Anger Counteraction-Based Implementation Intentions Reduce Fear Reinstatement and Avoidance Tendencies

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Date: 2025-06-28T00:00:00+00:00

Abstract

[Objective] To explore whether implementation intention (II) based on anger counter-attack can reduce fear reinstatement and avoidance behavior in patients with fear-related disorders. [Methods] A discriminative fear conditioning paradigm was employed. The II group formed an anger-countering implementation intention prior to extinction ("If I feel scared when I see pictures of fish and birds, I will think it' s stupid of me to be afraid of an animal picture, and I will clench my fists and feel very angry at myself, very angry!!"), while the control group had no II. Subjective measures (fear, anger, threat expectancy, avoidance distance) and skin conductance response were measured during the extinction/reinstatement phase. [Results] The II group exhibited significantly shorter avoidance distance to CS+ during late extinction; fear, anger, threat expectancy, and avoidance distance were all significantly lower during the reinstatement phase. No group differences were found in skin conductance. [Limitations] Unbalanced gender ratio; skin conductance measure cannot differentiate between anger and fear. [Conclusion] The anger-countering II formed before extinction requires repeated practice to automatically reduce fear reinstatement and avoidance tendencies.

Full Text

Preamble

Anger Countering-Based Implementation Intentions on Reducing Fear Reinstatement and Avoidance Tendency

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Abstract:
[Objective] To explore whether anger countering-based implementation intentions (II) can reduce fear reinstatement and avoidance behavior in individuals with fear-related disorders. [Methods] A differential fear conditioning paradigm was employed. Participants in the II group formed anger countering-based II prior to extinction training ("If I feel afraid when viewing fish/bird images, I will recognize how irrational it is to fear animal pictures. I will clench my fists and feel intensely angry with myself!!"). The control group received no II intervention. Subjective measures (fear, anger, threat expectancy, avoidance distance) and skin conductance response (SCR) were recorded during the extinction and reinstatement phases. [Results] During the late extinction phase, the II group showed a significantly shorter avoidance distance towards the CS+ compared to the control group. During the reinstatement phase, the II group reported significantly lower levels of fear, anger, threat expectancy, and avoidance distance. No significant between-group differences were observed in SCR. [Limitations] The sex ratio was unbalanced, and SCR was unable to distinguish between anger and fear. [Conclusion] Forming anger countering-based II prior to extinction requires repeated practice and can automatically reduce fear reinstatement and avoidance tendencies.

Keywords: Anger; Implementation intention; Fear extinction; Emotion regulation

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1. Introduction

Fear is an evolutionarily fundamental emotion that prepares organisms for potential threats by activating defensive response systems (Lang & Davis, 2000). However, maladaptive fear responses can lead to anxiety disorders, phobias, and post-traumatic stress disorder (PTSD) (Lebois et al., 2019). Differential fear conditioning serves as a crucial model for investigating the pathogenesis of these disorders, helping to explain how maladaptive fear, anxiety, and avoidance are learned and maintained (Vervliet et al., 2013). During fear acquisition, an aversive unconditioned stimulus (US) is repeatedly paired with one neutral conditioned stimulus (CS+) but never with another (CS−), leading participants to develop specific fear responses to the danger-predicting CS+. Strategies for regulating fear responses include fear extinction, cognitive emotion regulation, avoidance strategies, and disrupting fear memory reconsolidation. However, memory reconsolidation is constrained by boundary conditions related to memory characteristics and retrieval methods (Kindt, 2018; Lee et al., 2017; Monfils & Holmes, 2018; Vaverková et al., 2020; Zuccolo & Hunziker, 2019). For instance, high-intensity memories are more resistant to reconsolidation processes (Wang et al., 2009), making the intense fear memories in PTSD difficult to treat through reconsolidation interventions (Dębiec et al., 2011; Roger, 2011; Steckler & Risbrough, 2012). While avoidance strategies can prevent harm, excessive avoidance generalization interferes with threat verification and leads to functional disability (Meulders et al., 2024).

Cognitive behavioral therapy (CBT) based on fear extinction principles is a common treatment for anxiety and fear-related disorders. Fear extinction refers to the gradual reduction and disappearance of fear responses to CSs (including CS+ and CS−) through repeated exposure without US reinforcement (Britton et al., 2014). However, since extinction does not destroy the original fear memory but rather forms a new CS-no US safety memory, successfully extinguished fear can return through multiple pathways, including spontaneous recovery over time, renewal when the CS appears in a different context from extinction, and reinstatement after stress (Vervliet et al., 2013). The ease with which fear returns after extinction represents a critical challenge. Additionally, CBT is only effective for 50-60% of anxious children and adults, with limited efficacy for others (Loerinc et al., 2015). This may be because extinction requires exposure to CSs, yet some patients avoid environments or cues associated with anxiety/fear events even when harmless. Maladaptive avoidance is a core feature of anxiety and fear-related disorders (American Psychiatric Association, 2013) that impedes fear extinction (Lovibond et al., 2009; O' Malley & Waters, 2018; Rattel et al., 2017; Vervliet & Indekeu, 2015) and plays a central role in the development and maintenance of anxiety disorders (Pittig et al., 2018). For example, O' Malley and Waters (2018) used eye-tracking technology to direct participants' attention either toward (monitoring group) or away from (avoidance group) the CS+ during fear extinction, finding that avoidance impaired extinction outcomes. Other research shows that avoidance predicts worse treatment outcomes better than anxiety does (Pittig et al., 2015). Thus, addressing this "costly" avoidance behavior is urgent.

