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The impact of eye movements and tones on disturbing memories involving PTSD and other mental disorders

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ABSTRACT

Background: A wide array of experimental studies are supportive of a working memory explanation for the effects of eye movements in EMDR therapy. The working memory account predicts that, as a consequence of competition in working memory, traumatic memories lose their emotional charge.
Method: This study was aimed at investigating (1) the effects of taxing the working memory, as applied in EMDR, during recall of negative memories in 32 patients with posttraumatic stress disorder (PTSD), and 32 patients with other mental disorders, and (2) whether the results would differ between both groups. In a therapeutic session patients were asked to recollect a crucial upsetting memory while, in counterbalanced order (a) performing eye movements, (b) listening to tones and (c) watching a blank wall ('recall only'), each episode lasting 6 min.
Results: Eye movements were found to be more effective in diminishing the emotionality of the memory than 'recall only'. There was a trend showing that tones were less effective than eye movements, but more effective than 'recall only'. The majority of patients (64%) preferred tones to continue with. The effects of taxing working memory on disturbing memories did not differ between PTSD patients and those diagnosed with other conditions.
Conclusions: The findings provide further evidence for the value of employing eye movements in EMDR treatments. The results also support the notion that EMDR is a suitable option for resolving disturbing memories underlying a broader range of mental health problems than PTSD alone.

1. Introduction

Posttraumatic stress disorder (PTSD) is an anxiety disorder that is rooted in the experience of events involving actual or threatened death or serious injury, or the threat to the physical integrity of oneself or others (American Psychiatric Association, 2000). Individuals with PTSD repeatedly experience their traumatic event in the form of aversive and disturbing memories, nightmares, distressing dreams, hallucinations, and flashbacks. One of the most effective therapies for the treatment of such unpleasant memories is eye movement desensitization and reprocessing (EMDR). Clinical trials and meta-analyses demonstrate that EMDR is an evidence based treatment for PTSD, and equally effective as trauma-focused cognitive behavioral therapy (Bisson et al., 2007; Seidler & Wagner, 2006).

A core feature of EMDR therapy is that the patient is asked to hold a disturbing memory in mind while engaging in sets of eye movements or other bilateral stimuli, such as taps or tones (Lee & Cuijpers, 2013; Shapiro, 2001). In the original description of EMDR it was assumed that the bilaterality of the presented stimulus was a necessary factor to stimulate trauma recovery. However, evidence is mounting to support an explanation based upon a working memory model. The theory underpinning this model states that recalling an episode uses working memory capacity, which in itself is limited (Baddeley, 2012). Since a traumatic memory is inherently intense, vivid and emotionally charged, it

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taxes working memory resources when it is recalled. If at the same time another task (i.e. client's eyes following the therapist's hand back and forth) is executed during recall, fewer resources would be available for the memory (Baddeley, 2012). This competition within the working memory results in less memory resources for the vividness and the disturbance or emotionality of the memory (e.g. Andrade, Kavanagh, & Baddeley, 1997; Gunter & Bodner, 2008; Hornsveld et al., 2010). Consistent with hypotheses from a working memory theory, memories have been found to not only becoming less disturbing, and less vivid, during execution of an eye-movement task (e.g. Gunter & Bodner, 2008), but also during a range of other working memory taxing tasks (for an overview see van den Hout et al., 2012).

