dodd (2021), higher social anxiety was associated with greater avoidance during US-avoidance acquisition when SPIN was entered alone into the model. However, this association was no longer significant when controlling for IU and trait anxiety, suggesting that avoidance during acquisition may reflect variance shared with broader transdiagnostic anxiety-related traits. In contrast, higher social anxiety remained associated with greater overall avoidance responding during US-avoidance extinction when controlling for IU and trait anxiety. The finding that social anxiety did not uniquely predict avoidance behaviour during US-avoidance acquisition but did during US-avoidance extinction suggests that distinct psychological mechanisms may underlie the initial learning of avoidance behaviour and its persistence when it is no longer an adaptive response. This pattern of results aligns with theoretical models that distinguish between general threat sensitivity and disorder-specific maintenance mechanisms. General threat sensitivity, often present in elevated IU and trait anxiety, is considered a transdiagnostic vulnerability factor that contributes to heightened emotional reactivity and anticipatory anxiety across a range of internalising disorders (Carleton, 2016; Grupe & Nitschke, 2013). These transdiagnostic traits may predispose individuals to engage in avoidant behaviour during early threat learning, irrespective of the specific content of the threat. In contrast, the persistence of avoidance during US-avoidance extinction, when the aversive outcome is no longer present, may be more strongly associated with social anxiety relative to the other vulnerability factors measured in the current study. This finding supports cognitive-behavioural models of social anxiety disorder (e.g., Clark & Wells, 1995; Rapee & Heimberg, 1997), which propose that individuals with social anxiety engage in rigid safety behaviours (e.g., rehearsing what to say in advance to avoid embarrassment) that prevent the disconfirmation of negative beliefs and thereby maintain anxiety over time. The present findings suggest that while general cognitive-affective vulnerabilities contribute to the initial acquisition of avoidance, the sustained use of avoidance despite the absence of threat may reflect processes that are more strongly associated with social anxiety relative to other measured transdiagnostic traits (i.e., IU and trait anxiety).

The results of the present study also raise important questions about the mechanisms through which brief interventions influence different facets of fear learning. For example, although the CBT-based instruction did not produce reliable effects on extinction learning outcomes, exploratory analyses suggested lower avoidance in the CBT-instruction condition at higher levels of social anxiety. This may indicate divergence in how behavioural, cognitive, and physiological components of fear respond to brief intervention. One possible explanation is that avoidance behaviour, particularly when under voluntary control, may be more responsive to explicit, goal-oriented instructions that encourage active engagement with feared stimuli. In contrast, threat expectancy may reflect more deeply held beliefs about danger that are resistant to

change without repeated experiential disconfirmation. This pattern of results again aligns with cognitive-behavioural models of social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997), which posit that increased social anxiety is associated with elevated threat expectancies that are maintained by negative self-appraisals, attentional biases, and the use of safety behaviours that prevent corrective learning. Although there is indication that the CBT-based instruction reduced avoidance behaviour for individuals with increased social anxiety, it may not have provided a sufficiently potent learning experience to challenge underlying cognitive beliefs that maintain threat associations.

The findings of the current study have important implications for clinical intervention. While brief CBT-based instructions may support behavioural engagement during exposure, the present findings did not indicate reliable effects on threat expectancy or physiological indices of extinction learning. Interventions may therefore benefit from incorporating additional strategies, such as expectancy tracking, verbalised predictions, or post-exposure reflection, to specifically link behaviour with expectancy violation and facilitate cognitive restructuring and extinction learning. Moreover, the absence of change in threat expectancy highlights the need for repeated, emotionally salient exposure sessions that allow for the accumulation of disconformity evidence over time.

From a research standpoint, the results of the current study highlight the necessity of examining the temporal and mechanistic distinctions between behavioural, cognitive and physiological change during exposure-based interventions for social anxiety. Multi-session studies could clarify whether reductions in avoidance precede changes in threat expectancy and extinction learning and identify the conditions under which behavioural engagement translates into cognitive restructuring. Experimental studies might also investigate whether varying the intensity, frequency, or content of instructional interventions enhances their impact on expectancy-based measures. Taken together, this line of work will inform the refinement of exposure-based treatments and support the development of tailored strategies to more effectively disrupt maladaptive cognitive-affective processes in social anxiety.

