Journal of Behavior Therapy and Experimental Psychiatry 71 (2021) 101616

Contents lists available at ScienceDirect

Journal of Behavior Therapy and Experimental Psychiatry

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

Does valence contribute to the effects of dual tasking in aversive autobiographical memory? Some unexpected findings

T. IJdema [a,*], O.M. Laceulle [b], A. Karreman [a], J. de Vries [a,c], K. Korrelboom [a,d]

[a] Department of Medical and Clinical Psychology, Centre of Research on Psychology in Somatic Diseases, Tilburg University, Postbus 90153, 5000 LE Tilburg, the Netherlands
[b] Department of Developmental Psychology, Utrecht University, PO Box 80140, 3508, TC Utrecht, the Netherlands
[c] Department of Medical Psychology, Elisabeth-Tweesteden Hospital, Tilburg, Postbus 90151, 5000, LC Tilburg, the Netherlands
[d] Department of Anxiety and Obsessive Compulsive Disorders, PsyQ, Lijnbaan 4, 2512, VA, The Hague, the Netherlands

ARTICLE INFO

Keywords:
Dual tasking
Trauma
Working memory taxation
Valence
Emotional memory

ABSTRACT

Background and objectives: Lab experiments show that engaging in a working memory task while recalling an aversive memory reduces emotionality and vividness of memories. Studies targeting lab induced negative memory with valenced secondary tasks show promise, but work is needed on autobiographical memories to make it more in line with the original dual tasking research and PTSD treatment in clinical populations. In this study, we address this gap by evaluating differential effectiveness of valenced dual tasks on emotionality and vividness of aversive autobiographical memories.
Methods: University students ($N = 178$) recalled an aversive autobiographical memory while rating either positive pictures, negative pictures, or while looking at a cross in the exposure only condition. Participants were randomized to one of three aforementioned conditions and rated their memories before and after each intervention on emotionality and vividness.
Results: Against expectations, memories became more emotional and vivid regardless of condition. With regard to vividness, this effect was characterized by an interaction effect: memories became more vivid in the exposure only condition than in the combined dual tasking conditions. All effect sizes were small.
Limitations: Working memory load in the dual tasking conditions might have been insufficient.
Conclusions: The current study did not extend findings with regard to (valenced) dual tasking and revealed a possible sensitization effect of script driven autobiographical memory induction. Our study highlights the importance of aspects such as the total amount of exposure and characteristics of memory induction, specifically the addition of a script driven approach to the usual self-initiated memory activation in dual tasking research.

Eye Movement Desensitization and Reprocessing (EMDR) is among the most effective treatments (Bisson, Roberts, Andrew, Cooper, & Lewis, 2013) for Post-Traumatic Stress Disorder (PTSD), and is included in several PTSD guidelines (American Psychiatric Association, 2017; Balkom et al., 2014; National Institute for Clinical Excellence, 2005; World Health Organization, 2013). A hallmark procedural element in EMDR is performing eye movements while simultaneously thinking of the most distressing image of a traumatic memory (thus performing two tasks at the same time: dual tasking). Currently, the preferred explanation for dual tasking is that of working memory taxation (Andrade, Kavanagh, & Baddeley, 1997; Van den Hout & Engelhard, 2012). This theory states that performing a dual task (traditionally horizontal eye movements) while keeping a traumatic memory in mind creates competition for limited resources in the working memory. As a result, the memory cannot be retrieved completely and is therefore generally rated as less vivid and emotional.

Traditionally, the EMDR procedure prescribes eye movements as a necessary secondary task (Shapiro, 1989). However, according to the working memory theory, the only requirement the second task needs to meet is that of loading the working memory sufficiently. Indeed, as Van den Hout and Engelhard (2012) outlined in their review, many 'dual tasking' procedures are successful in the amelioration of autobiographical aversive memories: auditory shadowing and drawing complex figures (Gunter & Bodner, 2008), counting aloud (Kemps & Tiggemann,

* Corresponding author.
E-mail addresses: t.ijdema@uvt.nl (T. IJdema), o.m.laceulle@uu.nl (O.M. Laceulle), a.karreman@uvt.nl (A. Karreman), j.devries@uvt.nl (J. de Vries), c.w.korrelboom@uvt.nl (K. Korrelboom).

https://doi.org/10.1016/j.jbtep.2020.101616
Received 30 April 2019; Received in revised form 20 August 2020; Accepted 8 September 2020
Available online 9 September 2020
0005-7916/

2007; Van den Hout et al., 2010), mental arithmetic (Engelhard, van den Hout, & Smeets, 2011), mindful breathing (Van den Hout et al., 2011) and playing the computer game Tetris (Engelhard, van Uijen, & van den Hout, 2010). However, some studies did not find the same pattern of results on dual tasking (and working memory) (Leer, Engelhard, & Van Den Hout, 2014; Van Schie, van Veen, & Hagenaars, 2019; Van Veen, van Schie, van de Schoot, van den Hout, & Engelhard, 2020).

Researchers tried further refining, expanding, and testing the limits of the working memory model. For example, by varying the working memory load (Engelhard et al., 2011) or by matching modality of the interfering task with the modality of imagery (Kemps & Tiggemann, 2007; Matthijssen, Verhoeven, van den Hout, & Heitland, 2017). Otherwise, researchers explored adding valence of the interfering task as a possible refinement of the dual task model (Tadmor, McNally, & Engelhard, 2016; Tsai & McNally, 2014). While not put forward a priori as a possible mechanism by these studies, justification for studying valenced tasks in dual tasking procedures can be found in the literature pertaining to evaluative conditioning, US-revaluation and counter-conditioning (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010). Specifically, these procedures target the re-evaluation of the emotional value and/or intensity of valenced stimuli. For instance in counterconditioning, a conditioned stimulus (CS) that was associated with a negatively valenced unconditioned stimulus (US), is now associated with another US with an incompatible valence, consequently eliciting a different conditioned response (CR) from the original CS (Van Gucht, Baeyens, Vansteenwegen, Beckers, & Hermans, 2010). Research indeed showed that performing a positive task while recalling an aversive memory (induced by a trauma film) shows a larger reduction of emotionality (Tadmor et al., 2016) or fewer details remembered than a neutral, negative or control (no distraction) condition (Tsai & McNally, 2014). However, while research indicates that the valence of the secondary task in dual tasking might influence the perception of negative memories of a non-autobiographical nature, the question remains whether this also holds true for negative autobiographical memories. The answer to this question is relevant because research on dual tasking procedures assume to hold clinical implications for EMDR (Van den Hout & Engelhard, 2012). Studying the effects of valenced dual tasking on autobiographical memory would make research more in line with the original domain of dual tasking and PTSD treatment in clinical populations. Taken together, the results of studies with regard to valence show promise, but the effect of valenced dual tasking on autobiographical memory remains uninvestigated.