The symptom heterogeneity among trauma-exposed individuals suggests that regulating abnormal responses to CSs is central to treatment. Emotion regulation—the process by which we influence our emotions and how we experience and express them—is crucial for mental health and psychopathology (McRae & Gross, 2020). It can be achieved through conscious effort (cognitive reappraisal) or automatic processes (Gross, 2014). The former is limited by prefrontal sensitivity to stress (Raio et al., 2013; Raio & Phelps, 2015), making the latter more clinically promising. Recent research has increasingly explored automatic or implicit forms of emotion regulation at behavioral and neural levels (Chen et al., 2020, 2021; Gomez et al., 2015; Lutz & Krahé, 2018; Zhan et al., 2015, 2017, 2018), primarily including emotional counteraction and implementation intentions. Traditional Chinese philosophy and medicine posit that emotions have mutual promotion and counteraction relationships (MPMC) (Zhan et al., 2015). The incompatible response hypothesis similarly suggests that eliciting incompatible emotions can moderate the behavioral impact of a given emotion (Baron, 1984). Research shows that inducing sadness can reduce anger-driven aggression (Lutz & Krahé, 2018; Zhan et al., 2015, 2018), and this regulatory efficiency is unaffected by stress (Zhan, Wu, et al., 2017). Greenberg and Pascual-Leone (2024) propose that the best way to change emotion is to use an opposite-valence and more intense emotion. However, Pavlovian counterconditioning, which replaces the fear US with reward/positive stimuli, can reduce fear avoidance (Hulsman et al., 2024) but is limited by valence differences between positive and negative emotions (Ito et al., 1998; N. K. Smith et al., 2003) and cannot block fear relapse. This raises the question: Could using anger—a similar-valence but opposite-action-tendency emotion—be more effective for reducing fear avoidance and return?

Although fear and anger share threat-related neurophysiological underpinnings (Prather, 2016; Siegel et al., 2018) and fear can readily transform into anger (Zhan et al., 2015, 2018), they show significant behavioral differentiation: fear triggers avoidance responses (freezing/escape), while anger drives approach behavior (resistance/attack) (OToole & Mikkelsen, 2021). Unlike fear, anger effectively enhances individuals' sense of certainty and control (Lerner & Keltner, 2001; Song et al., 2021; Tiedens & Linton, 2001), makes both others (Sell et al., 2009) and oneself (Tibubos et al., 2013) feel powerful, and promotes goal-directed behavior (Lench et al., 2024). Sense of certainty and control are important factors influencing the negative effects of stress (Hartley et al., 2014; Meyer et al., 2021). Based on these anger characteristics, studies from the 1970s reported successful treatment of fear-related symptoms through anger induction (Butler, 1975; Goldstein et al., 1970). For example, Goldstein et al. (1970) guided patients to pair fear-provoking scenes with angry imagery and vocalizations, then apply these operations to real fear stimuli. A 34-year-old woman with severe, persistent anxiety, dizziness, and leg instability had failed desensitization due to intense fear. She was instructed to express anger when encountering fear stimuli, such as shouting "I' m not afraid" and hitting pillows. After three clinic sessions and 1.5 hours of daily home practice combined with thought-stopping procedures, she overcame her fear within two weeks and resumed normal life. However, these were case studies combining multiple interventions, leaving the pure effect of anger on fear unclear. Subsequent research has been scarce, primarily due to three concerns: (1) Anger is itself a consequence of trauma (Connor et al., 2003) and a symptom of some anxiety and trauma-related disorders. The DSM-5 PTSD criteria include anger in "alterations in cognition and mood" (Cluster D) and "irritable behavior and angry outbursts" (Cluster E) (American Psychiatric Association, 2013). (2) Anger is associated with negative consequences including impulsive aggression (Teten et al., 2010) and violent behavior (Chereji et al., 2012), posing safety risks. (3) Foa et al. (1995) found that in 12 female PTSD patients, stronger fear during early exposure predicted better treatment outcomes, suggesting anger might inhibit fear expression and impair treatment.

However, recent evidence alleviates these concerns: (1) Anger/irritability symptoms in anxiety disorders may be secondary rather than primary, reflecting defensive displacement where uncontrollable threat fear (e.g., social situations) transforms into controllable target anger (e.g., toward family), similar to "kick the cat" effects. Research shows COVID-19 fear may manifest as hidden online aggression (Ye et al., 2021). Neuroimaging reveals that hypervigilance to threat (e.g., amygdala activation) and insufficient prefrontal regulation in anxious individuals may cause emotional displacement (Shackman et al., 2011). CBT for generalized anxiety disorder can improve internally and externally expressed anger even without directly targeting it (Laposa & Fracalanza, 2019), likely because reduced emotional response to original threats eliminates reliance on "safe targets" for venting unresolved anxiety. This suggests anger symptoms may be byproducts of unresolved fear/avoidance rather than primary emotional dysregulation. Since both fear and anger involve amygdala-prefrontal circuits, successful fear reduction may also decrease angry motivational expression (e.g., aggressive impulses) (Blair, 2016). (2) Anger does not always lead to aggression; it varies along a continuum from minimal to intense rage (Deffenbacher et al., 1996). (3) Van Minnen et al. (2002) confirmed with larger samples that anger is unrelated to PTSD treatment efficacy or dropout; Forbes et al. (2008) found that fear of anger (e.g., "fearing feeling angry due to concerns about endless rage and harmful consequences") predicts poor outcomes. Importantly, recent research shows that excessively high fear levels during initial extinction training impair extinction learning and cause extinction deficits (Maren, 2014, 2022; Maren & Chang, 2006; Merz et al., 2016; Totty et al., 2019), challenging the old view that stronger fear predicts better outcomes.

Although anger is a strong negative emotion, angry individuals'risk estimates are closer to those of happy individuals (Lerner & Keltner, 2001), helping break the fear-avoidance cycle. According to MPMC theory, fear readily transforms into anger, and anger into happiness (Zhan et al., 2015, 2018), suggesting a circuitous path may better achieve fear-to-happiness conversion. Greenberg and Pascual-Leone (2024) also argue that eliciting adaptive anger toward threat sources (e.g., perpetrators' violations) can help change trauma victims' maladaptive fear. The key lies in adjusting anger induction methods, targets, and expression forms to maximize efficacy and minimize risk.