Two studies have investigated the effects of taxing working memory with trauma images using a clinical population with a PTSD diagnosis. Lilley and his colleagues used a within-subjects design in which 18 patients completed an imagery task under three concurrent task conditions: eye movements (following a letter flashing up on alternate sides of computer screen), counting, and exposure only (without a concurrent task) (Lilley, Andrade, Turpin, Sabin-Farell, & Holmes, 2009). The participants selected three distressing images each. Each image was assigned to a condition that comprised eight trials in which the participants were asked to recollect the image for 8 s while performing one of the three tasks. Vividness and emotionality of each of the images was assessed before and after the intervention. The eye-movement task reduced vividness and emotionality of the distressing images relative to the counting task and exposure only. In the other study (van den Hout et al., 2012) 12 PTSD patients were asked to recall the traumatic event while performing three tasks in counterbalanced order: eye movements (visually tracking the therapist's fingers), listening to tones, and just recalling the event. The results showed that eye movements were superior to tones in reducing emotionality and vividness of the trauma memories, whereas tones and 'recall only' had both similar, negligible effects. Interestingly, despite the fact that the application of eye movements was (far) more effective than auditory tones in almost all patients, eight out of 12 patients preferred the tones, while only three preferred the eye movements.

Key to the working memory explanation of EMDR therapy is the question of whether the findings observed translate to other memories than those involving PTSD *per se*. To this end, EMDR is increasingly applied as a treatment for other (anxiety) disorders (De Jongh & Ten Broeke, 2009a, 2009b), such as driving phobias (De Jongh, Holmshaw, Carswell, & van Wijk, 2011), and other conditions and symptoms that developed following an adverse event (see for instance De Jongh & Ten Broeke, 2009b; Maxfield & Melnyk, 2000). If the working memory model is a valid explanation for what occurs during EMDR, it would mean that taxing working memory is effective in resolving negative memories that play a role in, or underlie, a broad variety of psychological symptoms and conditions.

The purpose of the present study is two-fold. First, it was aimed at replicating previous clinical studies that tested the working memory explanation of EMDR, using a larger sample size to increase statistical power, thereby lending more credibility to the conclusions. As eye movements have been found to tax working memory more than tones, and tones more than 'recall only' (van den Hout et al., 2011), it was predicted that eye movements would outperform tones, whereas tones would outperform 'recall only' in diminishing emotionality and vividness of patients' crucial upsetting memories. As van den Hout et al. (2012) found that treatment efficacy did not coincide with preference of the patients, patients were not only asked for preferences, but also for the reason a particular task was evaluated as most effective. The second main aim of the study was to investigate whether results found in PTSD patients could be extrapolated to patients with other mental health conditions. It was hypothesized that the experimental tasks would have similar effects on memories of patients with other diagnoses than PTSD.

Table 1
Summary of the DSM-IV-TR classifications for which the patient was treated with EMDR ($N = 64$).

Psychiatric diagnosis	*N*	Percentage (%)	Examples of target images
PTSD	32	50.0	Robbery, rape, hit by ex.
Other anxiety disorder	9	14.0	Dental operation; social rejection
Mood disorder	6	9.4	Suicide of brother; bullied; rejection
Adjustment disorder	9	14.0	Divorce; reanimation: loss of job
Somatoform disorder	2	3.1	Humiliation, memory of pain
Other diagnoses	3	4.7	Death of father
Personality disorder	3	4.7	Being bullied

2. Method

2.1. Participants

Inclusion criteria for patients were at least 18 years old, indicated by their therapist for EMDR, but never having received EMDR treatment before, good command of the Dutch language and any valid clinical diagnoses based on the DSM-IV-TR (American Psychiatric Association, 2000) as determined by their therapist. The final sample consisted of 64 patients (50 females; mean age = 35.6 yrs, SD = 11.2; range = 19–61 yrs; education levels: 9.4% low, 48.4% middle, 39.1% high, and 3.1% unknown). It appeared that 32 patients met all DSM-IV-TR criteria for PTSD, and 32 remaining patients met other DSM-IV-TR diagnoses. Table 1 summarizes the DSM-IV-TR classifications for which the patient was treated with EMDR and gives, for each category, examples of the images targeted by EMDR. The Impact of Event Scale (see Measures) was administered to investigate the severity of symptoms relative to the identified traumatic event. PTSD patients had significantly higher IES scores ($M = 2.19$, SD = 0.66) than non-PTSD patients ($M = 1.60$, SD = 0.64; t (54) = −3.43, $p = .001$). Subscale differences were found for 'intrusions' (PTSD $M = 2.52$, SD = 0.91; non-PTSD $M = 1.70$, SD = 0.66; t (60) = −4.01, $p < .001$), and 'hyperarousal' (PTSD $M = 2.48$, SD = 0.89; non-PTSD $M = 1.63$, SD = 0.89; t (59) = −3.75, $p < .001$), but not for 'avoidance' (PTSD $M = 1.93$, SD = 0.91; non-PTSD $M = 1.50$, SD = 0.82; t (57) = −1.90, $p = .062$).