The majority of dual tasking studies show that dual tasking is more effective than the control condition (exposure only) in reducing emotionality and vividness of aversive autobiographical memories (Van den Hout & Engelhard, 2012). It is not clear, however, whether valence of the dual task affects further amelioration of autobiographical memory. The current study aims to investigate the specific contribution of different emotional values of the distracting task in a dual tasking procedure targeted at reducing the emotional impact of aversive autobiographical memory. In line with more recent dual tasking research (Leer et al., 2014; Van Veen et al., 2020; Van Schie et al., 2019) we increased exposure time compared to traditional dual tasking lab studies. To activate the aversive memory, we alternated between self-induced imagery commonly used in dual tasking studies (Van den Hout & Engelhard, 2012) and a variant of script driven imagery (SDI). The goal with our approach was to strike a balance between inclusion of idiosyncratic and momentary elements into the image (letting participants conjure up an image themselves: self-induced imagery) while also limiting the risk of cognitive and emotional avoidance of negative emotions (see: Ehlers & Clark, 2000; script-driven imagery). We operationalized the valenced dual task as rating positive or negative pictures on a screen. In the exposure only condition participants looked at a stationary cross on the screen while activating their memory. Several hypotheses were tested. Firstly, based on the working memory account, we expected that participants would display larger decreases of emotionality and vividness of aversive autobiographical memory in the combined dual tasking conditions than in the exposure only condition. Secondly, based on the counterconditioning theory, we hypothesized that a positive secondary task would show larger reductions in emotionality and vividness than the negative task.

Lastly, in order to address an unanswered question remaining from our main experiment about working memory taxation of our picture rating tasks, we conducted a post hoc Random Interval Repetition (RIR) task with a different set of participants.

1. Method

1.1. Subjects

We recruited psychology students from Tilburg University via an online University portal. In exchange for participating in the experiment, they received course credits. The participants signed informed consent, stating that they could withdraw from the study any moment they wanted to. The Ethics Review Board of Tilburg University approved the study. For ethical reasons, we excluded participants receiving clinical treatment for trauma related problems. The study was conducted in the GO-LAB.

After testing 67 men (36.6%) and 116 women (63.4%), we excluded three participants because they rated their memory as traumatic and one because of a mistake in the timing of measurements by the experimenter. This resulted in 178 participants for analyses, 65 men (36.5%) and 113 women (63.5%). Mean age was 20.42 ($SD = 2.80$). Reported cultural identity was 86% Dutch, 3.4% Turkish, 2.8% Moroccan and 7.8% other. The majority of the sample consisted of first year students (88.8%).

1.2. Design

The study consisted of one session lasting 1.5 h. Participants all received one of three conditions: exposure + rating positive pictures, exposure + rating negative pictures or exposure only (looking at a cross). Participants rated their aversive memory on emotionality and vividness before and after the intervention, resulting in a pre and post measurement.[1] Thus, the study employed a mixed design with two within (time) and three between (condition) factors. See Fig. 1 for a graphical representation of the study procedure.

1.3. Materials

1.3.1. Demographics

We collected information about age, sex, cultural identity and about years of attendance in university via a questionnaire before the experiment began.

1.3.2. Pictures

We selected images from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) by using data reported in the technical manual. Specifically, we chose 40 pictures (20 pairs) that had mirrored valence and scored equal on arousal. In the process, we omitted erotic pictures and pictures that were too similar to each other (e.g. smiling babies.). An independent sample *t*-test confirmed that the goals of our selection procedure were achieved: the positive pictures ($M = 7.93$, $SD = .16$) were rated more positively than the negative pictures ($M = 2.26$, $SD = .30$), $t(29,14) = -78.28$, $p < .001$, $d = 23.81$. There was no evidence for a difference in arousal (positive pictures ($M = 5.28$, $SD =$

[1] The original design consisted of three intervention blocks (and four VAS measurements). However, using this design, we were not able to guarantee that carry over effects did not influence the results. As such, we decided to base our calculations on the first block only, because it would make interpretation easier and our sample size allowed it.

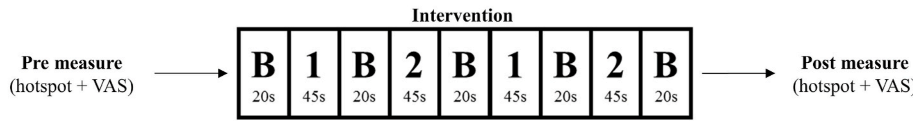

Fig. 1. Graphical representation of the experiment.
Note. Participants activated their aversive memory by 1 = having the experimenter read out the script aloud, or 2 = on their own. B = break. VAS = Visual Analog Scale. Hotspot = the most unpleasant/painful moment.

.77) and negative pictures ($M = 5.27$, $SD = .76$), $t(38) = .06$, $p = .951$, $d = -.02$. A random sequence determined the order of the pictures and this was the same for all participants. See appendix A for the exact IAPS numbers of the pictures and the ordering/pairing.

1.3.3. *Visual Analog Scales*

Pen and paper Visual Analog Scales (VAS) were used with a length of 100 mm for the measurement of emotionality (0: not unpleasant at all – 100: extremely unpleasant) and vividness (0: not vivid at all - 100: extremely vivid) associated with the most intense moment of the trauma script (the hotspot) of the aversive memory. These hotspot ratings functioned as pre and post measurements for the intervention, resulting in two scores total for each participant: vividness and emotionality.