Carey and Sarma (2016) found that increasing drivers' self-efficacy through questioning, then presenting high-threat information to induce fear, reduced speed, but anger counteracted this effect. Elkjær et al. (2023) attempted to examine counteraction between anger and anxiety—negative emotions with different action tendencies (approach vs. avoidance)—but failed to clarify anger' s counteractive effects due to methodological issues (the anger task also induced high anxiety and tension). Therefore, this study continues investigating anger' s counteractive effects on conditioned fear. Given that fear responses to CSs become automatic after fear conditioning (Gallo et al., 2009), implementation intentions may effectively control automatic thought processes and prevent expression bias (Stewart & Payne, 2008). To better counter fear, automatically generating anger in response to CSs may be superior. Equipping individuals with "implementation intentions" to produce anger represents the most promising approach.

Implementation intention (II) is a self-regulation strategy formulated as "if⋯, then⋯" that establishes automatic links between anticipated situations (if) and target behaviors (then). Once formed, when encountering situation X, the predetermined response becomes highly activated, promoting goal achievement without increased conscious involvement (Gallo et al., 2009; Gollwitzer & Sheeran, 2006; Webb et al., 2012). Many studies confirm that strategically forming different II content can automatically regulate negative emotions (Azbel-Jackson et al., 2016; Chen et al., 2020, 2021; Gallo et al., 2009; Gomez et al., 2015; Hallam et al., 2015; Huang et al., 2020; Ma et al., 2019), primarily using avoidance ("I will not feel afraid; if I see a spider, then I will ignore it" (Gallo et al., 2009)), suppression ("If I see a weapon, I will stay calm and relaxed" (Azbel-Jackson et al., 2016); "If I see an 'inhibit' cue, then I will 'block all bad feelings and stay calm' " (Hallam et al., 2015)), or reappraisal strategies ("If I see a 'reappraise' cue, then I will tell myself 'the upcoming pictures are just pixels on a screen, they cannot reach me' " (Hallam et al., 2015); "I will not feel disgusted; if I see blood, I will adopt a doctor' s perspective" (Chen et al., 2020, 2021; Gomez et al., 2015; Huang et al., 2020); "I will not feel disgusted; if I see blood, I will view it as representing vitality and health" (Ma et al., 2019)). However, existing II strategies lack exploration of emotional counteraction mechanisms, and it remains unclear how II affects conditioned fear extinction and return. Meanwhile, traditional exposure therapy neglects patients' active coping strategies, and the strong CS-US association after fear memory formation causes intense fear responses during early extinction. Forming II enables individuals to develop goal-directed responses with less effort and higher efficiency (Chen et al., 2021; Hallam et al., 2015) to actively cope and promote behavioral automation, offering potential to overcome traditional therapy limitations. Against this background, this study innovatively uses II to induce self-directed, non-verbal/non-behavioral anger to examine how emotion-countering II affects conditioned fear extinction and return. Specifically, the II instruction states: "If I feel afraid when viewing fish and bird pictures (the CS+ and CS− in this study), I will find myself stupid for fearing an animal picture, and I will clench my fists and feel very angry with myself, very angry!!" The core innovation is its "conditional triggering" mechanism: anger induction strictly depends on immediate fear perception of CSs (animal pictures). When no fear is felt, anger is not triggered. This design significantly reduces ethical risks of traditional anger induction (e.g., aggressive behavior) and meets safety requirements for clinical translation.

Through this anger-countering II, we aim to prompt individuals to re-evaluate threat (recognizing actual safety) when encountering CSs, automatically activating safety responses, reducing fear impact, and promoting extinction training effects. Additionally, anger' s induced initiative and sense of empowerment may enhance individuals' willingness and motivation to actively approach CSs, further strengthening intervention effects. Ultimately, combining anger-countering II with extinction training may achieve dual intervention on fear responses and fear memory, more comprehensively alleviating excessive fear reactions.

2. Methods

2.1 Participants

The study aimed to compare II and control conditions with repeated measures at multiple time points. Sample size was calculated using G*Power 3.1 software (Faul et al., 2007) with a medium effect size of f = 0.25, Type I error probability $\alpha = 0.05$, power $1 - \beta = 0.8$, and medium correlation among repeated measurements (r = 0.5), yielding a required sample of 34. Considering high dropout rates in fear conditioning studies, 49 university students were recruited through posters and voluntary enrollment, aged 18-25 years. Participants were asked to attend sessions at the same time of day for three consecutive days. All were right-handed, had no history of physical or mental illness, had normal or corrected vision, and had not participated in similar emotion experiments within six months. The study was approved by the Ethics Committee of the School of Psychology, Henan University (approval number: 20210923002). All participants presented ID to confirm they were at least 18 years old and signed informed consent. They were informed about the experimental procedures (including questionnaires and subjective ratings). Electric shocks were individually calibrated with strictly limited voltage ranges that would not cause harm, and participants were told they could reduce shock intensity or terminate the experiment if uncomfortable. All data were kept confidential, and participants were asked to keep experimental details confidential. Participants received monetary compensation, with possible increases based on engagement.

Participants were randomly assigned to two groups: Group 1 was the traditional extinction group (control group, n = 25), and Group 2 was the implementation intention group (II group, n = 24). Twelve participants were excluded from analysis: three failed category learning on Day 1 (two control, one II), eight withdrew due to inability to tolerate shocks or physical discomfort (four per group), and one (control) did not receive shocks during Day 3 reinstatement due to equipment failure. The final sample comprised 37 participants (control: n = 18; II: n = 19). The groups did not differ significantly in age, sex, trait anxiety, depression levels, or shock intensity (Table 1).

2.2 Stimuli

Following previous research (Kroes et al., 2017), fish and bird pictures served as conditioned stimuli. The study used 148 images total, sourced from https://pixabay.com/zh/ and Baidu. One representative fish picture and one bird picture were used for subjective ratings (Figure 1 [Figure 1: see original paper]C), while the remaining 73 fish and 73 bird pictures were used for training and testing. Each image (1280$×$720, 96dpi, 24bit) was presented centrally on a 21-inch LCD monitor for 5 seconds. One category was followed by electric shock on 67% of trials (CS+), while the other was never paired with shock (CS−), with categories counterbalanced across participants. The unconditioned stimulus (US; electric shock) was delivered via a constant voltage stimulator

(STM200-1, BIOPAC Systems, Inc.) to the left wrist to elicit fear responses. Each shock lasted 200 ms, with intensity individually calibrated based on each participant' s tolerance. Before the formal experiment, participants rated shock discomfort on a 1-9 scale (1 = "not uncomfortable" to 9 = "painfully intolerable"), with level 8 selected as the experimental intensity.

