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Enhanced Mental Reinstatement of Exposure to Improve Extinction Generalization: A Study on Claustrophobia and MRI Fear

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Fear of enclosed spaces prevents many people from receiving magnetic resonance imaging (MRI) scans. Although exposure therapy can effectively treat such fears, reductions in fear during exposure often do not generalize beyond the context in which they took place. This study tested a strategy designed to increase generalization, which involved revisiting the memory of a prior exposure to enhance retrieval of extinction learning. Forty-five participants with claustrophobia that included fear of MRI scans underwent a series of exposures lying inside a narrow cabinet. One week later, participants were randomly assigned to enhanced mental reinstatement (EMR) or control procedures. Prior to entering a mock MRI scanner, EMR participants recalled the memory of exposure training and listened to an audio recording of themselves describing what they learned, whereas control participants recalled a neutral memory. Compared to the control condition, EMR led to significantly reduced heart rate reactivity in the mock MRI scanner, but not self-reported fear or avoidance. There were no differences between conditions in claustrophobia symptoms or MRI fear at 1-month follow-up. Results suggest some benefits of mental reinstatement for improving generalization of gains following exposure training for claustrophobia, with measures of subjective fear and physiological arousal showing discordant outcomes.

Keywords: exposure therapy; extinction; generalization; claustrophobia; anxiety disorders; fear

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EXPOSURE-BASED cognitive-behavioral therapy has been shown to be the gold-standard treatment for anxiety disorders, yet treatment outcomes remain suboptimal (Carpenter et al., 2018). One hypothesized reason for this is that the learning that occurs during exposures, known as extinction learning, often does not generalize well across dif-

ferent feared situations (Dibbets et al., 2013; Mineka et al., 1999; Mystkowski et al., 2002; Vervliet et al., 2005). A failure to generalize can prevent successful exposures conducted with a therapist from translating to reduced anxiety outside of the treatment context (de Jong et al., 2019). It can also leave individuals vulnerable to relapse when encountering novel feared situations, or even a familiar fear in a new context (Abramowitz & Arch, 2014). Furthermore, poor generalization has been associated with worse treatment response (Richter et al., 2021), and likely reduces treatment efficiency given the wide variety of scenarios that individuals with anxiety disorders tend to fear.

Techniques aimed at improving generalization typically attempt to increase the likelihood that the safety memory formed during extinction learning is retrieved after a context change, thereby inhibiting fear expression (Bouton, 2002; Craske et al., 2018). One promising clinical approach to facilitating extinction memory retrieval across contexts is called mental reinstatement, which involves recalling in one's imagination what happened during a prior exposure, as well as the context in which it occurred, before encountering a new exposure context (Elsesser et al., 2013; Laborda et al., 2016; Mystkowski et al., 2006). Mental reinstatement of the context where information was encoded has been shown to reduce the decrement in memory that occurs after a context change (Smith & Vela, 2001), and thus could help facilitate safety memory retrieval. In addition, deliberately recalling the nonoccurrence of feared outcomes and one's ability to tolerate fear in a previous exposure could help provide individuals an explicit reason to feel less afraid in a different feared situation. Therefore, mental reinstatement may enhance generalization not just through eliciting retrieval of prior safety learning, but also by utilizing top-down reasoning processes known to influence fear extinction (Blechert et al., 2015; Hofmann, 2008; Lovibond, 2004).

Studies examining mental reinstatement to enhance generalization have shown some promise, but effects are inconsistent. Mystkowski et al. (2006) showed that in spider phobics, mental reinstatement of exposure led to reduced recovery of subjective fear after a context change compared to reinstatement of a neutral memory. Mental reinstatement also led to shorter approach latencies to a novel phobic stimulus after exposure for dental phobia (Elsesser et al., 2013). However, a study on public speaking anxiety found no effect of mental reinstatement on fear renewal (Laborda et al., 2016), and in the spider and dental phobia studies, positive results were limited to one of several indicators of fear recovery. In a variation on mental reinstatement procedures, McGlade and Craske (2021) found that repeated mental rehearsal of the exposure memory in the days following exposure training (rather than reinstatement immediately before a subsequent exposure) led to reduced anticipatory anxiety and avoidance when re-encountering the same exposure situation, though this study did not test generalization to a new context.

Importantly, the mental reinstatement procedures used in the studies examining generalization involved minimal guidance on what participants should recall about their prior exposure treatment. The way an exposure is evaluated after it occurs can impact subsequent fear responses (Raeder et al., 2019), indicating that variability in what a participant recalls about their exposure experience during mental reinstatement (e.g., recalling how aversive it was) could substantially alter its effects. In addition, participants in previous mental reinstatement studies may not have viewed the outcome of the previous exposure as sufficiently relevant to a new feared situation, particularly since the outcome of a single exposure may be attributed to the specific context in which it occurred (Bouton, 2002; Vervliet et al., 2013). If this occurs, previously held fear associations would be more likely to predominate and advantages of reinstating the exposure memory could be lessened.

To address these potential pitfalls of mental reinstatement, the present study sought to test a modified version of the procedure designed to (1) enhance recall of the most therapeutic components of an exposure experience and (2) facilitate reasoning processes about the relevance of the recalled memory to a similar, novel situation that evokes fear. To do so, participants undergoing mental reinstatement were explicitly instructed to recall the extent to which fear levels changed and feared outcomes did not occur during exposure training. Facilitating awareness of the nonoccurrence of feared outcomes is thought to drive the development and retention of new nonfearful associations (Craske et al., 2008) and has been shown to improve exposure outcomes (Deacon et al., 2013; McGlade & Craske, 2021; Raeder et al., 2019). Therefore, highlighting the extent to which expectancies were violated in a prior exposure should help to more effectively retrieve the newly developed nonthreat association in place of the original threat association, thereby decreasing fear in a new exposure situation. To further control the content, enhance the level of detail, and maximize the salience of what participants recalled, mental

reinstatement procedures were also augmented by having participants listen to an audio recording of themselves (created immediately after training) articulating what happened during the exposure and what they learned about their feared outcomes.

Another modification to the mental reinstatement procedure was to have participants identify similarities between prior and subsequent exposure situations, and then articulate how the learning recalled from the prior exposure was relevant to the upcoming situation. This was done to explicitly harness top-down cognitive processes and facilitate the generation of propositional beliefs about the likelihood of safety and one's ability to cope. Threat expectancies and coping beliefs have been shown to impact exposure outcomes (Fentz et al., 2013; Valentiner et al., 1996), including generalization of therapeutic changes to untreated exposure situations (Williams et al., 1989). Moreover, enhancing the perceived relevance of an extinction experience has been shown to improve generalization (Scheveneels et al., 2017). Therefore, helping participants reason how prior learning about the absence of expected danger applies to a novel feared situation was expected to facilitate greater awareness that feared consequences related to the new exposure situation are unlikely to occur.