This study has several strengths. The study incorporated multiple indices of learning, including behaviour (avoidance responses), cognitive (US-expectancy ratings) and physiological (skin conductance responses) measures. This multimodal assessment enables a comprehensive examination of conditioning and extinction processes implicated in social anxiety and allows for a more nuanced interpretation of how different aspects of fear learning respond to brief interventions and vary as a function of individual differences in anxiety. A further strength lies in the study's examination of whether observed effects were specific to social anxiety, as opposed to reflecting broader transdiagnostic features such as IU and trait anxiety. Examining the specificity of individual differences measures is critical for informing tailored intervention approaches and advancing theoretical models of anxiety pathology. In addition, a notable strength of the current study is the integration of a cognitive-behavioural instruction into an experimental avoidance paradigm, an approach that has rarely been used to examine individual differences in anxiety. This translational approach provides insight into the processes through which therapeutic techniques may influence avoidance behaviour in individuals with elevated social anxiety. As such, the paradigm offers a promising framework for experimentally isolating and evaluating key elements of CBT-based interventions within controlled laboratory conditions.

The study also had some limitations. Firstly, the generalisability of the findings may be constrained by the nature of the threat stimulus used in the paradigm. The US consisted of a combination of a mild electric shock and a critical vocal statement, which was designed to be aversive but may not fully approximate the types of social evaluative threats experienced in daily life by individuals with social anxiety. Secondly, the study's assessment of cognitive change was limited to US-expectancy ratings on a 9-point Likert scale. While this provides a useful measure of participants' predictions regarding the likelihood of aversive outcomes, it may not fully capture the complexity of cognitive appraisals that contribute to the maintenance of social anxiety. Incorporating additional cognitive outcome measures, such as belief ratings or post-task reflection, would provide a more comprehensive account of cognitive change processes and their responsiveness to instructional interventions in relation to social anxiety. Finally, as mentioned above, a notable limitation of the current study is its single-session design. While this design provides a controlled setting to examine the immediate effects of CBT-based instructions on avoidance and conditioned responding, it does not capture the cumulative effects of repeated exposure. The present findings, therefore, may underestimate the efficacy of CBT-based instructions, particularly with respect to cognitive change, which may require more sustained engagement. Future studies employing longitudinal or multi-session designs would help determine whether the observed reduction in avoidance persists over time and whether repeated instructional exposure is necessary to alter maladaptive threat expectancy associated with social anxiety.

To conclude, by replicating and extending previous findings, the present study demonstrates that elevated social anxiety is associated with persistent avoidance behaviour and heightened threat expectancy and conditioned responding, particularly during extinction learning. Importantly, while a brief instruction derived from cognitive behavioural principles reduced avoidance behaviour among individuals with higher social anxiety, it did not attenuate conditioned threat expectancies, demonstrated by elevated US-expectancy ratings and SCR. These findings underscore a potential dissociation between behavioural responses and cognitive and physiological components of fear in social anxiety and suggest that reducing avoidance behaviour alone may be insufficient to alter maladaptive threat beliefs and physiological arousal. Moreover, by isolating the effects of social anxiety from broader transdiagnostic traits, such as IU and trait anxiety, the current study provides evidence for the social anxiety-specific maintenance mechanisms proposed in cognitive models of social anxiety. Taken together, these findings advance our understanding of mechanisms that impair extinction learning and offer translational insights for enhancing the efficiency of exposure-based interventions for social anxiety. Future research is warranted to examine the conditions under which the extinction of avoidance behaviour and threat expectancy can be improved for individuals with elevated social anxiety.

CRediT authorship contribution statement

Sruthi Sridhar: Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation. **Nicolo Biagi:** Writing – review & editing, Software, Formal analysis. **Shannon Wake:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors have no competing interests to declare.

Acknowledgements

The authors wish to thank participants for taking part in this experiment and Maya El Dana for assistance with collecting the data. This research was funded by an Economic and Social Research Council (ESRC) Postdoctoral Fellowship awarded to Dr Shannon Wake (ES/W007177/1).

Data availability

I have shared the link to the raw data in the manuscript.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society: Series B, 57*(1), 289–300.

Ben-Shakhar, G. (1985). Standardization within individuals: A simple method to neutralize individual differences in skin conductance. *Psychophysiology, 22*(3), 292–299.

Carleton, R. N. (2016). Into the unknown: A review and synthesis of contemporary models involving uncertainty. *Journal of Anxiety Disorders, 39*, 30–43.

Chesham, R. K., Malouff, J. M., & Schutte, N. S. (2018). Meta-Analysis of the efficacy of virtual reality exposure therapy for social anxiety. *Behaviour Change, 35*(3), 152–166.