2.3 Subjective Assessment

Participants rated five subjective measures for CS+ and CS− (using bird pictures as an example, see Figure 1D): (1) US expectancy ("How likely do you think the bird picture will be followed by a shock?") as a prospective index of associative memory, rated 1-9 (1 = definitely not, 5 = uncertain, 9 = definitely); (2) CS-US association ("Based on previous learning, how often was the bird picture followed by a shock?") as a retrospective index, rated 1-9 (1 = never, 3 = occasionally, 5 = sometimes, 7 = often, 9 = always); (3) fear level ("How fearful do you feel when seeing the bird picture?"), rated 1-9 (1 = not at all fearful, 9 = extremely fearful); (4) anger level ("How angry do you feel when seeing the bird picture?"), rated 1-9 (1 = not at all angry, 9 = extremely angry); and (5) avoidance distance from the CS, rated 1-9 (higher numbers = greater distance). US expectancy was rated before CS presentation; the other four measures were assessed before and after each learning phase. For measures 1-4, the probe text appeared at the top of the screen, the representative bird/fish picture in the center, and the rating scale at the bottom. For avoidance distance, the probe appeared at the top, the representative picture on the lower left, and a 1-9 scale on the lower right. Participants moved a blue figure representing themselves along the scale and were asked "Which number do you want to move to relative to the bird/fish?" Higher numbers indicated greater distance and avoidance.

Shock discomfort was measured twice: once after Day 1 acquisition (followed by II training in the II group) and once after Day 3 reinstatement testing (following the four CS-related subjective ratings). After Day 3 reinstatement, participants also recalled how many shocks followed each CS category on Day 1.

2.4 Physiological Recording

Skin conductance response (SCR) was recorded using two Ag/AgCl standard electrodes (8mm diameter) filled with 0.05M NaCl electrolyte, connected to a Biopac® MP150 electrodermal activity amplifier (Biopac Systems, Inc., Goleta, California, USA) attached to the index and middle fingertips of the non-dominant hand. The raw signal was processed with a 10Hz low-pass filter, recorded at 5 S/V resolution, and amplified signals were continuously sampled at 2000Hz. Since fear and anger are defense responses to threat marked by sympathetic nervous system activation (Damasio & Carvalho, 2013), their peripheral physiological responses show substantial overlap, including increased heart rate and blood pressure, elevated skin conductance, and vasoconstriction (Stemmler et al., 2001). Due to this overlap and because Day 2 extinction training comprised 96 trials, we did not expect significant between-group SCR differences and thus only collected SCR data during Day 1 acquisition and Day 3 reinstatement.

2.5 Procedure

The experiment was programmed and run using E-Prime 2.0 software across three days: Day 1 acquisition, Day 2 extinction, and Day 3 spontaneous recovery/reinstatement testing and picture recognition. Stimulus types, presentation durations, and inter-stimulus intervals were identical each day. The experimental design and procedure are illustrated in Figure 1.

Day 1 Fear Conditioning: After presenting ID and signing consent, participants completed the State-Trait Anxiety Inventory (STAI) (Spielberger et al., 1983), Beck Depression Inventory (BDI) (A. T. Beck et al., 1996), Trait Anger Scale (Tibubos et al., 2020), and Intolerance of Uncertainty Scale (IUS) (Buhr & Dugas, 2002). After electrode placement and shock calibration (30-70V range), participants rested 4-5 minutes before viewing instructions stating that fish and bird pictures would appear and they should learn to predict shock likelihood. Acquisition used 15 unique fish and 15 bird pictures with a 2/3 reinforcement rate. The 1st, 3rd, 5th, 10th, and 12th CS+ trials were non-reinforced (pseudo-random). The first two trials were one CS− and one non-reinforced CS+ (order counterbalanced) with pre-CS US expectancy ratings. Remaining trials were divided into two blocks of 14 trials each (5 CS+-US, 2 CS+-no US, 7 CS−). Each block began with US expectancy ratings for CS− and CS+-no US trials; the other 30 trials had no US expectancy ratings. CS order was pseudo-random. After each block, participants recalled which picture category was followed by shocks and completed CS-related subjective ratings (association, fear, anger, avoidance), then rested 1-2 minutes. After acquisition, shock discomfort was rated. The control group then left, while the II group received additional 3-minute II training, silently rehearsing: "If I feel afraid when viewing fish and bird pictures, I will find myself stupid for fearing an animal picture, and I will clench my fists and feel very angry with myself, very angry!!" They spent two minutes with eyes closed imagining executing this intention and were told the training was important for Day 2 and should be practiced mentally. Pre-training on Day 1 ensured the II would be automatic for Day 2 extinction.

Day 2 Fear Extinction: After 4-5 minutes of quiet sitting, participants completed the four CS-related subjective ratings to test whether post-acquisition II training on Day 1 had created group differences. The control group then proceeded directly to extinction, while the II group first recalled the previous day' s II statement and typed it into the computer. The correct II statement then appeared, and participants rated their recall accuracy. If subjective similarity $ $5, they completed 3 minutes of II training; if <5, they completed 6 minutes. The II group then entered extinction. Extinction used 24 new fish and 24 bird pictures, each repeated twice for 96 trials divided into three blocks. Each block randomly presented 16 CS+ and 16 CS− trials, all without shock. As in acquisition, each block began with US expectancy ratings for CS− and

CS+ trials; the remaining 30 trials had no US expectancy ratings. CS order was pseudo-random. After each block, participants completed four CS-related subjective ratings, rested 1-2 minutes, then continued.

