Journal of Behavior Therapy and Experimental Psychiatry 72 (2021) 101639

Contents lists available at ScienceDirect

Journal of Behavior Therapy and Experimental Psychiatry

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

Threat memory devaluation by a dual-task intervention: Testing return of fear and intrusive memory over 48 hours

Elze Landkroon [*], Elske Salemink, Iris M. Engelhard

Department of Clinical Psychology, Utrecht University, Utrecht, the Netherlands

ARTICLE INFO

Keywords:
Threat memory
Dual-tasks
Fear conditioning
Return of fear
Intrusive memory
Trauma film

ABSTRACT

Background and objectives: In dual-tasking, individuals recall a threat-related memory while performing a demanding dual-task. This is a fruitful approach to reduce the unpleasantness and vividness of aversive memories and to reduce conditioned fear responses. Crucially, it remains unclear whether dual-tasking can also reduce conditioned fear responses and intrusive memories over time. In this pre-registered two-day fear conditioning paradigm, we examined whether a dual-task intervention reduces return of fear and the frequency of intrusive memories of an aversive film over time.

Methods: On Day 1, 76 healthy participants underwent fear acquisition with aversive film clips. They were then randomly allocated to one of three conditions: dual-tasking, memory recall without a dual-task ('recall only'), or no task. Afterwards, they underwent an extinction phase and were asked to record intrusive film memories over 48 h. On Day 3, return of fear was assessed.

Results: On Day 1, fear acquisition and extinction were successful. On Day 3, spontaneous recovery and renewal were evident, but, overall, participants reported few intrusions. The dual-task and recall only groups reported reduced unpleasantness of threat memory compared to the no task group, but they did not show reduced (return of) fear responses or fewer intrusions.

Limitations: Intrusion frequency was low in all three groups, which limits the detection of intervention effects.

Conclusions: Even though dual-tasking and recall only devalued threat memory temporarily compared to no task, these interventions did not reduce (return of) fear responses and intrusions. Future studies could focus on improving the potency of imagery-based interventions.

1. Introduction

Cognitive behavioral therapy is a recommended treatment for anxiety disorders (National Institute for Health and Clinical Excellence, 2011), in which patients are systematically confronted with fear-provoking stimuli and situations to disconfirm their threat expectancies during exposure. For many patients, fear reduces during treatment, but for a significant minority improvements are not retained after treatment (relapse rates: 0–14%; van Dis et al., 2020). Its presumed working mechanism is the learning of safety associations that inhibit threat associations (Bouton, 2002; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014). However, threat associations can be expressed again, for instance, after a time lapse ('spontaneous recovery') or exposure to a new context ('renewal'; Bouton, 2002). Thus, there is a need to improve treatment for anxiety disorders.

According to contemporary learning theories, fear is determined by the strength of the threat association (i.e., threat expectancy), and by the intensity of the mental representation of threat (i.e., threat intensity; Davey, 1997; Vervliet, Craske, & Hermans, 2013). Therefore, another potential approach to reduce fear, besides disconfirming threat expectancy, is by devaluing the intensity of this mental threat representation. Theoretically, this latter approach could reduce the return of fear because it may not rely on inhibitory learning: when the threat association is reactivated after treatment (e.g., due to a time-lapse or a context switch), but the mental representation of threat is less threatening, fear responses can remain low.

Several psychological interventions for posttraumatic stress disorder (PTSD) aim at devaluing the mental representation of threat, such as Eye Movement Desensitization and Reprocessing (EMDR) therapy. EMDR uses a dual-task approach, in which patients recall a traumatic memory while performing a demanding task (e.g., making bilateral eye movements; Shapiro, 2017). Experimental laboratory research has shown that

* Corresponding author. Department of Clinical Psychology, Utrecht University, PO Box 80140, 3508 TC, Utrecht, the Netherlands.
E-mail address: e.landkroon@uu.nl (E. Landkroon).

https://doi.org/10.1016/j.jbtep.2021.101639
Received 10 April 2020; Received in revised form 23 October 2020; Accepted 5 February 2021
Available online 13 February 2021

dual-tasks reduce self-reported unpleasantness and vividness of emotional memories and of images of feared future events, which is typically interpreted as devaluation of the mental threat representation (Engelhard, McNally, & van Schie, 2019). This technique offers great therapeutic potential, because many patients with anxiety disorders suffer from future-oriented threat images ("flashforwards"), rather than memories of threatening events ("flashbacks"; Brewin, Gregory, Lipton, & Burgess, 2010; Engelhard, van den Hout, Janssen, & van der Beek, 2010; Holmes & Mathews, 2010). Therefore, dual-tasks seem promising as intervention for anxiety disorders to modulate anxiety-relevant memories.

Earlier fear conditioning research has indeed provided evidence that dual-tasks, compared to mere recall of aversive memories, reduce conditioned fear responses (Leer, Engelhard, Altink, & van den Hout, 2013; Leer, Engelhard, Dibbets, & van den Hout, 2013). These studies used aversive visual stimuli to retrieve a visual threat memory during the intervention. Using aversive pictures, Leer, Engelhard, Dibbets, and van den Hout (2013) found that dual-tasking reduced renewal of threat expectancy compared to a control condition in which participants completed a filler task, but not compared to a control condition in which participants merely imagined the memory ('recall only'). Three other studies using film clips as aversive stimuli found that dual-tasking reduced self-reported threat expectancy and fear more than 'recall only' did (Leer, Engelhard, Altink, & van den Hout, 2013), but did not attenuate renewal (Landkroon, Mertens, & Engelhard, 2020) or reinstatement one day later (Dibbets, Lemmens, & Voncken, 2018) on both subjective and psychophysiological measures. Thus, fear conditioning research has demonstrated the potential of dual-tasks to attenuate (return of) conditioned fear on the same day, but findings are not as promising in studies with multiple sessions.

These earlier studies investigated whether devaluation of threat memory reduces conditioned responses. However, patients often suffer from intrusive threat-related imagery (Hackmann & Holmes, 2004). These can be recollected without a retrieval attempt and are experienced as distressing and as if the event is currently happening (Berntsen, 2010). Such intrusive memories may prevent natural memory decay, resulting in enhanced memory for these aversive events (Herz, Bar-Haim, Holmes, & Censor, 2020), and may be involved in installment and preservation of learned fear and avoidance (Mertens, Krypotos, & Engelhard, 2020). Hence, interventions that modulate intrusive memories may also enhance treatment of anxiety disorders.

The trauma film paradigm can be used as a laboratory analog for investigating the development and treatment of intrusive memory (James et al., 2016). Studies showed that after viewing a traumatic film, reactivation of the aversive film memory before playing the computer game Tetris reduced the intrusion frequency in the subsequent week compared to no task (Badawi, Berle, Rogers, & Steel, 2020; Holmes, James, Coode-Bate, & Deeprose, 2009, 2010; James et al., 2015). The procedure in these trauma film studies differs from dual-task interventions, because participants were not instructed to actively retrieve the trauma memory *while* playing Tetris (i.e., no dual-task). One study that used dual-tasks within the trauma film paradigm, demonstrated that a dual-task intervention reduced intrusive memories compared to no task, but only when the intervention length was relatively long (16 × 24 s; exp 2; van Schie, van Veen, & Hagenaars, 2019), and not with a shorter intervention (6 × 24 s; exp 1; van Schie et al., 2019), although these results were not replicated (exp 3; van Schie et al., 2019). As such, increasing the intervention length of the dual-task intervention seems necessary to improve intervention effects. Taken together, trauma film paradigm studies have demonstrated that secondary tasks after or during memory retrieval reduce intrusion frequency.

Previously, research demonstrated that fear conditioning with 30-s film clips successfully induces intrusive memories (Wegerer, Blechert, Kerschbaum, & Wilhelm, 2013). Combining fear conditioning and a trauma film paradigm allows us to investigate dual-task interventions that target intrusive memory. The important next step is to examine whether dual-tasking can prevent return of fear and intrusive memory over time.

The current study investigates whether dual-tasking with an increased intervention length before extinction training reduces conditioned responding directly after the intervention, and most importantly, return of fear and intrusive memories of aversive film clips two days later. We hypothesized that both dual-task and recall only interventions, compared to no task, attenuate conditioned responses directly after intervention, spontaneous recovery, renewal, and intrusive memories. We hypothesized that recall only is also effective, because previous research demonstrated that when mere recall of aversive memories is prolonged (as in imaginal exposure; Powers, Halpern, Ferenschak, Gillihan, & Foa, 2010), intensity of aversive memories is reduced (van Veen, van Schie, van de Schoot, van den Hout, & Engelhard, 2020). Based on earlier research (e.g., Leer, Engelhard, Altink, & van den Hout, 2013), we hypothesized that the effects of dual-tasking are stronger than of recall only.