Clark, D. M., & Wells, A. (1995). A cognitive model of social phobia. In R. G. Heimberg, M. R. Liebowitz, D. A. Hope, & F. R. Schneier (Eds.), *Social Phobia: Diagnosis, assessment, and treatment* (pp. 69–93). New York, NY: Guilford Press.

Connor, K., Davidson, J., Churchill, L., Sherwood, A., Weisler, R., & Foa, E. (2000). Psychometric properties of the Social Phobia Inventory (SPIN): New self-rating scale. *British Journal of Psychiatry, 176*(4), 379–386.

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). American Psychological Association.

Craske, M. G., Stein, M. B., Eley, T. C., Milad, M. R., Holmes, A., Rapee, R. M., & Wittchen, H.-U. (2017). Anxiety disorders. *Nature Reviews Disease Primers, 3*(1), Article 17024.

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.

Dawson, M. E., Schell, A. M., & Filion, D. L. (2007). The electrodermal system. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), *Handbook of psychophysiology* (pp. 182–210). Cambridge University Press.

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.

Dugas, M. J., & Robichaud, M. (2007). *Cognitive-behavioural treatment for generalized anxiety disorder*. New York, NY: Taylor & Francis Group.

Dunsmoor, J. E., Campese, V. D., Ceceli, A. O., Ledoux, J. E., & Phelps, E. A. (2015). Novelty-Facilitated Extinction: Providing a novel outcome in place of an expected threat diminishes recovery of defensive responses. *Biological Psychiatry, 78*(3), 203–209.

Dymond, S. (2019). Overcoming avoidance in anxiety disorders: The contributions of Pavlovian and operant avoidance extinction methods. *Neuroscience & Biobehavioral Reviews, 98*, 61–70.

Dymond, S., & Roche, B. (2009). A contemporary behavior analysis of anxiety and avoidance. *The Behavior Analyst, 32*(1), 7–27.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191.

Freeston, M. H., Rhéaume, J., Letarte, H., Dugas, M. J., & Ladouceur, R. (1994). Why do people worry? *Personality and Individual Differences, 17*(6), 791–802.

Grupe, D. W., & Nitschke, J. B. (2013). Uncertainty and anticipation in anxiety: An integrated neurobiological and psychological perspective. *Nature Reviews Neuroscience, 14*(7), 488–501.

Heimberg, R. G. (2002). Cognitive-behavioral therapy for social anxiety disorder: Current status and future directions. *Biological Psychiatry, 51*(1), 101–108.

Keller, B. T. (2024). Mlmpower: An R package for conducting power analysis and data simulation with multilevel models, 1.0.11 .

Leng, L., Beckers, T., & Vervliet, B. (2024). What a relief! the pleasure of threat avoidance. *Emotion, 24*(3), 539.

Leonard, D. W. (1975). Partial reinforcement effects in classical aversive conditioning in rabbits and human beings. *Journal of Comparative & Physiological Psychology, 88*(2), 596–608.

Livneh, U., & Paz, R. (2012). Amygdala-prefrontal synchronization underlies resistance to extinction of aversive memories. *Neuron, 75*(1), 133–142.

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.

Lonsdorf, T. B., & Merz, C. J. (2017). More than just noise: Inter-individual differences in fear acquisition, extinction and return of fear in humans - Biological, experiential, temperamental factors, and methodological pitfalls. *Neuroscience & Biobehavioral Reviews, 80*, 703–728.

Lovibond, P. F., Mitchell, C. J., Minard, E., Brady, A., & Menzies, R. G. (2009). Safety behaviours preserve threat beliefs: Protection from extinction of human fear conditioning by an avoidance response. *Behaviour Research and Therapy, 47*(8), 716–720.

Lucas, K., Luck, C. C., & Lipp, O. V. (2018). Novelty-facilitated extinction and the reinstatement of conditional human fear. *Behaviour Research and Therapy, 109*, 68–74.

Ly, V., & Roelofs, K. (2009). Social anxiety and cognitive expectancy of aversive outcome in avoidance conditioning. *Behaviour Research and Therapy, 47*(10), 840–847.

Milad, M. R., & Quirk, G. J. (2012). Fear extinction as a model for translational neuroscience: Ten years of progress. *Annual Review of Psychology, 63*(1), 129–151.

Morriss, J., Christakou, A., & van Reekum, C. M. (2016). Nothing is safe: Intolerance of uncertainty is associated with compromised fear extinction learning. *Biological Psychology, 121*, 187–193.