Day 3 Fear Recovery Test: After 4-5 minutes of quiet sitting, participants first completed four CS-related subjective ratings as a spontaneous recovery test (SR) to assess Day 2 extinction effects. They then received four unsignaled shocks (200 ms each) with inter-shock intervals of 20, 30, 25, and 15 seconds. After a 10-minute rest, reinstatement testing began. This comprised nine trials, each beginning with expectancy ratings followed by CS presentation using nine old pictures from Day 1 (5 CS−, 4 CS+ that had been paired with shock). The first trial was CS−, followed by two blocks with 2 CS+ and 2 CS− trials each, all without shock. After each block, participants completed four CS-related subjective ratings; there was no rest between blocks. After reinstatement, shock discomfort was rated and participants recalled how many shocks followed each picture category on Day 1. The few reinstatement trials were based on the assumption that group differences would appear primarily in early trials, after which both groups would rapidly extinguish due to the 96 extinction trials on Day 2. Additionally, we were not concerned about post-reinstatement fear because the subsequent 136-picture recognition test would itself produce extinction effects.

Day 3 Post-Reinstatement Memory Test (Surprised Recognition Test): After reinstatement, participants completed an unexpected picture recognition test to assess whether anger-countering II regulated emotions automatically without increasing cognitive effort. They judged whether pictures were "old" (presented in the first two days) or "new" (never presented), rating confidence on keys 1-3 for old pictures (lower numbers = more confident seen) and 4-6 for new pictures (higher numbers = more confident not seen). The test included 136 pictures (68 fish, 68 birds): 10 old pictures from Day 1 (excluding those used in reinstatement), 24 old pictures from Day 2, and 34 new pictures. Pictures were divided into six groups by novelty (Day 1 old, Day 2 old, new) and CS type (CS+, CS−), with pseudo-random group order ensuring no more than two consecutive pictures from the same group, though CS order within groups was random. Each picture appeared with a 1-6 novelty rating scale at the bottom for responses, disappearing after keypress. Inter-trial intervals were 1-second red fixation crosses. After recognition testing, four CS-related subjective ratings were collected again before debriefing and compensation. This post-reinstatement recognition test followed previous research (Kroes et al., 2017).

The overall procedure is shown in Figure 3 [Figure 3: see original paper]. Figure 1 illustrates the experimental design and procedure: (A) experimental flow and trials (blue arrows = four CS-related subjective ratings; red arrows = II training; "US expectancy" = pre-CS rating screen); (B) block 1 flowcharts for Day 1 acquisition (left) and Day 2 extinction (right), using fish as CS+; (C) representative CS pictures for subjective ratings (bird: top; fish: bottom); (D) schematic for US expectancy (left), CS avoidance (center), and picture recognition (right) ratings.

2.6 Data Analysis

All analyses used SPSS 26.0. Continuous variables are presented as mean ± standard deviation (M±SD). Between-group baseline differences (age, trait anxiety, etc.) were compared using chi-square (^{2}) or Welch' s corrected independent samples t-tests. For subjective measures (fear, anger, association, avoidance, US expectancy) across acquisition, extinction, spontaneous recovery, and reinstatement phases, CS difference scores (CS+ minus CS−) served as dependent variables in repeated-measures ANOVA testing group (II vs. control) × time point (block or test time) interactions and main effects. For SCR and post-reinstatement recognition, two-way repeated-measures ANOVA examined group (II, control) × CS (CS+, CS−). Significant interactions were followed by simple effects analysis with Bonferroni correction for multiple comparisons. Effect sizes are reported as partial ^{2}. Statistical significance was set at $\alpha = 0.05$ (two-tailed).

SCR data were analyzed using AcqKnowledge 4.2 software. Data were low-pass filtered (Blackman −92 dB, 1 Hz) before analysis (Stussi et al., 2019). SCR magnitude for each CS trial was calculated as the peak skin conductance difference (in microsiemens) within a 0.5-5.5 second window post-stimulus onset. Raw SCR values were square-root transformed to normalize distributions, then divided by each participant' s maximum SCR value that day for standardization to facilitate group comparison (Scheuermann et al., 2025).

3. Results

3.1 Control Variables

Groups did not differ significantly on sex ratio, age, state anxiety, trait anxiety, depression, intolerance of uncertainty, trait anger, US intensity, or US unpleasantness (Table 1).

Table 1 Descriptive statistics for participant grouping and questionnaire data (M±SD)

Variable	II Group (n=19)	Control Group (n=18)	^{2}/t
Age (years)	20.74 ± 1.91	20.78 ± 2.02	-
STAI-S	42.95 ± 4.64	44.56 ± 4.22	-
STAI-T	45.74 ± 4.70	44.00 ± 3.63	-
Shock Unpleasantness	37.21 ± 7.08	37.33 ± 8.16	-
BDI	19.84 ± 4.71	20.94 ± 4.61	-
IUS	52.40 ± 4.75	54.71 ± 10.62	-
Trait Anger	7.53 ± 0.77	7.50 ± 0.79	-

Note: II = Implementation Intention group; STAI-S = State Anxiety Inventory; STAI-T = Trait Anxiety Inventory; BDI = Beck Depression Inventory; IUS = Intolerance of Uncertainty Scale.

3.2 Subjective Assessments

CS difference scores (CS+ minus CS−) for fear, anger, association, avoidance, and US expectancy across phases are shown in Figure 2 [Figure 2: see original paper].

Day 1 Fear Acquisition: Two-way repeated-measures ANOVA (group [II, control] × block [B1, B2]) on CS difference scores revealed no significant group main effects for any measure (fear: $F(1,35) = 0.041$, $p = 0.841$; anger: $F(1,35) = 0.088$, $p = 0.769$; association: $F(1,35) = 3.782$, $p = 0.06$; avoidance: $F(1,35) = 0.952$, $p = 0.336$; US expectancy: $F(1,35) = 0.564$, $p = 0.458$). Block main effects were significant, with all CS difference scores higher in Block 2 than Block 1 (fear: $F(1,35) = 25.524$, $p < 0.001$, $p^2 = 0.465$; association: $F(1,35) = 24.466$, $p < 0.001$, $p^2 = 0.422$; anger: $F(1,35) = 30.448$, $p < 0.001$, $p^2 = 0.445$; US expectancy: $F(1,35) = 24.356$, $p < 0.001$, $p^2 = 0.410$; avoidance: $F(1,35) = 28.013$, $p < 0.001$, $p^2 = 0.410$). No significant group × block interactions emerged (all ps > 0.147). These results indicate successful and equivalent fear conditioning across groups.