1.4. *Procedure*

Eight experimenters received training and supervision by an experienced, certified clinical psychologist, experienced in treating PTSD patients with EMDR and trauma-focused Cognitive Behavioral Therapy (the last author) to conduct the experiment.

First, participants read an information letter, were checked on inclusion criteria (wanting to talk about a personal memory and not receiving clinical treatment for trauma related problems) and signed informed consent. Then, the participant filled out questionnaires about age, gender, cultural identity and years of attendance in the university. Next, the experimenter helped the participants formulate a ‘script’ of their aversive memory by asking a set of standardized questions about stimulus (sight, sounds, feeling, taste or smell), meaning (negative thoughts about themselves and important aspects of their lives in relation to the aversive image) and response representations (feelings, bodily tendencies) when thinking about the aversive memory. The definitive script lasted approximately 45 s, roughly corresponding with the ‘sets of eye movements’ applied in EMDR treatment (Ten Broeke, de Jongh, & Hornsveld, 2020). This was done by reading back the script to the participant in 45 s and asking if all the details were correct and if anything important was missing. Then, the most unpleasant moment within the script was identified (the hotspot) and formulated in the same manner. We used the hotspot to measure our main dependent variables: emotionality and vividness of the aversive autobiographic memory.

To practice the picture evaluation procedure, participants rated five IAPS pictures that were not in the main experiment on a scale from 1 to 9 (extremely unpleasant-extremely pleasant) on a computer screen for 9 s before changing to the next picture. Following the practice trial, the experimental procedure started.

The procedure started with the experimenter activating the aversive memory by reading the hotspot aloud to the participants. Subsequently, participants rated their aversive memory on the pen and paper VAS for emotionality and vividness.

After a short break of 20 s, participants activated their aversive memory again by alternating having the experimenter read the formulated script aloud or having the participant visualize the memory without the experimenter’s assistance. However, this time the participants, depending on the condition, had to rate positive or negative pictures or look at the fixed cross concurrently. All conditions consisted of four blocks of five pictures each. In the first and third block, the experimenter read the script aloud. In the second and fourth block, the participants visualized this same script by themselves without the experimenter’s assistance. In this manner, we tried to balance between self-controlled imaginal exposure (second and fourth block), allowing for adding idiosyncratic aspects of the memory by the subject and experimenter-controlled imaginal exposure (first and third block), obstructing mental avoidance of the subject during exposure.

After the intervention, the experimenter presented the hotspot again after which the participants filled out the pen and paper VAS (post measure). Participants received debriefing after handing in their last VAS.

1.5. *Data analysis*

We used two separate mixed ANOVAs to assess the trajectories of change in emotionality and vividness between conditions. We checked the Cook’s distances and none of the values came close to the critical value of 1. All other assumptions for mixed ANOVAs were also checked and gave no reason for concern. If we found an omnibus effect in either analysis, we conducted planned difference contrasts to (1) assess differences between the combined dual tasking conditions vs. exposure only condition and (2) positive pictures vs. negative pictures. Eta squared are reported for the ANOVAs and Cohen’s d are reported for the contrasts. We used SPSS 24.0 for the analyses. The databases and syntaxes for both experiments can be found at the website of the Open Science Framework (https://osf.io/dka29/?view_only=2b30ebcb437f4ab1b5b2962325c2a001).

2. Post hoc Random Interval Repetition experiment

To gain insight into the working memory taxation of our picture rating task, we conducted a post hoc Random Interval Repetition experiment with a different set of participants.

2.1. *Method*

2.1.1. *Participants*

We invited 24 participants to the lab ($M = 20.87$, $SD = 2.18$). They received course credit needed to pass a course. The sample consisted of mainly first year students (91.7%).

2.1.2. *Design*

The study was within subject (variable: condition) and was fully balanced resulting in six different orders. The experiment followed the Random Interval Repetition paradigm (RIR; Goten, Vandierendonck, & De Vooght, 1998; cf. Van Veen, Engelhard, & van den Hout, 2016; Van den Hout et al., 2011) and the main experiment as closely as possible. The addendum experiment used the same pictures and ordering of the main experiment (see appendix A). There were three conditions: positive pictures, negative pictures and baseline (fixed cross).

2.1.3. *Procedure*

First, participants set the volume of the headphones to what was comfortable for them. Then they received a couple of practice trials consisting of either a picture (two different pictures were used) or a fixed cross. They were asked to react as quickly and as accurately as possible to beeps, while thinking of how to rate the picture displayed on the screen (in the picture condition) or to just look at the cross (in the baseline condition). The RIR trials were split quasi randomly between

900 and 1500 ms trials, never more than four the same in succession. Each stimulus was displayed for a total of 9.6 s during the RIR trials (4*900 ms + 4*1500 ms). Then, the RIR task stopped and participants were asked to rate the same picture on a scale from 1 (very unpleasant) to 9 (very pleasant) before moving on to the next picture.

The experiment followed the exact same outline. Participants rated all 40 pictures (20 positive and 20 negative) in this manner and in the same order as in the main experiment. Beeps were presented for 50 ms (and 200 hz) during which no measurement was possible. This resulted in 160 trials per condition (20 pictures per condition* 8 trials).

2.1.4. Data analysis

We calculated the mean for the 160 trials[2] per condition and subsequently analyzed the means with a repeated measures ANOVA. To improve the skewness and the normality of residuals of the data, we removed 220 total outlying scores on the top end (1.9%) based on a cutoff score of 3 standard deviations. There were no scores under −3 standard deviations. This resulted into excluding 89 scores (2.3%) from both the positive and negative condition, and 42 scores (1.1%) from the baseline condition. The Cook's distances did not reach the critical value of 1. Omnibus effect size are reported with eta squared and pairwise comparisons with Cohen's d.

3. Results

3.1. Main experiment

All the means and frequencies associated with the below described preliminary analyses can be found in Table A.1, A.2, A.3 and A.4 (appendix A).