To test the effect of such a manipulation, the present study examined individuals with claustrophobia that included a fear of magnetic resonance imaging (MRI) scans, a commonly avoided claustrophobic situation. Approximately 1% of patients in need of an MRI refuse or prematurely terminate a scan due to claustrophobia, posing a significant problem for accurate detection of many serious medical issues (Munn et al., 2015). Although exposure therapy has potential for significantly helping to alleviate this problem, poor generalization from exposure training in a separate context to an actual MRI could limit its utility. Accordingly, MRI-related claustrophobia offers a target for investigating generalization that has ecological validity and relates to an important public health issue.

The primary aim of this study was to compare the effects of the enhanced mental reinstatement (EMR) procedures described above with standard exposure (SE) on the generalization of gains after a single session of exposure training for claustrophobia. Main outcomes were the recovery of subjective, behavioral, and physiological indices of fear during exposure to a mock MRI 1 week after exposure training in a different context. We also examined the effect of EMR vs. SE on feared outcome expectancies prior to entering the mock MRI, self-reported claustrophobia symptoms at 1-month follow-up, and expected fear and likelihood of getting a real MRI scan. Given the emphasis on nonoccurrence of feared outcomes in the EMR intervention, it was hypothesized that larger reductions in feared outcome expectancies resulting from the EMR manipulation would mediate intervention effects. Furthermore, we conducted exploratory analyses examining whether effects of EMR were influenced by what participants described learning after exposure training, as the quality of such learning could impact the benefits of mentally reinstating the exposure memory (methods and results described in Supplementary Materials).

Methods

PARTICIPANTS

Participants consisted of adults ($n = 45$) endorsing claustrophobia recruited through university student job sites, Craigslist, email list-serves of local hospitals, and an affiliated anxiety clinic. Participants received $75 for their participation. See Figure 1 for a CONSORT diagram. Inclusion criteria included: (1) 18–75 years of age; (2) self-reported fear of enclosed spaces at a moderate or greater level (≥2 on a 0–4 Likert scale); (3) expected fear of being in an MRI scanner at a moderate or greater level (≥2 on a 0–4 Likert scale); and (4) peak self-reported fear during a behavioral approach test (BAT) in a claustrophobia chamber (i.e., a horizontal metal cabinet) of ≥50 of 100. Participants with peak fear <50 who exited the cabinet before the end of the 2-minute BAT for fear-related reasons were also eligible. Exclusion criteria included: (1) a medical condition that contraindicated participation in claustrophobia exposures; (2) exceeding height and weight limits for claustrophobic spaces used in this study, specifically >350 lbs and >6′4″; (3) prior exposure therapy for claustrophobia; (4) bipolar disorder, psychotic disorder, or cognitive dysfunction likely to impair participation in study activities; (5) refusal to enter the claustrophobia chamber during the initial BAT. Participants who took as-needed medication for anxiety were asked to refrain from taking medication the day leading up to study visits.

The sample was racially/ethnically diverse, with 40% identifying as Asian, 36% White/Caucasian, 18% Black/African American, 4% Latinx, and 2% multiracial. Females made up 64% of the sample, mean age was 29.2 ($SD = 12.3$), and 58% of participants were graduate or undergraduate students. Most participants (84%) met DSM-5 diag-