2.2. Procedure

Using the database of the Dutch EMDR Association, 828 qualified therapists who had completed advanced EMDR therapy (Level II) training, and had been extensively supervised in the application of EMDR, were approached by email and asked to participate in the study. If a therapist agreed to participate he or she received detailed instructions, including a step-by-step video demonstration of the research protocol[1]. In total, 226 therapists responded, of which 119 agreed to participate. Eventually, 35 therapists actually participated of whom 18 treated multiple patients (range: 2–5). Reasons for not participating were: no eligible patients, the patient was not willing to participate or the therapist found the procedures and the preparations – on second thoughts – too time consuming.

No patient had received previous EMDR therapy. The study took place during the very first part of the first EMDR session. Patients

[1] http://www.youtube.com/watch?v=BUmH1qvagkg.

were asked to participate in a study on the effects of different procedures for resolving negative memories with EMDR. They were given a description of the study, and written informed consent was obtained from those who agreed to participate. The assessment phase took place prior to the experimental phase. The PTSD part of the clinical interview MINI+ (see Measures) was conducted to distinguish between patients with and without PTSD. Also, the Dutch translation of the Impact of Event Scale was given to all patients.

The therapist selected an aversive, 'traumatic' memory with a clear, agreed upon beginning and ending, that he or she considered to be crucial in terms of etiology and maintenance of the condition for which the patient was in treatment. This was done in a standardized manner (De Jongh, Ten Broeke, & Meijer, 2010). Next, the full EMDR protocol (De Jongh & Ten Broeke, 2009a; Shapiro 2001) was used. For the purpose of the study, the patient was asked to bring up the memory while undergoing three consecutive tasks: (a) performing eye movements, (b) listening to bilateral auditory tones (ATs), and (c) looking at a blank wall ('recall only' condition). The duration of these conditions was set at about 6 min each. Tasks were given using a counterbalanced design, which means that each patient underwent one of six sequences of tasks (ABC, ACB, BAC, BCA, CAB, CBA).

In the 'eye-movement condition' patients were requested to mentally bring up the memory, and immediately thereafter to visually track the fingers of the therapist who moved his fingers horizontally back and forth in front of patient's face at a speed of one cycle per second (1 Hz). This was done in separate series of 30 s each. In the 'tones condition' patients were presented with tones ('beeps') on headphones, alternating to the left and right ear in a steady rhythm of 1 Hz, and in separate series of 30 s each. In the 'recall-only' condition patients were asked to watch a blank wall without further distraction, for 30 s. At the start of the procedure, and after each episode of 6 min, patients were asked to recall the target image (termed 'back to target' in the EMDR protocol), and to rate its emotionality and vividness. The standard EMDR protocol was followed as much as possible, including the facilitation of associative processing by asking the patient (after each 30 s) "What are you noticing now?" (see Shapiro, 2001). This aspect was equal for all conditions.

2.3. Measures

DSM-IV-TR diagnosis for PTSD was established by means of a short standardized diagnostic interview, the Mini International Neuropsychiatric Interview (MINI Plus 5.0.0; Sheehan et al., 1998).