Morriss, J., Wake, S., Lindner, M., McSorley, E., & Dodd, H. (2020). How many times do I need to see to believe? The impact of intolerance of uncertainty and exposure experience on safety-learning and retention in young adults. *International Journal of Psychophysiology, 153*, 8–17.

Otto, M. W., Pollack, M. H., Gould, R. A., Worthington III, J. J., McArdle, E. T., Rosenbaum, J. F., & Heimberg, R. G. (2000). A comparison of the efficacy of clonazepam and cognitive-behavioral group therapy for the treatment of social phobia. *Journal of Anxiety Disorders, 14*(4), 345–358.

Peugh, J. L. (2010). A practical guide to multilevel modeling. *Journal of School Psychology, 48*(1), 85–112.

Pilling, S., Mayo-Wilson, E., Mavranezouli, I., Kew, K., Taylor, C., & Clark, D. M. (2013). Recognition, assessment and treatment of social anxiety disorder: Summary of NICE guidance. *BMJ, 346*. f2541–f2541.

Pineles, S. L., Orr, M. R., & Orr, S. P. (2009). An alternative scoring method for skin conductance responding in a differential fear conditioning paradigm with a long-duration conditioned stimulus. *Psychophysiology, 46*(5), 984–995.

Pittig, A. (2019). Incentive-based extinction of safety behaviors: Positive outcomes competing with aversive outcomes trigger fear-opposite action to prevent protection from fear extinction. *Behaviour Research and Therapy, 121*, Article 103463.

Pittig, A., van den Berg, L., & Vervliet, B. (2016). The key role of extinction learning in anxiety disorders: Behavioral strategies to enhance exposure-based treatments. *Current Opinion in Psychiatry, 29*(1), 39–47.

Pittig, A., & Wong, A. H. (2021). Incentive-based, instructed, and social observational extinction of avoidance: Fear-opposite actions and their influence on fear extinction. *Behaviour Research and Therapy, 137*, Article 103797.

Pittig, A., & Wong, A. H. (2022). Reducing the return of avoidance and fear by directly targeting avoidance: Comparing incentive-based and instructed extinction of avoidance to passive fear extinction. *Journal of Experimental Psychopathology, 13*(4), Article 20438087221136424.

Quené, H., & Van den Bergh, H. (2004). On multi-level modeling of data from repeated measures designs: A tutorial. *Speech Communication, 43*(1–2), 103–121.

Rapee, R. M., & Heimberg, R. G. (1997). A cognitive-behavioral model of anxiety in social phobia. *Behaviour Research and Therapy, 35*(8), 741–756.

Remes, O., Brayne, C., Van Der Linde, R., & Lafortune, L. (2016). A systematic review of reviews on the prevalence of anxiety disorders in adult populations. *Brain and Behavior, 6*(7), Article e00497.

Robichaud, M., & Dugas, M. J. (2006). A cognitive-behavioral treatment targeting intolerance of uncertainty. In G. C. L. Davey, & A. Wells (Eds.), *Worry and its psychological disorders: Theory, assessment and treatment* (1st ed., pp. 289–304). Wiley.

Robichaud, M., Koerner, N., & Dugas, M. J. (2019). *Cognitive behavioral treatment for generalized anxiety disorder: From science to practice*. Routledge.

Simos, G., & Hofmann, S. G. (2013). *CBT for anxiety disorders: A practitioner book* (1st ed.). Wiley.

Snijders, T. A. B. (2005). Power and sample size in Multilevel Linear Models. In B. S. Everitt, & D. C. Howell (Eds.), *Encyclopedia of statistics in behavioral science* (1st ed., pp. 1570–1573). Wiley.

Sosic, Z., Gieler, U., & Stangier, U. (2008). Screening for social phobia in medical in-and outpatients with the German version of the Social Phobia Inventory (SPIN). *Journal of Anxiety Disorders, 22*(5), 849–859.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the state-trait anxiety inventory*. Palo Alto, CA: Consulting Psychologists Press.

Vervliet, B., & Indekeu, E. (2015). Low-cost avoidance behaviors are resistant to fear extinction in humans. *Frontiers in Behavioral Neuroscience, 9*, 351.

Wake, S., Morriss, J., Johnstone, T., Van Reekum, C. M., & Dodd, H. (2021). Intolerance of uncertainty, and not social anxiety, is associated with compromised extinction of social threat. *Behaviour Research and Therapy, 139*, Article 103818.

Wake, S., Van Reekum, C. M., & Dodd, H. (2021). The effect of social anxiety on the acquisition and extinction of low-cost avoidance. *Behaviour Research and Therapy, 146*, Article 103967.