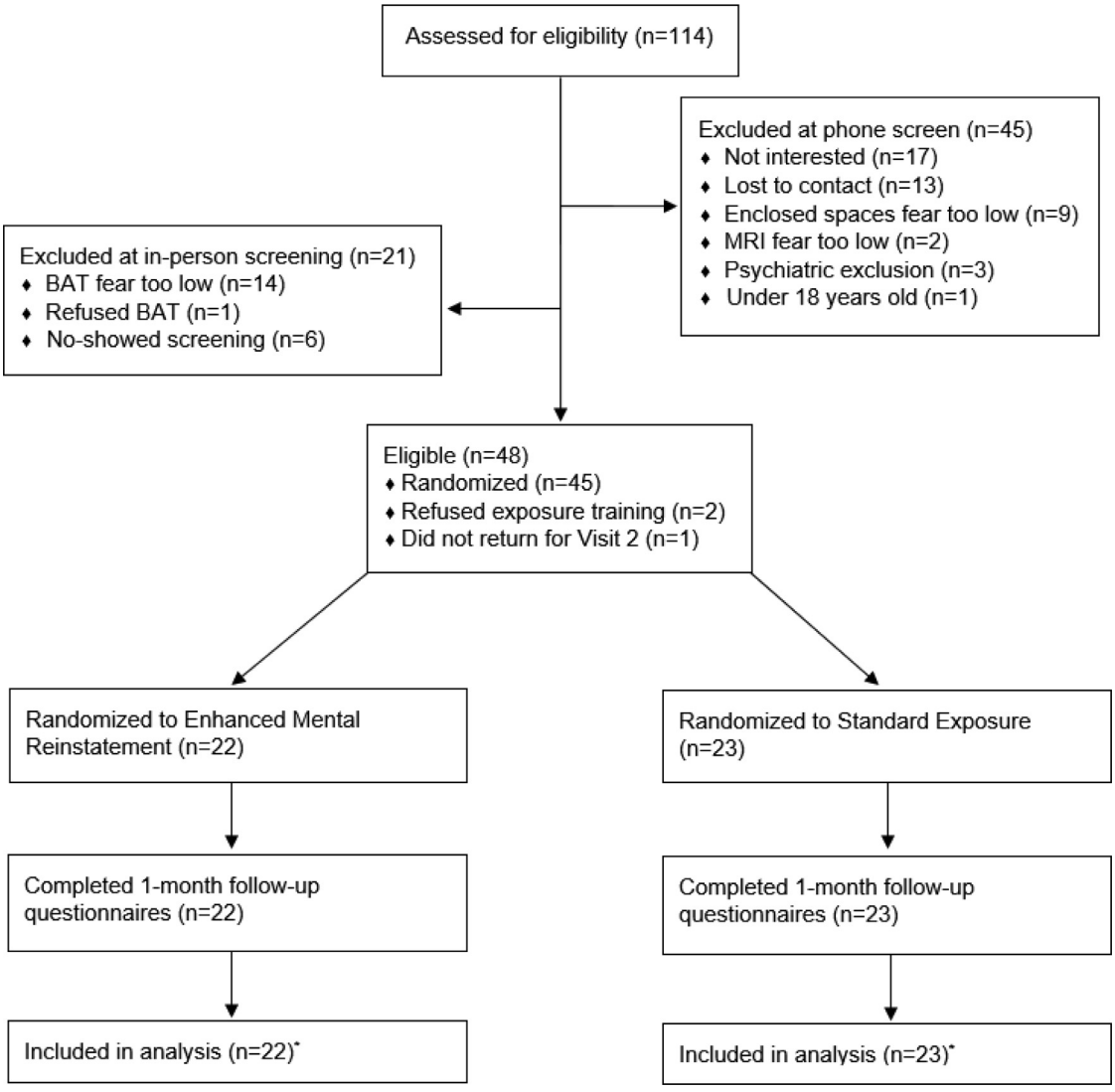

FIGURE 1 CONSORT diagram of participant screening, randomization, and study completion. *For analysis of heart rate data, $n = 21$ for EMR and $n = 22$ for SE due to equipment failure.

nostic criteria for specific phobia with claustrophobia. See Table 1 for baseline clinical characteristics across conditions.

PROCEDURES

A schematic of the experimental design can be seen in Figure 2.

Screening Process

Screening procedures were based on prior studies examining exposure training for claustrophobia (Deacon et al., 2010; Kamphuis & Telch, 2000; Powers et al., 2008; Telch et al., 2004, 2014). During a phone screen, potential participants rated their overall fear of enclosed spaces and their anticipated fear of the mock MRI scanner used in this study on a 5-point Likert scale (0 = *no fear*, 2 = *moderate fear*, 4 = *extreme fear*). Those who endorsed a rating of ≥ 2 on both questions and did not meet any exclusion criteria were invited into the laboratory. Following informed consent, state anxiety was measured using the 6-item version of the State-Trait Anxiety Inventory (STAI-S; Marteau & Bekker, 1992) and baseline heart rate data was measured over a 5-minute resting period while participants were seated. Participants then completed BAT 1A. Those who reported peak fear ≥ 50 of 100 or were unable to complete the BAT (i.e., remain for the full 2 minutes) were eligible to participate in the rest of the study.

Behavioral Approach Test 1 (BAT 1)

Participants were first shown the claustrophobia chamber, which consisted of a metal cabinet with internal dimensions of $6' \times 3' \times 1.5'$ laid on the

Table 1
Baseline Clinical Characteristics

	EMR ($n = 22$) *M (SD) or n (%)*	SE ($n = 23$) *M (SD) or n (%)*	*p* value for T, χ^2 or Fisher's Exact Test
Diagnosis of Specific Phobia with Claustrophobia			0.15
Currently meets	19 (86%)	19 (82%)	
Past only	2 (9%)	0 (0%)	
Does not meet	1 (5%)	4 (17%)	
On psychiatric medication	2 (9%)	4 (17%)	0.67
MRI Variables			
Prior MRI Experience	13 (59%)	12 (52%)	0.64
MRI Fear (0–100)	75.4 (19.1)	71.5 (18.9)	0.49
MRI Likelihood (0–100)	56.5 (27.4)	67.0 (34.7)	0.27
Questionnaire Scores			
CLQ-fear	58.6 (17.4)	59.4 (17.7)	0.87
CLQ-avoidance	59.6 (19.2)	62.8 (16.8)	0.59
STAI-S	43.8 (10.7)	40.9 (11.3)	0.38
BAT 1A Variables			
Peak Fear (0-100)	76.3 (14.0)	70.9 (15.1)	0.22
Exited early	8 (36%)	3 (14%)	0.10
CLEQ	48.6 (16.1)	51.9 (20.6)	0.56

Note: EMR = Enhanced Mental Reinstatement; SE = Standard Exposure; CLQ = Claustrophobia Questionnaire; STAI-S = State-Trait Anxiety Inventory – state; CLEQ = Claustrophobia Expectancies Questionnaire.

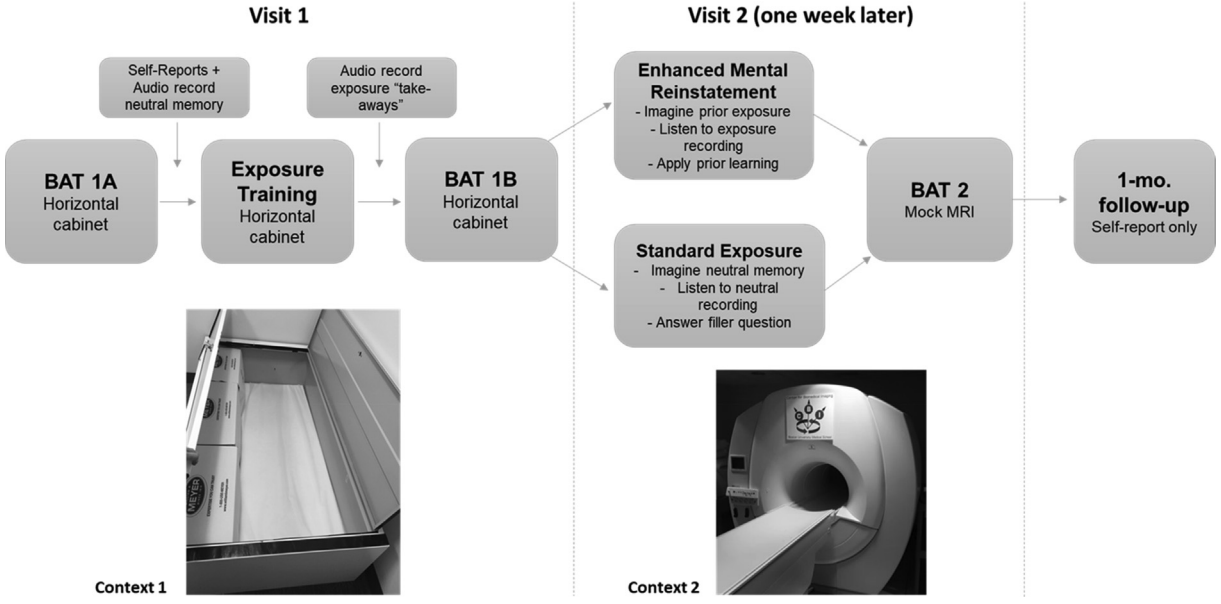

FIGURE 2 Schematic of study design, including situations used for Behavioral Approach Tests (BAT). In Context 1, doors of the metal cabinet were closed once participants were inside. As shown in the picture, one side of the cabinet was filled with boxes to increase the sense of enclosure. In Context 2, participants were slid into tube headfirst into the mock MRI scanner until their entire upper body was enclosed, and then were moved an additional 6″ back in the scanner at 2-minute intervals over the course of the BAT 2. The back of the scanner was covered in opaque plastic to increase sense of enclosure.