Trauma symptom severity was assessed using the Dutch translation of the Impact of Event Scale-Revised (IES-R; Weiss & Marmar, 1997). This questionnaire consists of 22 items constituting the subscales intrusions, avoidance and hyperarousal. Subjects are asked to indicate how frequently the symptoms related to the distressing life event had been present during the past seven days. The frequency of each symptom is scored using a 5-point (1–5) format, ranging from 'not at all' (1) to 'very much' (5). The scores can be summed to produce a total IES score (range 22–110) with a higher score indicating a greater level of posttraumatic stress sequelae. Cronbach's alpha in the present study was 0.89 for the total scale, 0.87 for the subscale intrusions, 0.78 for the subscale avoidance and 0.78 for the subscale hyperarousal.

Level of emotionality and vividness of the memory were indexed by the Subjective Units of Distress (SUD) and Subjective Units of Vividness (SUV) scales. At the start of the procedure, and after each block (eye movements, tones and 'recall only'), patients were asked to retrieve the target memory, and to indicate the extent to which the memory was experienced as emotional (SUD scores ranging from 0 = 'not emotional at all' to 10 = 'extremely emotional'), and vivid (SUV scores ranging from 0 = 'not vivid at all', 10 = 'extremely vivid').

Patients' subjective ideas on the effectiveness of the three conditions were assessed after all experimental tasks were completed. The patient was asked to indicate 'to what extent do you think the treatment with [eye movements/tones/staring at the neutral wall] was beneficial'. Patients were requested to indicate their answer on a scale from 0 = 'not at all helpful' to 10 = 'extremely helpful'. The question was repeated for each condition. Next, patients were asked which condition they would prefer to continue with and to explain their answer.

2.4. Statistical analysis

Statistical analyses were performed with SPSS 18.0 for Windows using GLM (general linear model, repeated measures) to test the main hypotheses. Dependent measures were level of emotionality (SUD), and level of vividness (SUV). Posthoc analyses were performed using paired samples *t*-tests on the difference scores (pre-post). Analyses also employed the effect size which was done by determining Cohen's *d* or partial eta-squared (η_p^2). Assumptions of sphericity and equality of variance were checked using Mauchly's test and Levene's test, respectively. When the assumption of sphericity was violated, Greenhouse–Geisser corrections were administered. For all statistical analyses, a *p* value of .05 was considered statistically significant. One-tailed tests were used to test the hypotheses on tasks (eye movements, tones and recall only), while two-tailed tests were performed to test the hypotheses regarding diagnosis (PTSD versus non-PTSD).

3. Results

3.1. General effects on emotionality and vividness

First, it was tested whether the procedure as a whole was effective in terms of reduction of emotionality and vividness. Main effects of time on emotionality (F (1.98, 114.80) = 60.27, $p < .001$, $\eta_p^2 = .51$) and on vividness (F (2.08, 122.66) = 27.49, $p < .001$, $\eta_p^2 = .32$) were significant, indicating a decrease across the four measurement points. Posthoc analyses examining the decline per time-block showed that all decreases were significant (see Table 2).

3.2. Differences between eye movements, auditory tones, and 'recall only'

Table 3 shows the emotionality and vividness scores. Regarding *emotionality*, memories were experienced as less negative at

Table 2
Time effects of emotionality and vividness across the four measure points ($N = 64$).

	Measurement point	Mean score (SD)	Mean decrease compared to previous measure (SD)	*t*-Value
N				
Emotionality	T1 (baseline)	8.31 (1.74)	–	–
	T2 (after 1st task)	6.84 (2.62)	1.37 (2.46)	4.42***
	T3 (after 2nd task)	5.46 (2.83)	1.44 (1.78)	6.37***
	T4 (after 3rd task)	4.69 (3.03)	1.14 (1.35)	6.44***
Vividness	T1 (baseline)	7.48 (2.39)	–	–
	T2 (after 1st task)	6.77 (2.34)	0.71 (2.74)	2.08*
	T3 (after 2nd task)	5.42 (2.95)	1.42 (2.33)	4.84***
	T4 (after 3rd task)	4.81 (2.85)	0.87 (1.39)	4.83***

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 3
Scores on emotionality and vividness (scale 0–10) of the target memories for eye movements, auditory tones, and 'recall only'.

