ENHANCING TRAUMA TREATMENT

Exploring working mechanisms and testing a novel route

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HET VERBETEREN VAN TRAUMABEHANDELING

Het exploreren van werkingsmechanismen en het testen van een nieuwe route

(met een samenvatting in het Nederlands)

Proefschrift

ter verkrijging van de graad van doctor aan de Universiteit Utrecht op gezag van de rector magnificus, prof.dr. H.R.B.M. Kummeling, ingevolge het besluit van het college voor promoties in het openbaar te verdedigen op vrijdag 31 augustus 2018 des ochtends te 10.30 uur

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Promotor: Prof.dr. M. A. van den Hout

“It is a virtue to keep an open mind when evaluating new ideas, just not so open that your brains fall out.”

(Sagan, C.)

Contents

CHAPTER 01

General Introduction

Enhancing Trauma Treatment

Exploring working mechanisms and testing a novel route

Inevitably in life, we will all be confronted with adverse events (e.g.; one will experience illness or disease, go through difficult relationship break-ups or loose a job), and these events can (temporarily) cause serious stress in life. Some events are daily hassles or small setbacks, some are larger adverse events, and some are categorized as a 'traumatic event' in terms of the criteria of a posttraumatic stress disorder (PTSD) in the Diagnostic Statistical Manual (DSM)-IV-TR or DSM 5 (American Psychiatric Association; APA, 2000; 2013). According to the DSM-IV-TR a traumatic event is "an event in which a person has experienced, witnessed, or been confronted with an event or events that involve actual or threatened death or serious injury, or a threat to the physical integrity of oneself or others (APA, 2000). In the DSM 5 this definition was slightly altered into: exposure to "death, threatened death, actual or threatened serious injury, or actual or threatened sexual violence by direct exposure, witnessing a trauma, learning that a relative or close friend was exposed to a trauma or indirect exposure to aversive details of a trauma, usually in the course of professional duties (e.g., first responders, medics) (APA, 2013). According to the DSM-IV-TR and DSM 5 being exposed to a traumatic event or events can cause the development of PTSD; a disorder characterized by re-experiencing the event(s) by recurring nightmares and flashbacks, avoidance of situations that remind of the event(s), feeling hyper aroused and having negative beliefs or feelings. About 89.6% in U.S. community samples (Breslau et al., 1998) and 80.7% of a national representative sample in the Netherlands (de Vries & Olff, 2009) report a lifetime exposure to one or more traumatic events according to the definition provided by the DSM-IV-TR (APA, 2000). Although the experience of a traumatic event precedes PTSD, only in a minority of the people experiencing such an event results in developing PTSD (5.7%-9.2%, Breslau et al., 1998; de Vries & Olff, 2009; Kessler, Petukhova, Sampson, Zaslavsky, & Wittchen, 2012; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). The risk of developing PTSD was found to be higher as a consequence of sexual and physical assault, robbery and multiple trauma experiences (Frans, Rimmö, Åberg, & Fredrikson, 2005). However, results from a meta-

analysis on predictors of PTSD show the subjective psychological response to traumatic exposure is the strongest predictor for developing PTSD (Ozer, Best, Lipsey, & Weiss, 2003). PTSD is a debilitating disorder and is highly co-morbid with other mental disorders (Chapman et al., 2012). Reported long-term remission rates from PTSD without a specific treatment varies widely (between study variation from 8 to 89%). Overall, 44.0% remits from PTSD after a mean of 40 months without a specific treatment. Reported remission rates are higher in studies with baseline measurement within five months following trauma. The highest remission rate was reported following the experience of a natural disaster (60.0%), whereas the lowest after experiencing physical disease (31.4%) (Morina, Wicherts, Lobbrecht & Priebe, 2014).

DSM-IV to DSM 5

One has to bear in mind that in the studies discussed in this thesis that were conducted with patients the DSM-IV-TR classification system was used, due to the fact that the DSM 5 was not in use in the Netherlands at the time when the studies were designed or conducted. In the passage from the DSM-IV-TR to the DSM 5 there was, as described, a slight alteration in the definition of a 'traumatic event', but there were also some other changes. One criterion ('the person's response involves intense fear, helplessness, or horror') was removed. All other 17 DSM-IV criteria were retained in the DSM 5, though some (greatly) modified. Furthermore, three new symptoms were added (i.e., overly negative thoughts and assumptions about oneself or the world, negative affect & reckless or destructive behavior). Furthermore, PTSD was no longer classified as an anxiety disorder but as a "Trauma and Stressor-Related Disorder" by the establishment of this diagnostic category in the DSM 5. PTSD was reconceptualized broadly to include, along with the original fear-based anxiety disorder, posttraumatic anhedonic/dysphoric, externalizing and dissociative clinical presentations, and preschool and dissociative subtypes were established. Although there is substantial overlap, there is also some worrying discordance between PTSD DSM-IV-TR and DSM 5 criteria reported in the diagnosis of PTSD in veterans (Hoge, Riviere, Wilk, Herrell & Weathers, 2014; McFarlane, 2014).

Associated with a more chronic course of PTSD are the number and type of traumas experienced (Kolassa et al., 2010), symptom severity of and co-morbidity with mental and

substance use disorders (McFarlane, 2000; Zlotnick et al. 1999; Zlotnick et al., 2004). Taken into account that 80-90% of PTSD patients suffer from comorbid conditions and two thirds have at least one co-morbid disorder, such as depression, an anxiety disorder, substance abuse or a personality disorder (Kessler et al., 1995) this warrants effective treatment strategies and further defining of existing therapies. This thesis is an attempt to contribute to this goal of developing effective treatment strategies and refining existing ones and tries to do this in three different ways.

Psychological treatment of PTSD

Meta-analyses were unable to define which psychological intervention was most promising for patients with PTSD symptoms (Benish, Imel & Wampold, 2008; Bisson & Andrew, 2007; Gerger et al, 2014). However, it should not be taken to imply that *all* psychological treatments are effective (Watts et al., 2013). Effective psychotherapies for PTSD are cognitive therapy (including cognitive processing therapy, cognitive behavioral therapy and mixed therapies), exposure therapy (including prolonged exposure), eye movement desensitization and reprocessing (EMDR) and narrative exposure therapy (Cusack et al., 2016; Watts et al., 2013). The effect sizes are large for each of the therapies, but head-to-head comparative effectiveness evidence is limited (Cusack et al., 2016). Since no intervention was consistently superior to other interventions Watts et al. (2013) conclude that factors such as access, acceptability and patient preference should therefore be decisive in the choice of treatment.

One of the psychological interventions growing in popularity among patients as well as therapists is EMDR. In EMDR, patients are instructed to make horizontal eye movements while holding a distressing memory in mind. This procedure typically results in a decrease of the vividness and emotionality associated with the memory (van den Hout & Engelhard, 2012) and is exploited as such in PTSD treatment. EMDR, discovered in 1987 by Shapiro, was initially named Eye Movement Desensitization (EMD) because of the perceived similar impact of the eye movements to that of systematic desensitization, whereby maladaptive responses are reciprocally inhibited by relaxation responses. Shapiro believed EMDR was based on an innate relaxation response caused by the eye movements. A few years later the word “reprocessing” was added by Shapiro, because of her understanding that desensitization was only just *one* outcome of the therapy, and the additional effects could

be better understood through information processing theory (Oren & Solomon, 2012). EMDR was first received with great skepticism (e.g., Lohr, Kleinknecht, Tolin, & Barrett, 1995; Lilienfeld, 1996; McNally, 1999; Muris & Merckelbach, 1999; Herbert et al., 2000), but a mere two decades later its effectiveness has been shown in several meta-analyses (e.g., Bisson et al., 2007; Bradley, Greene, Russ, Dutra, & Westen, 2005; Chen et al., 2014; Lee & Cuijpers, 2013; Seidler & Wagner, 2006). As a result of this, EMDR nowadays has been recommended as a first-line treatment for PTSD in treatment guidelines in the Netherlands, United Kingdom, France, United States, Israel, Northern Ireland and by the World Health Organization (American Psychiatric Association, 2004; Bleich, Kotler, Kutz, & Shalev, 2002; CREST, 2003; Dutch National Steering Committee Guidelines Mental Health Care, 2003; Haute Autorité de la Santé, 2007; National Institute for Clinical Excellence, 2005; World Health Organization, 2013).

Working mechanisms of EMDR

A theoretical framework that is an attempt to explain the beneficial clinical effects of EMDR is provided by adaptive information processing (AIP; Shapiro, 2001). According to the AIP model, experiences are stored in adaptive memory networks (Oren & Solomon, 2012). New information is processed and integrated with these existing memory networks, but some distressing negative events seem to overwhelm the information processing system and are not adaptively integrated. The information is stored in isolation, unable to connect with the adaptive networks (Oren & Solomon, 2012). EMDR would elicit its effect by processing the disturbing memories resulting in adaptive resolution by integration of adaptive information with the traumatic memories. However, it is unknown which specific mechanism(s) enable this processing (Maxfield, 2008).

But why even wonder about the mechanisms? It may be tempting to maintain that knowing *that* a therapy is effective is sufficient. However, uncovering and explaining underlying mechanisms of an effective treatment, creates the opportunity to enhance and optimize treatment by targeting the specific mechanisms of action responsible for its effectiveness. In the case of EMDR, many scientists have tried to uncover the working mechanism(s) underlying the effect of the therapy. The eye movements, of which the added value was demonstrated in a meta-analysis (Lee & Cuijpers, 2013), were awarded much focus in research. However, according to EMDR protocol, besides eye movements, patients

could also engage in other bilateral stimuli, such as taps or tones while holding the disturbing memory in mind, and it was assumed that the bilaterality of the presented stimulus was a necessity to stimulate trauma recovery (Shapiro, 2001). Bilateral stimulation was supposed to increase interaction between the left and right cerebral hemispheres (Propper & Christman, 2008), which enhanced memory retrieval and thereby facilitated desensitization (Christman, Garvey, Propper, & Phaneuf, 2003). However, no significant increases in interhemispheric coherence were found (Keller, Stevens, Lui, Murray & Yaggie, 2014; Yaggie et al., 2015). Furthermore, other tasks that did not include bilateral stimulation also proved to be effective (e.g., playing Tetris; Engelhard, van Uijen, & van den Hout, 2010; progressive counting; Greenwald, McClintock, Jarecki, & Monaco, 2015, auditory shadowing, copying a complex figure, vertical eye movements; Gunter & Bodner, 2008, articulatory suppression; Kemps & Tiggemann, 2007).

Several researchers argue that more than one effect occurs in EMDR and these effects are related to more than one mechanism (e.g., Maxfield, Melnyk, & Hayman, 2008; Keller et al., 2014). Data suggest that EMDR derives its beneficial effects at least in part from taxing working memory during recall of emotional memories (Gunter & Bodner, 2008; Maxfield et al., 2008; van den Hout & Engelhard, 2012). Memory recall induces a labile period, during which previously consolidated memories are sensitive to change. When a memory is recalled in EMDR therapy, working memory, which has limited capacity (Baddeley, 2012), has to divide its limited resources between the recalled memory and another taxing task (e.g., customarily making eye movements) performed at the same time, which causes interference in the reconsolidation process. This results in an updated memory, in the case of EMDR, a memory without the negative emotional response, and the memory is reconsolidated as such. Several neural mechanisms of memory destabilization and updating have been provided (see Lee, Nader, & Schiller, 2017) and also EMDR's neurobiological mechanisms of action are summarized (Bergmann, 2010). Though interesting and important, providing insight in how processes work on a neurobiological level, this subject is beyond the scope of the current thesis.

Working memory comprises several systems; the central executive, visuospatial sketchpad (VSSP), phonological loop (PL) and episodic buffer. The episodic buffer is a passive storage rather than an active processor, capable of holding multidimensional episodes or chunks, which may combine visual and auditory information and possibly olfactory and

gustatory information (Baddeley, 2010). The central executive is the attentional control system, able to focus and divide attention and switch between tasks (Baddeley, 2012). Modality specific information is preferentially processed in one of the two subsystems: the VSSP, responsible for processing visual and spatial information and the PL, responsible for auditory and verbal processing (Baddeley, 2012; Baddeley & Hitch, 1974).

Modality specificity in working memory taxation

The working memory taxation hypothesis states memories become less emotional and vivid when a dual task is performed during memory recall. In research there is debate on how to optimize working memory taxation. One way is to increase working memory loading, which is associated with larger decreases in emotionality and vividness (Maxfield et al., 2008; van Schie, van Veen, Engelhard, Klugkist & van den Hout, 2016; van Veen et al., 2015), although Engelhard, van den Hout, and Smeets (2011) found a U-curve-dose-response relationship. Another way of optimizing working memory taxation might be to adapt the modality of the dual task to the modality of the memory. Although memories in PTSD patients are for the greater part visual, other sensory modalities may also be involved (Ehlers et al., 2002; Hackmann, Ehlers, Speckens, & Clark, 2004). This raises the question whether memories in different modalities benefit from modality specific taxation. Scientific research focused mainly on auditory and visual imagery. From a working memory perspective it seems plausible that modality specific taxation is effective. The VSSP is involved in visual imagery and the PL in auditory imagery (Kristjánsdóttir & Lee, 2011). Recalling a memory predominantly auditory or visual in content would thereby best be taxed by a modality matching task, because this would cause greater interference during recall of the memory by occupying the same subsystem, so can be assumed. However, research on this subject does not allow for clear conclusions. There is data showing that competing tasks which are matched with the modality of the memory result in a greater reduction of vividness and emotional intensity ratings compared to non matching tasks (Kemps & Tiggemann, 2007), but other studies fail to find this modality specific effect (Kristjánsdóttir & Lee, 2011; Tadmor, McNally, & Engelhard, 2017). Gunter and Bodner (2008) state that eye movements may not only tax the VSSP, but might also draw upon the central executive. This *central executive account* implies taxing in general, regardless of its modality is important (Gunter & Bodner, 2008). The *modality specificity account* however

suggests taxing in matched modality during recall leads to more beneficial effects. Another possible explanation for the inconsistent results is that the central executive account and the modality specificity account co-exist and both contribute to optimizing working memory taxation. Clarification on the subject op modality specificity would lead to a better understanding of the psychological mechanisms in EMDR and could potentially contribute to enhancement of treatment. Section 2 of the present thesis is devoted to this subject.

EMDR in positive verbal material

Another way to enhance treatment is to optimize existing treatment protocols by dissecting the protocol, testing different elements, discard non-working ingredients and adapt the protocol to retain only the working elements in it. In this thesis one element of the Dutch standard EMDR-protocol was put to the test. The Dutch standard EMDR-protocol deviates slightly from the original American standard protocol. One of the phases in the Dutch EMDR protocol is 'Positive Closure.' This procedure was added to the Dutch protocol, with the expectation that it might reinforce any positive changes that occurred during the trauma reprocessing, stimulate positive responses, and 'anchor' identified changes (de Jongh & ten Broeke, 2003, p.124-129). Although sometimes unclear on what empirical basis elements make their way in treatment protocol, enhancing interventions or existing protocols can obviously best be done on the basis of empirical and controlled results. Thus far no research was conducted on the effect of the procedure or the manner in which it was executed. The procedure involves that at the end of the session the patient is asked, "What is the most positive or valuable thing you have learned about yourself during this last hour/this last session, with regard to this theme or this event?" The patient identifies a trait or a positive self-affirmation, such as "I am strong" or "I am a fighter." Then, the therapist conducts a set of eye movements while the patient focuses on the statement. If the patient reports other positive associations additional sets of eye movements are conducted. The typically performed eye movements in this procedure are - from a working memory taxation perspective - highly plausible. Identifying a trait or positive self-affirmation and focusing on it demands working memory resources. Making eye movements competes for the same limited resources. EMDR not only shows effect on disturbing autobiographical memories, but reductions in vividness and/or emotionality have also been observed in neutral pictures (Andrade, Kavanagh, & Baddeley, 1997), negative pictures (van den Hout, Bartelski, &

Engelhard, 2013), prospective memories (Engelhard, van den Hout, Janssen, & van der Beek, 2010) and positive memories (Barrowcliff, Gray, Freeman, & MacCulloch, 2004; Engelhard, van Uijen, et al., 2010; van den Hout, Muris, Salemink, & Kindt, 2001), although a study of Keller et al. (2014) reported an increase in memory strength and vividness in positive memories after recalling a memory with simultaneous performance of eye movements, followed by a period of free association. From a working memory perspective one can hypothesize that also verbal statements are sensitive to the degrading of emotionality and/or vividness and this would lead to results opposite from the intention of the procedure in the EMDR protocol. Section 1 of the thesis elaborates on the effect of eye movements in positive verbal material.