ground (see Figure 2). They were told they would be lying inside the cabinet with the doors closed, and the goal of the task was to remain inside the cabinet for as long as they could, though if they wanted to leave they could tell the experimenter and be let out immediately. Participants were not told the maximum length of the task, which was 2 minutes. Prior to entering the chamber, participants completed a series of questions about their fears and expectations for the task. The test was conducted prior to exposure training (BAT 1A) and after (BAT 1B).

Pre-Exposure Procedures

Following BAT 1A, participants completed a self-report measure of claustrophobia symptoms, the Claustrophobia Questionnaire (CLQ; Radomsky et al., 2001), and an experimenter administered the specific phobia module of the Composite International Diagnostic Interview (World Health Organization, 1997) to determine whether they met DSM-5 criteria for claustrophobia. They then created an audio recording of a neutral memory. They were asked to recall what they did for the first 30 minutes when they got out of bed that morning, and then rated the negative and positive emotion elicited by this memory on a 5-point Likert scale (0 = *none*, 4 = *extreme*). If either rating was >1 they were asked to identify a different memory from the previous 24 hours that met these criteria. Participants then recounted the memory out loud while being audio-recorded.

Exposure Training

Exposure procedures followed those used by Telch and colleagues (Kamphuis & Telch, 2000; Powers et al., 2008; Telch et al., 2004, 2014) and are outlined in further detail in the supplementary materials. After a brief rationale for exposure was presented by video, participants completed six 5-minute exposure trials in which they were instructed to lie on their backs in the cabinet with the doors closed in the same manner as BAT 1. Participants rated fear levels and feared outcome expectancies before and after each exposure.

Post-Exposure Audio Recording

After the final exposure trial, the experimenter helped the participant to complete a form in which they reviewed (1) what happened during the exposure training, including how their fear and expectancy ratings for their three most feared outcomes changed, and (2) their biggest "take-away" from the training (i.e., the most important thing they learned). Then, participants made an audio recording of themselves verbalizing what they had just reviewed on the form. They then completed BAT 1B.

Visit 2 Procedures and Randomization

Visit 2 occurred 1 week after Visit 1, plus or minus one day, at a biomedical imaging center in a different part of the city from the initial visit. Participants were randomized only once they arrived at Visit 2. Randomization was done in blocks of 4 and 6 and stratified by participant type (university student vs. community) using the web-based service Sealed Envelope. Upon arriving, participants completed the STAI-S and CLQ, and baseline heart rate data were recorded as in Visit 1. The experimenter then showed participants the mock MRI scanner they would be entering, explained BAT 2 procedures, and took participants to a separate room for condition-specific procedures.

Enhanced Mental Reinstatement (EMR)

Prior to BAT 2, EMR participants were asked to close their eyes and reimagine what took place during their exposure training 1 week prior. Specifically, they were told to recall out loud where they were, how their fear levels and feared outcomes changed and why, and what they learned from the training. Next, participants were instructed to keep their eyes closed and keep the memory of the training in mind while listening to the audio recording made the prior week about their experience during the exposure training. Finally, participants completed a form in which they wrote down all the ways the situation they just recalled in their memory was similar to the mock MRI scanner they were about to enter, including similarities about the space itself and the types of fears elicited. They also were asked to describe how their learning from the prior exposure training was relevant to the situation they were about to enter. The experimenter helped participants answer these questions as needed, and then participants verbalized their responses aloud.

Standard Exposure (SE)

SE procedure were designed to mimic the EMR condition as much as possible. Participants were instructed to: (1) recall the neutral memory they recorded at Visit 1; (2) close their eyes and imagine what took place during that memory, saying out loud exactly what they remembered; (3) keep this memory in mind while listening to the audio recording in which they had described the neutral memory; (4) write down and then verbalize how what happened the morning of the experiment was similar to what had happened the morning of Visit 2 (or equivalent, if a different memory).

Behavioral Approach Test 2 (BAT 2)

BAT 2 took place in a decommissioned 3T MRI scanner (see Figure 2). Participants lay on a stretcher with their head held in place by plastic siding, and the experimenter slid the stretcher into the tube of the mock scanner until the participant's entire upper body was inside. The opening of the scanner had a diameter of 23.6 inches. As in BAT 1, participants answered questions about their feared outcomes and fear levels prior to entering the scanner and then were told that the goal of the task was to remain in the tube for as long as they were able, though if they became too uncomfortable they could ask the experi-

menter to remove them. To reduce the chance of ceiling effects for time spent in the mock scanner, participants were moved 6 inches further into the scanner every 2 minutes until they reached the maximum time for the task, which was 10 minutes.

One-Month Follow-up

One month after Visit 2, participants completed questionnaires assessing claustrophobia symptoms, likelihood and expected fear of getting an MRI scan, and MRI scan-related feared outcomes.

OUTCOME MEASURES

Subjective Fear

Participants rated their subjective fear on a scale from 0 to 100, with anchors of 0 (*no fear*), 25 (*mild*), 50 (*moderate*), 75 (*strong*), and 100 (*extreme fear/panic*). Immediately upon exiting the claustrophobia chamber during BATs and exposure trials, participants rated their maximum level of fear while in the chamber.

Behavioral Avoidance

Time until each participant exited each of the BAT tasks was recorded as an indicator of behavioral avoidance. Given that the majority of participants did not leave the BATs before the end of the task, we also used early exit from the BAT as a categorical indicator of avoidance for some analyses (described further in the Data Analytic Approach).

Heart Rate Reactivity

Heart rate was measured continuously throughout the experiment via the Zephyr BioModule,™ an ambulatory heart rate monitor producing electrocardiogram readings (sampling rate 1000 Hz) via skin conducting chest electrodes (Nazari et al., 2018). Artifact detection was conducted automatically using Kubios Version 3.1 Premium (Tarvainen et al., 2014) and additional corrections were made through manual inspection. Mean heart rate data were extracted for baseline and BAT periods from Visits 1 and 2. Heart rate during BATs was adjusted for baseline by calculating the difference between mean heart rate during each BAT and the corresponding baseline period, then adding that value to the mean baseline heart rate for the sample. This baseline-adjusted heart rate variable was used in all analyses.