3.1.1. Preliminary analyses

Each of the three conditions contained approximately 60 participants (range 58–61). There was no evidence that participants assigned to different conditions differed on age ($F(2, 177) = 0.70$, $p = .500$), sex ($\chi^2(2, N = 178) = 2.51$, $p = .286$), cultural identity ($\chi^2(12, N = 178) = 15.50$, $p = .215$) or years in university ($F(2, 177) = .496$, $p = .610$).

Additionally, there was no evidence for differing baseline scores of the participants on the basis of assignment to the experimenter on emotionality ($F(7, 177) = 1.31$, $p = .246$) or vividness ($F(7, 177) = .86$, $p = .542$); indicating no evidence for difference in ability to activate memories between experimenters. Secondly, a mixed ANOVA showed that there was no evidence for different change trajectories of the emotionality ($F(7, 170) = 1.06$, $p = .394$) and vividness ($F(7, 170) = 0.95$, $p = .472$) scores of the participants on the basis of assignment to the experimenter.

Lastly, we validated our pre-selected set of pictures from the manual with our own participants. As expected, the participants rated the positive pictures ($M = 6.60$, $SD = .47$) more positively than the negative pictures ($M = 2.53$, $SD = .47$), $t(38) = -27.38$, $p < .001$, $d = 8.66$.

3.1.2. Primary analyses

Table 1 shows the means and standard deviations with regard to the outcome measures. Figs. 2 and 3 shows the distribution of the outcome measures in violin plots.

Emotionality. The mixed ANOVA showed that there was a main effect of condition, $F(2, 175) = 3.06$, $p = .049$, $\eta^2_p = .03$. Secondly, we found a significant time effect $F(1, 175) = 10.36$, $p = .002$, $\eta^2_p = .06$, meaning that emotionality scores increased regardless of condition. Lastly, the analysis showed that the crucial time*condition interaction was not significant, $F(2, 175) = .86$, $p = .425$, $\eta^2_p = .01$, meaning that there was no evidence for a differing trajectory of change between conditions.

Table 1
Means and standard deviations for the pre and post emotionality and vividness scores.

		Exposure + positive pictures	Exposure + negative pictures	Exposure only
Emotionality	Pre	70.62 (19.36)	61.79 (20.59)	68.92 (15.92)
	Post	72.07 (17.14)	66.37 (21.25)	72.47 (19.11)
Vividness	Pre	79.52 (13.95)	77.97 (17.11)	77.19 (14.41)
	Post	81.47 (11.47)	80.30 (15.03)	83.36 (12.75)

Vividness. The mixed ANOVA showed that concerning vividness of the memory there was no evidence for a main effect of condition, $F(2, 175) = .178$, $p = .837$, $\eta^2_p < .01$. Secondly, we found a significant time effect $F(1, 175) = 22.52$, $p < .001$, $\eta^2_p = .11$, meaning that vividness scores increased over time regardless of condition. Lastly, the crucial time*condition interaction was significant, $F(2, 175) = 3.36$, $p = .037$, $\eta^2_p = .04$, indicating that the trajectory of change (increase) differed between conditions.

Then, to compare the differential effectiveness of valenced dual tasking, we conducted difference contrasts on the change scores. The first contrast showed that the change scores in the combined dual tasking conditions (positive + negative) were lower than in the exposure only condition, $t(175) = -2.59$, $p = .011$, $d = 0.41$. Secondly, we found no evidence for a difference in change scores between the positive and negative conditions $t(175) = -0.21$, $p = .833$, $d = -0.004$.

4. Post hoc Random Interval Repetition experiment

4.1. Analysis

The number of missing trials per conditions were 2.6% for positive (100), 2.9% (113) negative, 2.6% (98) baseline. The repeated measures ANOVA showed that there was a main effect of condition on reaction times (RT), $F(2, 46) = 22.62$, $p < .001$, $\eta^2_p = .50$. A subsequent difference contrast showed that the baseline condition scored lower than the combined positive and negative condition on RT, $F(1, 23) = 49.49$, $p < .001$, $d = -1.05$, while there was no evidence for differences between the positive and negative conditions $F(1, 23) = 1.20$, $p = .285$, $d = 0.18$. The distributions for the RT data are shown in the violin plot in Fig. 4.

5. Discussion

In the current study, we aimed to examine differential effectiveness of valenced dual tasking in reducing emotionality and vividness of autobiographical aversive memory. Firstly, we found, contrary to expectation, that emotionality and vividness of the aversive memory *increased* from pre to post measurement regardless condition. For vividness, this *increase* was higher in the exposure only condition than in the combined dual tasking conditions. While these findings are significant, it must be stressed that the effect sizes all fall in the 'small' category by Cohen's (1988) guidelines. These results contradict our hypotheses that (1) dual tasking should show larger decreases than exposure only based on working memory theory and that (2) positive dual tasking should show a bigger decrease than negative dual tasking based on the counterconditioning theory.

One possible explanation for not finding the effects in both hypotheses pertains to the working memory load of our picture rating task. Tasks used by other valenced dual tasking studies seem more taxing than our task (rating pictures for 9 s): flashing a picture for 2 s and then having to select that picture in 2 s from an array containing four pictures (Tsai & McNally, 2014) or engaging in an immersive activity, like watching a movie (Tadmor et al., 2016). These studies might imply that there exists a threshold for an added effect of counterconditioning

[2] Due to a coding error, some orders deviated one or two trials from each other.

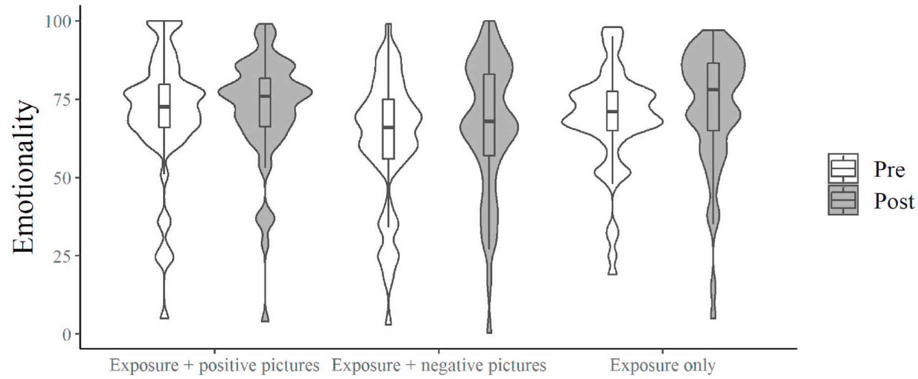

Fig. 2. Violin plots for the emotionality outcome measure for the pre and post conditions, split per condition. The width of the violin represents the frequency of participants at that value, showing the distribution in the process. Boxplots are superimposed in the violin.