Exploring a novel route: Visual Schema Displacement Therapy

A third way of contributing to the enhancement of trauma therapy is by exploring new interventions. When it concerns the relationship between clinical practice and laboratory research a common idea seems to be that laboratory scientists do fundamental studies, and consequently develop new techniques that are finally employed by clinicians. But, in reality the opposite very often happens as well: Clinicians stumble upon a technique and develop it by trial and error or intuition. Many of these techniques may prove to be ineffective but once in a while such interventions prove to be of great value. EMDR therapy was in fact characterized by a development of that kind. As Carl Sagan says “It is a virtue to keep an open mind when evaluating new ideas, just not so open that your brains fall out.” In the field of trauma treatment such a new idea was provided by Nik and Eva Speakman. They claimed emotionally disturbing memories could be successfully processed by instructing patients to follow the hand of the therapist, who stands in front of the patient and is holding a watch as a focus point. First the patient is asked to identify a point where - once the patients keeps the eyes focused there - the patient feels the most disturbance while recalling a negative emotional memory (the ‘trauma point’) and after that to identify a point where the patient feels the urge to laugh the most when recalling a positive memory, person or event which made them laugh (the ‘laughter point’). This procedure precedes the therapist moving the watch quickly from the trauma point to the laughter point while saying ‘Whoosh!’ out loud. The patient is instructed to keep their eyes focused on the watch, blink and sigh. The therapy is referred to as Visual Schema Displacement Therapy (VSDT)

(https://www.youtube.com/watch?v=y3nRRMVHpWI). Although its originators claim positive effects, and videos show patients reporting immediate and large responses, the technique has never been evaluated in any controlled way and lacks a coherent theoretical rationale. Keeping up with Sagan's remark about the importance of an open mind, we decided to study this curious therapy under controlled conditions and discuss the results in section 3.

Enhancing treatment: Experimental Psychopathology and Clinical Research

There are different ways to investigate existing or new interventions. One way is to disentangle elements of (existing or new) treatments under laboratory conditions and test them on healthy participants. Researchers that take this approach study psychological processes that underlie abnormal behavior. One can use experimental models which mimic abnormal processes in healthy individuals, with the aim of studying these processes in a highly controlled way (Vervliet & Raes, 2013). This is an obvious advantage of experimental lab research in healthy participants, allowing manipulation of exact variables of interest, leaving out as much confounding variables as possible. However, predictive validity of experimental psychopathology research in healthy participants has hardly been tested (Vervliet & Raes, 2013), although it is unlikely that "healthy people are from Mars, while patients are from Venus" (Boddez, Davey, & Vervliet, 2017). Another way to investigate existing or new interventions is by performing clinical studies, testing procedures or alterations directly in a clinical setting thereby reducing validity problems. Clinical studies however often face other confounding variables and testing alterations in one patient population still does not imply translation to another patient population. In the current thesis an experimental approach and clinical approach were pursued to gain fundamental insights and to enable practical translations of theory in to practice.

Outline of the current thesis

The thesis comprises 6 chapters in which a total of 8 studies are discussed. Three studies were conducted in clinical practice and five in laboratory settings. **Chapter 2** describes two laboratory experiments aimed at testing the effects of eye movements on positive verbal statements as performed in the procedure 'Positive Closure', a procedure the Dutch EMDR protocol. This procedure consists of recalling positive verbal statements

under dual task conditions. The supposedly additive effect of eye movements in this procedure was put to the test by letting participants recall positive traits under dual task conditions or a control condition. **Chapter 3** describes a study performed on PTSD-patients in which the additive value of the eye movements in the same procedure was tested. Patients recalled two personal positive traits and rated the belief and emotionality of the traits before and after exposure to either a dual task condition (eye movements) or no dual tasking.

The next three chapters elaborate on targeting auditory memories with dual tasking and the subject of modality specific taxation. The described studies were set up to gain more insight in the mechanisms of action of EMDR. In the study described in **Chapter 4** auditory and visual memories of PTSD patients were targeted with two active dual task conditions - one visual and one auditory - and one control condition. The working memory taxation hypothesis suggested that auditory memories can best be targeted with auditory taxation and visual memories with visual taxation and this was examined. In **Chapter 5** we explored effects of dual tasking in the treatment of auditory memories of auditory hallucinations. Psychotic patients were asked to recall a memory of an auditory hallucination and while recalling the memory they were exposed to alternately visual dual tasking, auditory dual tasking or a control condition. In both studies (Chapter 4 and 5) the effect on emotionality of the memories was assessed. **Chapter 6** comprises an experimental design. We wanted to know if modality matched dual tasking resulted in larger effects on working memory load than cross modality tasking. Undergraduates were asked to recall an emotional auditory and visual memory while performing a visual and auditory reaction time task. Reaction times, indicative of working memory loading were used to provide objective measures of taxation and modality specific loading was explored that way.

The last chapter (**Chapter 7**), elaborates on Visual Schema Displacement Therapy. Two experimental studies were conducted in which undergraduates were asked to recall emotionally disturbing memories under three conditions; VSDT, EMDR and a control condition, hereby not only comparing the novel VSDT technique to an inactive control condition but also an active and proven one, i.e. EMDR.

The thesis concludes with a general discussion in **Chapter 8**.

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SECTION 01

EMDR in positive verbal material

CHAPTER 02

Fifteen to twenty seconds of eye movements have no effect on believability of positive personal verbal statements: Results from a working memory study

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Abstract

According to working memory theory, a task that taxes working memory during simultaneous focus on a memory will tend to reduce memory vividness and emotional intensity. Results have been found for both negative and positive memories. Some studies have shown the necessity of modality-specific tasks, with visual tasks producing greater deterioration of a visual memory, and auditory tasks reducing the quality of an auditory or verbal memory; other studies have reported cross-modality effects. Research has confirmed that eye movements similar to those in eye movement desensitization and reprocessing (EMDR) therapy produce these effects on visual imagery. However, the effects of eye movements on positive verbal imagery remain unclear. This study tested the effects of eye movements on positive verbal statements. In two experiments, undergraduates performed 15-20 seconds of eye movements or 15-20 seconds of keeping eyes stationary while focusing on a statement of a positive relevant personality trait (e.g., "I'm persistent"). Results showed that 15-20 seconds of eye movements did not enhance or diminish participant's belief in possessing the trait. Discussion focuses on methodological factors and calls for future research on the effect of eye movements on verbal material.

Keywords: positive verbal material, verbal imagery, positive closure, working memory, modality-specific taxing, eye movements

Introduction

With more than 25 randomized clinical trials, eye movement desensitization and reprocessing (EMDR) therapy has been established as an evidence-based intervention for posttraumatic stress disorder (PTSD) and proven equally effective as trauma-focused cognitive behavioral therapy (Bisson et al., 2007). Preliminary studies indicate that it may also be effective for a broad variety of other disorders and psychological conditions where EMDR is used to resolve negative memories thought to underlie the symptoms (see Shapiro, 2014, for summary).

EMDR Therapy

The core feature of EMDR therapy is the client holding an emotionally disturbing negative memory in mind while simultaneously engaging in sets of eye movements or other bilateral stimuli, such as taps or tones (Shapiro, 2001). EMDR uses a standardized eight-phased procedure to address past, present, and future aspects of the distressing event. Two of the eight phases are (a) "desensitization" of the memory, which continues until the client reports no related negative emotional disturbance; followed by (b) "installation" of a related positive self-referring cognition. The installation phase continues until the client reports that the previously unbelievable positive statement now has high validity.

Positive Closure

Sometimes, a client is able to completely resolve a targeted memory in one session; at other times, more than one session is required. Various strategies have been developed for therapists to provide positive closure for incomplete sessions (e.g., Leeds, 2009; Shapiro, 2001). Of relevance for the experiments described in this article is the "positive closure" procedure in the Dutch version of the standard EMDR protocol. It is standard protocol in the Netherlands for this procedure to be used at the end of both complete and incomplete sessions. The client is asked, "What is the most positive or valuable thing you have learned about yourself during this last hour/this last session, with regard to this theme or this event?" The client identifies a trait or a positive self-affirmation, such as "I am strong" or "I am a fighter." After this, the therapist conducts a set of 20-25 eye movements while the client focuses on the statement. Additional sets of eye movements are conducted if the client reports that other positive thoughts were elicited. The procedure continues until no further positive change is reported. Although no research has been conducted on this specific procedure, it was added to the Dutch protocol, with the expectation that it might

reinforce any positive changes that had occurred during trauma reprocessing, stimulate positive responses, and "anchor" identified changes (de Jongh & ten Broeke, 2003, pp. 124–129).

Research on EMDR's Eye Movements

A large number of studies have investigated the eye movement component in EMDR. In a meta-analysis by Lee and Cuijpers (2013), results showed that eye movements contribute to EMDR's successful treatment outcome. Various theories have proposed different mechanisms of action by which eye movements may achieve this effect, and numerous studies have sought to determine this mechanism. Currently, many researchers and theorists (e.g., Bergmann, 2010; Keller, Stevens, Lui, Murray, & Yaggie, 2014) argue that eye movements have more than one effect in EMDR and are related to more than one mechanism. The various theories and their level of research support are well summarized by Yaggie et al. (2015).

The Working Memory Account for Eye Movement Effects in EMDR

Working Memory

With numerous studies (e.g., Engelhard, van Uijen, & van den Hout, 2010; Gunter & Bodner, 2008; Maxfield, Melnyk, & Hayman, 2008; van den Hout et al., 2010; van den Hout et al., 2011), working memory is one of the most thoroughly researched mechanisms of action in EMDR therapy. Working memory research has found that engaging in a dual task which taxes working memory while focusing on a recalled mental image will reduce the vividness and emotional intensity of the mental image. Both tasks (keeping the image in mind and the other taxing task) compete for working memory space, which is limited. With less working memory capacity available for keeping the recalled image in mind, the mental image becomes less vivid and less emotional, and the recalled memory is reconsolidated in this way (van den Hout & Engelhard, 2012). Eye movements, such as those used in EMDR therapy, have been found effective in reducing the vividness and emotionality of emotionally charged visual and/or auditory images. Other tasks having these effects include calculating out loud (Kemps & Tiggemann, 2007), auditory shadowing (Gunter & Bodner, 2008), copying a complex figure (Gunter & Bodner, 2008), playing the computer game Tetris (Engelhard et al., 2010), mental arithmetic (Engelhard, van den Hout, & Smeets, 2011; van den Hout et al., 2010), and mindful breathing (van den Hout et al., 2011).

Research on Eye Movement as a Dual Attention Task

Various studies have investigated the effects of eye movements as the dual task during memory recall. Although results varied somewhat from study to study, overall, the effects are robust. Most studies have evaluated the effects of eye movements on the vividness and emotionality of a memory image, finding a reduction in these variables (e.g., de Jongh, Ernst, Marques, & Hornsveld, 2013; Gunter & Bodner, 2008; van den Hout, Muris, Salemink, & Kindt, 2001).

Cross-Modality Effects

Cross modality is a term that describes the pairing of a dual attention task with a primary task that is of a different modality. For example, eye movements (a visual task) can be paired with focusing on a verbal statement (an auditory task). Research has shown variability in the cross-modality effects of eye movements. Kemps and Tiggemann (2007) compared eye movements with a verbal task for auditory and visual images and reported modality-specific outcomes, with eye movements producing greater deterioration of visual images and the verbal task producing greater deterioration in auditory images. On the other hand, Maxfield et al. (2008) found non-modality-specific results. They investigated the effects of eye movements on the clarity of thoughts related to the targeted autobiographical memory and found a significant reduction in thought clarity. This effect occurred even when participants focused only on the memory image during the eye movement dual attention task. Maxfield et al. concluded that the memory components appeared to be linked because there was an effect on different nontargeted memory components.

Baddeley and Andrade (2000) conducted seven studies in which vividness of visual and auditory images was rated while performing various tasks that disrupted working memory. In particular, they found that modality-specific tasks had larger effects on generic nonautobiographical memory targets (i.e., a visual task disrupted generic visual memories but not generic auditory memories). However, for autobiographical memories, there was less disruption of image vividness when memories were “meaningful” or “familiar.” They attributed the maintenance of image clarity to long-term memory effects in spite of reduced working memory capacity.

Working Memory Effects of Eye Movement Tasks on Positive Material

Positive memories and images tend to become less vivid and less positive when they are retrieved with simultaneous eye movements (Barrowcliff, Gray, Freeman, & MacCulloch, 2004; Engelhard et al., 2010; van den Hout et al., 2001). Hornsveld et al. (2011) used a stripped down version of the EMDR Resource Development and Installation (RDI) protocol (Korn & Leeds, 2002) to evaluate the effects of eye movements on positive memories similar to those used in the RDI protocol. They measured the vividness, pleasantness, and the experienced strength of three positive memories (representing pride, perseverance, and self-confidence). Rather than enhancing the quality of the positive memories, the eye movement task reduced the vividness, pleasantness, and subjectively experienced strength of the resource. Hornsveld, de Jongh, and ten Broeke (2012) concluded that eye movements were counterproductive in RDI applications and should not be used. However, RDI developers, Leeds and Korn (2012) disagreed. They commented that Hornsveld et al. did not use important elements of the RDI procedure and that the design "disqualifies the authors from making any claims about the relevance of their findings to the clinical usage of EMs [eye movements] in EMDR and, more specifically, in RDI" (Leeds & Korn, 2012, p. 170).

The effect of eye movements on positive personal memories was also studied by Keller et al. (2014). Their results indicated an increase in memory strength and vividness, which seemed to contradict earlier research on positive memories. They pointed out that the ratings in their study were conducted after 1-minute processing periods, whereas other studies did not include these processing periods. This is why in their discussion they suggest a "two-stage process," where working memory first blurs and desensitizes the image and a second stage of reprocessing produces increased memory vividness and a more constructive reframe of the original memory (Keller et al., 2014). This is in line with suggestions made by Maxfield et al. (2008) that once the salience of negative material is diminished by working memory effects, other material will become more accessible.

Experiment 1

The objective of these studies was to test the additional value of eye movements on the positive verbal material, such as used in the procedure positive closure. It was hypothesized that eye movements would have a working memory effect and reduce the believability of possessing the positive relevant personality trait. We compared two

conditions: (a) recall with 15-20 seconds of horizontal eye movements and (b) recall only (15 seconds of "eyes stationary" control condition). To obtain sufficient statistical power (0.8, with a confidence interval of 95% and an expected medium effect size, f = 0.26), 30 participants were needed.

Experiment 1: Method

Participants

The participants in the experiment were 30 undergraduates (22 females) of Utrecht University and the Higher Vocational Education of Utrecht. They had a mean age of 21.3 years (*SD* = 3.03) and participated in exchange for financial compensation. Exclusion criteria were uncorrected visual impairments, hearing impairments, and use of medication that might influence attention or memory and current psychiatric complaints. Information regarding these items was collected on a checklist. Potential participants filled out a form to describe a short description of a vivid negative memory. Inclusion criterion was that the described memory was determined by the therapist to be suitable for EMDR processing. No participants were excluded.

Procedure

Each participant received a 20-minute EMDR therapy session on the selected negative memory, using the standard Dutch EMDR protocol (de Jongh & ten Broeke, 2003, 2012). Following this, a modified version of the positive closure procedure was given. Participants were asked, "What are the two most valuable things that you have learned about yourself during this last hour/this last session, with regard to this theme or this event?" Participants could choose from a list of relevant personality traits or indicate any other characteristic. The list of 18 relevant personality traits was based on the "Big Five" personality traits (van Eijck & de Graaf, 2001). The trait "emotionally stable" was replaced by "energetic" and "positive attitude."

Participants were randomly assigned to one of four conditions. The trait with the highest/lowest score, and the order of the two conditions (eye movements and eyes stationary), was counterbalanced. This resulted in four separate order conditions: trait with highest score first versus lowest score first and eye movements first versus eyes stationary first.

The positive closure procedure was administered for each personality trait, once with eye movements and once with eyes stationary. In the eye movement condition, participants performed 20-25 horizontal left-right-left eye movements which were evoked by following the top of the researcher's fingers. The eye movement velocity was as fast as the participant could follow the researcher's fingers. The eyes stationary task was to look at the top of the researcher's fingers for a duration of 15 seconds, which was approximately the same amount of time as the eye movement condition. The dependent variable "belief in possessing the relevant personality trait" was assessed before and after each condition by participants, putting a mark on the Belief in Personality Trait Visual Analogue Scale (VAS). After completing the postcondition rating for the second personality trait, participants completed the Perception Checklist.