The Claustrophobia Questionnaire (CLQ)

The CLQ (Radomsky et al., 2001) is a 26-item assessment of claustrophobia symptoms. Participants are asked to rate how anxious they would feel on a 5-point Likert scale (0 = *not at all anxious*, 4 = *extremely anxious*) in situations eliciting concerns about suffocation and physical restriction, the two components of fear thought to underlie claustrophobia (Rachman & Taylor, 1993). For the purposes of this study, participants also indicated the strength of their desire to avoid the rated situations from 0 (*no desire to avoid*) to 4 (*avoid at all costs*). The CLQ was administered after eligibility screening, the beginning of Visit 2 prior to randomization, and at 1-month follow-up. Internal consistency in the present study was excellent at all three time points, both for fear and avoidance subscales separately and combined (α = .92–.96).

Claustrophobic Expectancies Questionnaire (CLEQ)

The CLEQ is a measure adapted for this study that assessed respondents' concern about 20 specific feared outcomes related to the claustrophobic situations they were about to enter during exposures or BATs (e.g., "I might run out of air"). Items were taken from various measures of claustrophobia- and fear-related cognitions, and consisted of four items each regarding concerns about suffocation, entrapment, coping self-efficacy (Valentiner et al., 1996), loss of control (Febbraro & Clum, 1995), and fear intolerance (Simons & Gaher, 2005). Items were selected to generate a wide variety of possible feared outcomes that could capture claustrophobic participants' greatest specific concerns, and enable them to be tracked throughout the exposure training. Items were rated on a scale from 0 (*no concern*) to 100 (*extreme concern*). The CLEQ was administered prior to all BATs and prior to the first and last trials of exposure training. Internal consistency for the full scale was excellent across time points (α = .92–.96).

MRI Expectancies, Fear and Likelihood

At baseline, after BAT 2 and at 1-month follow-up, participants were asked how likely they would be to get a medically indicated MRI from 0 (*definitely would not get it*) to 100 (*definitely would get it*) and how fearful they would be if they were to undergo a real MRI scan (based on a standardized description of MRI procedures) using the same 0–100 fear scale used during BATs. At follow-up, they also rated CLEQ items, imagining they were about to enter the MRI scanner from BAT 2 (CLEQ-MRI).

Exposure Memory Retrieval

After participants completed BAT 2, they indicated whether they thought about their prior exposure training during BAT 2. If they answered affirmatively, they were prompted to write what specifically they thought about. Responses were coded for whether the participant described something they learned from the exposure training or

reported using the memory to help them feel less anxious.

DATA ANALYTIC APPROACH

Data were analyzed using SPSS 26.0. Prior to running the primary analyses, a series of 2 × 2 mixed effects ANOVAs with time as a within-subject factor and condition as a between-subject factor were used to examine equivalence of treatment effects on prerandomization fear, heart rate, and behavioral avoidance (i.e., BAT duration, measured continuously). To establish whether fear returned following exposure training, one-way ANOVAs collapsing across condition were used to test for differences in main outcome variables between BATs.

We used hierarchical linear regression to analyze the effect of condition (EMR vs. SE) on primary fear outcome variables, entering each outcome at BAT 1B and Visit 2 STAI-S as predictors in the first step and condition at the second step (SE coded as 0, EMR coded as 1). For behavioral avoidance, a survival analysis was performed using Cox regression to predict the relative likelihood of exit from the mock MRI scanner for EMR vs. SE over the course of the 10-minute BAT, controlling for relevant covariates. Because no participants exited early from BAT 1B, a categorical variable was created to indicate whether a participant exited early from BAT 1A, which was used to control for baseline avoidance. For secondary outcomes, linear regression was used to examine the effect of condition on CLQ scores at 1-month follow-up, controlling for CLQ at Visit 2 (prerandomization). The effect of condition was also examined on CLEQ-MRI, MRI fear, and MRI likelihood ratings at Visit 2 (post-BAT 2) and 1-month follow-up, controlling for BAT 1B CLEQ, baseline MRI fear, and baseline MRI likelihood, respectively. In addition, the effect of EMR vs. SE was investigated on CLEQ scores prior to BAT 2, controlling for CLEQ at BAT 1B. The squared semipartial correlation coefficient (sr^2), which represents the unique portion of variance explained by the predictor, was used as an indicator of effect size for regression analyses.

Missing Data

No data were missing for self-report or behavioral variables. Due to equipment failure, heart rate data were not collected for two participants (one SE, one EMR). Across participants with any heart rate data, 9.7% of values were missing due to poor-quality ECG signal. Multiple imputation was used to generate plausible values for missing data (see supplemental materials for further details).

Power Analysis

Based on the large effect size (partial eta squared of 0.15) found for the mental reinstatement in Mystkowski et al., (2006), we conservatively estimated a medium-to-large effect size ($f^2 = 0.25$) for the effect of condition on fear outcomes at BAT 2. A power analysis conducted with G*Power indicated that a sample size of 34 with power = .80 would be sufficient to detect a significant effect, thought recruitment continued until it was no longer feasible to increase power to detect a smaller effect and investigate mediation. A post-hoc sensitivity analysis indicated that with the final $n = 45$, controlling for an additional covariate (STAI-S), the study had power = .80 to detect a medium effect size of $f^2 = 0.18$.

Results

Table 1 shows baseline clinical characteristics for each condition, and that there were no significant differences between groups (all ps > .10). There were also no significant differences between conditions in demographic characteristics (all ps > .18).

RESPONSE TO EXPOSURE TRAINING

Means and standard errors of BAT Fear and Heart Rate across time-points and condition can be seen in Figure 3. A series of 2 × 2 mixed-effects ANOVA showed a main effect of time-point on BAT fear, $F(1,43) = 598.78$, $p < .001$, $\eta_p^2 = .93$, heart rate, $F(1,41) = 55.23$, $p < .001$, $\eta_p^2 = .57$, and avoidance, $F(1,43) = 8.72$, $p = .005$, $\eta_p^2 = .17$, during Visit 1, with significantly decreased fear and heart rate values at BAT 1B compared to BAT 1A, and significantly increased BAT duration (i.e. avoidance). There was also a significant main effect of time on CLQ scores between Visit 1 and Visit 2 (prerandomization), $F(1,43) = 23.06$, $p < .001$, $\eta_p^2 = .35$. There were no significant effects of condition (all p's > .10) or time-by-condition interactions (all p's > .22) across any outcomes. In summary, exposure training led to significant and large improvements in subjective fear, heart rate, behavioral avoidance, and claustrophobic symptoms, with no differences across conditions.