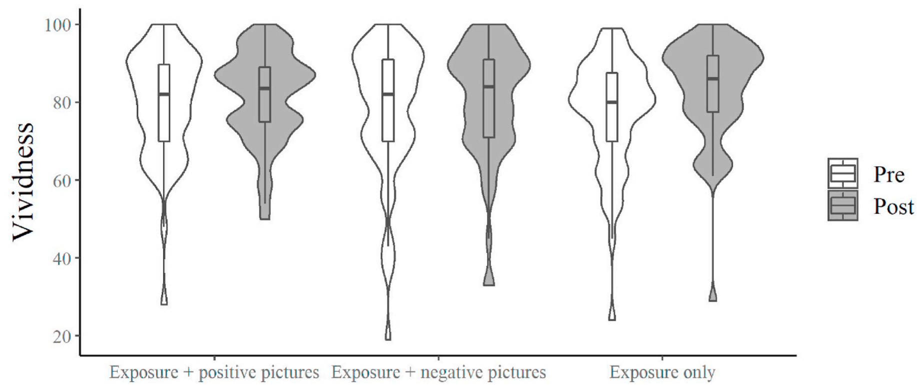

Fig. 3. Violin plots for the vividness outcome measure for the pre and post conditions, split per condition. The width of the violin represents the frequency of participants at that value, showing the distribution in the process. Boxplots are superimposed in the violin.

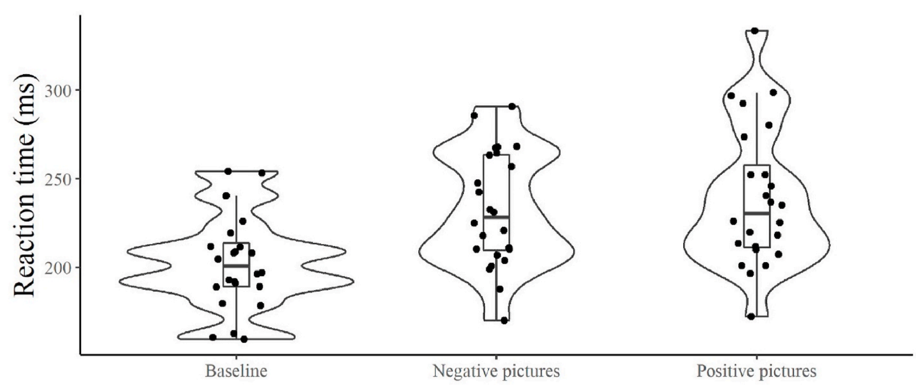

Fig. 4. Violin plots for the reaction times in milliseconds, split per condition. The width of the violin represents the frequency of participants at that value. Boxplots and the individual means are superimposed in the violin.
Note. The values in the upper bound fall within the range of 1 Cook's distance.

account in dual tasking. With our post hoc auditory Random Interval Repetition task, we confirmed our expectation that the combined dual tasking conditions loaded more working memory than a single task condition. This is important for the first hypothesis as on the basis of the working memory theory, it would be expected that the more loading conditions (combined dual tasking) would show more effect than the lesser loading condition (exposure only). While we detected no reduction from pre to post measurement as expected, we did find the increase in vividness smaller in the dual tasking conditions than in the lesser loading condition (exposure only) in the main experiment. This is in line with our RIR data, but this does not apply to emotionality as we found increases in all conditions in the main experiment. Interestingly, our study is not the only study that has trouble modeling effects of dual tasking in terms of working memory: researchers have suggested an inverted U-curve (Engelhard et al., 2011) or a linear relationship (Littel & van Schie, 2019). Others found an inconsistent relationship between emotionality/vividness reductions and amount of working memory taxation of different dual tasks (Mertens et al., 2019) or found no reduction of emotionality/vividness at all even though the dual tasks employed were shown to load more working memory than the no-task condition (Van Schie et al., 2019). Lastly, while it is easy to find significant differences in the RIR paradigm because of the many measurements, the large effect size ($d = -1.05$; Cohen, 1988) indicates that it is a meaningful difference. However, this gives no information about whether this was enough for the dual task in itself to bring about a reduction in emotionality and vividness.

Another possible explanation for not extending findings with regard to valenced dual tasking from newly acquired memory to idiosyncratic emotional memory (Tadmor et al., 2016; Tsai & McNally, 2014) is that the positive stimuli might not have been potent or specific enough. With regard to potency: while we did assess the emotional nature of our stimuli, it is plausible that the positive pictures we used might not mirror the affectivity of an aversive personal memory. Secondly, regarding specificity: just the valence dimension might not be enough to trigger a counterconditioning mechanism. Indeed, other clinical interventions that rely on counterconditioning revolve around using positive experiences that are personally relevant to the patient (i.e. COMET; Korrelboom, de Jong, Huijbrechts, & Daansen, 2009). In sum, the lack of extension of valenced dual tasking results to autobiographical memory might be due to lack of potency or specificity of our stimuli.