Measures

Belief in Personality Trait. Pretest and posttest ratings were obtained by using four 10-cm VAS to measure belief in the relevant personality trait. This "belief" measure is conceptually similar to EMDR's Validity of Cognition Scale, which measures to what extent the client is convinced of the positive cognition. The extreme left side of the VAS scale represented 0 (*no belief in possession of the trait at all*) and the extreme right side of the scale represented 10 (*convinced of possessing the trait*). The numerical values 0 and 10 were visible on the actual scales themselves. During the posttest rating, participants were not able to see their previous scoring of the belief.

Perception Checklist. A checklist was given at the end of the study to see whether or not the participants thought about the characteristic during the conditions; if they experienced inconvenience; if they had knowledge about EMDR prior to the experiment; and if they evaluated the eye movements or eyes stationary condition to be equally beneficial or detrimental, or if one was superior.

Data Processing and Statistical Analyses

The data for this study was processed using SPSS (Version 21). A 2 (pretest, posttest) x 2 (eye movement [EM], eyes stationary [ES]) repeated measures analysis of variances (ANOVAs) was conducted using the level belief of the relevant personality trait as the dependent variable to detect any significant main or interaction effects. Also, a secondary analysis, a 2 (pretest, posttest) x 2 (EM, ES) x 2 (Knowledge of EMDR)

was conducted, using Time and Condition as within-subject variables and Knowledge of EMDR as a between subject variable.

Experiment 1: Results

No participants were excluded. One participant was diagnosed with PTSD by the researcher. The participant was unaware of this before starting the experiment. Proper treatment was provided for the participant afterwards. Of the negative memories, 7% of the participants described relational problems (e.g., being cheated on), 23% described problems in social interaction (e.g., having an argument), 47% described a loss event (e.g., loss of a loved one), and 23% described an illness of themselves or a loved one.

For the first personality trait (this was the first selected trait), 30% of the participants chose “someone who persists,” 26.7% “open,” 10% “self-assured,” 6.7% “positive attitude,” 6.7% “helpful,” 3.3% “other traits,” and 6.7% identified a trait not on the list. For the second relevant personality trait, 23.3% chose “positive attitude,” 10% “someone who persists,” 10% “open,” 10% “self-assured,” 3.3% “other traits,” and 20% of the participants identified a trait not on the list.

The mean pre- and posttest values of the belief are presented in Table 1 and suggest that there was no change after either the eye movements or the eyes stationary condition in belief of the relevant personality trait.

The data was analyzed with a 2 (Time; pretest vs. posttest) x 2 (Condition; EM vs. ES) repeated measures ANOVA. There were no significant main effects of Time, $F(1, 29) = .351$, $p = .558$, and Condition, $F(1, 29) = .061$, $p = .806$, and no significant interaction effect between Time x Condition, $F(1, 29) = .004$, $p = .951$. To test if prior knowledge of EMDR would have an effect, a secondary analysis (a 2 x 2 x 2 ANOVA) was conducted with a Time (pretest vs. posttest) and Condition (EM vs. ES) as within group factors and Knowledge about EMDR (Yes/No) as a between group factor. Neither the main effects nor the interactions were significant ($Fs < 1.83$; $ps > .186$).

Results of the Perception Checklist

Of the participants, 4 rated both conditions as not useful; 3 as both equally beneficial; 8 rated the eye movements conditions as more beneficial, and 15 the eyes stationary condition as more beneficial.

Table 1

Means and Standard Deviations of Belief Before and After Horizontal Eye Movement (EM) and Eyes Stationary (ES) Condition

	EM (*SD*)	**ES (*SD*)**
Pretest	7.74 (1.51)	7.54 (1.37)
Posttest	7.76 (1.60)	7.58 (1.48)

Experiment 1: Discussion

To the best of our knowledge, this was the first study on the effects of eye movements on positive personal *verbal* statements, which were not grounded in personal memories or autobiographical context. The Dutch version of the standard EMDR protocol was used with a modification in the procedure positive closure. Eye movements are part of that procedure, and this study tested the working memory hypothesis that eye movements would decrease the level of belief in the relevant personality trait, rather than increasing the belief.

Results were clear: Eye movements did not decrease or enhance the belief of the positive relevant personality trait. There were no differences between the eye movement and the eyes stationary control condition.

We considered several explanations for the null results and identified two possible methodological explanations for the lack of working memory effects on decreasing the positive belief. The first was that the effect may have been diminished if participants had developed a positive bias toward eye movements; this may have been created by the beneficial experience of EMDR therapy in the first 20 minutes of the session. A testable implication was that, if participants had no prior positive experiences with eye movements, the working memory effect would be found and eye movements would have a detrimental effect on the belief.

The second explanation relates to the emotionality of the material. Van den Hout, Eidhof, Verboom, Littel, and Engelhard (2014) showed that taxing of working memory with eye movements did not reduce the vividness of non-emotional memories (cf., Baddeley & Andrade, 2000). In Experiment 1, the emotionality of the positive personality trait

statements was not assessed. A testable implication was that eye movements would have a detrimental effect on the belief if the belief was experienced with strong emotion.

Experiment 2

Experiment 2 was designed to rule out these explanations. To rule out the possibility that provision of EMDR therapy created a positive bias to eye movements and interfered with working memory effects, participants were not exposed to EMDR and an alternative pre-positive closure activity was provided. To rule out the possibility that the lack of working memory effects was related to low emotionality, emotionality was assessed in Experiment 2. To stay as close as possible to Experiment 1, the experiment was repeated without the preparatory EMDR session and emotionality ratings were added. With a power of 0.9 (with a confidence interval of 95% and an expected medium effect size, f = 0.25), 46 participants were needed.

Experiment 2: Method

Participants

Participants were 46 undergraduates (33 females) of Utrecht University and the Higher Vocational Education of Utrecht. They had a mean age of 22.0 years (*SD* = 2.2) and participated in exchange for financial compensation. Exclusion criteria were uncorrected visual impairment, hearing impairment, use of medication that might influence attention or memory, and current psychiatric complaints.

Procedure

The procedure for Experiment 2 was identical to that of Experiment 1 except (a) a suitable negative memory was not an inclusion criterion, (b) EMDR processing of the negative memory was replaced by participants working on a Sudoku puzzle for 10 minutes, (c) the VAS measure "Emotionality" was added, and (d) the eyes stationary control condition was 20 seconds.

Measures

Belief in Personality Trait. See description in Experiment 1 "Measures" section.

Perception Checklist. See description in Experiment 1 "Measures" section.

Emotionality. Pretest and posttest ratings of Emotionality scale were obtained by means of four 10-cm VAS. Scores ranged from 0 (*not pleasant at all*) to 10 (*very pleasant*).

The numerical values 0 and 10 were visible on the actual scales. At posttest rating, participants were not able to see their previous scorings.

Data Processing and Statistical Analyses

The data for this study were processed using the same statistical package and the same analyses as in Experiment 1. The analyses were repeated for the second variable (Emotionality) which was added in Experiment 2.

Experiment 2: Results

Before the actual study started, a pilot study was performed on 16 participants to see if participants could come up with the positive things they learned about themselves during solving the puzzle and to see if they understood the question of "how pleasant" the trait was for them. It appeared that participants could all select positive personality traits and could rate how pleasant they were for them. No changes were made in the procedure as a result of the pilot study.

No participants were excluded. For the first personality trait (this was the first selected trait), 60.9% of the participants selected "someone who persists," 10.9% "creative," 8.7% "investigating," 8.7% "accurate," and 6.5% "emotionally stable." For the second trait, 37% chose "investigating," 23.9% "accurate," 10.9% "self-assured," and 6.5% chose both "precise" and "open." Less than 2.5% selected "other characteristics."

The mean pre- and posttest values of Belief and Emotionality are presented in Table 2 and suggest that there was no change after either the EM or the ES condition on the level of belief or the emotionality of the relevant personality trait.

Table 2

Means and Standard Deviations of Level of Belief and Emotionality Before and After Horizontal Eye Movement (EM) and Eyes Stationary (ES) Condition

	EM		**ES**	
	Belief (*SD*)	Emotionality (*SD*)	Belief *(SD*)	Emotionality (*SD*)
Pretest	6.90 (1.15)	7.35 (1.44)	7.11 (1.28)	7.73 (1.52)
Posttest	6.50 (1.86)	7.05 (1.71)	7.14 (1.42)	7.52 (1.41)

Data were analyzed with a 2 (Time; pretest vs. post-test) x 2 (Condition; EM vs. ES) repeated measures ANOVA. There was no significant main effect of Time, $F(1, 45) = 1.416$, $p = .240$, Condition, $F(1, 45) = 3.834$, and no significant interaction effect between Time x Condition, $F(1, 45) = 1.812$, $p = .185$, was found. With the exclusion of two outliers, the same analysis still failed to reach any significance. However, a closer look at the data showed a large variance. The differences in VAS scores were also tested nonparametrically and the conclusions agree with the parametrical tests and fail to reach any significance (all p values > 1.5).

For emotionality, data were analyzed also with a 2 (Time; pretest vs. posttest) x 2 (Condition; EM vs. ES) repeated measures ANOVA. There was no significant main effect of Time, $F(1, 45) = 2.771$, $p = .103$, and Condition, $F(1, 45) = 2.556$, $p = .117$, and no significant interaction effect between Time x Condition, $F(1, 45) = 0.105$, $p = .748$.

Results of the Perception Checklist

In the eye movement condition, none of the participants stated that they were aware of keeping the trait in mind while performing the eye movements, and in the eyes stationary condition, four participants were aware of keeping the trait in mind. If being aware of keeping the trait in mind caused a decrease in the belief (or emotionality) could not be tested because the subgroup was nonexistent (EM condition) and too small (ES condition) for analysis. Of the participants, 16 rated both conditions as “not useful,” 16 rated as both “equally beneficial,” 7 rated the eye movements conditions as “more beneficial,” and 7 rated the eyes stationary condition as “more beneficial.” Groups were too small for analysis.

Experiment 2: Discussion

The second study examined the effect of 15-20 seconds of eye movements versus 20 seconds of an eyes stationary task on a positive verbal statement. The statement was a belief related to the positive relevant personality trait. It was identified after participants solved a Sudoku puzzle. Participants focused on the positive relevant statement while engaging in the two conditions. The eye movement condition was a modified version of the positive closure procedure of the Dutch version of the standard EMDR protocol. The experimental task provided only one set of eye movements, and therapists did not elicit associative material.

Results were as clear as in the first experiment: Brief eye movements did not diminish or enhance the belief of the positive relevant personality trait. There were no differences between the eye movement and the eyes stationary conditions.

Experiment 2 was designed to rule out two possible explanations for the lack of working memory effects in Experiment 1. We determined that the null results could not be explained by a possible positive response bias in participants who had experienced beneficial effects of EMDR therapy. The same null results were found when participants played Sudoku instead of receiving EMDR therapy and had no positive response bias toward eye movements. We also determined that the lack of working memory effects in Experiment 1 was not related to low emotion in the positive belief. In Experiment 2, participants' mean scores were between 7.35 and 7.73 (out of 10), which indicates that the material was emotionally charged.

Discussion

We tested whether applying 15-20 seconds eye movements while focusing on positive personal verbal material would decrease the believability or the pleasantness of the positive statement. In Experiment 1, healthy participants selected two positive personality traits which they recalled while performing brief eye movements or holding eyes stationary, after receiving an analogue EMDR session. There was no discussion of whether the traits were grounded in personal memories or autobiographical context. There was no enhancement or deterioration of the belief in possessing the personal trait for either condition. In Experiment 2, we used the same procedure on healthy participants, but it was not preceded by an EMDR session, and we also assessed emotionality of the positive statements. Again, we observed no enhancement or deterioration for either condition.

One of the purposes of this research was to evaluate the positive closure procedure to determine if the eye movement component resulted in any decrease in the believability of the positive statement. The study used a truncated version of the procedure, with only one set of eye movements and no elicitation of associated material. Results were clear. No effect was found of the eye movements. This raises questions about the usefulness of eye movements in the positive closure procedure, but no conclusions thus far can be drawn.

In clinical EMDR and laboratory studies, EM have been found to affect the emotionality and vividness of retrieved negative memories (Lee & Cuijpers, 2013). Laboratory studies have also provided evidence that eye movements tend to decrease the emotionality and vividness of positive memories (Barrowcliff et al., 2004; Engelhard et al., 2010; van den Hout et al., 2001; cf., Keller et al., 2014). Why were such effects absent in this study? Perhaps the reason for our null findings was related to the limitations in our methodology — or perhaps there was no effect to be found.

Limitations

Speed and Number of Eye Movements

The foremost explanation for the lack of results could be that the manipulation was not strong enough. Only 15-20 seconds of eye movements were conducted (20-25 left-right-left movements), which is a very brief manipulation. Previous working memory research has typically used multiple manipulations of 24 seconds (Keller et al., 2014; van den Hout et al., 2001) or 30 seconds (de Jongh et al., 2013); the brief intervention may have provided insufficient dosage. The speed of eye movements in this study was fast: 20-25 eye movements in about 15-20 seconds, at a rate of 0.6-1 second for each left-right-left movement. Most working memory studies used a rate of about 1 second for each left-right-left movement (de Jongh et al., 2013; Keller et al., 2014; Nieuwenhuis et al., 2013; van den Hout et al., 2011). Faster eye movements used in this study may have made it difficult for participants to simultaneously engage in the task of focusing on the verbal statement. On the other hand, the speed was adjusted to the potential of the participants, in the same way the EMDR therapist does this with his patients.

Modality-Specific Taxing

Modality-specific taxing — taxing in the same modality — was not used. Some working memory studies (Baddeley & Andrade, 2000; Kemps & Tiggeman, 2007) showed a (small) beneficial effect for modality-specific taxing; other studies showed cross-modality effects (Gunter & Bodner, 2008; Maxfield et al., 2008). In both experiments reported here, cross-modality taxation was used, with a visual taxation (eye movements) on an auditory recollection (verbal statement).

Modality-specific taxing was not added because the researchers wanted to stay as close as possible to the original positive closure procedure. In the positive closure procedure, verbal material is activated while a visual spatial load is presented (eye

movements). Further research could examine in more detail the effect of modality-specific taxing or taxing in cross-modality in this procedure.

Outcome Measure

The primary outcome measure used in this study was belief in a possession of a positive personality trait, based on the Big Five personality traits (van Eijck & de Graaf, 2001). Although participants did not discuss related autobiographical material, it is likely that the endorsed trait was meaningful to participants and embedded in their identity. Because the Big Five personality traits are known to have high test-retest reliability, and to be fairly immutable, it is likely that endorsement of the trait will not easily change over time - especially after a 15-20 seconds intervention. A question then arises about whether endorsed traits are less responsive to working memory effects. Future research could examine the types of self-statements that are more amenable to change and those which are more resistant.

Recommendations for Future Research

Many studies have determined that working memory effects of eye movements result in desensitization of memories, with decreased vividness and emotionality. The implications for the use of eye movements in EMDR therapy are evident, and many agree that working memory effects may be a credible mechanism of action in EMDR and that they may account for some or most of the desensitization effect in EMDR therapy (Keller et al., 2014; Maxfield et al., 2008).

Future research needs to examine these effects with patients in actual treatment sessions to determine the extent and prevalence of these effects. The limitations and boundaries of the working memory effects need to be more carefully examined. For example, in this study, we found no change in endorsed beliefs about personality traits. A question then arises if the manipulation was not strong enough or whether endorsed traits are less responsive to working memory effects, and if so, to determine how to use such knowledge to improve individual treatment.

In EMDR therapy, memories are not only desensitized but they are also transformed. Can the desensitization effects of working memory account for this transformative outcome, or is there another process involved? To what extent, if any, is desensitization modified by EMDR's elicitation of associations and facilitation of processing?

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Author contributions

Experiment 1: SM developed the study concept, SM and MvH contributed to the study design. SM developed the study material and was responsible for data collection and for data analysis. SM drafted the manuscript, MvH provided critical revisions, both SM and MvH approved of the final manuscript. Experiment 2: SM and MvH developed the study concept and contributed to the study design. SM developed the study material and was responsible for data collection and for data analysis. SM drafted the manuscript, MvH provided critical revisions, both SM and MvH approved of the final manuscript.