RETURN OF FEAR

Results of one-way ANOVAs on fear ratings and heart rate across all three BATs showed there was a partial return of fear following the context change, indicating data were suitable for investigating the effect of EMR on generalization of gains. Results indicated there were significant differences across time-points in fear, $F(1.54, 67.78) = 140.69$, $p = <.001$, $\eta_p^2 = .76$, as fear rat-

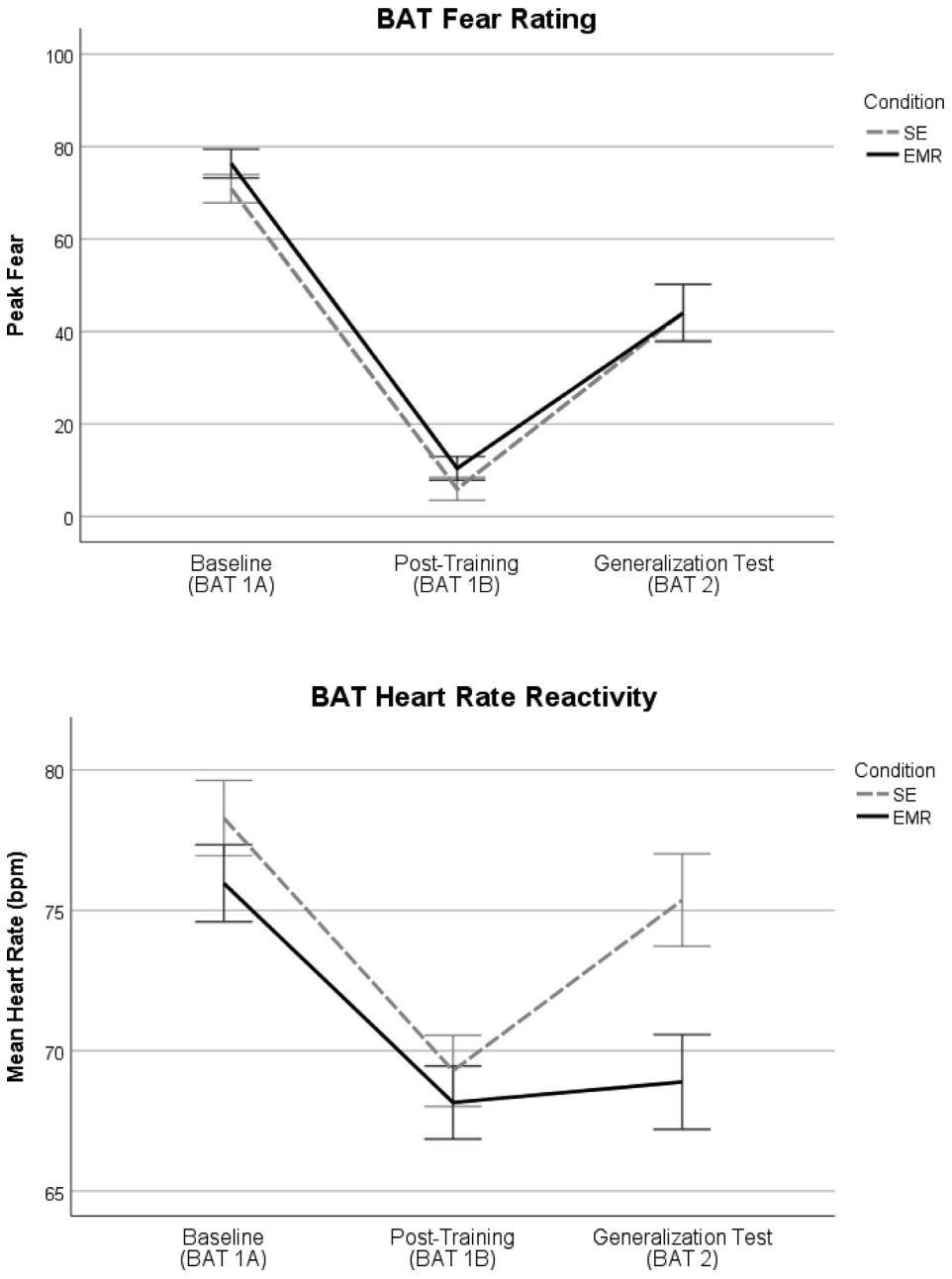

FIGURE 3 Peak fear rating (top) and heart rate (bottom) during across conditions. Heart rate values are adjusted for baseline. Error bars reflect 95% confidence intervals. SE = Standard Exposure; EMR = Enhanced Mental Reinstatement.

ings at BAT 2 (M = 44.04, SE = 4.29) were significantly greater than at BAT 1B, (M = 8.13, SE = 1.78; t[44] = 8.35, p < .001, d = 1.25), and significantly lesser than at BAT 1A, (M = 73.53, SE = 2.19, t[44] = 6.55, p < .001, d = 0.98. Similarly, there were significant differences across time-point in heart rate, F(1.51, 66.20) = 27.68, p = <.001, η_p^2 = .40, as BAT 2 heart rate (M =72.21, SE = 1.27) was significantly greater than BAT 1B (M = 68.80, SE = 0.92; t(42) = 2.21, p = .03, d = 0.34), and significantly lower than BAT 1A (M = 77.01, SE =0.97; t(42) = 3.96, p < .001, d = 0.61).