		Time	*M*	SD	df	*t*	Effect size[a]
Eye movements	Emotionality	Pre task	7.24	2.35	61	6.27*	0.63
		Post task	5.52	3.06			
	Vividness	Pre task	7.08	2.40	62	5.22*	0.55
		Post task	5.54	2.80			
Auditory tones	Emotionality	Pre task	6.56	2.85	60	6.44*	0.64
		Post task	5.47	3.07			
	Vividness	Pre task	6.14	2.94	61	3.55*	0.41
		Post task	5.49	2.88			
Recall only	Emotionality	Pre task	6.84	2.83	60	3.67*	0.43
		Post task	6.09	2.71			
	Vividness	Pre task	6.47	2.69	61	1.95	0.24
		Post task	6.03	2.83			

*$p < 0.001$.
[a] Cohen's *d*.

posttest relative to pretest for eye movements, tones, and 'recall only'. Thus, overall, in each condition mean emotionality ratings decreased, even in the 'recall-only' condition. Difference scores (pre-post) are depicted in Fig. 1. The main effect for stimulus condition (eye movements, tones, 'recall only') on emotionality was significant (F (2, 116) = 2.67, $p = .037$, $\eta_p^2 = .04$). Posthoc paired *t*-tests on difference scores showed that the mean decrease of emotionality in the eye-movement condition was significantly larger than in the recall-only condition, (t (59) = 1.82, $p = .037$, $d = 0.36$). No significant differences were found between eye movements and tones (t (59) = 1.02, $p = .16$, $d = 0.16$), and between tones and 'recall only' (t (58) = 1.43, $p = .08$, $d = 0.28$). Trends, however, were in the expected direction.

For vividness, there were significant decreases (pre–post) for eye movements and tones, but not for recall only (see Table 3). The crucial test for differences between conditions was not statistically significant, but showed a trend (F (1.76, 103.54) = 2.28, $p = .057$, $\eta_p^2 = .04$) in the expected direction.

3.3. Perceived effectiveness by patients

Patients gave the effectiveness of auditory tones an average rating of 6.90 (SD = 1.58), eye movements 6.55 (SD = 1.97), and 'recall only' 5.33 (SD = 2.68). The ANOVA yielded a significant effect (F (1.60, 92.66) = 8.21, $p = .001$, $\eta_p^2 = .12$). Posthoc *t*-tests showed that 'recall only' was perceived as less effective than tones (t (59) = 4.02, $p < .001$, $d = .70$), and eye movements (t (60) = 2.58, $p = .012$, $d = .48$). Tones were not perceived as more effective than eye movements (t (59) = 1.53, $p = .130$, $d = .23$), but when asked which condition they preferred to continue with, 64% of the participants chose tones; 20% chose eye movements, 8% 'recall only', and 8% indicated that they had no preference. Reasons for continuing with tones were: 'With tones, I can concentrate better,' 'I can feel more,' 'tones are most relaxing,' 'I can shut my eyes and feel what is happening,' 'more comfortable,' 'eye movements are too distracting,' 'I am not good in dual tasking'. Remarkably, patients gave similar reasons when they preferred to continue with eye movements: 'With eye movements I felt that more was happening inside me', 'with eye movements I can stay in the present', 'my thoughts wander with tones', etc.

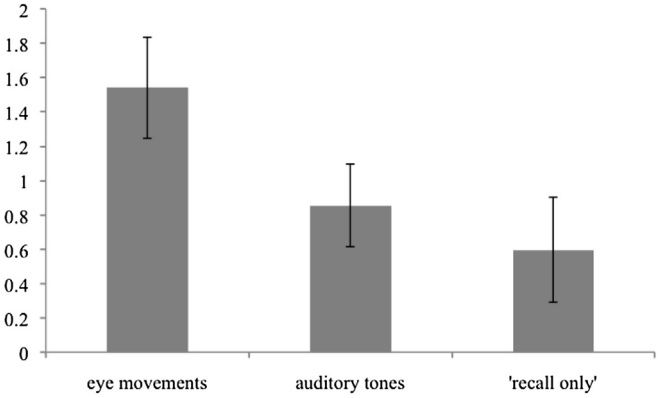

Fig. 1. Reduction of emotionality per working memory task. Bars indicate one standard error of the mean.