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CHAPTER 03

The use of EMDR in positive verbal material: Results from a patient study

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Abstract

Background. According to the working memory (WM) theory of eye movement desensitization and reprocessing (EMDR), dual tasks that tax WM during memory recall reduce image vividness and emotionality of memory during future recalls when no dual task is carried out. There is some evidence that WM taxing also reduces vividness and emotionality of auditory or verbal imagery. **Objective.** The present study tests the effect of eye movements (EM) on positive verbal material (verbal imagery), which is used in different parts of the EMDR protocol. In the Dutch version of the standard EMDR protocol, a procedure ''Positive Closure'' (PC) is performed, which uses verbal imagery under dual task condition (EM). The value of EM in this procedure has not been established and according to the WM account would be counterproductive. Two earlier studies with undergraduates, with a set-up comparable to the present one, showed no additive value of the EM in the procedure, but no counterproductive effect either. **Method.** Thirty-six patients rated the belief in possessing two positive personality traits and emotionality of the traits. They then had an EMDR session targeting a negative memory and recalled and re-rated the belief and emotionality of the traits afterward. Subsequently, they recalled one trait while dual tasking (EM) and the other trait without dual tasking. Afterward, they re-rated the belief and emotionality. **Results.** EM did not affect the belief in possessing the trait or the emotionality. Secondary analysis shows an effective EMDR session itself enhances the belief in the traits, compared to a less or non-effective EMDR session. **Conclusions.** EM are not effective in enhancing the belief in possessing a personality trait or the emotionality. If replicated by other patient studies, this suggests elimination of the PC procedure.

Keywords: EMDR, working memory theory, positive verbal material, verbal imagery, positive closure, modality-specific taxing, eye movements

Highlights

- In this study the additive value of EM on verbal material (in the procedure Positive Closure) is not found.
- No effect of the procedure Positive Closure on the belief in a personality trait nor the emotional intensity of the trait was found.
- An effective EMDR session (large reduction of the SUD during the session) was effective in changing the Belief in personality traits.

Introduction

Since the introduction of eye movement desensitization and reprocessing (EMDR) in 1989 (Shapiro, 1989), the field has moved a long way from scepticism toward this therapy to viewing it as an evidence-based intervention for posttraumatic stress disorder (PTSD; see Chen et al. [2014] for a recent meta-analysis) proven equally effective as trauma-focused cognitive behavioural therapy (Bisson et al., 2007). A study by de Jongh, Ernst, Marques, and Hornsveld (2013) even suggests that it is effective in resolving negative memories that play a role in, or underlie, a broad variety of psychological symptoms and conditions. The core feature of EMDR therapy is that the patient is asked to hold a disturbing image of a negative memory in mind while engaging in sets of eye movements (EM) or other bilateral stimuli, such as taps or tones (Lee & Cuijpers, 2013; Shapiro, 2001). The additive value of the EM in comparison to recall only was established in numerous studies, and a recent meta-analysis of Lee and Cuijpers (2013) showed the effect size for the additive effect of EM in EMDR treatment studies to be significantly moderate (Cohens d = 0.41) and significantly large in laboratory studies (d = 0.74).

Still there is a lot of debate about the working mechanism of EMDR and why EM are effective. In the original description of EMDR (Shapiro, 2001) it was assumed that the bilaterality, which was induced by the horizontal EM (or bilateral tones or taps), was a necessity to ensure effective treatment. However, evidence is accumulating that supports an explanation based on working memory theory (WMT). The theory predicts that any dual task that taxes working memory during memory recall will reduce the vividness and emotional intensity of mental images. Two tasks (keeping the image in mind and the other taxing task) compete for the limited working memory capacity (Baddeley, 2012). Moving one's eyes from side to side while recalling a memory would, according to the WMT, leave less capacity for the memory. As a result, the memory would become less vivid and emotional, and the image is reconsolidated as such (van den Hout & Engelhard, 2012). The WMT implies that the crucial part of EMDR would be that the traumatic experience is reprocessed while a *distracting* stimulus is given, not necessarily a *bilateral* stimulus. This is con-firmed by studies showing efficacy of vertical EM (Gunter & Bodner, 2008), drawing a complex figure (Gunter & Bodner, 2008), playing the computer game Tetris (Engelhard, van Uijen, & van den Hout, 2010), mental arithmetic (Engelhard, van den Hout, & Smeets, 2011; van den Hout et al., 2010), calculating out loud (Kemps & Tiggemann, 2007), and mindful

breathing (van den Hout et al., 2011). It is stressed that this is not the only explanation for the working mechanism of EMDR and for the relief of trauma in general. There are many explanations given for the mechanism behind EMDR itself and for the relief of symptoms. Also, TF-CBT is an evidence-based therapy for the relief of trauma symptoms. Both TF-CBT and EMDR have the ‘‘exposure’’ element, but a distinct feature is EM which in EMDR have proven their additive value (Lee & Cuijpers, 2013).

EMDR typically targets negative visual imagery, but also seems to affect vividness and emotionality of positive visual imagery. A study of van den Hout, Muris, Salemink, and Kindt (2001) showed that, compared to control conditions that did not (or hardly) tax working memory, positive memories were rated less positive by 60 undergraduates after EM. A study of Barrowcliff, Gray, Freeman, and MacCulloch (2004) showed engagement in EM compared to the eyes stationary (ES) condition resulted in significant reductions on measures of vividness and emotional valence for both positive and negative autobiographical memories in 80 participants (20 community participants and 60 undergraduates).

In a study of Engelhard et al. (2010) 60 undergraduates recalled negative and positive memories in three conditions: recall only, recall with EM, and recall with playing Tetris. Before and after these conditions, vividness, emotionality, and physiological startle responses during recall were measured. For positive memories, EM and Tetris decreased startle responses compared to recall only. In addition, EM decreased emotionality but Tetris did not, and Tetris decreased vividness but EM did not.

Hornsveld et al. (2011) also reflected on positive visual imagery. They evaluated the effects of EM on positive memories such as those used in the Resource Development and Installation (RDI) protocol. The RDI protocol is an EMDR-related procedure developed to strengthen positive associations in positive and resourceful memories (Korn & Leeds, 2002). Fifty-three university under-graduates were asked to recall three positive memories (memories representing pride, perseverance, and self-confidence, respectively) under three conditions: horizontal EM, vertical EM, and a control condition. Vividness, emotionality, and subjective strength of the resource were measured. Both types of EM reduced the vividness, emotionality, and also the subjectively experienced strength of the positive memories, indicating that EM were counterproductive (Hornsveld et al., 2011).

However, a contradictory result was found by Keller, Stevens, Lui, Murray, and Yaggie (2014). They studied the effect of EM on positive personal memories and their results indicated an increase in memory strength and vividness. Different in their design, ratings were conducted after 1-minute processing periods, whereas other studies did not include such periods.

In summary, most research indicates that both negative and positive visual imagery are rated less vivid and emotional after recall + EM. But does this also hold true for *auditory* or *verbal* imagery? To the authors' knowledge two studies assessed auditory images. Baddeley and Andrade (2000) conducted seven studies of which five included auditory images. The auditory images consisted of novel sequences of tones, familiar sounds or bizarre sounds. All of the studies used healthy participants and they rated the auditory images on vividness. In all five studies, participants were asked to hold the auditory stimulus in mind as an image under dual task conditions and then to rate its vividness. Dual task conditions were either auditory or visual suppression or a control condition. Auditory images were rated less vivid after dual task suppression. An interaction between modality of imagery and concurrent task occurred, with the rated vividness of auditory images being reduced to a greater extent by the auditory suppression than by the visual suppression. A limitation of the study is that Baddeley and Andrade used only vividness ratings and did not include emotionality ratings, and the imagery used did not have meaningful autobiographical content.

A study by Kemps and Tiggemann (2007) also included auditory images. The authors conducted a study in which 68 undergraduates were instructed to specifically form visual or auditory images and were asked to rate the vividness and emotionality of the images. The memory was recalled three times in succession, each time in a different dual task condition (a control condition, EM, and articulatory suppression). Auditory images were rated less vivid and emotional after dual task suppression and concurrent modality-specific taxation (articulatory suppression for auditory images and EM for visual images) reduced vividness and emotional intensity ratings in both auditory and visual images to a greater extent.

Positive auditory material (verbal imagery) is used at different moments of the standard EMDR protocol, for example, installing the future template and installing the positive cognition. Installing the future template is a procedure where a feared non-harmful situation is being visualized while pronouncing the sentence ''I can handle this'' and at the

same time EM are performed, until the point where the patient feels capable to face the feared situation in real life (e.g., walking in the street where a person once was robbed). Installing the positive cognition is the procedure where, after desensitizing a negative image a positive cognition (e.g., ''I can handle this'', ''I am safe'', and ''I am a good person'') is pronounced while still visualising the prior selected negative image and simultaneously performing EM. In the Dutch version of the standard EMDR protocol another procedure that addresses verbal material called ''Positive Closure'' is added at the end of the session, to enhance belief or faith in possessing relevant personality traits (Matthijssen & van den Hout, 2016). This is an adaptation to the original EMDR protocol and may deviate from other international versions of the EMDR protocol. The procedure addresses solely verbal imagery under dual task condition (EM). The procedure is not considered a core part of the EMDR procedure, but is added to strengthen a patient's belief in self-statements with respect to the progress made in the EMDR session. In their first study, Matthijssen and van den Hout (2016) compared the belief in possessing two selected personality traits in 30 undergraduates under two different conditions: EM and a control condition (ES). After exposure to an EMDR session the participants were asked to select two positive personality traits and to rate the *belief* in the chosen traits. While recalling the traits participants were exposed to EM or ES, the order of which was counterbalanced. A second study, with a sample population of 46 undergraduates also addressed the same procedure where two personality traits were recalled under two conditions (EM or ES), but the intervention was not precipitated by an EMDR session, to rule out any positive bias toward EM. In this study besides *Belief* in the trait, *Emotionality* was added as a dependent variable to test if the selected material was emotional. Results in both studies showed that, regardless of the condition, there was no significant difference between pre- and post-test measurements, neither for Belief nor for Emotionality. The utility of EM in the Positive Closure procedure was not supported by these laboratory findings. A limitation of both studies is that undergraduates in a non-clinical setting were studied. Possibly, the positive closure procedure *is* effective under clinical conditions, that is, during real EMDR. Certainly, the latter is the assumption that underlies the procedure. However, note that extrapolating from the findings discussed above on the negative effects of EM on positive visual imagery, one might expect negative effects of EM on positive closure as well.

Thus, the aim of the present study was to test whether, in PTSD patients who were eligible for trauma-focused psychotherapy with EMDR, positive closure + EM affects the belief in possessing a personality trait. To obtain sufficient statistical power (0.8, with a confidence interval of 95% and an expected medium effect size, $f = 0.25$), 34 patients were needed. This would also address whether the procedure PC is of any value in the EMDR protocol. A second aim was to assess whether the course of the EMDR session (within session improvement) influences the belief in (and emotionality of) the positive trait.

Method

Patients

Data from 36 patients were collected. They had a mean age of 39.1 years (*SD* = 11.4), with an age range from 19 to 60. For more patient characteristics see Table 1. Inclusion criteria were being diagnosed with PTSD and being eligible for trauma-focused psychotherapy with EMDR. No patients were excluded from the study and there were no drop-outs. Since therapists asked their patients to participate, the researchers do not know if and how many patients refused participation.

No selection was made in the type of trauma of the patients (which encompassed sexual violence, physical violence, physical accidents, war trauma, physical violence in childhood, sexual violence in childhood, neglect, and other trauma), length or quantity of the trauma. The years since index trauma varied from 9 months up to 35 years. The number of prior EMDR sessions varied from it being the first session up to 30 sessions (*M* = 6.8, *SD* = 7.4). Twenty patients were treated at the Altrecht Academic Anxiety Centre, where complex anxiety disorders are treated. At the centre patients are diagnosed through a thorough assessment procedure, where they are subjected to The Structural Clinical Interview for DSM-IV for axis I (SCID-I and on request The Structural Clinical Interview for DSM-IV for axis II [SCID-II]). The other patients that were treated mostly in smaller settings were diagnosed by their therapists who were all experienced EMDR therapists and are expected to have the skills to diagnose their patients either with an axis I or axis II diagnosis.

Table 1

Patient characteristics (N=36)

Characteristic		**% (*N*)**
Age		(*M* =39.1, *SD* = 11.4)
Gender	Female	72.2% (*N* = 26)
	Male	27.8% (*N* = 10)
Comorbid disorders		
Comorbid Axis I disorder	Depression	52.8% (*N* = 19)
	Bipolar Disorder	8.3% (*N* = 3)
	Panic Disorder	5.6% (*N* = 2)
	Cognitive Disorder	2.8% (*N* = 1)
	Vaginism	2.8% (*N* = 1)
	Undifferentiated somatoform disorder	2.8% (*N* = 1)
Comorbid Axis II disorder	Personality disorder NOS	22.2% (*N* = 8)
	Avoidant personality disorder	5.6% (*N* = 2)
	Borderline personality disorder	2.8% (*N* = 1)
Education level	Primary school	2.8% (*N* = 1)
	Secondary school	33.3% (*N* = 12)
	Lower vocational education	2.8% (*N* = 1)
	Middle vocational education	22.2% (*N* = 8)
	Higher vocational education	16.7% (*N* = 6)
	University	19.4% (*N* = 7)
	Missing	2.8% (*N* = 1)
Psychopharmacological drugs	Antidepressants	47.2% (*N* = *17*)
	Antipsychotics	19.4% (*N* = 7)
	Anti-epileptics	8.3% (*N* = 3)
	Hypnotics	5.6% (*N* = 2)
	Anti-histaminic medication	5.6% (*N* = 2)

Design

The study had a 2 (Time: T2 and T3) by 2 (Condition: eye movements [EM] and eyes stationary [ES]) repeated measures within-subject design. Dependent variables were ‘‘Belief in possessing the positive relevant personality trait’’ (Belief) and ‘‘Emotional intensity’’ (Emotionality). All patients selected two relevant personality traits from the Personality Characteristics List (see Materials) and while thinking through one or the other trait, they were exposed to two conditions: eye movements (Recall + EM) and eyes stationary (Recall only), the order of which was counterbalanced. There was also a counterbalance for strength of the Belief, resulting in four conditions (see Procedure). The study was conducted by certified EMDR therapists. A third measurement moment (T1 at the beginning of the EMDR session) was included for answering the second question about EMDR sessions affecting the belief in possessing the trait. A one-way ANOVA was conducted with Time (T1 and T2) as the independent variable.

Materials

List of personality characteristics. For the purpose of the study, patients selected two positive personality traits. A list of relevant personality traits was created based on the Dutch version of the standardised short version of the BIG Five (Gerris et al., 1998). The trait ‘‘emotionally stable’’ was replaced by ‘‘energetic’’ and ‘‘positive attitude.’’ Patients were also given the opportunity to mention a relevant personality trait that was not on the list. This list is the same list used in earlier studies of Matthijssen and van den Hout (2016).

Visual analogue scales. The use of the 10-cm visual analogue scales (VAS) was also replicated from the earlier studies by Matthijssen and van den Hout (2016). To measure belief in possessing the relevant personality trait the patients were asked ‘‘To what extent do you believe that you possess this personality trait right now?’’ and to put a mark on a 10-cm VAS ranging from 0 (not believing) to 10 (completely believing) at three specific time moments (T1, T2, T3). Emotionality was also measured on a 10 cm VAS ranging from ‘‘not pleasant at all’’ (0) to ‘‘very pleasant’’ (10) by asking the question: ‘‘If you think about how much the trait is applicable to you, how pleasant is that for you?’’ The numerical values 0 and 10 were visible on the actual scales. At T2 and T3 ratings, participants were not able to see their previous scoring.

SUD-difference scores. Subjective Units of Disturbance (SUD) is a scale that measures the subjective intensity of disturbance or distress felt by the individual at that

moment of time, from 0 (none at all) to 10 (maximum distress). This was verbally rated by the patient. The effectiveness of the desensitization phase (''EMDR effectiveness'') was measured by SUD-difference scores which were calculated by measuring the SUD of the image before start of the desensitization phase and measuring the SUD after the desensitization phase and subtracting the last from the first score.