EFFECTS OF TREATMENT CONDITION ON FEAR OUTCOMES AT BAT 2

A comparison of Visit 2 STAI-S values indicated that prior to randomization, EMR participants (M = 42.58, SE = 2.75) endorsed greater levels of state anxiety than SE participants (M = 34.93, SE = 2.36), t(43) = −2.11, p = .04, d = 0.63. Accordingly, STAI-S was controlled for in subse-

Table 2
Results From Regression Models Examining Effect of Condition on Primary Outcomes During BAT 2

Outcome	Step	Predictor	ΔR^2	B	*SE* B	β	sr^2
Fear Rating	1.	BAT 1B Fear	.19*	0.42	0.35	.17	.04
		STAI-S		0.87	0.32	.38**	.15
	2.	Condition	.03	−9.79	8.41	−.17	.03
Heart Rate	1.	BAT 1B HR	.01	0.03	0.22	0.03	.00
		STAI-S		−0.02	0.11	−0.04	.00
	2.	Condition	.14*	−6.73	2.64	−0.33*	.14

Outcome	Step	Predictor	$\Delta\chi^2$	Hazard Ratio	95% CI	*p*
Avoidance	1.	STAI-S	6.62*	1.04	0.98–1.10	.15
(Time to exit)		BAT 1A Exited		7.55*	1.52–37.44	.01
	2.	Condition	0.28	0.64	0.12–3.38	.60

Note. BAT = Behavioral Approach Test; STAI-S = State Trait Anxiety inventory – State, measured at the beginning of Visit 2; HR = Heart rate.
* $p < .05$.
** $p < .01$

quent analyses examining the effect of condition. There was no significant difference in baseline heart rate at Visit 2, $t(41) = 1.82$, $p = .55$, $d = 0.05$.

Results of the full regression models predicting fear outcomes can be seen in Table 2, with graphical depiction of outcomes across condition in Figure 3. Controlling for BAT 1B fear and STAI-S, the effect of treatment condition (EMR vs. SE) on fear at BAT 2 was not significant, B = −9.79, *SE* = 8.41, $p = .25$, $sr^2 = .03$.

For heart rate data, after controlling for STAI-S and heart rate at BAT 1B, the effect of condition was significant, B = −6.73, *SE* = 2.64, $p = .01$, $sr^2 = .14$, indicating that EMR participants had a lower heart rate during BAT 2 relative to baseline than participants in SE. To ensure that such an effect was not confounded by the variable length of time participants spent in BAT 2, heart rate data during the first minute of BAT 2 was compared to the full duration of the BAT (among participants who stayed more than 1 minute, i.e., 95% of the sample), and a paired *t*-test showed no significant difference, $t(40) = -0.44$, $p = .66$, $d = .07$. The effect of condition was also examined on heart rate during the first minute of BAT 2, and which again showed lower heart rate relative to baseline in EMR vs. SE, B = −5.35, *SE* = 2.67, $p = .04$, $sr^2 = .09$.[1]

For avoidance, when entered together in a Cox regression, exiting BAT 1A early was a significant predictor of exiting early during BAT 2, *Hazard Ratio (HR)* = 5.79, 95% CI [1.45, 37.10], $p = .02$, but treatment condition was not, *HR* = 0.60, 95% CI [0.12, 3.38], $p = .60$. Given that only 7 of 45 participants (16%) exited the MRI scanner early ($n = 4$ in SE, $n = 3$ in EMR), results should be interpreted in the context of possible ceiling effects.

[1] In a sensitivity analysis examining only participants with complete data, the effect of condition remained significant, with slightly larger effect sizes for the full duration of BAT 2, B = −8.89, *SE* = 3.30, $p = .01$, $sr^2 = .20$, and the first minute only, B = −7.42, *SE* = 3.53, $p = .04$, $sr^2 = .14$.

EFFECTS OF TREATMENT CONDITION ON SECONDARY OUTCOMES

Visit 2

There was no significant effect of condition on pre-BAT 2 outcome expectancies (i.e., CLEQ scores), B = −3.06, *SE* = 5.79, $p = .60$, $sr^2 = .01$, controlling for each variable at BAT 1B as well as STAI-S at the beginning of Visit 2. Accordingly, planned analyses of CLEQ as a mediator of the effect of EMR vs. SE were not conducted. There was also no significant difference between conditions on MRI-related variables, including expected fear, B = 5.21, *SE* = 8.23, $p = .53$, $sr^2 = .01$, and likelihood of getting a medically indicated MRI scan, B = 7.37, *SE* = 5.07, $p = .15$, $sr^2 = .05$.

Follow-up

Effects at follow-up mirrored those at Visit 2. Controlling for CLQ scores at Visit 2 (prerandomization), there was no significant effect of condition on CLQ at 1-month follow-up, B = −11.71, *SE* = 9.25, $p = .21$, $sr^2 = .04$. Similarly, there was no significant effect of condition on MRI fear, B = −2.20, *SE* = 9.25, $p = .81$, $sr^2 = .001$, MRI likelihood, B = 8.75, *SE* = 5.63, $p = .13$, $sr^2 = .05$, or CLEQ-MRI, B = −3.86, *SE* = 6.05, $p = .53$, $sr^2 = .01$.

Table 3 shows means of the CLQ, CLEQ and MRI-related variables across study time-points,

Table 3
Claustrophobia Expectancies, Symptom Scores and MRI Fear Variables Across Study Time-Points

	Condition	Baseline *M (SD)*	Visit 2: Post-Treatment[a] *M (SD)*	One-mo. follow-up *M (SD)*	Effect of Time[b] (*F*-test)	η_p^2
CLQ	EMR	118.4 (36.1)	98.4 (38.1)	72.0 (34.0)	31.70*	0.42
	SE	122.2 (34.1)	92.0 (37.0)	79.2 (46.3)		
CLEQ[c]	EMR	48.6 (16.1)	24.3 (17.5)	15.7 (17.6)	61.47*	0.59
	SE	51.9 (20.6)	22.8 (21.1)	18.1 (22.5		
MRI Fear	EMR	75.5 (19.1)	52.7 (24.1)	39.6 (31.0)	36.46*	0.46
	SE	71.5 (18.9)	46.3 (30.8)	39.4 (34.4)		
MRI Likelihood	EMR	56.6 (27.4)	74.1 (25.3)	84.4 (17.6)	21.57*	0.33
	SE	67.0 (34.7)	74.3 (30.6)	80.7 (28.4)		

Note.
* $p < .001$.
[a] CLEQ and CLQ were administered pre-BAT 2, other measures administered post-BAT 2.
[b] Paired samples t-tests (collapsed across condition) indicated significant differences between all Baseline and Visit 2 variables (all *p*'s < .001), and between Visit 2 and follow-up (all *p*'s < .001 except $p = .04$ for CLEQ).
[c] Measure reflects expectancies for BAT 1 at baseline, BAT 2 post-treatment, and a hypothetical MRI scan at follow-up. EMR = Enhanced Mental Reinstatement; SE = Standard Exposure; CLQ = Claustrophobia Questionnaire; CLEQ – Claustrophobic Expectancies Questionnaire.

along with the results of a one-way ANOVAs examining differences in each variable across time when collapsing across condition. Significant decreases in CLQ, CLEQ and MRI fear were seen between all time-points, as were significant increases in likelihood of getting an MRI (all *p*s < .001).