The preferences of the therapists were less pronounced. One therapist found eye movements most effective, one therapist auditory tones, two therapists considered both modalities were equally effective, while 27 of the 35 participating therapists indicated that they believed that sometimes eye movements, and sometimes tones were most effective. Four therapists reported to have no particular preference.

3.4. Differences between patients with PTSD and those with other diagnoses

Based upon the information of the MINI+, of the 64 patients, 32 (50%) were diagnosed with PTSD. No significant effects were found between PTSD and non-PTSD patients for decreases in emotionality (F (1, 57) = 2.62, $p = .11$), and in vividness (F (1, 58) = 1.82, $p = .18$). Similarly, no interaction effects were observed between diagnosis and task (eye movements, tones and 'recall only') for decreases in emotionality (F (1.81, 103.32) = 0.46, $p = .62$), and in vividness (F (1.75, 101.48) = 0.32, $p = .77$) (see Table 4). Hence, in terms of the effectiveness of any of the tasks it did not matter whether the patient was diagnosed as having PTSD or as having another diagnosis. Because the number of patients was small, we were not able to conduct subgroup analyses.

4. Discussion

In this study all patients underwent two widely used variations of EMDR (eye movements and bilateral tones via a headphone), and a control ('recall only') condition. The results showed that eye movements outperformed 'recall only' in diminishing emotionality of patients' crucial upsetting memories. This is in accordance with van den Hout and his colleagues who performed a similar clinical study in 12 PTSD patients (van den Hout et al., 2012). Both studies showed a mean decrease of about 1 SUD during the 'recall-only' phase, and a significant larger decrease (1.6–2.1 SUD) during the eye-movement phase. These findings are also in line with those of a recent meta-analysis showing a significant advantage for eye movements over no eye movements in EMDR treatments (Lee &

Table 4
Change scores regarding emotionality and vividness of the three conditions for patients both with PTSD ($N = 32$) and with other mental health conditions ($N = 32$).

Outcome measure	Diagnosis	Eye movements	Auditory tones	Recall only
Emotionality	PTSD	−1.95 (1.99)	−1.34 (1.72)	−1.10 (2.05)
	Other	−1.29 (2.20)	−1.30 (1.64)	−0.52 (1.54)
Vividness	PTSD	−1.79 (2.36)	−0.84 (1.93)	−0.69 (2.80)
	Other	−1.05 (2.29)	−0.75 (1.90)	−0.32 (1.87)

Cuijpers, 2013). Yet, the similarities do not appear to apply to the effects of tones. Whereas van den Hout and his colleagues found a trend for tones being inferior to 'recall only', a finding they did not anticipate nor could explain, our findings are more consistent with the notion of a dose–response-relationship between working memory load and decreases in emotionality and vividness. The fact that in both studies eye movements outperformed tones suggests that it is good clinical practice to apply eye movements as the first choice of modality when using EMDR.

The present findings provide further support for the notion that manipulation of processing in the consolidation phase of recently activated trauma memories via visuospatially demanding cognitive tasks can serve to modulate intrusive negative memories, and diminish the emotionality as well as other aspects of such memories (Holmes, James, Coode-Bate, & Deeprose, 2009). Although in the present study this effect was not significant for memory vividness, given the p value of 0.057, and the fact that the pattern of the results on the decreases of vividness (see Fig. 2) generally mirrors that of emotionality in virtually the same way, it is conceivable that an inclusion of a higher number of patients might have led to a statistical significant difference.