Day 2 Fear Extinction: Two-way repeated-measures ANOVA (group [II, control] × time [preExt, B1, B2, B3]) on CS difference scores showed no significant group main effects for fear ($F(1,35) = 1.571$, $p = 0.218$) or anger ($F(1,35) = 3.373$, $p = 0.075$). However, the control group showed significantly higher association scores than the II group ($F(1,35) = 5.218$, $p = 0.029$, $p^2 = 0.128$), and the control group also showed marginally higher avoidance ($F(1,35) = 5.133$, $p = 0.030$, $p^2 = 0.124$), indicating that forming anger-countering II before extinction facilitated fear extinction and reduced CS+ avoidance. Time main effects were significant for all measures (fear: $F(3,105) = 38.151$, $p < 0.001$, $p^2 = 0.522$; anger: $F(3,105) = 24.055$, $p < 0.001$, $p^2 = 0.407$; association: $F(3,105) = 69.916$, $p < 0.001$, $p^2 = 0.666$; avoidance: $F(3,105) = 9.415$, $p < 0.001$, $p^2 = 0.212$). Bonferroni post-hoc tests showed all CS difference scores at extinction end (B3) were significantly lower than pre-extinction (preExt) (all ps < 0.007). No significant group × time interactions emerged for anger, association, or avoidance (all ps > 0.100). However, fear showed a significant group × time interaction ($F(3,105) = 4.933$, $p = 0.012$, $p^2 = 0.13$). Simple effects analysis revealed no group differences at preExt or B1 (preExt: $p = 0.328$; B1: $p = 0.088$), but significant differences at B2 and B3 (both $p = 0.038$). The II group' s fear difference scores were significantly higher at preExt than at all other time points (all ps < 0.001), with no differences among B1, B2, and B3 (all ps > 0.218). The control group showed preExt significantly higher than B2 and B3 ($p = 0.032$ and $p = 0.007$), with no differences among B1, B2, and B3 (all ps > 0.191). This indicates both groups showed fear expression to CS+ at extinction onset that decreased significantly after extinction training, reducing the CS+

vs. CS− difference, but the II group showed superior extinction.

For US expectancy during extinction, two-way ANOVA (group [II, control] × block [B1, B2, B3]) revealed no significant group main effect ($F(1,35) = 2.177$, $p = 0.149$) or group × block interaction ($F(2,70) = 1.409$, $p = 0.251$), but a significant block main effect ($F(2,70) = 18.542$, $p < 0.001$, $p^2 = 0.346$). Bonferroni tests showed US expectancy difference scores at B3 were significantly lower than B1 and B2 (both ps < 0.001), and B2 was lower than B1 ($p = 0.035$), indicating successful extinction in both groups.

Day 3 Fear Return Test: Two-way repeated-measures ANOVA (group [II, control] × time [SR, B1, B2]) on CS difference scores showed the II group was significantly lower than the control group on all four measures (fear: $F(1,35) = 6.540$, $p = 0.015$, $p^2 = 0.157$; anger: $F(1,35) = 7.787$, $p = 0.008$, $p^2 = 0.182$; association: $F(1,35) = 4.590$, $p = 0.039$, $p^2 = 0.116$; avoidance: $F(1,35) = 6.000$, $p = 0.019$, $p^2 = 0.146$). Significant time main effects emerged for fear ($F(2,70) = 3.661$, $p = 0.039$, $p^2 = 0.095$) and association ($F(2,70) = 7.918$, $p = 0.004$, $p^2 = 0.184$); anger showed a marginal time effect ($F(2,70) = 3.650$, $p = 0.052$, $p^2 = 0.094$), while avoidance showed no time effect ($F(2,70) = 0.239$, $p = 0.747$). Bonferroni tests showed fear and association difference scores at spontaneous recovery (SR) were significantly higher than at reinstatement end (B2) (both ps < 0.05). No significant group × time interactions emerged (all ps > 0.280). For post-reinstatement US expectancy across four trials, two-way ANOVA (group [II, control] × trial [t1, t2, t3, t4]) showed a significant group main effect ($F(1,35) = 7.588$, $p = 0.009$, $p^2 = 0.178$), with control group US expectancy difference scores significantly higher than the II group. Trial main effect was also significant ($F(3,105) = 10.066$, $p < 0.001$, $p^2 = 0.223$). Bonferroni tests showed US expectancy at trial 4 was significantly lower than at trials 1-3 (all ps < 0.029), indicating rapid threat expectancy reduction even across only four trials. No group × trial interaction emerged ($F(3,105) = 1.892$, $p = 0.149$). These results demonstrate that anger-countering II significantly reduces conditioned fear return.

3.3 Day 3 Unexpected Recognition Memory Test

In the post-reinstatement recognition test, two-way ANOVA (group [II, control] × CS [CS+, CS−]) revealed no significant main effects or interactions for Day 1 acquisition pictures (group: $F(1,35) = 0.100$, $p = 0.921$; CS: $F(1,35) = 1.369$, $p = 0.250$; interaction: $F(1,35) = 0.049$, $p = 0.827$), Day 2 extinction pictures (group: $F(1,35) = 0.007$, $p = 0.935$; CS: $F(1,35) = 0.488$, $p = 0.489$; interaction: $F(1,35) = 1.614$, $p = 0.212$), or new pictures (group: $F(1,35) = 0.009$, $p = 0.923$; CS: $F(1,35) = 2.193$, $p = 0.148$; interaction: $F(1,35) = 0.421$, $p = 0.521$).

3.4 Physiological Indices

SCR results for acquisition and reinstatement are shown in Figure 3 [Figure 3: see original paper].

Day 1 Fear Acquisition: One control participant' s data were missing. Two-way repeated-measures ANOVA (group [II, control] × stimulus [CS+, CS−]) on the final acquisition trial revealed a significant stimulus main effect ($F(1,34) = 15.256$, $p < 0.001$, $p^2 = 0.31$), with CS+ SCR significantly higher than CS−. No group effect ($F(1,34) = 0.060$, $p = 0.808$) or group × stimulus interaction ($F(1,34) = 0.064$, $p = 0.801$) emerged.