Other reasons might also explain our unexpected results. The sensitization effect (seemingly most pronounced in our exposure only condition with regard to vividness) might have occurred because of two deviations from other protocols (i.e. Andrade et al., 1997; Van den Hout, Muris, Salemink, & Kindt, 2001). The first deviation is that we required participants to elaborately verbalize their aversive memory with help of our experimenters, which was then read aloud to the participants in half of our trials, while in the other half, participants activated their images themselves, without any help or prompting from the experimenters. It might be that verbalizing and then hearing your own script made mental avoidance of the aversive memory more difficult than visualizing your memory on your own accord as is usually done in most dual tasking studies (Van den Hout & Engelhard, 2012). Notably, Kearns and Engelhard (2015) similarly used a script driven approach to the dual tasking paradigm and also found an increase in the recall only condition while targeting a standardized memory about public speaking. In line with their findings, it is possible that using script-driven imagery (SDI) could have caused stronger emotionality and vividness in our study than is usually triggered in dual tasking studies that do not make use of SDI. However, SDI is considered a method to adequately trigger relevant emotional imagery (i.e. McTeague et al., 2010; Jovanovic, Rauch, Rothbaum, & Rothbaum, 2017). Moreover, according to most experts in the field of PTSD, triggering vivid images of the traumatic event along with the accompanying thoughts, feelings and emotions as the patient remembers this event is the hallmark of effective PTSD treatment (Foa, Hembree, & Rothbaum, 2007). The second deviation which might have steered our results in an unexpected direction is our explicit warning to the subjects prior to the start of the experiment that the memory might evoke strong negative emotions. However, this seems implausible as expectation effects generally do not seem to affect dual tasking outcomes (Littel, van Schie, & van den Hout, 2017). In sum, it might be possible that our approach to the standard dual tasking protocol increased emotionality and vividness of aversive autobiographical memories.

Lastly, it might be that the effects of the treatment emerge later. Previous research seems to indicate that immediate reductions are not always observed on emotionality in dual tasking, but emerge 24 h later (Leer et al., 2014). Interestingly, van Veen et al., 2020 also found a sensitization effect after four sets of exposure only. Further sets of exposure showed desensitization, which was sustained in the exposure only condition, but not in the eye movement condition at follow-up a day later. Extrapolating these findings to the current study, it might also be possible that we needed more exposure sets to bring about amelioration of emotionality and vividness, or a more taxing dual task. Findings like these seem to fall in line with the variability commonly found into the early stages of new 'extinction learning' (see also Vansteenwegen, Dirikx, Hermans, Vervliet, & Eelen, 2006): memory ratings go up and down, but the average trend is downwards. In sum, our study might not have captured the downward trend because of the short measurement window.

Several strengths and other limitations need to be noted. Firstly, because of the large sample size our study had large statistical power. Because of this, it becomes even more important to not only look at p-values, but also the effect sizes (Sullivan & Feinn, 2012). It is worth emphasizing that they all fall within the 'small' category ($d < 0.5$, Cohen, 1988). A weak point of the study is that we recruited a non-clinical population. Another limitation is that memory was only assessed within the session. To be able to speak of memory reconsolidation, time must elapse before measuring the memory again. Future studies should employ a valenced dual task in a design that loads more working memory and find a way to operationalize the specificity and potency of the stimuli. For example, this can be done by making the positive distracting task more salient by enhancing its personal relevance and impact. An example is Competitive Memory Training (COMET; Korrelboom et al., 2009) in which the patient imagines situations in which positive personal characteristics were in action and by supporting these images with positive self-verbalizations as well as posture and facial expression. In the context of the current task, participants could select personal relevant pictures themselves. Additionally, the role of script driven imagery and including a follow-up measure at least 24 h later in the design to capture possible delayed effects should be considered.

5.1. Conclusions

In sum, the current study did not find the expected beneficial effects on the vividness and emotionality of aversive autobiographical memories with regard to (1) general dual tasking and (2) a positively valenced dual tasking intervention. Moreover, it seemed to reveal a (small) sensitization effect possibly caused by a combination of script driven imagery and a possible non-taxing dual task. More studies are needed to disentangle the mechanisms that are at work. Our study highlights the importance of aspects such as the total amount of exposure and characteristics of memory induction, specifically the addition of a script driven approach to the usual self-initiated memory activation in dual tasking research.

CRediT authorship contribution statement

T. IJdema: Conceptualization, Formal analysis, Investigation, Writing - original draft, Visualization, Project administration. **O.M. Laceulle:** Conceptualization, Writing - review & editing, Validation, Project administration. **A. Karreman:** Conceptualization, Writing - review & editing, Validation. **J. de Vries:** Conceptualization, Writing - review & editing. **K. Korrelboom:** Conceptualization, Writing - review & editing, Validation, Supervision, Project administration.

Declaration of interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

Acknowledgements

We would like to thank Marcel van den Hout and Suzanne van Veen for their helpful comments in an early draft of this article, and Kevin van Schie for assistance in setting up the RIR task.

Appendix A

Table A.1

Pair	Positive	*M* (*SD*)	Negative	*M* (*SD*)
1	1710	7.76 (1.57)	3230	1.86 (1.39)
2	5910	6.63 (1.72)	9302	1.92 (1.56)
3	5825	7.17 (1.77)	2800	2.06 (1.43)
4	1920	6.98 (1.55)	2750	3.16 (1.58)
5	8501	5.78 (1.70)	9187	1.96 (1.52)
6	8370	5.88 (1.65)	9412	1.90 (1.26)
7	5830	6.59 (1.66)	2141	2.13 (1.52)
8	2347	6.79 (1.52)	6831	2.54 (1.47)
9	2154	6.88 (1.56)	2205	2.32 (1.45)
10	1141	7.20 (1.47)	9220	2.75 (1.57)
11	2045	6.31 (1.67)	2710	2.88 (1.30)
12	2340	6.37 (1.82)	2375.1	2.96 (1.49)
13	7502	6.51 (1.71)	3550	2.71 (1.55)
14	8190	6.23 (1.76)	6821	3.26 (1.56)
15	2550	6.69 (1.81)	2276	2.96 (1.44)
16	2150	6.15 (1.83)	9435	2.30 (1.34)
17	2530	6.44 (1.66)	9000	2.99 (1.68)
18	2071	6.58 (1.53)	2799	2.54 (1.30)
19	5833	6.76 (1.64)	3350	2.20 (1.46)
20	8420	6.26 (1.53)	9900	3.11 (1.38)

Numbers, means and standard deviations of the IAPS positive and negative pictures used in the experiments, displayed in the order and pairs they were shown.
Note. The means and standard deviations were collected from our own sample (not the IAPS manual data).