A remarkable finding was patients' preference for tones, while this condition was not found to be most effective. This pattern mirrors the findings of van den Hout et al. (2012). Patients generally have no knowledge about the active ingredients of EMDR therapy and are simply not aware of the fact that performing an attention-demanding task is probably a key factor in the process that makes memories lose their emotional charge. Perhaps patients think they must concentrate, feel, 'suffer' and be aware of their inner feelings to heal, and that EM's are too distracting. This would explain why the few patients who preferred recall only – the least effective task – indicated that it enabled them to better concentrate on the image. Another explanation for the experienced superiority of tones is that listening to tones, compared to tracking the fingers of the therapist, is less demanding. This may lead to an increased degree of perceived control over their processing and their emotions, and perhaps it is this experience that is perceived as, or confused with, effectiveness. These discrepant findings suggest that patients are not the ones that should chose or decide which modality is best for them when they request for EMDR therapy. The fact that the therapist in the present study did not show a strong preference for either eye movements or tones may have minimized the potential role of demand characteristics with respect to these conditions. Yet, it cannot be ruled out that subtle therapist demands have influenced the outcome.

The final main question addressed in this study was whether our manipulations would produce equivalent effects in patients with PTSD and those with other psychiatric conditions. It was found that the effects of dually taxing the working memory while holding in mind a disturbing memory did not differ between PTSD patients and those diagnosed with other conditions. The effects of eye movements, tones and 'recall only' were strikingly similar in this respect. This finding is in line with recent studies showing that images of potential future catastrophes (so called 'flashforwards'; characteristic of patients with an anxiety disorder) respond in a similar way to interventions that tax working memory as negative images of past events (Engelhard et al., 2011). These results are further relevant as recent studies have shown that in a wide range of different disorders, clients' specific areas of concern are accompanied by vivid, frequent, and distressing forms of imagery. For example, images of physical appearance in body dysmorphic disorder (Osman, Cooper, Hackmann, & Veale, 2004), frightening images of snakes in snake phobia (Hunt et al., 2006), and intrusive memories in depression (Brewin, Watson, McCarthy, Hyman, & Dayson, 1998). There is also an increasing amount of literature about the effectiveness of imagery-based interventions, like imagery rescripting (Arntz, 2012) or Schema Focused Therapy (Young, Klosko, & Weishaar, 2003). To this end, the results have important clinical implications as these suggest that such procedures could potentially be applied to resolve a much broader array of memories than those of PTSD alone. With regard to EMDR therapy, it is an already established clinical practice for this therapy to be deployed in a broad range of psychological conditions, in which memories of earlier life events are deemed to play a pivotal role in the acquisition and maintenance of these conditions, ranging from the spectrum of anxiety disorders (De Jongh & Ten Broeke, 2009b) to somatoform disorders (van Rood & de Roos, 2009), and psychotic disorders (van den Berg & van der Gaag, 2012). Yet, it should be noted that, compared to the wealth of evidence favoring EMDR therapy for PTSD, treatment outcome studies on these conditions are still scarce.

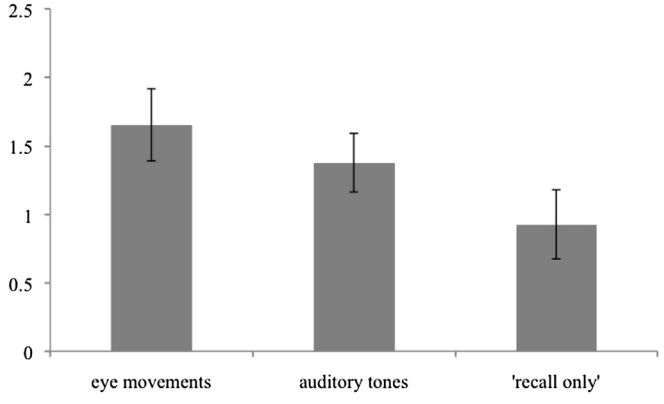

Fig. 2. Reduction of vividness per working memory task. Bars indicate one standard error of the mean.