2. Method

2.1. Participants

Ninety participants were recruited. Exclusion criteria (self-report) were: serious medical conditions; medication use that influences attention, memory or concentration; (a history of) psychological problems; poor sight/color blindness; hearing difficulties; proneness to fainting; pregnancy; and suicidal ideation (score 2 or 3 on item 9) on the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996). These are common exclusion criteria in fear conditioning/trauma film studies given the aversive stimuli (e.g., Landkroon et al., 2020; Siegesleitner, Strohm, Wittekind, Ehring, & Kunze, 2019). Fourteen participants were excluded for the following reasons: BDI-II item (1), quit day 1 (2; ill [1], US too aversive [1]), nonattendance day 3 (5), and unaware of US expectancy contingencies (6; see 2.6.1 Data exclusion). The final sample consisted of 76 participants (mostly students; $n = 73$). The sample size was powered to investigate the primary hypotheses (see pre-registration on Open Science Framework: https://osf.io/g2q8t/). We expected a medium effect size ($\eta^2_p = .08$) for conditioned fear immediately after the intervention (CS fear: $\eta^2_p = .14$; US expectancy: $\eta^2_p = .08$ in Leer, Engelhard, Altink, & van den Hout, 2013), a small to medium effect size ($\eta^2_p = .04$) for return of fear (US expectancy: $\eta^2_p = .08$ in Leer, Engelhard, Dibbets, & van den Hout, 2013), and a medium to large effect size ($f = .37$) for intrusion frequency (Cohen's $d = 0.62$–0.79 in Holmes et al., 2009, 2010). For conditioned fear and return of fear, a power analysis with G-Power for repeated measures (RM) ANOVAs with 3 groups and 2 measurements ($f = .29$ or $.20$, $\alpha = .05$, power $= .80$) yielded a total sample size of 33 and 63, respectively. For intrusion frequency, a power analysis for a one-way ANOVA ($f = .37$, $\alpha = .05$, power $= .80$) yielded a sample size of 75. The Ethics Committee of the Social Sciences Faculty of Utrecht University approved this study (FETC15-104).

2.2. Stimuli

Conditioned stimuli (CSs) were three pictures of men's faces (Langner et al., 2010). Context pictures were a yellow (context A) and a cyan (context B) background. CSs and context colors were counterbalanced across participants. The unconditioned stimulus (US) was a violent scene from the movie Irréversible (Noé, 2002), in which a man is killed with a fire extinguisher. This film clip has been used successfully to induce intrusive memories (Arnaudova & Hagenaars, 2017). The film clip was split into six fragments of 30-s each and presented in sequential order to reduce potential habituation effects (e.g., Leer, Engelhard, Altink, & van den Hout, 2013; Rattel et al., 2019).

2.3. Questionnaire

The State-Trait Anxiety Inventory (STAI-DY; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was used to measure whether state and trait anxiety differed between groups, because they may influence fear learning (Lonsdorf & Merz, 2017; but see Torrents-Rodas et al., 2013). Higher scores reflect higher levels of anxiety (range: 20–80).

2.4. Outcome measures

2.4.1. US memory ratings

Participants were asked to select the most aversive mental image of the US, keep it in mind for 10 s, and then rate its unpleasantness and vividness on two visual analog scales (VAS; 0 = not at all unpleasant/vivid; 100 = very unpleasant/vivid; Leer, Engelhard, Altink, & van den Hout, 2013).

2.4.2. Conditioned responses

US expectancy. US expectancy was rated online during each CS presentation on a VAS (−5 = 'definitely not followed by aversive film clip'; 0 = uncertain; 5 = 'definitely followed by aversive film clip'; Landkroon, Mertens, Sevenster, Dibbets, & Engelhard, 2019).

CS measures. Fear to each CS was measured on a 9-point scale, from 'not at all' to 'very much' (Landkroon et al., 2020). Valence and arousal were rated with Self-Assessment Manikins (SAM; Bradley & Lang, 1994) on 9-point scales from 'negative'/'no activation' to 'positive'/'a lot of activation' respectively. Valence was reverse-scored: higher scores reflect a more negative evaluation.

2.4.3. Intrusive memory

Participants were instructed that intrusive memories of the film clip could pop into their mind unexpectedly and that these intrusions could be experienced as mental images (e.g., visual, auditory), verbal thoughts or a combination (see Holmes et al., 2010). Participants were asked to keep a diary for 48 h and to list each occurrence of an intrusion immediately. They were asked to describe its content and form (image/thought/combination), and rate its unpleasantness and vividness (1 = not at all unpleasant/vivid; 10 = very unpleasant/vivid). Mental image-based intrusions (image and combination) were added as a total score (Holmes et al., 2009, 2010).

2.5. Procedure

2.5.1. Day 1

Participants gave informed consent and completed the BDI-II, STAI-S, and STAI-T. They were told that two faces would be followed by aversive film clips and a third face would never be followed by aversive film clips on either day, and that it was their task to predict when an

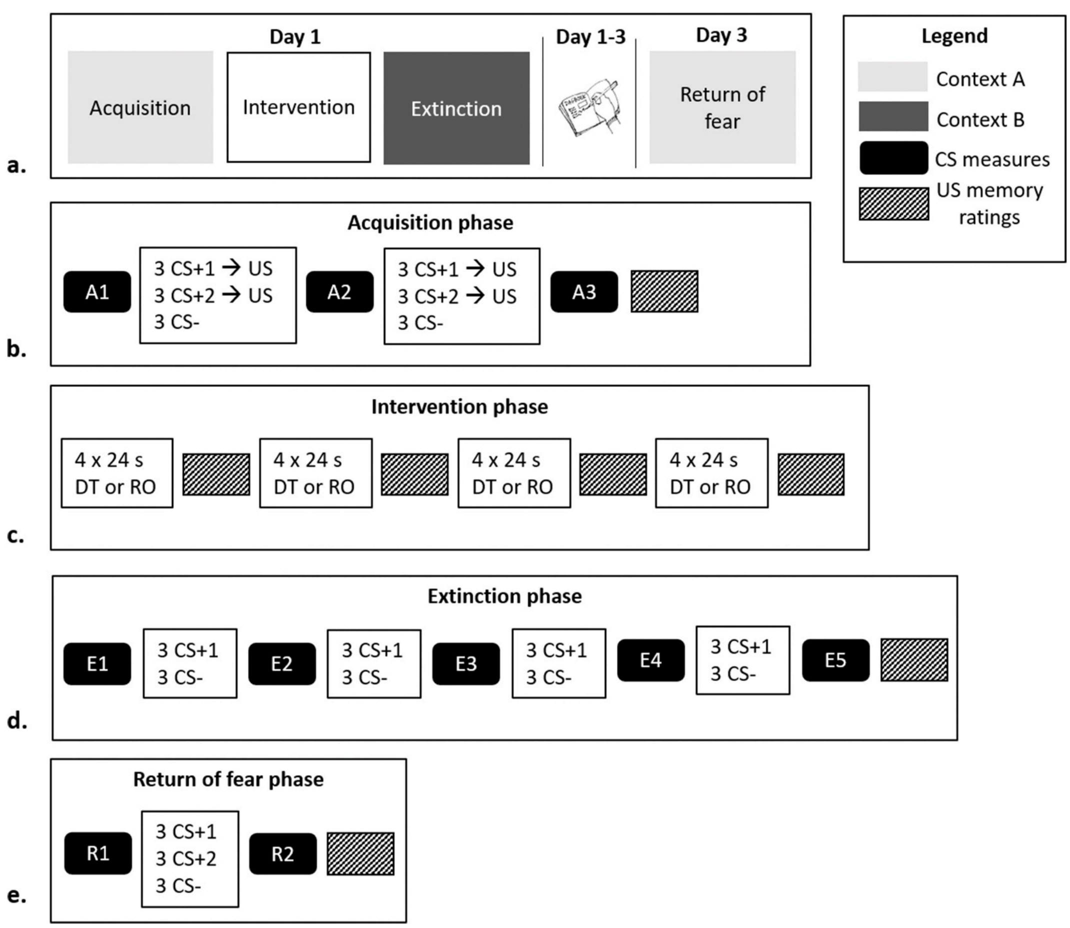

Fig. 1. Overview study design. Panel a) Overview of the experimental phases of the experiment. Intrusions are measured with a diary between Day 1 and 3. Panel b) Trials and measurements in the acquisition phase. Conditioned responses are measured by unconditioned stimulus (US) expectancy during every conditioned stimulus (CS) presentation, and by CS measures (fear, valence, and arousal; A1-A3). Panel c) Trials and measurements in the intervention phase for the dual-task (DT) and recall only (RO) groups. Threat memory devaluation is measured by US memory ratings (unpleasantness and vividness). Panel d) Trials and measurements in the extinction phase. Conditioned responses are measured by US expectancy during every CS presentation, and by CS measures (E1-E5). Panel e) Trials and measurements in the return of fear phase. Spontaneous recovery is measured with the first CS measures (R1). Renewal is measured with US expectancy on the first CS presentation.

aversive film clip would be shown. Then they practiced rating US expectancy, read instructions about the CS measures, and rated the CSs with pen-and-paper.