EMDR protocol. For the study, the Dutch version of the standard EMDR protocol was used (ten Broeke & de Jongh, 2012). The EMDR protocol consists of eight steps: (1) introduction, (2) assessment, (3) desensitization, (4) installation, (5) body scan, (6) future template, (7) Positive Closure, and (8) reassessment (of the session). The study focusses on the seventh step: Positive Closure. The standard procedure involves the question ''What is the most positive or valuable thing you have learned about yourself during this last hour/this last session, with regard to this theme or this event?'' The patient mentions a personality trait, and this is then re-formulated into an ''I-statement'' (e.g., ''I am strong''). Once the statement is formulated, a set of 20-25 left-right-left eye-movements are performed by the patient. After the set the patient is asked if any other positive things arise or spring to mind. If yes, then another 20-25 left-right-left eye-movements are offered up until the point when the patient doesn't mention any new positive qualities or relevant personality traits. A modification was made in this standard procedure to allow for two conditions per patient. The patient was asked at the start of the session - and not once arriving at the seventh step - ''What are the *two* most valuable things that *you want to learn* about yourself during this next hour/this session, with regard to this theme or this event?'' The patient was asked to evaluate both traits on Belief and Emotionality. Then the normal EMDR session was executed and once arrived at the seventh step in the protocol the patient was asked to take the two selected traits back in mind and re-evaluate the traits on Belief and Emotionality. After exposing the patients to the conditions (EM and ES) the question to re-evaluate the traits on Belief and Emotionality was posed one more time.

Attention checklist. A checklist was given after the last re-evaluation of the traits on Belief and Emotionality. In the checklist patients were asked how much they held the trait in mind while being exposed to one of the two conditions. This variable was measured on a 10 cm VAS with poles from 0 to 10.

Procedure

Ethical statement: The study was conducted by Dutch EMDR therapists on their own patients and the sessions were performed in the therapist's room. Most of the patients received treatment at the Altrecht Academic Anxiety Centre in Utrecht, the Netherlands and the research was approved by the committee of scientific research of Altrecht (a mental health institution). Other approached EMDR therapists (from the Dutch association of EMDR) conducted the research mostly in smaller (private) practices. There were 11 therapists from the Altrecht Academic Anxiety Centre involved and 8 therapists from outside Altrecht, of which 7 saw patients in their private practice. One therapist saw patients in a large mental health institution. The research was conducted according to the principles expressed in the Declaration of Helsinki. There were no invasive techniques used or substance administration given. In giving consent, patients indicated to have read and to have agreed with both the rules regarding participation and the researchers' commitments and privacy policy. They were also informed that they could stop participating at any time, without consequences.

Patients were given an oral and written briefing that provided information about the research. This was done by the therapist of the patient in the session before executing the study or at the start of the session itself. When patients decided to participate they signed an informed consent. The EMDR session was carried out as usual, with the standard EMDR protocol with the minor alterations mentioned. When the session time was over - regardless in which step of the protocol the patient was - or when the therapist arrived at step 7, the slightly altered procedure ''Positive Closure'' was given. The patient was asked to re-evaluate the two selected traits for both Belief and Emotionality. After this the therapist differentiated between the most and the least believed in trait in order to counterbalance for strength and order. The trait with the highest/lowest score, and the order of the two conditions (EM and ES), was counterbalanced. The patients were informed which trait the experiment would commence with, and the trait was then stated out loud. They recalled the trait while performing EM simultaneously or while performing the control condition. In the EM condition, participants were exposed to 20-25 left-right-left EM which were evoked by following the top of the therapists' fingers. Therapists were instructed to move the fingers as fast as possible as long as the patient could still follow the fingers of the therapist. The control task was to look at the top of the therapists' fingers for a duration of 15 seconds,

which was approximately the same interval as the EM condition. After the exposure to one of the two conditions the participants were asked to re-rate to the Belief and Emotionality. The procedure was then repeated for the other condition. Finally the patient had to evaluate how much they thought about the traits during the intervention (EM or ES). After this they were given a debriefing form with more details and background about the research itself, and also the contact possibilities with the researcher responsible for the study. After this the session was either closed or another image was selected to desensitize.

Results

Effects of positive closure with or without EM on the Belief and Emotionality

For the main research question - to test the effect of EM on the belief in possessing a positive personality trait - data was analysed with a 2 by 2 repeated measures ANOVA. The independent variables were Time (T2 and T3) and Condition (EM and ES). The dependent variable was *Belief in possessing the personality trait* (Belief). There was no significant main effect of Time ($F(1, 35) = 1.167$, $p = 0.287$) or Condition ($F(1, 35) = 0.071$, $p = 0.792$) and no significant interaction effect between Time x Condition ($F(1, 35) = 0.109$, $p = 0.743$) was found. Thus, the belief in possessing the trait was not affected by the procedure, neither with, nor without EM. Also a 2 by 2 ANOVA was executed for Emotionality. No main effect for Time ($F(1, 35) = 0.575$, $p = 0.453$), Condition ($F(1, 35) = 0.017$, $p = 0.897$) or an interaction effect ($F(1, 35) = 0.610$, $p = 0.440$) was found. Emotionality of the positive trait did not change from T2 to T3, regardless of the condition (EM or ES). The results can be found in Table 2.

Table 2

Mean and standard deviation of the VAS-scores on the variables Belief and Emotionality at T1, T2 and T3 for both conditions (EM and ES)

	EM		**ES**	
	Belief (*SD*)	Emotionality (*SD*)	Belief (*SD*)	Emotionality (*SD*)
T1	4.29 (2.95)	6.23 (3.05)	4.08 (2.98)	5.87 (3.50)
T2	4.94 (2.91)	6.27 (2.99)	4.87 (3.37)	6.43 (3.07)
T3	5.19 (3.12)	6.64 (2.89)	5.04 (3.25)	6.40 (2.97)

Effects of the EMDR session on Belief and Emotionality

Note that from T1 to T2 the groups were treated equally. Therefore, the scores on the two traits were averaged per person. A one-way ANOVA with Time (T1, T2) as an independent variable and Belief as a dependent variable showed an effect for Time (F(1, 35) = 4.792, p = 0.035), suggesting that Belief differed from T1 to T2; Table 2 shows that Belief went up from T1 to T2. Also for *Emotionality* a one-way ANOVA was conducted, but no significant effect (F(1, 35) = 0.630, p = 0.433) was found there, showing that *emotional intensity* of the personality trait did not differ between T1 and T2.

Possibly, the increased belief in possessing the trait was related to the efficacy of the EMDR session that was conducted between T1 and T2. There was a strong negative correlation between the decrease in SUD and the increase in the Belief (r = - 0.494, p < 0.002), indicating that the degree of within session improvement (decrease in negativity of the trauma image) was accompanied by an increase in the belief in the positive characteristic between T1 and T2. This however did not affect the Emotionality from T1 to T2. To test to what degree the difference in Belief was explained by the SUD-difference score, the latter was added as a covariate to the ANOVA. There was an effect of the SUD-difference score (F(1, 35) = 10.998, p = 0.002), but the main effect of Time disappeared after entering the covariate (F(1, 35) = 1.248, p = 0.272) which means the increase in Belief scores

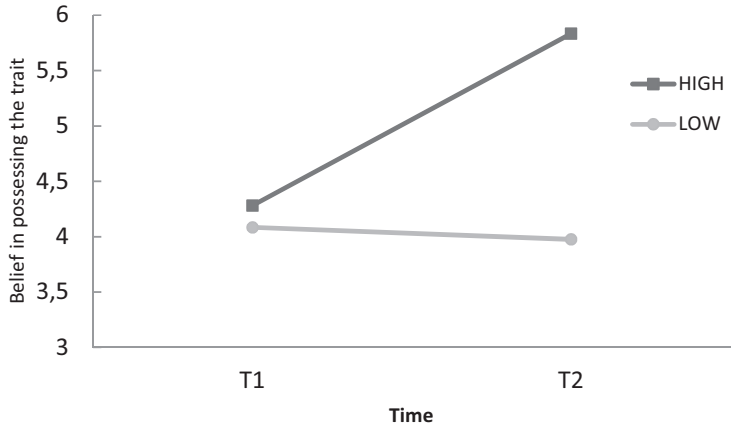

Figure 1. To visualize the effect of the SUD-scores a median split was conducted. LOW and HIGH SUD-difference scores are displayed. Scores are the Belief from T1 to T2.

from T1 to T2 can be explained by the decrease in SUD scores. Figure 1 visualises the effect of the SUD scores on belief. A median split was conducted to visualise this. LOW SUD-difference scores represent scores < -4.25 and HIGH SUD-difference scores represent scores > -4.25. Another interesting question would be if the procedure PC would be more helpful for patients who ended the session with a high SUD. The procedure could possibly be more helpful for those who have an unfinished session. The difference in belief scores between T2 and T3 when adding ''SUD end scores'' as a covariate were analysed. Adding the ''SUD end scores'' showed no significance ($F(1, 35) = 0.640$, $p = 0.803$) in change of Belief scores from T2 to T3.

Attention to the trait during the condition

Participants were classified as low, middle, or high attenders based on their scores on the VAS ($M = 6.37$, $SD = 3.08$). Low attention represent scores from 0 to 3.29 (> -1 *SD*). Middle attention is 3.29-9.44 (between -1 *SD* and +1 *SD*) and high attention represent scores from 9.44 to 10 (> +1 *SD*). Examining whether paying attention to the trait while performing the dual task (EM) was influencing Belief was tested by conducting a mixed factorial 3 (between factor; low attention, middle attention, high attention) x 2 (within factor; T2, T3)

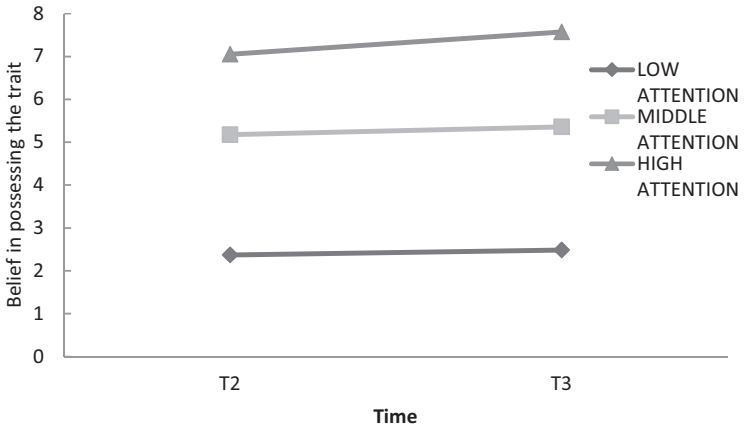

Figure 2. To visualize the effect of paying attention three groups were created (LOW, MIDDLE and HIGH ATTENTION). Scores are the Belief from T2 to T3.

design with Belief as the dependent variable. No interaction effect was found for Time x ''attention to the trait'' ($F(1, 35) = 0.169$, $p = 0.845$). Thus the pattern reported earlier, no effects of positive closure with or without EM, remained unchanged when the attention paid to the trait during the procedure was taken into account (see Fig. 2).

Discussion

The aim of the study was to test whether EM had an effect on the strength of positive verbal material as used in the procedure Positive Closure (PC). Two positive personality traits were selected and recalled under two conditions: EM (standard in PC) and a control condition, ES. According to the WMT one might assume EM would produce a decrease in belief in possessing the personality trait (Belief) and emotional intensity (Emotionality), but inferred from earlier research (Matthijssen & van den Hout, 2016) no effect of EM may be predicted. The results of the present study are in line with earlier research. No effect of EM during PC on the belief in possessing the positive personality trait, or emotionality was found. EM appears to be ineffective in the procedure, and also the control condition shows no effect on Belief and Emotionality. Note that the present findings replicate two earlier analogue experiments but that the present study had a very high clinical/ecological validity. We studied PTSD patients treated with real life EMDR administered by trained and skilled EMDR therapists. If replicated by other patient studies, we suggest eliminating the PC procedure from the protocol at least in the way as it is now performed. It does not relate to elimination of the installation of the positive cognition, as this is a different procedure being performed and was not examined in this study.

What does seem to have an effect on the belief in possessing the trait is the success of the prior EMDR session. Patients with a strong decrease in SUD scores during the desensitization phase had an increase in belief in possessing the trait during the session. When SUD scores decrease during the session one can assume that the patient feels better, relieved or less disturbed. This in turn could lead to a better feeling about oneself and an increase in the belief in possessing the positive personality trait. This does not explain why Emotionality ratings do not change during the EMDR session. It appears then that during EMDR sessions, the idea of having certain positive traits remains as pleasant, but what changes is the belief in actually having such positive traits.

In summary, positive closure does not have any additional effect on beliefs and emotionality of positive self-statements and the belief in a positive self-statement is correlated with the decrease of distress due to the EMDR procedure. Of course, the reported belief in the positive trait may reflect a state effect and the increase in belief may disappear once the emotional state is replaced by other ones. Alternatively, the increased belief may, to some extent, persist and it would be worthwhile to document whether a series of EMDR sessions are attended by between-session increases in believability of positive traits. No effects were found of paying attention to the trait during PC, which means that there was no difference in Belief scores between patients who paid a lot of attention and patients that did not or hardly paid attention.

Why no effect is found on ‘‘emotional intensity’’ even from T1 to T2 remains unclear. Maybe the question ‘‘If you think about how much the trait is applicable to you, how pleasant is that for you?’’ was difficult for patients to answer.

Some limitations of the current study may be noted. First the order of the EMDR protocol was slightly altered. The positive cognitions were asked before the actual EMDR session was started; this differs from the usual protocol where the cognitions are elicited after the sixth step of the EMDR protocol. Meanwhile there is no *a priori* reason to suspect that this alteration affected the results achieved. A second alteration was that a list of positive personal characteristics was given to the patients, wherefrom they were asked to choose two positive characteristics, where in the usual EMDR session the patient is not presented a list of characteristics. One may argue that asking the patient to mention a desired personality trait (e.g., ‘‘resilient’’) may be sub-optimal and that asking to formulate some current state (e.g., ‘‘I am doing well’’) may be more helpful. But again, and certainly given the robustness of the null-effects observed here and earlier, there is no reason to assume that this alteration affected the results observed. Another limitation of the study was that no information was collected on participation rates, so no information was collected about how many and what kind of patients refused participation. This generates a potential source of bias for patients included. A final limitation concerns confirmation of PTSD diagnoses of patients included. Patients who were included from private practices were diagnosed by the therapists in the practices, but were not assessed by structured clinical interviews to confirm diagnoses. However, the therapists were experienced trauma therapists and insurers expect them to diagnose patients.

An explanation for the lack of effect from EM could be attributable to the type of memory that is used. The present relevant personality traits do not relate to any single episode and are, by their very nature, generic. Furthermore, it is an abstract idea and not a concrete picture. It remains unclear if or to what extent making EM during the recall of generic information and abstract ideas reduces the actual vividness or emotionality of that information during future recalls. Future research should address this question.

Furthermore, modality-specific-taxing - meaning taxing in the same modality (verbal material verbally and visual material visually) - was not used. No modality-specific-taxing was added because the researchers wanted to stay as close as possible to the original ''Positive Closure'' procedure. Earlier studies (Baddeley & Andrade, 2000; Kemps & Tiggemann, 2007) showed a (small) beneficial effect of modality specific taxing. Here the taxing was conducted in the opposite modality - a visual taxation on an auditory image. This may partly explain the absence of the effects of EM.

Moreover, the lack of results could be that the manipulation was not strong enough. Only 20-25 left-right-left EM were conducted, as this was the standard PC-procedure. Perhaps multiple sets of EM should be performed to test the effect of EM on positive verbal material. Future research could easily tackle this.

Finally, note that the occurrence of null-results may always be attributed to some potential artefact. The present findings were collected under ecologically valid conditions. They show that the positive closure procedure as routinely carried out has no detrimental but also no beneficial effect, which questions adding the procedure in its current form. Of course one might study under what conditions the positive closure procedure (with or without EM) may still prove beneficial. Given the robustness of the present findings, such studies may not be a promising endeavour.

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Author contributions

SM and MvH developed the study concept and contributed to the study design. SM developed the study material and was responsible for data collection and for data analysis. SM drafted the manuscript, MvH provided critical revisions, SM and MvH approved of the final manuscript.