Maybe one of the most intriguing aspect of the present findings is that these are in striking contrast to the core assumption of Foa and Kozak's emotional processing model, the theoretical framework that helps to elucidate the effects of imaginal exposure therapy (Foa & Kozak, 1986). This model predicts that holding in mind a disturbing memory will expedite processing, while distraction, cognitive avoidance, or employing an attention-demanding task will impede it. Although this seems plausible, it should be noted that there are several studies with phobic individuals which show that distraction during exposure does not impede, but actually facilitates fear reduction (e.g. Johnstone & Page, 2004). Perhaps these seemingly contradicting findings could best be explained in the light of recent developments and insights in the field of neurobiology. For example, experimental work by Suzuki and others suggests that apparently stable emotional memories re-enter an unstable state after their reactivation through recall of the memory that makes them become 'labile' so that they can be updated with new information, a process termed 'reconsolidation' (Monfils, Cowansage, Klann, & LeDoux, 2009; Schiller, Monfils, Raio, Johnson, & Ledoux, 2010; Suzuki et al., 2004). Based on these findings, it is conceivable that the taxing of working memory with a dual task titrates the original experience in a way that facilitates incorporation of new information into the memory trace, resulting in less vivid memories and thus in a reduced fear response.

Limitations of this study include the lack of control over treatment fidelity, and the lack of follow-up measurements. Because the experiment was carried out with patients suffering from diagnosed mental disorders, it was decided to use a sample of experienced and certified therapists who had been extensively educated and supervised in using the fixed steps of the EMDR therapy protocol. Although this has large benefits in terms of generalizability of the

findings, variations in the application of the protocol cannot be ruled out. To collect information about the punctuality with which the protocol was applied, the therapists were asked to estimate their level of adherence to the protocol (0–100%), and to explain any abnormalities. Almost all therapists reported a high level of self-rated fidelity (94.3%) to the protocol, and reported to have applied only small deviations in reading a certain sentence within the protocol in order to avoid repeating exactly the same formulations too many times. However, it should be noted that by handing over the control of the experiment to the therapists may have influenced the results in an unverifiable manner. Another limitation of the study is the lack of follow-up measurements. Due to a design in which all participants underwent all experimental tasks, it was impossible to determine differences between tasks after one week or one month. However, the results of both experimental work (Gunter & Bodner, 2008) and controlled outcome studies on EMDR (e.g., Bisson et al., 2007) demonstrate that emotionality and vividness of unwanted memories, as well as changes in symptoms of anxiety and depression, are likely to be permanent. One remark should be made about the 'recall-only' condition. In retrospect, the instruction to focus on the wall may have not been a pure 'recall-only' task (see Shapiro, 2001). When a patient is asked to simultaneously perform two tasks – i.e. eye fixation which entails concentration and control along with the recall – this could tax working memory. Indeed, the fact that both vividness and emotionality of patients' memories of the 'recall-only' condition diminished significantly supports the notion that the instruction to focus on the wall was not innocuous. It is suggested that participants in future research be asked to simply "recall the memory with eyes open."

The present study is an example of translational research in that it was originally based upon a clinical observation (i.e., the relation between performing eye movements and the fading of memories), a phenomenon which was subsequently studied in a laboratory environment with healthy subjects. The study was aimed at testing the theoretical framework (working memory theory) deemed to explain this phenomenon, when applied in the "real world" of patient care and public health, using a relatively large group of therapists, and patients with a wide range of mental disorders. The results show that employing eye movements and related working memory tasks typically results in a positive amelioration of the emotionality of memories. This adds support to the contention that the use of tasks competing for working memory resources, as for instance applied in EMDR therapy, is a viable option, not only for resolving unprocessed memories underlying PTSD, but also for those in other mental conditions.

Conflict of interest

None.

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