Table A.2
Means and SDs for age, split out per condition

	Exposure + positive pictures	Exposure + negative pictures	Exposure only
Age	20.17 (1.83)	20.75 (2.31)	20.32 (3.86)

Table A.3
Frequencies and percentages (in brackets) for gender, cultural identity and education in years, split out per condition

	Total (*N* = 178)	Exposure + positive pictures (*N* = 58)	Exposure + negative pictures (*N* = 61)	Exposure only (*N* = 59)
Gender				
Man	65 (36.5%)	18 (31%)	27 (44.3%)	20 (33.9%)
Woman	113 (63.5%)	40 (69%)	34 (55.7%)	39 (66.1%)
Cultural identity				
Dutch	153 (86%)	49 (84.5%)	50 (82%)	54 (91.5%)
Antillean	2 (1.1%)	1 (1.7%)	0 (0%)	1 (1.7%)
Turkish	6 (3.4%)	3 (5.2%)	2 (3.3%)	1 (1.7%)
Moroccan	5 (2.8%)	3 (5.2%)	0 (0%)	2 (3.4%)
Surinamese	2 (1.1%)	0 (0%)	2 (3.3%)	0 (0%)
Indonesian	1 (0.6%)	0 (0%)	1 (1.6%)	0 (0%)
Other	9 (5.1%)	2 (3.4%)	6 (9.8%)	1 (1.7%)
Education in years				
First year	158 (88.8%)	52 (89.7%)	54 (88.5%)	52 (88.1%)
Second year	6 (3.4%)	3 (5.2%)	1 (1.6%)	2 (3.4%)
Third year	8 (4.5%)	3 (5.2%)	2 (3.3%)	3 (5.1%)
Longer than 3 years	6 (3.4%)	0 (0%)	4 (6.6%)	2 (3.4%)

Note. Values may slightly deviate from 100% due to rounding off.

Table A.4
Emotionality and vividness means and standard deviations (in brackets) for the eight different experimenters, split out per time point (*N* = 178)

		Exp. 1 (*N* = 30)	Exp. 2 (*N* = 29)	Exp. 3 (*N* = 29)	Exp. 4 (*N* = 43)	Exp. 5 (*N* = 18)	Exp. 6 (*N* = 3)	Exp. 7 (*N* = 17)	Exp. 8 (*N* = 9)
Emotionality	Pre	64.07 (20.15)	61.24 (22.97)	66.69 (20.69)	71.53 (15.62)	69.61 (19.14)	78.00 (4.00)	63.00 (17.43)	73.89 (10.94)
	Post	65.87 (18.02)	66.77 (22.92)	70.03 (20.94)	75.67 (17.39)	70.28 (21.52)	89.00 (7.00)	68.18 (16.61)	68.44 (13.97)
Vividness	Pre	77.60 (15.83)	76.24 (11.46)	75.28 (19.91)	79.58 (16.50)	82.56 (9.98)	90.67 (9.29)	79.29 (9.79)	74.67 (18.03)
	Post	78.73 (12.04)	81.00 (10.79)	80.24 (14.25)	82.93 (15.54)	83.56 (10.99)	96.33 (4.04)	86.12 (6.62)	75.56 (19.08)

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jbtep.2020.101616.

References

American Psychiatric Association. (2017). In *Clinical practice guideline for the treatment of posttraumatic stress disorder (PTSD) in adults*. Retrieved from https://www.apa.org/ptsd-guideline/ptsd.pdf.

Andrade, J., Kavanagh, D., & Baddeley, A. (1997). Eye-movements and visual imagery: A working memory approach to the treatment of post-traumatic stress disorder. *British Journal of Clinical Psychology, 36*(2), 209–223. https://doi.org/10.1111/j.2044-8260.1997.tb01408.x

Balkom, A. L. J. M., van Vliet, I. M., Emmelkamp, P. M. G., Bockting, C. L. H., Spijker, J., Hermens, M. L. M., et al. (2014). *Multidisciplinaire richtlijn Angststoornissen (Derde revisie). Richtlijn voor de diagnostiek, behandeling en begeleiding van volwassen patiënten met een angststoornis*. Utrecht: Trimbos-instituut.

Bisson, J. I., Roberts, N. P., Andrew, M., Cooper, R., & Lewis, C. (2013). Psychological therapies for chronic post-traumatic stress disorder (PTSD) in adults. *Cochrane Database of Systematic Reviews, 12*, CD003388. https://doi.org/10.1002/14651858.CD003388.pub4

Cohen, J. W. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Ehlers, A., & Clark, D. M. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy, 38*(4), 319–345. https://doi.org/10.1016/S0005-7967(99)00123-0

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., & Smeets, M. A. M. (2011). Taxing working memory reduces vividness and emotional intensity of images about the Queen's Day tragedy. *Journal of Behavior Therapy and Experimental Psychiatry, 42*(1), 32–37. https://doi.org/10.1016/j.jbtep.2010.09.004

Foa, E. B., Hembree, E., & Rothbaum, B. O. (2007). *Prolonged exposure therapy for PTSD: Emotional processing of traumatic experiences. Therapist Guide (Treatments that work)*. New York: Oxford University Press.

Goten, A., Vandierendonck, G., & De Vooght, K. V. D. (1998). Interfering with the central executive by means of a random interval repetition task. *Quarterly Journal of Experimental Psychology: Section A, 51*(1), 197–218. https://doi.org/10.1080/027249898391828

Gunter, R. W., & Bodner, G. E. (2008). How eye movements affect unpleasant memories: Support for a working-memory account. *Behaviour Research and Therapy, 46*(8), 913–931. https://doi.org/10.1016/j.brat.2008.04.006

Hofmann, W., De Houwer, J., Perugini, M., Baeyens, F., & Crombez, G. (2010). Evaluative conditioning in humans: A meta-analysis. *Psychological Bulletin, 136*(3), 390. https://doi.org/10.1037/a0018916

Jovanovic, T., Rauch, S. A., Rothbaum, A. O., & Rothbaum, B. O. (2017). Using experimental methodologies to assess posttraumatic stress. *Current opinion in psychology, 14*, 23–28. https://doi.org/10.1016/j.copsyc.2016.10.001

Kearns, M., & Engelhard, I. M. (2015). Psychophysiological responsivity to script-driven imagery: An exploratory study of the effects of eye movements on public speaking flashforwards. *Frontiers in Psychiatry, 6*(115), 1–9. https://doi.org/10.3389/fpsyt.2015.00115

Kemps, E., & Tiggemann, M. (2007). Reducing the vividness and emotional impact of distressing autobiographical memories: The importance of modality-specific interference. *Memory, 15*(4), 412–422. https://doi.org/10.1080/09658210701262017

Korrelboom, K., de Jong, M., Huijbrechts, I., & Daansen, P. (2009). Competitive memory training (COMET) for treating low self-esteem in patients with eating disorders: A randomized clinical trial. *Journal of Consulting and Clinical Psychology, 77*(5), 974–980. https://doi.org/10.1037/a0016742

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical report A-8*.