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SECTION 02

Modality specificity in working memory taxation

CHAPTER 04

Auditory and visual memories in PTSD patients targeted with eye movements and counting: The effect of modality-specific loading of working memory

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Abstract

Introduction. Eye movement desensitization and reprocessing (EMDR) therapy is an evidence-based treatment for post-traumatic stress disorder (PTSD). A key element of this therapy is simultaneously recalling an emotionally disturbing memory and performing a dual task that loads working memory. Memories targeted with this therapy are mainly visual, though there is some evidence that auditory memories can also be targeted. **Objective.** The present study tested whether auditory memories can be targeted with EMDR in PTSD patients. A second objective was to test whether taxing the patient (performing a dual task while recalling a memory) in a modality specific way (auditory demanding for auditory memories and visually demanding for visual memories) was more effective in reducing the emotionality experienced than taxing in cross-modality. **Methods**. Thirty-six patients diagnosed with PTSD were asked to recall two disturbing memories, one mainly visual, the other one mainly auditory. They rated the emotionality of the memories before being exposed to any condition. Both memories were then recalled under three alternating conditions [visual taxation, auditory taxation, and a control condition (CC), which comprised staring a non-moving dot] - counterbalanced in order - and patients rerated emotionality after each condition. **Results**. All three conditions were equally effective in reducing the emotionality of the auditory memory. Auditory loading was more effective in reducing the emotionality in the visual intrusion than the CC, but did not differ from the visual load. **Conclusion.** Auditory and visual aversive memories were less emotional after working memory taxation (WMT). This has some clinical implications for EMDR therapy, where mainly visual intrusions are targeted. In this study, there was no benefit of modality specificity. Further fundamental research should be conducted to specify the best protocol for WMT.

Keywords: EMDR, working memory taxation, visual intrusions, auditory intrusions, modality specificity, eye movements

Introduction

Post-traumatic stress disorder (PTSD) is a debilitating disorder which is categorized as a trauma- and stressor-related disorder in DSM 5. It can be developed after being exposed to a traumatic event. The disorder is characterized by suffering from repeatedly re-experiencing the traumatic event (in flashbacks or nightmares), avoidance of trauma-related stimuli, negative alterations in mood and cognition, and alterations in arousal and reactivity (American Psychiatric Association, 2015). Several psychological treatments are effective in treating PTSD. One of those treatments is eye movement desensitization and reprocessing (EMDR) therapy. A core feature of EMDR therapy is that a disturbing memory is held in mind by a patient while simultaneously making horizontal eye movements (EMs). These movements are typically induced by following a moving dot that is displayed on a light bar or the therapist's fingers, moving a hand continuously back and forth in front of the patient's eyes. Clinical trials and meta-analyses have demonstrated the effectiveness of EMDR in treating PTSD (for meta-analyses, see, e.g., Bradley et al., 2005; Seidler & Wagner, 2006; Bisson et al., 2007; Chen et al., 2014; Cusack et al., 2016).

Evidence that EMDR is an effective treatment for PTSD does not imply knowing what the underlying working mechanism is. One explanatory hypothesis for how EMDR works, which is gaining accumulating evidence, is based on the working memory (WM) model (Baddeley & Hitch, 1974). The hypothesis states that recalling memories requires WM resources, which are limited. If a dual task, which also uses WM capacity, is performed during recall, fewer resources will be available for recall. As a consequence, the recalled memory will be less emotional and less vivid and will be reconsolidated as less emotional and less vivid in long-term memory (van den Hout et al., 2010). EMs are considered a dual task. Consistent with the hypotheses from WM theory, memories have been found to not only become less disturbing and less vivid after execution of an EM task but also after a range of other tasks that load WM (e.g., counting, watching an array of small squares that constantly and randomly change between black and white, mindful breathing) (e.g., Andrade et al., 1997; Kavanagh et al., 2001; Kemps & Tiggemann, 2007; Gunter & Bodner, 2008; van den Hout et al., 2010, 2011a; Engelhard et al., 2011).

In therapy, EMDR focuses on the intrusive memories of traumatic events - one of the hallmark symptoms of PTSD. Ehlers et al. (2002) asked patients with PTSD to describe the content of their typical intrusive memory and concluded that visual intrusions were more

common (70-97%) than bodily sensations (28-66%), sounds (38-51%), smell (48-51%), actions (22-65%), or thoughts (26-60%). Hackmann et al. (2004) interviewed 22 patients with chronic PTSD about the content of their intrusive memories and found the majority included visual and/or bodily sensations. Auditory content was experienced in about half of the intrusions. Taste and smell sensations were least common. Hence, it is clear that intrusive memories can appear in different sensory modalities. EMDR aims at reducing PTSD symptoms by reducing emotional intensity of *visual* images. However, the question remains if intrusions in other sensory modalities can be successfully targeted with EMDR?

The WM model (Baddeley & Hitch, 1974) comprises the central executive (CE) and two so-called "slave" systems; the visuospatial sketchpad (VSSP) and the phonological loop (PL). The CE carries out higher order cognitive functions (i.e., problem solving and planning), whereas the VSSP is concerned with processing and storing visual and spatial information and the PL with processing and storing auditory information (Andrade et al., 1997). The VSSP is thus involved in visual imagery and the PL in auditory imagery (Kristjánsdóttir & Lee, 2011). Earlier studies show some inconsistencies in whether the CE is merely responsible for the reduction in vividness and emotionality of memories or if this is a consequence of loading the slave systems, the latter implying a benefit of modality-specific demanding tasks (Andrade & Baddeley, 1993 in Andrade et al., 1997; Baddeley & Andrade, 2000; Gunter & Bodner, 2008; Kristjánsdóttir & Lee, 2011). In a series of experiments Andrade and Baddeley (1993 in Andrade et al., 1997) showed that counting made auditory images less vivid, whereas tapping tasks made visual images less vivid. They asked participants to imagine how things looked or sounded. They did so while performing either a task taxing the PL (counting) or the VSSP (tapping a pattern). After imagining how things looked or sounded they were asked to rate the vividness of their image on a scale from 0 (no image) to 10 (as clear as normal). Tasks matched in modality appeared to have a larger effect on vividness ratings than tasks not matched in modality. Andrade et al. (1997) conducted another series of experiments where they asked participants to imagine neutral or negative stimuli (consisting of earlier presented neutral or negative photographs) and to perform different dual tasks (counting, a simple tapping task, a complex tapping task, and EM) and a control task (monitoring a nonmoving letter on a screen). They consistently found concurrent tasks had a larger effect on vividness. The results were less clear and less consistent for emotionality. In the last of their series of experiments they used personal

memories and found that concurrent visuospatial tasks reduced the emotionality ratings, but the effect was much smaller for the vividness ratings. They concluded that the locus of the effect was the VSSP (Andrade et al., 1997). However, the authors did not test the effect of a concurrent phonological load on auditory personal memories. Baddeley and Andrade (2000) conducted seven experiments, exposing participants to novel stimuli, being either visual or auditory (e.g., shapes or musical notes) while conducting a visual, auditory, or control dual task. They found an interaction between modality of images and the dual task on vividness ratings. For familiar or meaningful scenes or sounds this modality specific effect was still present, but smaller. Baddeley and Andrade (2000) therefore concluded that the slave systems are involved in reducing vividness, and that the CE also plays a role here.

A limitation of the studies described above is that there were no baseline measurements. Participants rated their images after the working memory taxation (WMT), leaving it unclear if there was any difference before conducting the task. Kemps and Tiggemann (2007) conducted two studies to investigate the effect of concurrent visual and auditory interference on emotional images, one of them contained a baseline measurement. They instructed 68 undergraduates to recall a specific visual or auditory image of happy and distressing memories, while they were exposed to either EM, articulatory suppression (counting aloud), or a control condition (CC). There was a large general effect of WM loading, but superimposed on that general effect, the authors reported a modality-specific effect: vividness and emotionality ratings were reduced to a greater extent when the modality of taxation was matched to the modality of the image.

Gunter and Bodner (2008), however, found no effect of modality specificity in reducing the distress of negative memories. They asked participants to hold distressing memories in mind while performing an auditory shadowing task or a demanding visuospatial task or EM. They found equal benefits for EM and the auditory task, but a demanding visuospatial task was more beneficial. Furthermore, Kristjánsdóttir and Lee (2011) asked participants to recall an unpleasant autobiographical memory while performing each of three dual-attention tasks (EM, listening to counting, or a CC). They found that EM led to a greater decrease in vividness than listening to counting. They also found that EM and listening to counting were equally effective in reducing

emotionality. Both effects were present irrespective of the modality of the memory. This was taken to support the crucial role of the CE relative to the VSSP or the PL. However, it is unclear how cognitively demanding the tasks were, leaving it unclear if effects could really be attributed to CE or if the VSSP and PL still play a role.

The studies reported by Gunter and Bodner (2008) and by Kristjánsdóttir and Lee (2011) were carried out to clarify how EMDR yields it positive effects. A crucial limitation of their studies is that non-clinical samples were used and, therefore, it is unclear whether the findings can be generalized to PTSD patients. The issue is an empirical one. Given its clinical importance it requires settling, although there may be no reason in advance to believe that a clinical sample would react differently than a non-clinical sample to WMT on disturbing memories. A second, perhaps more important limitation is that none of the studies cited above actually measured the *degree* of WMT of the dual tasks being used. This can lead to the conclusion – if not finding a modality specific effect – that the effect can be attributed to the CE, while it could actually be a consequence of a task being more demanding than another task. Also, no modality specificity can be inferred if the analysis only includes visual memories, hence a dual visuospatial task could just require more effort than a dual auditory task. A model in which both the CE and the slave systems are responsible for the effect on emotionality and vividness in emotional disturbing images is also possible. This would therefore lead to an absence of the modality specificity effect found in some of the previous studies.

In summary, some of the above studies indicate that auditory memories can be made less emotional and vivid by dual tasks in non-clinical samples. Furthermore, there are some studies indicating there is a greater reduction of vividness and emotionality ratings if the dual task is matched to the modality of the memory. The aim of this study is to test whether auditory intrusions can be targeted with EMDR in PTSD patients a second objective is to test whether modality-specific loading [auditory (visual) loading of auditory (visual) intrusions] is more effective in reducing the emotionality experienced than taxing in cross modality.

Materials and Methods

Patients

Thirty-eight patients with PTSD were recruited to the study. Diagnosis of PTSD was made by a trained clinician (clinical psychologist/psychiatrist) and based on DSM IV-TR criteria (American Psychiatric Association, 2000). Two patients were excluded on starting participation. One was too scared to participate and expressed that she thought she was unsuitable for the experiment. The other patient was unable to select memories which could be targeted. Data from 36 patients (32 females and 4 males) with a mean age of 39.19 (*SD* = 11.19) were collected. Apart from the PTSD, 77.8% had at least one other Axis I diagnosis and 33.3% had at least one Axis II diagnosis. They all received treatment in several Dutch mental health institutions. Eighteen patients received treatment at an Academic Anxiety Center, nine at a Medical Center, and nine at different Faculty Assertive Community Treatment Centers. Apart from being diagnosed with PTSD, inclusion criteria were that the patient had to have an estimated IQ higher than 80, be at least 18 years of age and have sufficient mastery of the Dutch language. Exclusion criteria were an acute suicide risk and severe visual or hearing impairments. IQ, mastery of the Dutch language, and suicide risk were estimated by the therapist referring the patient for the study. No data were obtained about the type of trauma, length or quantity of the trauma, or years since index trauma. Therefore, no exclusions were made based on one of these trauma-related factors. Although data from 36 patients were collected, for the auditory memory, data from only 30 patients (*M* = 38.93, *SD* = 12.09) were included into the analysis and for the visual memory this was the case for 31 patients (*M* = 39.58, *SD* = 12.09). (See design for further explanation on this.) For specific patient characteristics see Table 1.

Procedure

Study procedures were approved by the medical ethics institutional review board of the University Medical Center, Utrecht, Netherlands. Therapists from the participating mental health institutions were asked to check their caseload, select all patients meeting the criteria, and approach them for participation. Patients were given an information letter and were able to consider participating for at least a few days. Upon giving oral consent to their therapist they were referred to the researchers. The researchers are unaware whether and how many patients refused participation. All patients received treatment as usual while participating in the study.

Table 1

Patient characteristics

	Auditory memory (*N* = 30)	**Visual memory (*N* = 31)**
Gender		
Female	26 (86.7%)	27 (87.1%)
Male	4 (13.3%)	4 (12.9%)
Axis I disorder		
PTSD	7 (23.3%)	7 (22.6%)
PTSD + mood disorder	9 (30%)	7 (22.6%)
PTSD + anxiety disorder	5 (16.7%)	7 (22.6%)
PTSD + other disorder	6 (20%)	7 (22.6%)
PTSD + addiction + other	2 (6.7%)	2 (6.5%)
PTSD + addiction	1 (3.3%)	1 (3.2%)
Comorbid Axis II disorder		
No diagnosis	19 (63.3%)	23 (74.2%)
≥ Axis II diagnosis	11 (36.7%)	8 (25.8%)
Education level		
Primary school	2 (6.7%)	2 (6.5%)
Secondary school	11 (36.6%)	12 (38.7%)
Lower vocational education	1 (3.3%)	1 (3.2%)
Secondary vocational education	10 (33.3%)	9 (29%)
Higher professional education	6 (20%)	7 (22.6%)
Psychopharmacological drugs		
No use of medication	6 (20%)	7 (22.6%)
Antidepressants (AD)	7 (23.3%)	6 (19.4%)
Benzodiazepines (BD)	1 (3.3%)	3 (9.7%)
Antipsychotics (AP)	1 (3.3%)	1 (3.2%)
AD and/or BD and/or AP	5 (16.7%)	5 (16%)
Other (single or combination)	10 (33.3%)	9 (28.8%)

After giving written informed consent, patients were briefed in short about the study. They were instructed to recall two emotionally disturbing memories that were still giving emotional distress, one mainly auditory and one mainly visual. While recalling the visual (auditory) memory, the subjects were instructed to either consequently make EM (visual taxation, VT), to count down (auditory taxation, AT) or to stare at a non-moving dot (CC). After selection, the extent to which the memories were auditory or visual was rated on one 100 mm Visual Analog Scale (VAS), ranging from completely auditory to completely visual. For selection, a threshold of 50% auditory (visual) was applied. After this, other sensory modalities (gustatory, kinesthetic, and olfactory) were checked whether they were not more dominant than the auditory (visual) modality in the selected memory, by asking participants to divide a 100 mm VAS to the extent in which all sensory modalities were present in the memory. The order of the type of memory (visual vs. auditory) and the conditions (VT, AT, and CC) were counterbalanced. Once instructed, the patients were asked to recall the emotionally disturbing [visual (auditory)] memory and to rate the disturbance on a scale from 0 to 10 [the subjective units of disturbance (SUD) score; see below]. The memories were then recalled approximately 30 min each, while being exposed to each condition (VT, AT, and CC) twice for 5 min. To mimic EMDR procedures, after every 1 min during a 5-min period the condition was interrupted to check what was going through the patient's mind. Answers were not discussed by their content but were followed by the instruction "concentrate on that" after which the next 1-min period of the condition was continued.

During each condition, participants were seated in front of a light bar. During the CC, the bar displayed a non-moving dot in the center of the bar. During the VT, a moving dot was displayed. During the AT, the bar displayed nothing. The speed used for the moving dot in the VT condition and the type of counting task was based on previous research from van den Hout et al. (2010, 2011a) and Engelhard et al. (2011). In these studies individuals carried out a reaction time (RT) task. An increase in response time was observed when an additional task was added. The delay in response time as a result of EMs with 1 cycle (left-right-left) per second (RT of 115 ms) versus the response delay as a result of a countdown from 1000 (RT of 97 ms) was approximately equal (Engelhard et al., 2011; van den Hout et al., 2011b). Therefore, these two tasks were considered suitable to induce similar WM load.

Design

The study had a two (time; pre- and post-) by three (conditions: VT, AT, and CC) repeated measures within-subject design. For a detailed timeline see Figure 1.

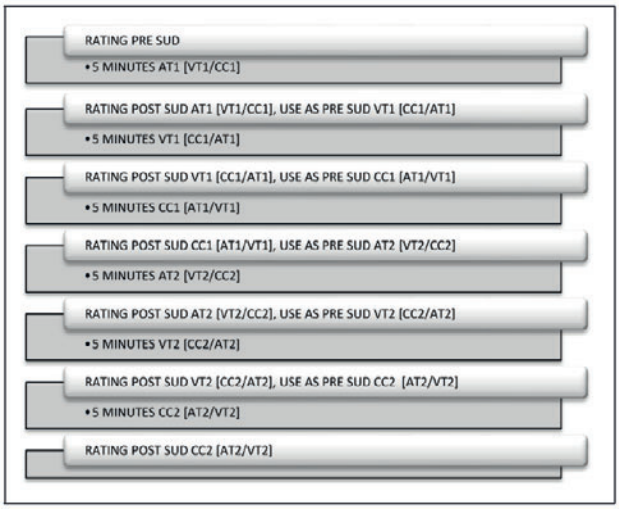

Figure 1. Timeline showing the presentation for all conditions.