Acquisition. Six trials for each CS type were presented in context A, see Fig. 1. Two CSs but not the CS- were followed by a US. The CSs were presented for 8 s and participants could rate US expectancy within 7 s. Intertrial intervals were 2, 3 or 4 s. After every three trials, CSs were rated. Lastly, participants were asked to select and rate the most aversive mental image from the film clips (Landkroon et al., 2020).

Intervention. Participants were randomly assigned to conditions. During dual-tasking, participants were asked to recall the most aversive image for 24 s while visually tracking a dot on a computer screen that moved at 1.2 Hz (van Veen et al., 2015) without moving their head. Then, participants were instructed to stop retrieving the image for 10 s. There were 16 trials in total, and after every 4 trials, participants rated their memory (see Landkroon et al., 2020; van Veen et al., 2020). Participants in the recall only group followed the same procedure without making eye movements. In the no task group, participants continued immediately with the next phase. This group was not matched in duration to the intervention groups, because sitting in silence potentially results in recall or rumination of threat memory (Mertens, Krypotos, & Engelhard, 2020) and a filler task can serve as a dual-task intervention (Tadmor, McNally, & Engelhard, 2016).

Extinction. Twelve trials for CS+1 and CS- were presented in context B, without the US. Timing and ratings were the same as in the acquisition phase. Afterwards, participants were asked to rate their threat memory and received diary instructions.

2.5.2. Day 1–3

Participants were instructed to record intrusions.

2.5.3. Day 3

Participants returned to the lab after 48 h, because trauma film paradigm studies have shown that most intrusions occur within the first 48 h (e.g., James et al., 2015). First, participants rated CSs (spontaneous recovery) and were presented with context A (renewal). Each CS was presented three times. The first trial was counterbalanced. Timing and ratings were the same as in previous phases. Participants rated US memory again. Then, the experimenter ensured whether all diary entries concerned the film clips (Holmes et al., 2010). Participants rated diary compliance on a VAS (0 = not at all complied; 100 = complied perfectly). Participants in the intervention groups were asked to rate whether they followed instructions during the intervention phase to vividly recall the US (both intervention groups) and to track the dot (dual-task group only), on VASs (0 = not at all (vivid); 100 = extremely vivid/absolutely; Landkroon et al., 2020). Finally, participants were debriefed (van Schie et al., 2019).

2.6. Data analyses

Violations of the sphericity assumption were corrected with Greenhouse-Geisser ($\varepsilon < .75$) or Huyn-Feldt ($\varepsilon > .75$). Deviations from normality (Kolmogorov-Smirnov tests) were further examined using bootstrap confidence intervals, and as these barely deviated from the standard confidence intervals, the influence of normality deviations was considered negligible. Moreover, ANOVAs are robust to deviations from normality (Schmider, Ziegler, Danay, Beyer, & Bühner, 2010). We calculated 90% confidence intervals (CI) for effect sizes (Lakens, 2013) using the MBESS package in R (Kelley, 2017).

We conducted our analyses within a Null-Hypothesis Significance Testing and a Bayesian framework (Krypotos, Mertens, Leer, & Engelhard, 2020). Within the Bayesian framework, Bayes factors were calculated that quantify the amount of evidence that the data shows for the alternative hypothesis compared to the null hypothesis in JASP (default settings; JASP Team, 2020). For instance, $BF_{10} = 3$ indicates that the data are three times more likely under the alternative hypothesis than the null hypothesis (vice versa for $BF_{10} = 0.333$).

2.6.1. Data exclusion

Participants were excluded from analyses if they were unaware of contingencies (see pre-registration: higher US expectancy on the last acquisition trial for CSs+ than for CS-; Dibbets et al., 2018).

2.6.2. Randomization and manipulation checks

First, to ensure successful randomization, chi-square test or one-way ANOVAs were performed on sex distribution, age, state, trait anxiety, and diary and intervention compliance. Second, to check successful fear acquisition, we used 3 (Stimulus: CS1+ vs. CS2+ vs. CS-) x 6 (or 3) (Time) x 3 (Group) RM ANOVAs for US expectancy and CS ratings. Third, to test the expected group differences in unpleasantness and vividness of threat memory separate 5 (Time: post-acquisition, 4 intervention trials) x 2 (Group: dual-task vs. recall only) RM ANOVAs were conducted. Finally, to test whether memory ratings remained low after the extinction and return of fear phases in both intervention groups, compared to no task group, 3 (Group: dual-task vs. recall only vs. no task) x 2 (Time: post-acquisition vs. post-extinction or post-renewal) RM ANOVAs were conducted.

2.6.3. Main analyses

To test whether conditioned responding was reduced directly after the intervention and two days later in the intervention groups, compared to the no task group, 3 (Group: dual-task vs. recall only vs. no task) x 2 (Stimulus: CS1+ vs. CS-) x 2 (Time: immediate effect: last acquisition trial vs. first extinction trial; spontaneous recovery: last CS measures Day 1 vs. first CS measures Day 3; renewal: last extinction trial vs. first renewal trial) RM ANOVAs for US expectancy and CS measures were performed (following Vervliet, Baeyens, van den Bergh, & Hermans, 2013). Moreover, we aimed to test whether the predicted intervention effects generalized to conditioned responding to a CS that was not extinguished by conducting separate 2 (Stimulus: CS+1 vs. CS+2) x 3 (Group: dual-task vs. recall only vs. no task) RM ANOVAs on the first trial of spontaneous recovery and renewal. To investigate whether intrusion frequency, unpleasantness and vividness were reduced after the interventions, compared to no task, separate one-way ANOVAs were used. Exploratory analyses on correlations between threat devaluation and outcome measures were included in Supplementary Materials.

3. Results

3.1. Randomization and manipulation checks

3.1.1. Randomization checks

Groups did not significantly differ in age, state, and trait anxiety, but did in sex distribution[1], see Table 1. Diary compliance differed between groups. Compliance was lower in the dual-task group than in the recall only group, $p < .01$ (Bonferroni corrected), $BF_{10,\ U} = 8.951$. We deem this group difference not important, because intrusion frequency was not affected by diary compliance as a covariate and even in the dual-task group diary compliance was high. The dual-task and recall only groups indicated that they adhered equally to intervention instructions.

3.1.2. Acquisition phase

As predicted, there was a significant interaction between CS type and time on US expectancy and CS fear, valence, and arousal, $Fs > 33.81$, *ps*

[1] Because Cramer's V was medium to large, we investigated whether sex influenced the results. When sex was entered as a covariate in the main analyses, the results remained the same, indicating that the sex distribution did not affect the main outcomes. We report the analyses without sex as a covariate.

Table 1
Distribution of sex (male/female frequency), means (SD) of age, state anxiety (STAI-S), trait anxiety (STAI-T), adherence to instructions during intervention phase (i.e., making eye movements and vividly recalling the US), and diary compliance.

	Dual-task ($n = 25$)	Recall only ($n = 25$)	No task ($n = 26$)	Test statistics
Sex	9/15[a]	13/12	5/21	χ^2 (2) = 5.98, p = .05, Cramer's V = .28, CI [.00, .45], BF_{10} = 1.777
Age (years)	21.54 (1.69)[a]	21.88 (2.22)	21.73 (2.01)	F(2, 72) = 0.18, p = .84, η^2_p = .01, CI [.00, .03], BF_{10} = 0.131
STAI-S	34.44 (9.44)	31.04 (8.29)	32.38 (8.55)	F(2, 73) = 0.95, p = .39, η^2_p = .03, CI [.00, .09], BF_{10} = 0.235
STAI-T	34.16 (9.12)	30.44 (7.22)	31.58 (6.40)	F(2, 73) = 1.55, p = .22, η^2_p = .04, CI [.00, .12], BF_{10} = 0.372
Eye movements	70.76 (17.28)	-	-	
Recall US	69.88 (22.66)	74.20 (25.24)	-	F(1, 48) = 0.41, p = .53, η^2_p = .01, CI [.00, .09], BF_{10} = 0.334
Diary compliance	81.00 (15.80)	92.52 (11.21)	86.54 (12.34)	F(2, 73) = 4.73, p = .01, η^2_p = .12, CI [.02, .22], BF_{10} = 4.043

[a] For one participant sex and age was missing.