Day 3 Fear Reinstatement: Two-way ANOVA (group [II, control] × stimulus [CS+, CS−]) on the first reinstatement trial showed no significant stimulus main effect ($F(1,35) = 0.542$, $p = 0.467$), group effect ($F(1,35) = 0.213$, $p = 0.647$), or group × stimulus interaction ($F(1,35) = 0.314$, $p = 0.579$).

4. Discussion

This study explored how forming anger-countering II before extinction training affects fear extinction and return. Results showed that during extinction, the II group had significantly lower CS-US association and avoidance tendency than the control group. On Day 3, during both spontaneous recovery and reinstatement tests, the II group showed significantly lower subjective ratings on all measures than the control group (US expectancy was not measured during spontaneous recovery). This indicates that forming anger-countering II before extinction facilitates fear extinction and reduces spontaneous recovery and reinstatement. However, as reported in some literature (Haesen & Vervliet, 2015; Scheuermann et al., 2025), this study also found a dissociation between subjective ratings and SCR. Specifically, during Day 3 reinstatement, SCR showed no significant between-group differences, CS differences, or group × stimulus interactions. Possible explanations include: (1) The high-intensity extinction training on Day 2 (96 trials: 48 CS+, 48 CS−) may have sufficiently weakened physiological fear responses to CS+. (2) Novelty of CS+ and CS− pictures may have obscured differential fear responses. SCR is an autonomic orienting response to novel stimuli (Zimmer & Richter, 2023). Although test pictures were used on Day 1, they were only presented once and after a 48-hour interval, making these colorful images still highly novel and eliciting strong orienting responses. (3) The four unsignaled shocks during reinstatement may have produced strong physiological arousal that masked differential CS fear responses. Regardless, equivalent SCR levels across groups indicate that the anger-countering II strategy did not increase physiological arousal. From an intervention perspective, this is beneficial because it aligns with the "controlled" and "non-cathartic" design principle, showing that using anger as a tool did not introduce additional, unintended physiological stress or burden, supporting overall physiological homeostasis recovery and avoiding "robbing Peter to pay Paul" side effects, thereby enhancing clinical safety. However, from a research perspective, SCR' s failure to reflect group differences evident in subjective reports highlights a key methodological challenge: validating whether this paradigm successfully induced the target state—brief, conditionally-triggered, goal-directed, and controlled anger—is extremely difficult via peripheral physiological indices.

The core problem is that both fear and anger activate the sympathetic nervous system (Damasio & Carvalho, 2013), showing substantial peripheral response overlap (Stemmler et al., 2001). This physiological similarity makes distinguishing fear-related arousal from the specific anger induced by our design nearly impossible. Therefore, this study relied primarily on verbal reports to confirm anger experience.

The II content— "If I feel afraid when viewing fish and bird pictures, I will find myself stupid for fearing an animal picture, and I will clench my fists and feel very angry with myself, very angry!!" —aimed to induce anger and harness its energizing and motivational properties to help participants overcome fear and approach the actually safe CS+. According to MPMC theory, fear catalyzes anger (Zhan et al., 2015, 2018). At acquisition end, participants reported high fear (II: 7.06; control: 7.26) and anger (II: 6.29; control: 5.95), leading us to expect greater anger during extinction in the II group. Unexpectedly, after the first extinction block (16 CS+, 16 CS−), the II group' s fear (3.53) and anger (3.00) toward CS+ had already decreased to low levels, and on Day 3 the II group' s anger was significantly lower than the control group' s. One possibility is that the instructions actually prompted cognitive reappraisal. The phrases "find myself stupid" and "angry with myself" are information participants are motivated to avoid and resolve. Emotion can influence certainty and thus information processing (Tiedens & Linton, 2001). High-certainty emotions like anger and happiness increase heuristic processing by increasing schematic thinking and expert knowledge use, while low-certainty emotions like fear may decrease heuristic processing. Anger also stimulates shallow cognitive analysis and immediate action (Parker & Isbell, 2010). Thus, the self-esteem threatening and self-annoying content may have prompted participants to restructure the situation: they were only facing fish or bird pictures, and fearing such harmless images was completely unnecessary, thereby eliminating CS fear and reducing anger. This differs from previous II studies focusing on non-emotional cognitive reappraisal (e.g., "I will not feel disgusted; if I see blood, I will adopt a doctor' s perspective" (Chen et al., 2020, 2021; Gomez et al., 2015; Huang et al., 2020) or "I will not feel disgusted; if I see blood, I will view it as representing vitality and health" (Ma et al., 2019)). Another possibility is that participants practiced the II during extinction; the induced anger helped them bravely face CS pictures without adverse consequences, recognized safety, promoted extinction, and weakened Day 3 fear return. The control group extinguished fear through safe CS repetition on Day 2, reducing anger, but fear and anger returned on Day 3. Our results demonstrate that skillfully harnessing anger can reduce rather than increase anger while achieving fear reduction.

Previous research shows that forming II enables automatic negative emotion regulation (Azbel-Jackson et al., 2016; Chen et al., 2020, 2021; Gallo et al., 2009; Gomez et al., 2015; Hallam et al., 2015; Huang et al., 2020; Ma et al., 2019). However, these studies have two key limitations: (1) Minimal time intervals between II training and application, relying on averaged effects across many trials, leaving unclear when the automatic regulation process is established (immediate vs. after multiple practices) and how; (2) Scant research on delayed effects. Our findings provide new evidence: (1) Participants formed II after Day 1 acquisition and could recall it well, but baseline assessments before Day 2 extinction showed no group differences, indicating II did not take immediate effect. During extinction, groups remained equivalent through the first two blocks (48 trials), with the II group only showing significantly shorter CS avoidance distance at the final block end (near trial 72). This suggests II' s automatic regulation is not established immediately after training but requires sufficient practice to develop, first manifesting in behavioral avoidance improvement. (2) Although no II training occurred on Day 3, the II group showed significantly lower fear, anger, avoidance, and threat expectancy than the control group during fear return tests, indicating that after repeated practice during Day 2 extinction, II' s emotional regulation became automatic, producing robust delayed effects. (3) The recognition memory test (Figure 2F) showed no group differences, suggesting that while II formation and recall are cognitively demanding (conscious, explicit), its execution in emotional regulation is automatic and does not involve intentional regulatory effort toward emotional stimuli (Chen et al., 2021; Gallo et al., 2009). In summary, II initiation of target responses (e.g., emotion regulation) is not completely "immediately automatic" ; early execution may require some cognitive involvement and multiple practices to become automatic. This automation process may vary by task characteristics. Compared to weaker automatic responses in previous studies (e.g., disgust from blood pictures), the strong fear responses in our study (CS-evoked shock fear) may require more practice for II to become effective.