Leer, A., Engelhard, I. M., & Van Den Hout, M. A. (2014). How eye movements in EMDR work: Changes in memory vividness and emotionality. *Journal of Behavior Therapy and Experimental Psychiatry, 45*(3), 396–401. https://doi.org/10.1016/j.jbtep.2014.04.004

Littel, M., & van Schie, K. (2019). No evidence for the inverted U-Curve: More demanding dual tasks cause stronger aversive memory degradation. *Journal of Behavior Therapy and Experimental Psychiatry, 65*, 101484. https://doi.org/10.1016/j.jbtep.2019.101484

Littel, M., van Schie, K., & van den Hout, M. (2017). Exploring expectation effects in EMDR: Does prior treatment knowledge affect the degrading effects of eye movements on memories? *European Journal of Psychotraumatology, 8*, 1328954. https://doi.org/10.1080/20008198.2017.1328954. sup.1.

Matthijssen, S. J., Verhoeven, L., van den Hout, M. A., & Heitland, I. (2017). Auditory and visual memories in PTSD patients targeted with eye movements and counting: The effect of modality-specific loading of working memory. *Frontiers in Psychology, 8*. https://doi.org/10.3389/fpsyg.2017.01937, 1937.

McTeague, L. M., Lang, P. J., Laplante, M. C., Cuthbert, B. N., Shumen, J. R., & Bradley, M. M. (2010). Aversive imagery in posttraumatic stress disorder: Trauma recurrence, comorbidity, and physiological reactivity. *Biological Psychiatry, 67*(4), 346–356. https://doi.org/10.1016/j.biopsych.2009.08.023

Mertens, G., Krypotos, A. M., van Logtestijn, A., Landkroon, E., van Veen, S. C., & Engelhard, I. M. (2019). Changing negative autobiographical memories in the lab: A comparison of three eye-movement tasks. *Memory, 27*(3), 295–305. https://doi.org/10.1080/09658211.2018.1507041

National Institute for Clinical Excellence. (2005). *Post-traumatic stress disorder: Management*. Retrieved from https://www.nice.org.uk/guidance/cg26/chapter/1-Guidance#the-treatment-of-ptsd Accessed 7 March 2017.

Shapiro, F. (1989). Eye movement desensitization: A new treatment for post-traumatic stress disorder. *Journal of Behavior Therapy and Experimental Psychiatry, 20*(3), 211–217. https://doi.org/10.1016/0005-7916(89)90025-6

Sullivan, G. M., & Feinn, R. (2012). Using effect size—or why the P value is not enough. *Journal of graduate medical education, 4*(3), 279–282.

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

Ten Broeke, E., de Jongh, A., & Hornsveld, H. (2020). *EMDR standaardprotocol (versie 2020)*. Retrieved from https://www.supervisie-sietskevanharen.nl/app/download/11984949712/EMDR+STANDAARDPROTOCOL+2020.pdf?t=1579086264.

Tsai, C., & McNally, R. J. (2014). Effects of emotionally valenced working memory taxation on negative memories. *Journal of Behavior Therapy and Experimental Psychiatry, 45*(1), 15–19. https://doi.org/10.1016/j.jbtep.2013.07.004

Van Gucht, D., Baeyens, F., Vansteenwegen, D., Beckers, T., & Hermans, D. (2010). Counterconditioning reduces cue-induced craving and actual cue-elicited consumption. *Emotion, 10*(5), 688–695.

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.

Van Veen, S. C., Engelhard, I. M., & van den Hout, M. A. (2016). The effects of eye movements on emotional memories: Using an objective measure of cognitive load. *European Journal of Psychotraumatology, 7*(1), 30122. https://doi.org/10.3402/ejpt.v7.30122

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 den Hout, M. A., & Engelhard, I. M. (2012). How does EMDR work? *Journal of Experimental Psychopathology, 3*(5), 724–738. https://doi.org/10.5127/jep.028212

Van den Hout, M. A., Engelhard, I. M., Beetsma, D., Slofstra, C., Hornsveld, H., Houtveen, J., et al. (2011). EMDR and mindfulness. Eye movements and attentional breathing tax working memory and reduce vividness and emotionality of aversive ideation. *Journal of Behavior Therapy and Experimental Psychiatry, 42*(4), 423–431. https://doi.org/10.1016/j.jbtep.2011.03.004

Van den Hout, M. A., Engelhard, I. M., Smeets, M. A. M., Hornsveld, H., Hoogeveen, E., et al. (2010). Counting during recall: Taxing of working memory and reduced vividness and emotionality of negative memories. *Applied Cognitive Psychology, 24*(3), 303–311. https://doi.org/10.1002/acp.1677

Van den Hout, M., Muris, P., Salemink, E., & Kindt, M. (2001). Autobiographical memories become less vivid and emotional after eye movements. *British Journal of Clinical Psychology, 40*(2), 121–130. https://doi.org/10.1348/014466501163571

Vansteenwegen, S., Dirikx, T., Hermans, D., Vervliet, B., & Eelen, P. (2006). Renewal and reinstatement of fear: Evidence from human conditioning research. In M. G. Craske, D. Hermans, & D. Vansteenwegen (Eds.), *Fear and learning. From basis research processes to clinical implications* (pp. 197–217). Washington, D.C: American Psychological Association.

World Health Organization. (2013). *Guidelines for the management of conditions specifically related to stress*. Geneva: WHO.