$< .01$, η^2_ps $> .31$, CI range [.24, .57],[2] $BFs_{10} > 1.710 \times 10^{13}$ (see Figs. 2 and 3). CSs+ responding increased on all outcome measures over time, $Fs > 37.12$, $ps < .01$, η^2_ps $> .33$, CI range [.23, .60], $BFs_{10} > 7.599 \times 10^{10}$. CS- responding decreased over time, $Fs > 4.14$, $ps < .03$, η^2_ps $> .05$, CI range [.00, .47], $BFs_{10} > 1.719$, except on CS arousal, $F(1.85, 138.63) = 0.55$, $p = .56$, $\eta^2_p = .01$, CI [.00, .04], $BF_{10} = 0.074$. Fear acquisition measured with US expectancy, CS valence and arousal did not differ between groups, $Fs < 1.07$, $ps > .38$, η^2_ps $< .03$, CI range [.00, .05], $BFs_{10} < 0.028$ (stimulus x time x group). For CS fear, acquisition differed between groups when all timepoints were analyzed, $F(7.85, 282.46) = 2.54$, $p = .01$, $\eta^2_p = .07$, CI [.01, .09], $BF_{10} = 0.198$ (stimulus x time x group), but not when acquisition was analyzed pre-post, $F(3.72, 133.92) = 1.47$, $p = .22$, $\eta^2_p = .04$, CI [.00, .08], $BF_{10} = 0.106$ (stimulus x time x group). In sum, differential acquisition was successful on all outcome measures.

3.1.3. Post-acquisition memory ratings

As intended, unpleasantness and vividness did not significantly differ between groups after acquisition, $Fs < 3.12$, $ps \geq .05$, η^2_ps $< .08$, CI range [.00, .17], $BFs_{10} < 1.215$, see Fig. 4.[3]

3.2. US memory ratings

3.2.1. Intervention phase

Memory unpleasantness and vividness decreased during the intervention phase, $Fs > 27.61$, $ps < .01$, η^2_ps $> .36$, CI range [.23, .56], $BFs_{10} > 2.236 \times 10^{15}$ (main effect of time), but contrary to the hypothesis, this decrease did not differ between the intervention groups, $Fs < 0.38$, $ps > .69$, η^2_ps $< .01$, CI range [.00, .04], $BFs_{10} < 0.049$ (time x group).

3.2.2. Post-extinction

Memory unpleasantness decreased for all groups from after acquisition to after extinction, $F(1, 73) = 74.68$, $p < .01$, $\eta^2_p = .51$, CI [.37, .60], $BF_{10} = 2.187 \times 10^{10}$ (main effect time), which differed between groups, $F(2, 73) = 4.18$, $p = .02$, $\eta^2_p = .10$, CI [.01, .21], $BF_{10} = 2.910$ (time x group). Compared to the no task group, unpleasantness decreased more in the intervention groups, $Fs > 4.45$, $ps < .05$, η^2_ps $>$ .08, CI range [.00, .26], $BFs_{10} > 1.650$. However, there was no difference between the two intervention groups, $F(1, 48) = 0.79$, $p = .38$, $\eta^2_p = .02$, CI [.00, .11], $BF_{10} = 0.391$. Memory vividness decreased from after acquisition to after extinction, $F(1, 73) = 98.82$, $p < .01$, $\eta^2_p = .58$, CI [.45, .66], $BF_{10} = 9.166 \times 10^{11}$ (main effect time), which unexpectedly did not differ between groups, $F(2, 73) = 2.62$, $p = .08$, $\eta^2_p = .07$, CI [.00, .16], $BF_{10} = 0.819$ (time x group).

3.2.3. Post-renewal

From after acquisition to after return of fear, unpleasantness and vividness decreased, $Fs > 109.02$, $ps < .01$, η^2_ps $> .60$, CI range [.48, .74], $BFs_{10} > 1.779 \times 10^{14}$, but this did not differ between groups, $Fs < 1.69$, $ps > .19$, η^2_ps $< .05$, CI range [.00, .13], $BFs_{10} < 0.423$ (time x group). This suggests that the interventions were not successful in reducing unpleasantness and vividness of threat memory over time, compared to no task.

3.3. Main analyses

3.3.1. Extinction phase

Unexpectedly, there was no group difference from the last acquisition trial to the first extinction trial on all outcome measures, $Fs < 1.43$, $ps > .23$, η^2_ps $< .04$, CI range [.00, .08], $BFs_{10} < 0.132$ (stimulus x time x group), suggesting that both interventions had no immediate effect on US expectancy and CS measures. Differential extinction for CS type was found on all outcome measures, $Fs > 12.84$, $ps < .01$, η^2_ps $> .15$, CI range [.09, .54], $BFs_{10} > 4714.750$ (stimulus x time), and this did not differ between groups, $Fs < 1.29$, $ps > .23$, η^2_ps $< .04$, CI range [.00, .04], $BFs_{10} < 0.003$ (stimulus x time x group).

3.3.2. Return of fear

Spontaneous recovery. CS fear, valence, and arousal increased more for the CS+1 than CS- from the last extinction trial to the first test trial 48 h later, $Fs > 11.54$, $ps < .01$, η^2_ps $> .13$, CI range [.04, .34], $BFs_{10} > 6.603$ (stimulus x time), but unexpectedly, this did not differ between groups, $Fs < 2.21$, $ps > .11$, η^2_ps $< .06$, CI range [.00, .14], $BFs_{10} < 0.377$ (stimulus x time x group), see Fig. 3. Thus, the interventions did not reduce spontaneous recovery compared to no task.

Renewal phase. US expectancy increased more for the CS+1 than CS- from the last extinction trial to the first test trial, $F(1, 72) = 118.15$, $p < .01$, $\eta^2_p = .62$, CI [.50, .70], $BF_{10} = 5.845 \times 10^{18}$ (stimulus x time), but this did not differ between groups, $F(2, 72) = 0.20$, $p = .82$, $\eta^2_p = .01$, CI [.00, .04], $BF_{10} = 0.134$ (stimulus x time x group), see Fig. 2. The interventions did not reduce fear renewal compared to no task.

Given the lack of expected group differences on spontaneous recovery and renewal, detailed results on generalization of the interventions to the non-extinguished CS+2 are not reported.[4]

3.3.3. Intrusions

Intrusion frequency was low in all groups, suggesting that the paradigm was limited in inducing sufficient intrusions to test the hypotheses, see Fig. 5. Intrusion frequency did not differ between groups, $F(2, 72) = 1.07$, $p = .35$, $\eta^2_p = .03$, CI [.00, .10], $BF_{10} = 0.261$, nor did intrusion unpleasantness and vividness ratings, $Fs < 1.34$, $ps > .27$, η^2_ps $< .07$, CI range [.00, .17], $BFs_{10} < 0.416$, see Table 2.

[2] When test statistics are summarized, the CI range shows the lowest and highest bound of all summarized effect sizes.

[3] See Supplementary Materials A for a specification of the selected aversive images.

[4] Exploratory analyses revealed a similar pattern on conditioned responses to the CS+2 on the first trial of the spontaneous recovery and renewal phases, namely no differences between groups.