The II group' s shorter avoidance distance during late extinction and fear return tests provides important behavioral evidence that II promotes fear extinction and reduces fear return. This has methodological significance. Traditional avoidance measurement methods include: (1) No/low-cost avoidance tasks where participants can prevent US via keypress (Klein et al., 2021) or joystick (Glogan et al., 2023); (2) Approach-avoidance tasks (AAT) where choosing CS+ may yield shock but earns rewards/money, while choosing CS− avoids shock but loses money (Berg et al., 2021; Pittig, 2019; Pittig et al., 2021). Both have limitations: no/low-cost tasks often produce excessive avoidance even when clearly ineffective (De Kleine et al., 2023; Pittig & Wong, 2021); costly AAT involves multiple motivational conflicts (approach reward vs. avoid fear) and cost-benefit trade-offs. Individual differences in shock sensitivity and reward valuation create varying "avoidance costs," indirectly affecting extinction. AAT choices also evoke implicit agency (sense of control over external events via one' s actions) (B. Beck et al., 2017), which itself can reduce fear (Sugawara et al., 2022). Using such tasks would make it unclear whether extinction effects were due to II manipulation or reward reinforcement in the avoidance test. Moreover, both anger and rewards elicit approach behavior, making it difficult to disentangle their contributions. Therefore, to more directly measure avoidance tendency toward CS stimuli while avoiding interference from motivational conflict, cost differences, agency, and reward approach motivation, we modified previous avoidance paradigms (Aupperle et al., 2011) to create a simplified numeric scale task retaining only the "avoidance" dimension. Participants used 1-9 ratings to control a figure's distance from the CS, with lower numbers indicating lower avoidance (greater willingness to approach). This method stripped direct associations with external reward/punishment, focusing on subjective avoidance willingness toward CS stimuli. Using this approach, we clearly captured the II group' s shorter avoidance distance during late extinction.

Although recent research has examined emotional counteraction, few have studied anger countering fear or treating PTSD-related fear symptoms, likely due to concerns about counterproductive effects. Anger countering fear may resemble a risky "fighting poison with poison" approach, but risky is not necessarily wrong. This study demonstrates that if individuals can be guided to use anger in controlled, goal-directed ways, it may convert resistance into motivation, becoming an effective tool against fear and for restoring control. However, given anger' s potential to trigger aggressive behavior, its use requires extreme caution. Research shows that the link between anger and PTSD may be unique to individuals with impulsive aggression (Teten et al., 2010), trait anger is a PTSD risk factor (McHugh et al., 2012), and it mediates PTSD' s effect on aggression (Bhardwaj et al., 2019). Some researchers propose that activation of threat-related cognitive networks strongly enhances anger in a positive feedback loop, and when combined with combat-related PTSD symptoms, inhibitory control over aggression is overridden, increasing violence (Novaco & Chemtob, 2015). Therefore, when using anger for counteraction or regulation, one must consider the individual, context, and conditions—it cannot be applied indiscriminately. Strategies must be skillful and measured. Anger-based countering may be considered for individuals with high fear or avoidance symptoms but no anger symptoms when safe therapy is ineffective, with careful attention to induction method and intensity. For individuals with impulsive aggression tendencies, high trait anger, or specific populations (e.g., veterans), anger-based emotion regulation methods should be used cautiously to avoid potential harm. Given anger' s complex role in fear-related disorders (as both secondary symptom and independent risk factor), developing "personalized" interventions and targeted prevention programs is crucial (Lonsdorf & Merz, 2017).

To overcome limitations of physiological indices like SCR in distinguishing fear from specific anger states and to more comprehensively understand psychophysiological responses, future research should explore more specific physiological measures such as heart rate variability, electromyography, and respiratory patterns, and utilize neuroscientific tools like functional near-infrared spectroscopy and fMRI to deeply explore how extinction training combined with cognitive reappraisal and II strategies affects neural system activity, more precisely describing the neural mechanisms of this intervention. Combining these methods will enable more comprehensive and sensitive evaluation of II' s functional effects in extinction training and allow precise mapping of the neural mechanisms underlying this anger-countering cognitive-emotion regulation strategy. This will not only advance fear extinction and emotion regulation theory but also provide more targeted and predictive biomarkers for clinical translation, guiding development of personalized treatment plans. Additionally, Brewster et al. (2016) found that II can change behavior not only in specific situations but also in similar contexts. Recent research shows that II-based emotion regulation generalizes to target-related but unplanned situations, with broader target coverage increasing generalization (Huang et al., 2020). Future research should explore whether II' s regulatory effects generalize to other conditioned stimuli and non-specific contexts. Meta-analyses show that II formation helps people with mental health problems achieve various goals (Toli et al., 2015). Future studies should test whether forming anger-countering II can improve treatment outcomes for anxiety or fear-related disorders in clinical samples undergoing CBT. Moreover, long-term follow-up studies assessing intervention durability are essential for validating clinical value, helping understand potential delayed effects or change patterns and their influencing factors.

5. Conclusion

Forming anger-countering implementation intentions before extinction requires multiple practice trials to automatically initiate behavioral responses and can reduce fear reinstatement and avoidance tendencies. This may offer new approaches for treating fear and anxiety-related disorders.

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Note: Figure translations are in progress. See original paper for figures.