This design was used both for the auditory as well as the visual memory. The dependent variable was the SUD score, which indicated the level of distress or emotional disturbance experienced by the patient in terms of the recalled emotional target image. SUD scores were verbally expressed by the patient and SUD scores are routinely used in EMDR. Data were analyzed with SPSS version 23. To obtain sufficient statistical power (power 0.8, with an α-level of 0.05 and an expected medium effect size, f = 0.25), 36 patients were needed.

Although the intention was to present all conditions (VT, AT, and CC) twice, 6 out of 36 patients reached SUD 0 – meaning experiencing no emotional disturbance when recalling the auditory memory – before the presentation of all conditions was completed. Before completing all conditions twice, 21 patients reached SUD 0. Clinically, this was an encouraging observation demonstrating that this procedure was efficient in reducing SUD scores. As there was insufficient data for the second presentation, the respective SUD was

excluded, meaning only data pertaining to the first exposure was analyzed. Hence, the final sample comprised 30 patients.

The same pattern of rapidly decreasing SUD was observed for the visual memory. Five out of 36 patients did not complete all conditions at least once, and in total only 14 patients were presented with all conditions twice. One person stopped halfway during the experiment because he was tired, but still was included into the analyses, because he went through all conditions once. Thirty-one patients were included in the analyses and their first exposure to the three conditions.

Materials

Subjective Units of Disturbance (SUD). Subjective units of disturbance scores ranged from 0 (no emotional disturbance) to 10 (the worst emotional disturbance possible). Patients were asked to verbally rate their SUD scores concerning the emotional target image before and after each condition (VT, AT, and CC).

EMDR Protocol. Patients were tested individually by the researchers (authors 1 and 2; both EMDR therapists) using steps 1, 2 and 3 (introduction, assessment, and desensitization) from the standard Dutch EMDR protocol (de Jongh & ten Broeke, 2012). A slightly altered version was used for the auditory memory. In this altered version, all words referring to "visual" sensory modality were altered into words referring to the auditory modality.

Results

Baseline

The average SUD pre-score was 8.97 (standard deviation, *SD* = 0.96) for the auditory memory (*N* = 30) and 8.87 (*SD* = 1.06) for the visual memory (*N* = 31). The difference was not significant [$t(35) = 0.19$, $p = 0.85$].

Auditory Memory

A two (time: pre- and post-) by three (conditions: VT, AT, and CC) repeated measures ANOVA was conducted. A main effect for time [$F(1,29) = 42.00$, $p < 0.01$] was found, but there was no main effect for condition [$F(2,58) = 2.02$, $p = 0.14$] and no time x condition interaction [$F(2,58) = 1.70$, $p = 0.19$] was found. The pre- and post-SUD scores of the VT, AT, and CC are depicted in Figure 2, showing that regardless of the condition, the SUD dropped from pre- to post.

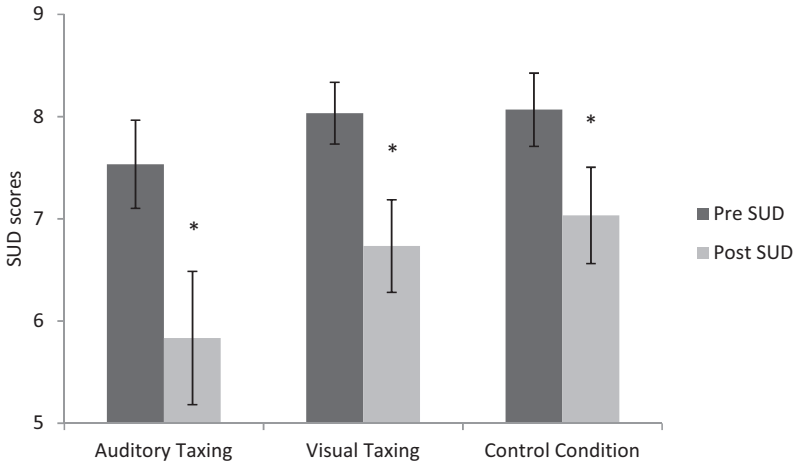

Figure 2. Pre- and post-SUD scores of the auditory memory are shown per condition. Error bars depict ±1 SEM (*$p < 0.05$).

Visual Memory

A two (time: pre- and post-) by three (conditions: VT, AT, and CC) repeated measures ANOVA was conducted. The pre- and post-SUD scores of the VT, AT, and CC are graphically depicted in Figure 3, showing that, regardless of the condition, the SUD dropped

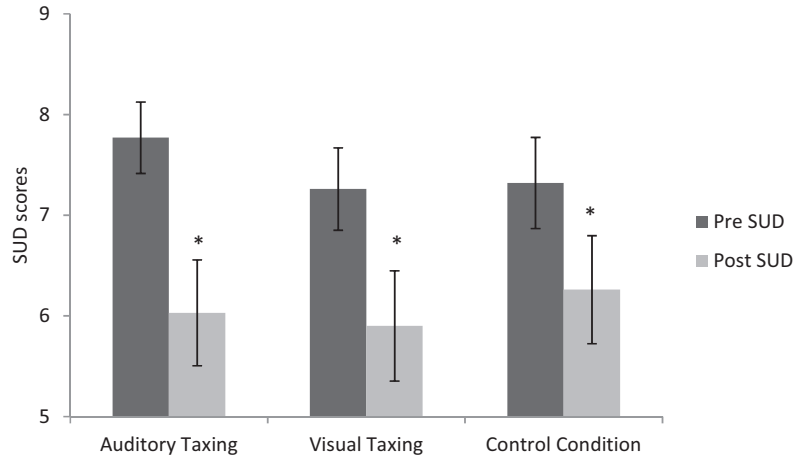

Figure 3. Pre- and post-SUD scores of the visual memory are shown per condition. Error bars depict ±1 SEM (*$p < 0.05$).

from pre- to post. This was reflected in a main effect for time [$F(1,30) = 47.06$, $p < 0.01$]. There was no main effect for condition [$F(2,60) = 0.25$, $p = 0.78$]. However, a time x condition interaction [$F(2,60) = 3.31$, $p = 0.04$] was found. *Post hoc* analyses with no correction for multiple comparisons revealed AT outperformed the CC ($p = 0.02$) but none of the interactions differed significantly after Bonferroni correction was applied ($p > 0.055$).

Discussion

The first aim of the present study was to test whether auditory intrusions could be successfully targeted with EMDR in PTSD patients. The second aim was to assess whether modality-specific loading of WM was more effective than providing non-modality-specific loads in reducing emotionality experienced in auditory and visual intrusions. This was assessed by asking PTSD patients to recall an auditory and visual emotional memory while engaging in modality-specific WMT (EMs or counting) or a CC. Although earlier studies showed the effect of WMT on non-autobiographical auditory material (e.g., Andrade et al., 1997; Baddeley & Andrade, 2000) and on autobiographical memories with (some) auditory content (Kemps & Tiggemann, 2007; Kristjánsdóttir & Lee, 2011) in non-clinical samples, to the best of our knowledge this is the first study to examine this in patients. Earlier studies did not control for the degree of interference of the tasks on the WM. The current study did try to match the degree of loading in the relevant condition (EMs and counting) in an attempt to improve the comparison. The results of the study are clear and indicate that emotionality can be reduced in both visual and auditory disturbing memories in PTSD patients. Furthermore, no difference was found between AT, VT, or the CC. This indicates no modality-specific effect and no support for the efficacy of WMT.

A possible explanation for finding an effect in the CC is that the CC may also be demanding. Although Lee and Cuijpers (2013) showed an additive effect of EMs in EMDR treatment and laboratory studies [significantly moderate (Cohen's $d = 0.41$) and significantly large ($d = 0.74$)], this was not found in a recent study by Sack et al. (2016). They found EMs had no advantage over fixation on a non-moving hand. Our hypothesis is that fixation on a non-moving stimulus still requires cognitive resources. This was also strengthened by the observation by the researchers that some patients in the CC were intensely focused on the non-moving dot. However, future research should address whether staring at a non-moving dot also requires effort or if there is another explanation for the absence of difference in

effect between the AT and VT versus the CC. A possible explanation for not finding a modality-specific effect is that – although the tasks were specifically chosen to be equally demanding – the tasks may actually not have been exactly matched and possibly the auditory dual task was more taxing than the visual task. On the other hand, some patients had difficulty pursuing the moving dot and were therefore unable to follow it at times. This could potentially have led to missing out on WMT. It is also possible that the auditory and visual tasks are not equally loading the PL or the VSSP, respectively, but that the AT has a more cognitive component to it than the VT, hence using more of the CE capacity. Furthermore, there can be individual differences in PL and VSSP functioning, which were not taken into account. Furthermore, the CC may have a more cognitive component than the VT or a more visual component than the AT. Future research should therefore address these points and could pre-test individuals with a RT test to optimize the comparability of the tasks.

A limitation of the study is the sample size. The power calculation showed 36 patients needed be included, whereas only 30 and 31, respectively, were included for analyses of the auditory and visual memory. The other patients had already reached SUD 0 (meaning experiencing no emotional distress) exposure to all conditions. This being a very welcome observation on the one hand, creates a power-problem on the other hand.

Working with visually disturbing memories in EMDR therapy does elicit positive effects on PTSD symptoms, so it is expected that this effect is generalizable to memories in other sensory modalities. Although future research is needed to examine whether EMDR or staring at a non-moving dot (the CC) for emotionally disturbing auditory memories has an effect on PTSD symptoms, positive clinical effects may be anticipated. The current study only consisted of one experimental "session" and no symptoms of PTSD were measured. Measuring the severity of PTSD symptoms and offering multiple sessions to patients are recommended for future research.

Ethics statement

This study was carried out in accordance with the recommendations of "Medical Ethical Committee of the University Medical Center, Utrecht" with written informed consent from all subjects. All subjects gave written informed consent in accordance with the

Declaration of Helsinki. The protocol was approved by the "Medical Ethical Committee of the University Medical Center, Utrecht."

Author contributions

SM, LV, and MvdH designed the research. SM and LV collected the data. SM, LV, and IH analyzed the data. SM drafted the manuscript. SM, MvdH, IH, and LV wrote the paper and approved the final manuscript.

Conflict of interest and funding

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CHAPTER 05

Reducing the emotionality of auditory hallucination memories

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Submitted

Abstract

Eye Movement Desensitization and Reprocessing (EMDR) therapy targets emotionally disturbing *visual* memories of traumatic life events, and may be deployed as an efficacious treatment for posttraumatic stress disorder. A key element of EMDR therapy is recalling an emotionally disturbing *visual* memory whilst simultaneously performing a dual task. Previous studies have shown that *auditory* emotional memories may also become less emotional as a consequence of dual tasking. This is potentially beneficial for psychotic patients suffering from disturbing emotional auditory memories of auditory hallucinations. The present study examined whether and to what extent emotionality of auditory hallucination memories could be reduced by dual tasking. The study also assessed whether a modality matching dual task (recall + auditory taxation) could be more effective than a cross modal dual task (recall + visual taxation). Thirty-six patients suffering from auditory hallucinations were asked to recall an emotionally disturbing auditory memory related to an auditory hallucination, to rate emotionality of the memory and to recall it under three conditions: two active conditions, i.e. visual taxation (making eye-movements) or auditory taxation (counting aloud) and one control condition (staring at a non-moving dot) counterbalanced in order. Patients re-rated emotionality of the memory after each condition. Results show the memory emotionality of auditory hallucinations was reduced and the active conditions showed stronger effects than the control condition. No modality-specific effect was found: the active conditions had an equal effect.

Keywords: EMDR, psychosis, working memory taxation, modality specific taxing, auditory emotional memories, auditory hallucinations

Introduction

Although auditory hallucinations (AH) are associated foremost with schizophrenia spectrum disorders (approximately 70% of the people with a diagnosis of schizophrenia report AH; Waters et al., 2012), they are also documented in patients with post-traumatic stress disorder (PTSD; 40%–50%); bipolar I disorder (37%), borderline personality disorder (30%), major depression (10%–23%), obsessive-compulsive disorder (14%), dementia (14%), and Parkinson disease (10%) (van der Gaag, Staring, van den Berg & Baas, 2013). AH are also common in the general population. A meta-analysis by Maijer, Begemann, Palmen, Leucht and Sommer (2017) reported a mean lifetime prevalence for auditory hallucinations in the general population of 9.6%.

Therapies for auditory hallucinations

AH can cause great distress and impairment in daily life and warrant effective treatment strategies. Research on treatment strategies most commonly focusses on auditory *verbal* hallucinations (AVH) or hearing voices. Sometimes the definitions AVH and AH are interchanged, although auditory hallucinations also include *non-verbal* hallucinations whereas AVH do not. Since AH and AVH occur mostly in patients with schizophrenia (Sartorius et al., 1986, Thomas et al., 2007), treatment strategies are derived mainly from studies on these patients. The treatment of choice for AH is antipsychotic medication, which induces a rapid decrease in hallucination severity (Sommer et al., 2012). Most patients with a first psychotic episode show a decline in psychiatric complaints in response to the medication (Agid et al., 2011). On the other hand, in approximately 25 to 30% of the patients, antipsychotic medication is ineffective in the treatment of AH (Buckley et al., 2001; Aleman and Larøi, 2011) In addition, antipsychotic medication has several significant side effects (Buckley et al., 2001). Furthermore, a substantial proportion of patients do not adhere to drug treatment (Aleman & Larøi, 2011). Lacro, Dunn, Dolder, Leckband & Jeste (2002) found a mean rate of nonadherence ranging from 41.2% to 49.5%, depending on the criteria used for non-adherence. Therefore, despite the large contribution of antipsychotic medication in the treatment of AH (and AVH), development of novel or enhancement of existing treatment strategies is important.

Treatment strategies for AH can be aimed at reducing the *frequency* and duration of hallucinations, but can also be aimed at a *reduction of the distress caused by hallucinations*. Cognitive Behavioral Therapy (CBT) aims at this reduction of distress by focusing on the

management of auditory hallucinations. This is recommended in the National Institute for Health and Care Excellence guidelines (NICE, 2015) in addition to medication for the treatment of hallucinations in adult patients with psychoses and schizophrenia. In a meta-analysis van der Gaag, Valmaggia and Smit (2014) reported small to medium effect sizes (*Hedges' g* =.31 to .49) for CBT on hallucination total scores of AH in patients with AH. As hallucination total scores were calculated, no differentiation of the effect on different symptom aspects of AH (e.g. burden, frequency, loudness) was possible. A review by Mazmanian, Mirabel-Sarron and Dardennes (2015) also discussed CBT effects in schizophrenia patients with auditory hallucinations. They concluded CBT had a beneficial effect (both in individual and in group therapy) on different clinical parameters (e.g. stress generated by auditory hallucinations, obedience to the voices, intensity of the voices, social skills). Unfortunately these authors did not report effect sizes.

Other treatment strategies for AH with different strengths of evidence are transcranial magnetic stimulation (Slotema, Blom, van Lutterveld, Hoek, & Sommer, 2014), AVATAR therapy (Craig et al., 2018), Acceptance and Commitment Therapy (Shawyer et al., 2017), mindfulness (Chadwick et al., 2016), relating therapy (Hayward, Jones, Bogen-Johnston, Thomas & Strauss, 2017) and voice dialogue (e.g.; Corstens, Longden & May, 2012).