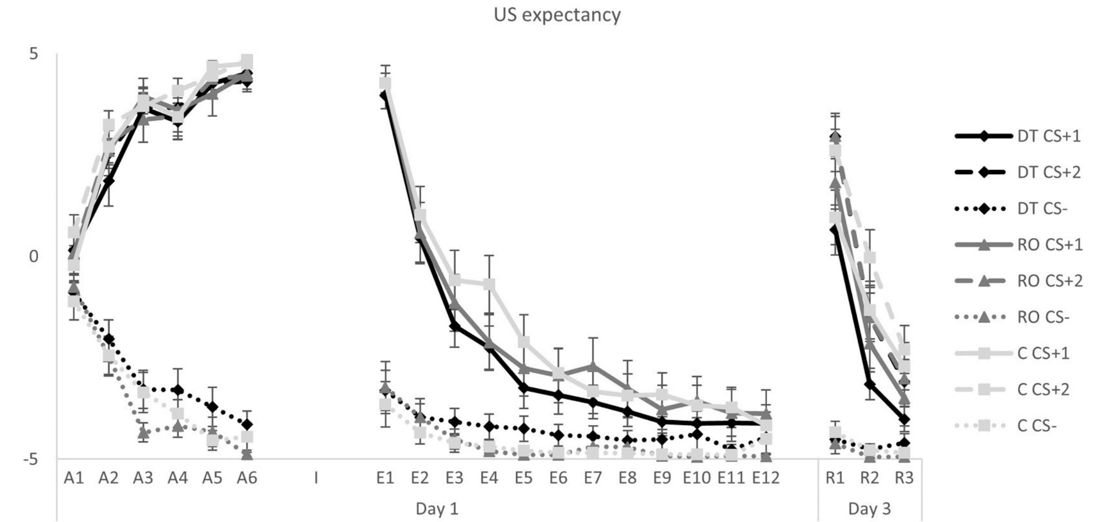

Fig. 2. US expectancy during the acquisition (A1-A6), extinction (E1-E12), and return of fear phases (renewal; R1-R3) in the dual-task (DT), recall only (RO), and no task control (C) groups. I = intervention phase. Error bars represent standard error of the mean (SEM).

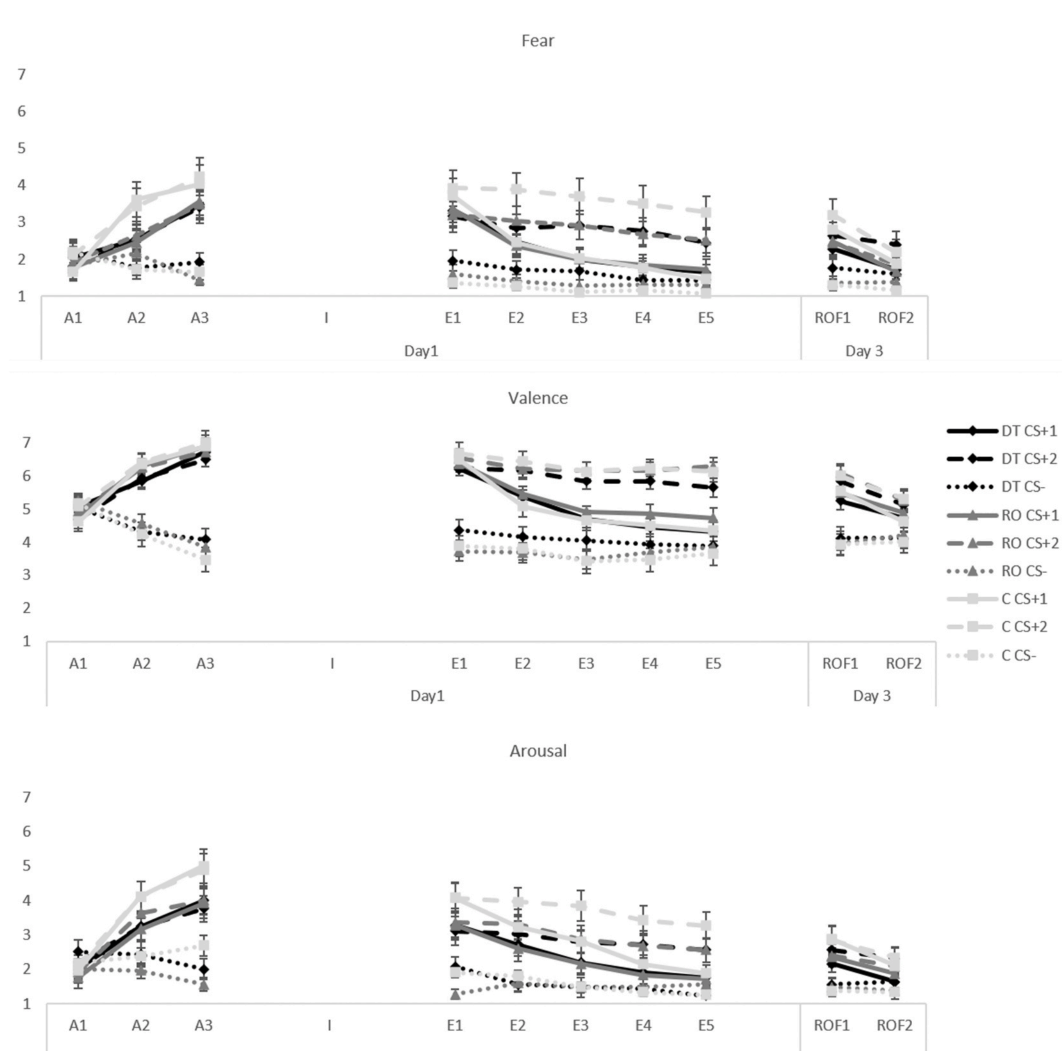

Fig. 3. CS fear, CS valence, and CS arousal during the acquisition (A1-A3), extinction (E1-E5), and return of fear (ROF; ROF1-ROF2) phases in the dual-task (DT), recall only (RO), and no task control (C) groups. I = intervention phase. Error bars represent SEM.

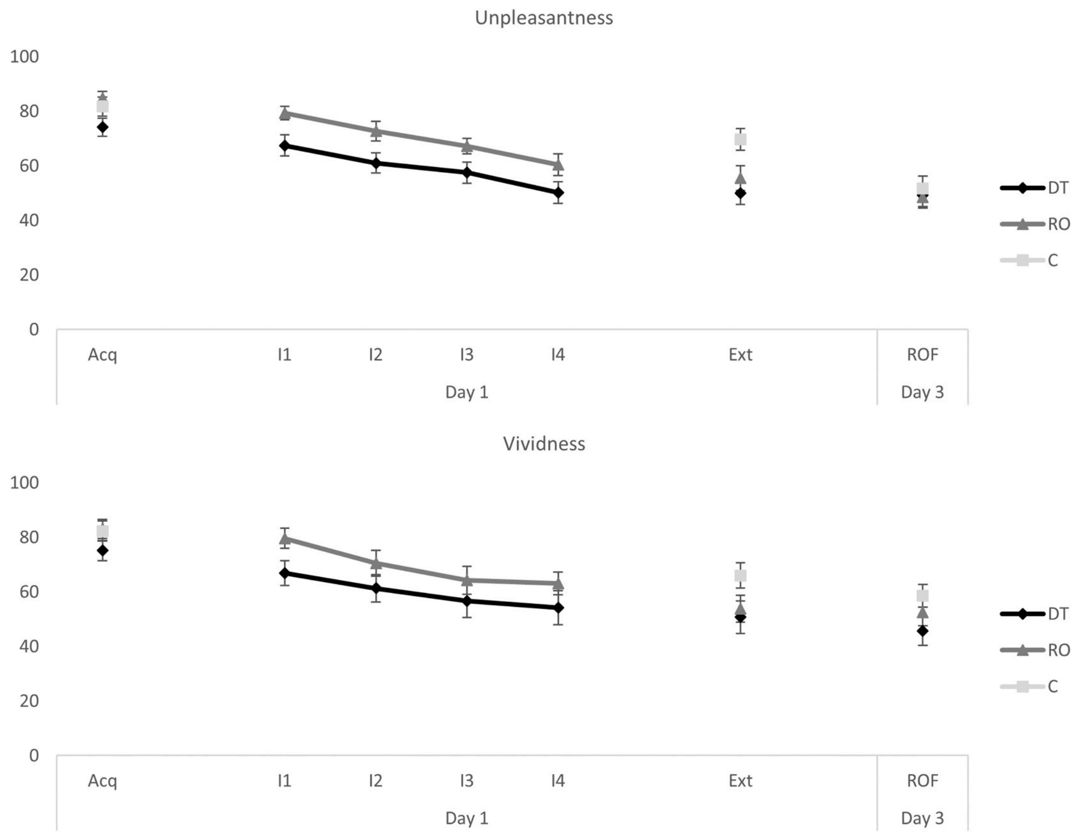

Fig. 4. Unpleasantness and vividness of threat memory after the acquisition phase (Acq), during the intervention phase (I1-I4), and after the extinction (Ext) and return of fear (ROF) phases in the dual-task (DT), recall only (RO), and no task control (C) groups. Error bars represent SEM.