EXPOSURE MEMORY RETRIEVAL

All but three participants endorsed thinking about the prior exposure training while in the mock MRI scanner, when asked after BAT 2. When examining the content of this memory retrieval, 81% of EMR participants described thinking about what they learned from exposure training or using the memory to help them feel less anxious (i.e., safety memory retrieval), compared to 56% of SE participants, a difference that approached significance, Fisher's Exact Test $p = 0.08$. Safety memory retrieval did not significantly predict BAT 2 fear, B = −9.04, *SE* = 9.66, $p = .36$, $sr^2 = .02$, or heart rate, B = −1.38, *SE* = 2.99, $p = .65$, $sr^2 = .01$, nor did its interaction with treatment condition, fear: B = 13.74, *SE* = 21.66, $p = .53$, $sr^2 = .01$; heart rate: B = 5.49, *SE* = 5.72, $p = .34$, $sr^2 = .02$.

Discussion

This study sought to examine whether mentally reinstating the memory of prior exposure training for claustrophobia would enhance the generalization of gains from exposure to a new context, specifically a mock MRI scanner. Results of the primary analyses showed that compared to SE, EMR led to significantly reduced heart rate reactivity in the mock scanner during BAT 2, reflective of a medium-sized effect ($sr^2 = .14$). The impact of EMR vs. SE on subjective fear was in the expected direction (i.e., less fear in EMR), but the effect was small ($sr^2 = .03$) and not significant. No significant differences were seen between conditions on feared outcome expectancies prior to BAT 2, self-reported claustrophobia and MRI fear at 1-month follow-up, or behavioral avoidance in the mock MRI, though there appeared to be a ceiling effect for avoidance.

This is the first study to show effects of mental reinstatement on heart rate reactivity during exposure following a context change. It should be noted, however, that only one previous reinstatement study examined effects on heart rate (Elsesser et al., 2013); thus, it is unclear whether the elements added to mental reinstatement procedure in this study (i.e., focusing recall on expectancy violations, listening to the audio-recording, identifying relevance of prior learning) impacted results. That effects were restricted to heart rate is somewhat surprising given that the "enhanced" aspects of the procedure were largely designed to target top-down reasoning processes about the relevance of prior learning, and therefore might be more likely to impact subjective ratings of fear and outcome expectancies. We hypothesized that the advantage of EMR over the control condition would be mediated by superior impacts on feared outcomes, but no difference in feared outcome expectancies was found across conditions. Notably, several other studies of exposure augmentation strategies have similarly shown effects on

physiological but not subjective fear outcomes (Craske et al., 2019; Maples-Keller et al., 2019; Rothbaum et al., 2014), potentially indicating greater sensitivity of biological outcomes in translational research. In contrast, others have argued that the subjective, conscious report of fear is of particular importance given that subjective distress is what tends to motivate people to seek treatment, and discordance between subjective experience and other measures of fear and anxiety point to important individual differences in brain processes (LeDoux & Hofmann, 2018; Taschereau-Dumouchel et al., 2022)

The absence of effect on subjective fear ratings contrasts with the findings of Mystkowski et al. (2006), who found mental reinstatement led to decreased subjective fear during a BAT with spider phobics, but is consistent with null findings in dental phobia (Elsesser et al., 2013) and social phobia (Laborda et al., 2016) in social phobia. A notable difference between the study by Mystkowski et al. (2006) and the present research, beyond the type of phobia treated, is that generalization was examined with the same exposure stimulus (a spider) across distinct contexts, whereas in the current study the context and stimulus differed, potentially leading to more difficulty generalizing.

Another potential contributor to nonsignificant effects of EMR on self-reported outcomes is the possibility that the memory of the prior exposure training was also highly salient for SE participants. Regardless of condition, participants engaged in an elaborated review of what happened during their exposures and what they learned. This may have functioned as a strong extinction memory consolidation intervention (Raeder et al., 2019), thereby reducing possible effects of a later retrieval-based manipulation. In addition, control procedures in the SE condition (i.e., revisiting a neutral memory from the same day) may have inadvertently elicited reinstatement of the exposure memory in a way that reduced differences seen between conditions. The difference in rates of self-reported safety memory retrieval during BAT 2 between conditions only approached significance (81% in EMR vs. 56% in SE), though this measure was not associated with subjective fear or heart rate outcomes during BAT 2 and is likely a limited indicator of memory retrieval processes (Shin & Newman, 2018). It is also worth noting that a sizeable return of fear effect (Cohen's $d = 1.25$) was still present in this study, suggesting there was meaningful room for improvement even if the prior exposure memory was salient for many SE participants.

Several limitations of this study should be mentioned. First, the low number of participants who exited the mock MRI scanner before the end of BAT 2 prevented a meaningful analysis of the effect of EMR on behavioral avoidance, an outcome that has been responsive to mental reinstatement (Elsesser et al., 2013) and rehearsal (McGlade & Craske, 2021) interventions in prior research. Second, because the EMR intervention included multiple ingredients (i.e., recall of exposure memory, listening to an audio recording, identifying relevance of the exposure memory), it is difficult to know whether certain elements may have been driving or impeding effects. Multiple components were used to maximize likelihood of improving outcomes given that exposure is quite robust, but it is possible that certain elements ended up increasing fear responses, for instance, among participants who emphasized fear reduction in their post-exposure audio recordings (see supplemental materials). Third, although the study was adequately powered to detect a medium-sized effect, sample size may have limited our ability to detect smaller effects. Future research with larger samples would also enable more systematic examination of individual differences that may moderate intervention effects. Finally, baseline heart rate was measured while participants were seated whereas heart rate during BATs was measured while participants were lying down. Given the impact of body position on heart rate, the optimal baseline measurement would have occurred while participants were lying down.

The above limitations notwithstanding, this study adds to the literature on potential strategies for enhancing generalization following exposure by demonstrating positive effects of an enhanced mental reinstatement intervention on a physiological indicator of fear, despite null effects on self-reported outcomes. This study also illustrates the utility of a brief exposure protocol for reducing fear of MRI scans when access to a real scanner for exposure practice is limited. Although not explicitly designed as an intervention for MRI-related claustrophobia, the exposure training in this study led to large reductions in MRI-related fear and increased likelihood of getting a medically indicated MRI. Given the public health impacts of MRI avoidance due to claustrophobia (Munn et al., 2015), this study could serve as the basis for future research investigating an efficient exposure-based intervention for fear of MRI scans.

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