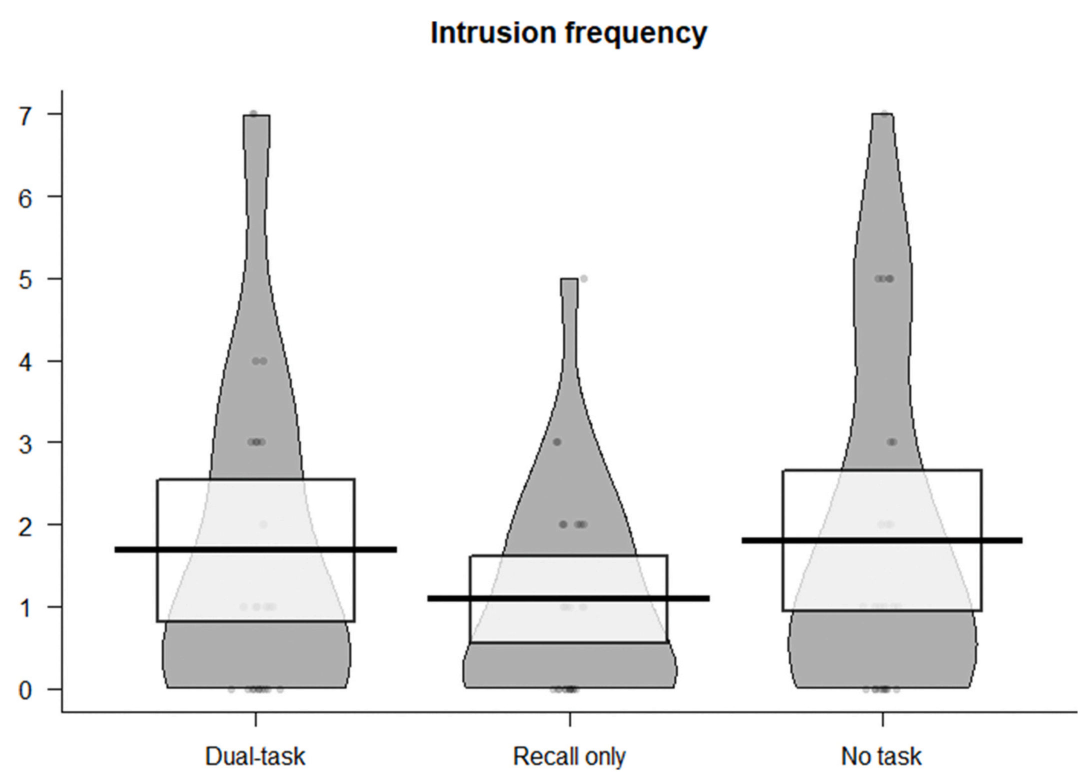

Fig. 5. Intrusion frequency over 48 h in between testing sessions. Means (lines), 95% confidence intervals (boxes), individual data points (dots), and the density of data distribution (beans).

Table 2
Means and standard deviations of unpleasantness and vividness of intrusive memories.

	Dual-task (n = 15)	Recall only (n = 14)	No task (n = 16)
Intrusion unpleasantness	4.53 (1.51)	4.08 (1.08)	5.17 (2.54)
Intrusion vividness	5.23 (1.32)	5.61 (0.87)	5.44 (1.92)

4. Discussion

This study aimed to investigate whether a dual-task intervention, and to a lesser extent a recall only intervention, reduces conditioned responses directly after the intervention, and return of fear and intrusive memories two days later. The main findings can be summarized as follows. First, the dual-task and recall only interventions decreased unpleasantness and vividness of threat memory similarly during the intervention phase, indicating threat devaluation. Second, inconsistent with the hypotheses, the dual-task and recall only groups did not differ from the no intervention group in conditioned responses immediately after the intervention, spontaneous recovery, renewal or intrusion frequency.

During the intervention phase, memory unpleasantness and vividness decreased similarly in both intervention groups, which contrasts studies with a short intervention duration that consistently found beneficial effects of a dual-task intervention compared to recall only (Lee & Cuijpers, 2013; Mertens, Lund, & Engelhard, 2020). However, our findings corroborate with research that also used an increased intervention duration (Landkroon et al., 2020; van Schie et al., 2019; van Veen et al., 2020). Moreover, a meta-analysis demonstrated that EMDR with or without eye movements might equally reduce clinical symptoms (Cuijpers et al., 2020). Thus, prolonged recall only may serve as imaginal exposure, and adding a dual-task may not further reduce intensity of threat memory.

Contrary to the prediction, compared to the no intervention group, both intervention groups did not show reduced conditioned fear responses directly after the intervention or two days later. Moreover, threat memory devaluation was inconsistently related to these outcome measures and Bayesian analyses provided support for the null hypothesis. Potentially, threat devaluation does not reduce conditioned responses. While earlier one-day studies demonstrated that a dual-task intervention reduced conditioned responses directly after the intervention, compared to recall only (Leer, Engelhard, Altink, & van den Hout, 2013) and compared to no task (Leer, Engelhard, Dibbets, & van den Hout, 2013), the latter study found no group differences in threat devaluation. This suggests that the observed differences in conditioned responses did not result from threat devaluation. In multiple-day studies, a dual-task intervention did not reduce conditioned responses compared to a control task, when tested one day after the intervention (Dibbets et al., 2018) or when the intervention was 24 h after fear acquisition (Landkroon et al., 2020). Collectively, this suggests that threat devaluation may not reduce conditioned responses, in contrast to contemporary learning theory (Davey, 1997).

An alternative interpretation of why the interventions did not reduce conditioned responses compared to no intervention, is that the interventions were not potent enough to devalue threat memory adequately and as a result, conditioned responses would not be attenuated. Indeed, threat memory was still rated as relatively unpleasant in both intervention groups after the intervention (>50 on 0–100 scale; see e.g., Dibbets et al., 2018; Landkroon et al., 2020; Leer, Engelhard, Altink, & van den Hout, 2013). Reducing the unpleasantness even further during such a brief intervention in the lab may not be feasible. Moreover, the interventions reduced unpleasantness of threat memory compared to no intervention after the extinction phase, but not after two days. Newly acquired footage as threat memory is perhaps more susceptible to decay over time than autobiographical memories (McGaugh, 2000), and consequently, unpleasantness also decreased in the no intervention group after two days.

There are several possibilities to increase the potency of interventions. First, the potency of a dual-task intervention may be enhanced by including other elements of the EMDR protocol, such as increasing the validity of positive cognitions (de Jongh & ten Broeke, 2012; Shapiro, 2017). This may be difficult in fear conditioning and trauma film paradigms, because these paradigms do not use idiosyncratic memories. Instead, aversive autobiographical memories might be more appropriate to investigate cognitive interventions. Behavioral avoidance tasks can then be used to measure conditioned responses (Beckers, Krypotos, Boddez, Effting, & Kindt, 2013). Second, future studies can select other imagery-based interventions that may sort larger effects, such as imagery rescripting (Morina, Lancee, & Arntz, 2017), in which a threat memory is imagined and changed into a more positive scenario. Future research using a more potent intervention and using mediation analyses could disentangle whether threat devaluation reduces conditioned responses or whether these are ultimately not related.

Another issue that warrants discussion is the low intrusion frequency. This resulted in minimal room for the interventions to reduce this frequency even further. Previous studies using the same trauma film reported between 2.5 and 5.5 intrusions (Streb, Mecklinger, Anderson, Johanna, & Michael, 2016; van Schie et al., 2019; Verwoerd, Jong, & Wessel, 2008). Those studies used a longer film clip (10 min. vs. our 6 clips of 30-s), a longer diary period (4–7 days vs. our 2 days), and did not use a fear conditioning paradigm with intervening materials between ‘acquisition’ and ‘diary’. However, previous studies with similar designs as our study (30-s film clips, 2-day diary, and intervening tasks after the film) reported four to eight intrusions (Rattel et al., 2019; Wegerer et al., 2013). The latter studies differed from our study in two ways that may influence intrusion frequency. First, the earlier studies used different film scenes, although all scenes showed severe violence. Second, in previous research participants registered intrusions with the Intrusive Memory Questionnaire each evening retrospectively, while here participants were instructed to register intrusions immediately. Future research may investigate these potential explanations for differences in intrusion frequency and then investigate interventions to reduce intrusion frequency and conditioned responses with an improved paradigm. Alternatively, future studies may test interventions in individuals who already experience intrusive imagery (Homer & Deeprose, 2017).

Several limitations of the experimental paradigm should be noted. First, as abovementioned, the potency of the interventions may be insufficient and intrusion frequency was overall low. Second, the acquisition and intervention phases took place on the same day. Future multiple-day studies could ensure that the interventions interfere with *consolidated* threat memories (McGaugh, 2000). Third, no psychophysiological measures of associative or evaluative fear learning were taken. It remains unclear whether a dual-task intervention affects psychophysiological measures (Landkroon et al., 2020; but see Engelhard, van Uijen, & van den Hout, 2010), so it is recommended that future studies also use these outcome measures to assess all components of learned fear (Constantinou et al., 2020). Finally, expected effect sizes based on previous research can be inflated (Brysbaert, 2019), resulting in underpowered studies. Yet, this seems an unlikely explanation for our null findings, because the Bayes factors provide evidence for the null hypotheses. Strengths of this study include using both active and passive control groups, having multiple self-report outcome measures showing similar results (see Constantinou et al., 2020; Wegerer et al., 2013), and the study’s pre-registration (Krypotos, Klugkist, Mertens, & Engelhard, 2019).

In conclusion, both dual-task and recall only interventions reduced aversiveness of threat memory compared to no task, but the interventions did not reduce conditioned fear responding, return of fear or intrusions. Future studies may improve interventions and focus on intrusive autobiographical memories. Considering the major impact of fear relapse and intrusive memories, further research on improving mental imagery-based interventions is warranted.

Author statement

Elze Landkroon: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Visualization. **Elske Salemink:** Writing - review & editing. **Iris M. Engelhard:** Conceptualization, Funding acquisition, Methodology, Writing - review & editing.

Declaration of competing interest

The authors declare no conflict of interest.

Acknowledgements

This study was funded by a VICI grant (grant number: 453-15-005) awarded to Iris M. Engelhard by the Netherlands Organization for Scientific Research (NWO). We are grateful to Dieuwke Sevenster for her input into the research design and Gaëtan Mertens for his comments on an earlier draft of the manuscript. We thank Babiche Keuls, Eefje Kooij, David Lasschuijt, Bernd van Schaik, Doortje Spliethoff, and Linde van Verre for assisting during data collection.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jbtep.2021.101639.

References

Arnaudova, I., & Hagenaars, M. A. (2017). Lights … action: Comparison of trauma films for use in the trauma film paradigm. *Behaviour Research and Therapy, 93*, 67–77. https://doi.org/10.1016/j.brat.2017.02.007

Badawi, A., Berle, D., Rogers, K., & Steel, Z. (2020). Do cognitive tasks reduce intrusive-memory frequency after exposure to analogue trauma? An experimental replication. *Clinical Psychological Science*, 1–15. https://doi.org/10.1177/2167702620906148

Beckers, T., Krypotos, A. M., Boddez, Y., Effting, M., & Kindt, M. (2013). What's wrong with fear conditioning? *Biological Psychology, 92*(1), 90–96. https://doi.org/10.1016/j.biopsycho.2011.12.015

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck depression inventory-II*. San Antonio, TX: Psychological Corporation.

Berntsen, D. (2010). The unbidden past: Involuntary autobiographical memories as a basic mode of remembering. *Current Directions in Psychological Science, 19*(3), 138–142. https://doi.org/10.1177/0963721410370301

Bouton, M. E. (2002). Context, ambiguity, and unlearning: Sources of relapse after behavioral extinction. *Biological Psychiatry, 52*(10), 976–986. https://doi.org/10.1016/S0006-3223(02)01546-9

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

Brewin, C. R., Gregory, J. D., Lipton, M., & Burgess, N. (2010). Intrusive images in psychological disorders: Characteristics, neural mechanisms, and treatment implications. *Psychological Review, 117*(1), 210–232. https://doi.org/10.1037/a0018113

Brysbaert, M. (2019). How many participants do we have to include in properly powered experiments? A tutorial of power analysis with reference tables. *Journal of Cognition, 2*(1), 1–38. https://doi.org/10.5334/joc.72

Constantinou, E., Purves, K. L., McGregor, T., Lester, K. J., Barry, T. J., Treanor, M., et al. (2020). Measuring fear: Association among different measures of fear learning. *Journal of Behavior Therapy and Experimental Psychiatry*, 105398. https://doi.org/10.1016/j.jcbs.2020.08.008

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

Cuijpers, P., Veen, S. C. Van, Sijbrandij, M., Yoder, W., Cristea, A., & Yoder, W. (2020). Eye movement desensitization and reprocessing for mental health problems: A systematic review and meta-analysis. *Cognitive Behaviour Therapy*, 1–16. https://doi.org/10.1080/16506073.2019.1703801, 00(00).

Davey, G. C. L. (1997). A conditioning model of phobias. In *Phobias: A handbook of theory, research and treatment* (pp. 301–322). Chichester: JohnWiley & Sons.

Dibbets, P., Lemmens, A., & Voncken, M. (2018). Turning negative memories around: Contingency versus devaluation techniques. *Journal of Behavior Therapy and Experimental Psychiatry, 60*, 5–12. https://doi.org/10.1016/j.jbtep.2018.02.001

van Dis, E., van Veen, S., Hagenaars, M., Batelaan, N., Bockting, C. L. H., van den Heuvel, R. M., et al. (2020). Long-term outcomes of cognitive behavioral therapy for anxiety-related disorders: A systematic review and meta-analysis. *JAMA Psychiatry*, 1–9. https://doi.org/10.1001/jamapsychiatry.2019.3986

Engelhard, I. M., McNally, R. J., & van Schie, K. (2019). Retrieving and modifying traumatic memories: Recent research relevant to three controversies. *Current Directions in Psychological Science, 28*(1), 91–96. https://doi.org/10.1177/0963721418807728

Engelhard, I. M., van Uijen, S. L., & van den Hout, M. A. (2010). The impact of taxing working memory on negative and positive memories. *European Journal of Psychotraumatology, 1*(1), 5623. https://doi.org/10.3402/ejpt.v1i0.5623

Engelhard, I. M., van den Hout, M. A., Janssen, W. C., & van der Beek, J. (2010). Eye movements reduce vividness and emotionality of "flashforwards". *Behaviour Research and Therapy, 48*(5), 442–447. https://doi.org/10.1016/j.brat.2010.01.003

Hackmann, A., & Holmes, E. A. (2004). Reflecting on imagery: A clinical perspective and overview of the special issue of Memory on mental imagery and memory in psychopathology. *Memory, 12*(4), 389–402. https://doi.org/10.1080/09658210444000133

Herz, N., Bar-Haim, Y., Holmes, E. A., & Censor, N. (2020). Intrusive memories: A mechanistic signature for emotional memory persistence. *Behavior Research and Therapy*, 103752. https://doi.org/10.1016/j.brat.2020.103752

Holmes, E. A., James, E. L., Coode-Bate, T., & Deeprose, C. (2009). Can playing the computer game "Tetris" reduce the build-up of flashbacks for trauma? A proposal from cognitive science. *PloS One, 4*(1), 1–6. https://doi.org/10.1371/journal.pone.0004153

Holmes, E. A., James, E. L., Kilford, E. J., & Deeprose, C. (2010). Key steps in developing a cognitive vaccine against traumatic flashbacks: Visuospatial tetris versus verbal pub quiz. *PloS One, 5*(11). https://doi.org/10.1371/journal.pone.0013706

Holmes, E. A., & Mathews, A. (2010). Mental imagery in emotion and emotional disorders. *Clinical Psychology Review, 30*(3), 349–362. https://doi.org/10.1016/j.cpr.2010.01.001

Homer, S. R., & Deeprose, C. (2018). Eye movement attenuation of intrusive social anxiety imagery: A pilot study. *Journal of Behavior Therapy and Experimental Psychiatry, 59*, 87–91. https://doi.org/10.1016/j.jbtep.2017.11.003

James, E. L., Bonsall, M. B., Hoppitt, L., Tunbridge, E. M., Geddes, J. R., Milton, A. L., et al. (2015). Computer game play reduces intrusive memories of experimental trauma via reconsolidation-update mechanisms. *Psychological Science, 26*(8), 1201–1215. https://doi.org/10.1177/0956797615583071

James, E. L., Lau-zhu, A., Clark, I. A., Visser, R. M., Hagenaars, M. A., & Holmes, E. A. (2016). The trauma film paradigm as an experimental psychopathology model of psychological trauma: Intrusive memories and beyond. *Clinical Psychology Review, 47*, 106–142. https://doi.org/10.1016/j.cpr.2016.04.010

JASP Team. (2020). *JASP (Version 0.13.1) [Computer software]*. https://jasp-stats.org/.

de Jongh, A. J. C. M., & ten Broeke, E. (2012). *Handboek EMDR: Een geprotocolleerde behandelmethode voor de gevolgen van psychotrauma [EMDR handbook: A protocol treatment for the effects of psychological trauma]*. Amsterdam: Pearson.

Krypotos, A.-M., Klugkist, I., Mertens, G., & Engelhard, I. M. (2019). A step-by-step guide on preregistration and effective data sharing for psychopathology research. *Journal of Abnormal Psychology, 128*(6), 517–527. https://doi.org/10.1037/abn0000424

Kelley, K. (2017). *MBESS (Version 4.0.0. and higher) [computer software and manual]*. http://cran.r-project.org.

Krypotos, A. M., Mertens, G., Leer, A., & Engelhard, I. M. (2020). Induction of conditioned avoidance via mental imagery. *Behaviour Research and Therapy, 132* (May), 103652. https://doi.org/10.1016/j.brat.2020.103652

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology, 4*(NOV), 1–12. https://doi.org/10.3389/fpsyg.2013.00863

Landkroon, E., Mertens, G., & Engelhard, I. M. (2020). Devaluation of threat memory using a dual-task intervention does not reduce context renewal of fear. *Behaviour Research and Therapy, 124*, 103480. https://doi.org/10.1016/j.brat.2019.103480

Landkroon, E., Mertens, G., Sevenster, D., Dibbets, P., & Engelhard, I. M. (2019). Renewal of conditioned fear responses using a film clip as the aversive stimulus. *Journal of Behavior Therapy and Experimental Psychiatry, 65*, 101493. https://doi.org/10.1016/j.jbtep.2019.101493

Langner, O., Dotsch, R., Bijlstra, G., Wigboldus, D. H. J., Hawk, S. T., & van Knippenberg, A. (2010). Presentation and validation of the radboud faces database. *Cognition & Emotion, 24*(8), 1377–1388. https://doi.org/10.1080/02699930903485076

Lee, C. W., & Cuijpers, P. (2013). A meta-analysis of the contribution of eye movements in processing emotional memories. *Journal of Behavior Therapy and Experimental Psychiatry, 44*(2), 231–239. https://doi.org/10.1016/j.jbtep.2012.11.001

Leer, A., Engelhard, I. M., Altink, A., & van den Hout, M. A. (2013). Eye movements during recall of aversive memory decreases conditioned fear. *Behaviour Research and Therapy, 51*(10), 633–640. https://doi.org/10.1016/j.brat.2013.07.004

Leer, A., Engelhard, I. M., Dibbets, P., & van den Hout, M. (2013). Dual-tasking attenuates the return of fear after extinction. *Journal of Experimental Psychopathology, 4*(4), 325–340. https://doi.org/10.5127/jep.029412

Lonsdorf, T. B., & Merz, C. J. (2017). More than just noise: Inter-individual differences in fear acquisition, extinction and return of fear in humans - biological, experiential, temperamental factors, and methodological pitfalls. *Neuroscience & Biobehavioral Reviews, 80*, 703–728. https://doi.org/10.1016/j.neubiorev.2017.07.007

McGaugh, J. L. (2000). Neuroscience - memory - a century of consolidation. *Science, 287* (5451), 248–251. https://doi.org/10.1126/science.287.5451.248

Mertens, G., Krypotos, A., & Engelhard, I. M. (2020). A review on mental imagery in fear conditioning research 100 years since the ' Little Albert ' study. *Behaviour Research and Therapy, 126*(January), 103556. https://doi.org/10.1016/j.brat.2020.103556

Mertens, G., Lund, M., & Engelhard, I. M. (2020). The effectiveness of dual-task interventions for modulating emotional memories in the laboratory: A meta-analysis. https://doi.org/10.31234/osf.io/3nqt5.

Morina, N., Lancee, J., & Arntz, A. (2017). Imagery rescripting as a clinical intervention for aversive memories: A meta-analysis. *Journal of Behavior Therapy and Experimental Psychiatry, 55*, 6–15. https://doi.org/10.1016/j.jbtep.2016.11.003

National Institute for Health and Clinical Excellence. (2011). Common mental health problems: Identification and pathways to care. NICE Guideline (CG123). https://www.nice.org.uk/.

Noé, G. (2002). *Irréversible*.

Powers, M. B., Halpern, J. M., Ferenschak, M. P., Gillihan, S. J., & Foa, E. B. (2010). A meta-analytic review of prolonged exposure for posttraumatic stress disorder. *Clinical Psychology Review, 30*(6), 635–641. https://doi.org/10.1016/j.cpr.2010.04.007

Rattel, J. A., Wegerer, M., Miedl, S. F., Blechert, J., Grünberger, L. M., Craske, M. G., et al. (2019). Peritraumatic unconditioned and conditioned responding explains sex differences in intrusions after analogue trauma. *Behaviour Research and Therapy, 116*, 19–29. https://doi.org/10.1016/j.brat.2019.01.009

van Schie, K., van Veen, S. C., & Hagenaars, M. A. (2019). The effects of dual-tasks on intrusive memories following analogue trauma. *Behaviour Research and Therapy, 120*, 103448. https://doi.org/10.1016/j.brat.2019.103448

Schmider, E., Ziegler, M., Danay, E., Beyer, L., & Bühner, M. (2010). Is it really robust? Reinvestigating the robustness of ANOVA against violations of the normal distribution assumption. *Methodology, 6*(4), 147–151. https://doi.org/10.1027/1614-2241/a000016

Shapiro, F. (2017). *Eye movement desensitization and reprocessing (EMDR) therapy: Basic principles, protocols, and procedures* (3rd ed.). Guilford Publications.

Siegesleitner, M., Strohm, M., Wittekind, C. E., Ehring, T., & Kunze, A. E. (2019). Effects of imagery rescripting on consolidated memories of an aversive film. *Journal of Behavior Therapy and Experimental Psychiatry, 62*, 22–29. https://doi.org/10.1016/j.jbtep.2018.08.007

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

Streb, M., Mecklinger, A., Anderson, M. C., Johanna, L. H., & Michael, T. (2016). Memory control ability modulates intrusive memories after analogue trauma. *Journal of Affective Disorders, 192*, 134–142. https://doi.org/10.1016/j.jad.2015.12.032

Tadmor, A., McNally, R. J., & Engelhard, I. M. (2016). Reducing the negative valence of stressful memories through emotionally valenced, modality-specific tasks. *Journal of Behavior Therapy and Experimental Psychiatry, 53*, 92–98. https://doi.org/10.1016/j.jbtep.2014.11.001, 2016.

Torrents-Rodas, D., Fullana, M. A., Bonillo, A., Caseras, X., Andión, O., & Torrubia, R. (2013). No effect of trait anxiety on differential fear conditioning or fear generalization. *Biological Psychology, 92*(2), 185–190. https://doi.org/10.1016/j.biopsycho.2012.10.006

van Veen, S. C., van Schie, K., van de Schoot, R., van den Hout, M. A., & Engelhard, I. M. (2020). Making eye movements during imaginal exposure leads to short-lived memory effects compared to imaginal exposure alone. *Journal of Behavior Therapy and Experimental Psychiatry, 67*, 101466. https://doi.org/10.1016/j.jbtep.2019.03.001

van Veen, S. C., van Schie, K., Wijngaards-de Meij, L. D. N. V., Littel, M., Engelhard, I. M., & van den Hout, M. A. (2015). Speed matters: Relationship between speed of eye movements and modification of aversive autobiographical memories. *Frontiers in Psychiatry, 6*, 45. https://doi.org/10.3389/fpsyt.2015.00045

Vervliet, B., Baeyens, F., van den Bergh, O., & Hermans, D. (2013). Extinction, generalization, and return of fear: A critical review of renewal research in humans. *Biological Psychology, 92*(1), 51–58. https://doi.org/10.1016/j.biopsycho.2012.01.006

Vervliet, B., Craske, M. G., & Hermans, D. (2013). Fear extinction and relapse: State of the art. *Annual Review of Clinical Psychology, 9*, 215–248. https://doi.org/10.1146/annurev-clinpsy-050212-185542

Verwoerd, J., Jong, P. J. De, & Wessel, I. (2008). Low attentional control and the development of intrusive memories following a laboratory stressor. *Journal of Psychopathology and Behavioral Assessment, 30*, 291–297. https://doi.org/10.1007/s10862-008-9080-6

Wegerer, M., Blechert, J., Kerschbaum, H., & Wilhelm, F. H. (2013). Relationship between fear conditionability and aversive memories: Evidence from a novel conditioned-intrusion paradigm. *PloS One, 8*(11). https://doi.org/10.1371/journal.pone.0079025