Eye Movement Desensitization and Reprocessing

EMDR therapy is an evidence-based therapy for Posttraumatic Stress Disorder (PTSD; e.g., Bisson et al., 2007; Bradley, Greene, Russ, Dutra & Westen, 2005; Chen et al., 2014; Lee & Cuijpers, 2013; Seidler & Wagner, 2006). One of the core symptoms of PTSD is the repeated re-experiencing of traumatic events by intrusions from memory (American Psychiatric Association, 2013). EDMR therapy aims at reducing the emotionality of these intrusive memories and thereby reducing PTSD symptoms. The key element of the therapy is letting the patient simultaneously recall an emotional disturbing memory and move their eyes back and forth horizontally. One explanation of how EMDR yields its effects is provided by the working memory (WM) taxation hypothesis. Working memory has limited capacity (Baddeley, 2012). Holding an emotional memory in mind being one task, and making eye movements (EM) another, forces competition in performing the two tasks, as they both tax the limited capacity of working memory (Andrade, Kavanagh & Baddeley, 1997; Gunter & Bodner, 2008; van den Hout & Engelhard, 2012). By recalling a memory it becomes unstable

and in this transient state, memories are susceptible to the incorporation of new information (Wichert, Wolf & Schwabe, 2013). As a consequence of the competition, the unstable memory becomes less emotional during recall and the less emotional memory is stored back in long-term memory. This result has been found in a series of experiments which showed that a period of recall + EM not only blurred memory during recall, but also during future recalls, when no EMs were made (Lee & Cuijpers, 2013; van den Hout & Engelhard, 2012). In line with the working memory taxation hypothesis, there is evidence that not only EM, but any dual task that taxes working memory during memory recall elicits this effect (Engelhard, van den Hout & Smeets, 2011; Gunter & Bodner, 2008; Holmes, James, Coode-Bate & Deeprose, 2009; Kemps & Tiggemann, 2007**;** van den Hout et al., 2011). Typically, in EMDR visual memories are targeted, yet analogue studies have also shown autobiographical emotional memories with a predominant auditory component - which are mainly experienced as auditory - can be targeted (Kemps & Tiggemann, 2007; Kristjánsdóttir & Lee, 2011; Matthijssen, van Schie, & van den Hout, 2018). A study by Matthijssen, Verhoeven, Heitland and van den Hout (2017) has also shown that auditory memories can be made less emotional in PTSD patients.

There is a large overlap in symptomatology of auditory intrusions in PTSD and AH in psychotic disorders, and this may be due to the fact that the content of AVH relates to earlier traumatic events in a similar way in PTSD and schizophrenia (McCarthy-Jones & Longden, 2015). Considering this overlap and the assumed relation to earlier trauma EMDR therapy could be considered for alleviating symptoms associated with auditory hallucinations. However, providing trauma treatment to patients with a psychotic disorder is uncommon and these patients are often even excluded from PTSD treatment studies (Spinazzola, Blaustein and van der Kolk, 2005). Van den Berg et al. (2015) studied the treatment of PTSD in subjects with a schizophrenia spectrum disorder using EMDR and prolonged exposure. Both interventions were more effective than a waiting list condition and not only reduced PTSD symptoms, but also paranoid thoughts. Even so, more patients remitted from schizophrenia, as measured with a Structured Clinical Interview for Symptoms of Remission (Andreasen et al. 2005; Opler Yang, Caleo & Alberti, 2007) for the Positive and Negative Syndrome Scale (SCI-SR-PANSS; Kay, Fiszbein & Opler, 1987; de Bont et al., 2016). However, the severity of auditory verbal hallucinations remained unchanged (de Bont et al., 2016). The focus in EMDR therapy of the previous study was on emotional

disturbing *visual memories* of *traumatic life events* in psychotic patients. To the best of our knowledge, no studies have tested whether EMDR targeting emotional disturbing *auditory memories* of *auditory hallucinations* is effective in reducing emotionality of the hallucination memories or maybe even the emotionality of the hallucinations themselves. To assess this, a first step would be to assess if emotional intensity of a memory of an auditory hallucination can be reduced. The present study investigates if this can be achieved by dual tasking, a crucial ingredient of EMDR.

Modality Specific Dual Tasking

In clinical practice, EMDR is typically performed by allowing the patient retrieve an emotionally disturbing visual memory and simultaneously make horizontal eye-movements (EM). In these cases there is a *match* between the visual modality of the intervention (EM) and the *visual* modality of the recalled memory. However, targeting disturbing auditory memories of auditory hallucinations with EM would result in a *mismatch* between the modality of the intervention (visual) and the modality of the recalled memory (auditory). The working memory comprises a central executive (CE), which is engaged when attention needs to be divided, and two slave systems where modality specific information is processed: the visuospatial sketchpad (VSSP) responsible for processing visual and spatial information and the phonological loop (PL) which is responsible for auditory and verbal processing (Baddeley, 2012; Baddeley & Hitch, 1974). The VSSP is thus involved in visual and the PL in auditory imagery (Kristjánsdóttir & Lee, 2011). Some studies explored the effects of modality matching dual tasking and cross modality taxing in autobiographical memories. Kemps and Tiggemann (2007) conducted a study in which undergraduates were instructed to recall a specific visual or auditory image of happy and distressing memories, while they were exposed to three different conditions (EM, articulatory suppression and a control condition). Concurrent articulation reduced vividness and emotional intensity ratings of auditory images to a greater extent than did EM, whereas concurrent EM reduced ratings of visual images more than articulatory suppression. Matthijssen, van Schie, and van den Hout (2018) asked undergraduates to recall an auditory and visual emotionally disturbing memory and to perform a random interval repetition task. The results showed modality-matching dual-tasking was more taxing during memory recall, resulting in larger reaction time delays than cross-modal taxing. Kristjánsdóttir and Lee (2011) found quite different results. They asked participants to recall an unpleasant autobiographical memory while

performing EM, listening to counting or a control condition (short exposure). They found that EM led to a greater decrease in vividness than listening to counting and that EM and listening to counting were equally effective in reducing emotionality. The effects were found irrespective of the modality of the memory, which led them to conclude there was no modality specific benefit in taxing. Matthijssen et al. (2017) found similar results. They asked PTSD patients to recall an auditory and visual intrusive memory under three alternating conditions (EM, counting, staring at a non-moving dot). Auditory memories decreased in emotionality in all conditions and no modality specific benefit was found.

In summary, from a general WM approach and earlier findings (Matthijssen et al., 2017; Gunter & Bodner, 2008; Kristjánsdóttir & Lee, 2011; Maxfield, Melnyk & Hayman, 2008; van Veen et al., 2015; van Schie, van Veen, Engelhard, Klugkist & van den Hout, 2016) one can assume that taxing WM during memory recall would result in larger decreases in emotionality scores than no dual taxing. Results on a modality specific benefit however are less clear. Some studies suggest that competing tasks which are matched with the modality of the memory result in a greater reduction of vividness and emotional intensity ratings compared with tasks which are not matched (Kemps & Tiggemann, 2007, Matthijssen, van Schie & van den Hout, 2018), but other studies fail to find this modality specific benefit (Kristjánsdóttir & Lee, 2011, Matthijssen et al., 2017). The second aim of the present study is to test whether a modality matched (auditory) task is more effective than a cross modal (visual) task in reducing the emotionality of disturbing auditory memories of auditory hallucinations.

Methods

Patients

For the study, 38 patients suffering from AH were recruited. Two patients were excluded. One patient had insufficient mastery of the Dutch language. The other patient expressed psychotic symptoms which interfered with the experiment. In total, data from 36 patients (23 males, 13 females) with a mean age of 39.56 (*SD*= 11.45, range 18-64) were collected. Thirty-five patients were recruited at several Faculty Assertive Community Treatment Centers, and one patient at a medical Centre. All patients received treatment as usual which mainly consisted of antipsychotic medication and/or psychological treatment and/or supportive counseling by psychologists, caseworkers or psychiatrists. Inclusion

criteria for the study were that the patient had to suffer from auditory hallucinations, had an estimated IQ ≥ 80, was ≥ 18 years of age and was able to recall an emotionally disturbing auditory memory of a predominantly auditory hallucination, which had to be rated at least 50% auditory in content. Exclusion criteria were a high acute suicide risk, insufficient mastery of the Dutch language and severe visual or hearing impairment(s). IQ, suicide risk and mastery of the Dutch language were estimated by the therapist who referred the patient for the study. Although data from 36 patients were collected, data from only 33 patients (20 males, 13 females) with a mean age of 40.03 (*SD*= 11.63, range 18-64) were included into the analysis. The reason to exclude three patients was that although intended to present all conditions (VT, AT & CC) twice, these patients did not complete all conditions at least once. The patients reached a Subjective Units of Disturbance (SUD) score of zero - indicating no emotional disturbance when recalling the memory - before all conditions (VT, AT, CC) were presented once. Out of the 33 patients, 87.9% was classified with a psychotic disorder based on DSM-IV-TR criteria (American Psychiatric Association, 2000). For specific patient characteristics see Table 1.

Table 1

Patient characteristics (N=33)

Characteristics	***N* (%)**
Gender	
Female	13 (39.4%)
Male	20 (60.6%)
Axis I disorder	
Psychotic disorder	16 (48.5%)
Psychotic disorder + addiction disorder (+ADHD)	9 (27.3%)
Psychotic disorder + other diagnoses	4 (12.2%)
Mood disorder with psychotic features (+ other)	3 (9.1%)
PTSD + other disorders	
Anxiety disorder + PTSS + autism	1 (3%)
Comorbid Axis II disorder	
No diagnosis	28 (84.8%)

≥ Axis II diagnosis	5 (15.2%)
Education level	
No education	1 (3%)
Primary school	9 (27.3%)
Secondary school	11 (33.3%)
Lower vocational education	5 (15.2%)
Secondary vocational education	4 (12.1%)
Higher professional education	2 (6.1%)
University	1 (3%)
Psychopharmacological drugs	
No use of medication	1 (3%)
Antipsychotics (AP)	8 (24.2%)
Antipsychotics (AP) + Benzodiazepines (BD)	10 (30.3%)
Antipsychotics (AP) + Antidepressants (AD)	2 (6.1%)
AP + BD + AD	2 (6.1%)
AP + Other (single or combination)	9 (27.2%)
AD + BD	1 (3%)

The mean age of onset of voice-hearing was 22 years (*SD*= 10.24). Patients reported hearing between 0 and 1000 voices, most commonly hearing three voices (30.3%, *N*= 10). For specific characteristics of the auditory hallucinations see Table 2 and 3.

Table 2

Characteristics of auditory hallucinations last week measured with the PSYRATS-AH (N=33)

	***N* (%)**
Modalities	
No other modalities	10 (30.3%)
Visual hallucinations	5 (15.2%)
Olfactory hallucinations	1 (3%)
Tactile hallucinations	2 (6.1%)
Multiple modalities	15 (45.5%)

Frequency	
No voices present or less than once per week	1 (3%)
At least once a week	3 (9.1%)
At least once a day	4 (12.1%)
At least once per hour	8 (24.2%)
Continuously or almost continuously	17 (51.5%)
Duration	
No voices	1 (3%)
A few seconds	6 (18.2%)
Several minutes	7 (21.2%)
At least one hour	4 (12.1%)
Several hours	15 (45.5%)
Location	
No voices	1 (3%)
Only voices in the head	7 (21.2%)
Voices close to the ears or head (and possibly inside)	10 (30.3%)
Voices in or close to the ears and further away	4 (12.1%)
Voices from the surrounding, further away from the head	11 (33.3%)
Loudness (last time heard)	
No voices	1 (3%)
Quieter than own voice, whispering	13 (39.4%)
As loud as own voice	12 (36.4%)
Louder than own voice	3 (9.1%)
Very loud, shouting	4 (12.1%)
Attribution (at moment of interview)	
No voices	-
Convinced voices are internally generated and connected with the patient himself	7 (21.2%)
Less than 50% convinced voices are caused by external cause	5 (15.2%)
50, but less than 100% convinced voices have external cause	11 (33.3%)
100% sure voices are externally caused	10 (30.3%)

Negative content	
No negative content	3 (9.1%)
Now and then negative content	5 (15.2%)
Less than 50% unpleasant	4 (12.1%)
More than 50% unpleasant	11 (33.3%)
All content is unpleasant	10 (30.3%)
Severity of negative content	
Not unpleasant or negative	-
Certain amount of negative content but not aimed at the person or his family	-
Negative content aimed at the behavior of the person	1 (3%)
Negative content aimed at the self-concept of the person	20 (60.6%)
Threats aimed at the person or its family	12 (36.4%)
Burden	
Voices are never unpleasant or annoying	2 (6.1%)
Sometimes annoying, but mostly not	3 (9.1%)
Equally annoying as not annoying	3 (9.1%)
Majority of the voices unpleasant or annoying	9 (27.3%)
Voices are always unpleasant or annoying	16 (48.5%)
Intensity of the burden	
Voices cause no discomfort	2 (6.1%)
Voices cause limited discomfort	4 (12.1%)
Voices cause moderate discomfort	10 (30.3%)
Voices cause severe discomfort	10 (30.3%)
Voices cause extreme discomfort	7 (21.2%)
Disturbance in everyday life	
No disturbance of everyday life	-
Limited disturbance (e.g. concentration)	3 (9.1%)
Moderate disturbance (e.g. hindering daily activities)	15 (45.5%)
Severe disturbance (e.g. often requiring hospitalization)	15 (45.5%)
Total disturbance of life (e.g. constant hospitalization required)	-

Experienced control over voices	
Control	1 (3%)
Mostly some control	6 (18.2%)
Half of the time some control	1 (3%)
Mostly no control	11 (33.3%)
No control	14 (42.4%)

Table 3

Patients' beliefs, emotions and behavior about their auditory hallucinations measured with the VOS-R (N=33)

Characteristics	**M (*SD*)**
Malevolence (0-18)	11.58 (4.21)
Benevolence (0-18)	2.88 (3.61)
Power (0-18)	10.58 (4.15)
Involvement (0-24)	4.06 (5.04)
Resistance (0-27)	18.52 (5.26)

Procedure

Study procedures were approved by the Medical Research Ethics Committee of the University Medical Center Utrecht (The Netherlands) (NL54140.041.15, protocol number 15/428D). The study was conducted by two trained EMDR therapists. To enhance clinical relevance, the study was designed with EMDR features that mimic clinical practice as much as possible (e.g., session in the therapy room, adhering as much as possible to the EMDR protocol). Therapists from participating mental healthcare institutions were asked to screen their caseload for eligible patients. Patients were provided with an information letter and were able to consider participating for at least a few days. As patients gave oral consent to their therapist before referral to the researcher, the researchers are unaware how many patients refused participation.

After providing written informed consent, patients completed two questionnaires concerning information about the characteristics of their auditory hallucination(s), the Psychotic Symptoms Rating Scale - Auditory Hallucinations (PSYRATS-AH) and the Beliefs

about Voices Questionnaire-revised (BAVQ-R, in Dutch VOS-R) (See Materials for further elaboration on the questionnaires). Patients were then instructed to recall an emotionally disturbing auditory memory of an auditory hallucination and indicate to what degree the content was auditory by indicating this on a 100 mm Visual Analogue Scale (VAS) ranging from 0 (content of the memory is not auditory at all) to 100 (content of the memory is completely auditory). The memory had to be rated at least 50% auditory in content to be included. If memories were rated below 50% auditory in content, patients were asked to recall another auditory memory. Furthermore, other sensory modalities (visual, gustatory, kinesthetic and olfactory) were determined not to be more dominant in the selected memory than the auditory modality by asking patients to divide a 100 mm VAS between the different modalities present in the memory. Then patients were asked to recall the memory and to rate how disturbing the memory was when being recalled on a scale from 0 (no disturbance) to 10 (maximum disturbance). After this, patients were instructed to recall the auditory memory again and to either consequently make horizontal eye movements at a speed of one cycle eye-movements per second (visual taxation; VT), to count down aloud from 1000 (auditory taxation; AT) or to stare at a non-moving dot (control condition; CC). The study used step one, two and three (introduction, assessment & desensitization) from the standard Dutch EMDR protocol (de Jongh & ten Broeke, 2012). The protocol was slightly altered for this study to fit the auditory content and the research set-up. All words referring to visual images were changed to refer to auditory content. Every condition (AT, VT & CC) was offered 5 times for periods of one minute each before switching to the next condition. Each condition was offered twice, resulting in recalling the memory approximately 30 minutes in total. After each one minute period, the condition was interrupted and the patient was asked what arose to mind. The answer was, regardless of the content, followed by the researchers' instruction "concentrate on that" and followed by the next 1-minute period. Before alternating to another condition, the SUD was re-rated (by verbal expression of the patient) on a scale from 0-10. The experiment continued until all conditions were offered twice or until the patient reached SUD score of zero. For an outline of the procedure see Figure 1.

During all conditions, participants were seated in front of a light bar. During the VT condition, a moving dot was displayed. During the AT condition, the bar displayed nothing and during the CC, the bar displayed a non-moving dot in the center of the bar. The speed

used for the moving dot in the VT condition and the type of counting task were copied from studies of Engelhard, van den Hout and Smeets (2011) and van den Hout et al. (2010; 2011). In these studies individuals carried out a simple reaction time task, where they had to press a button every time a stimulus was perceived. An increase in response time was observed

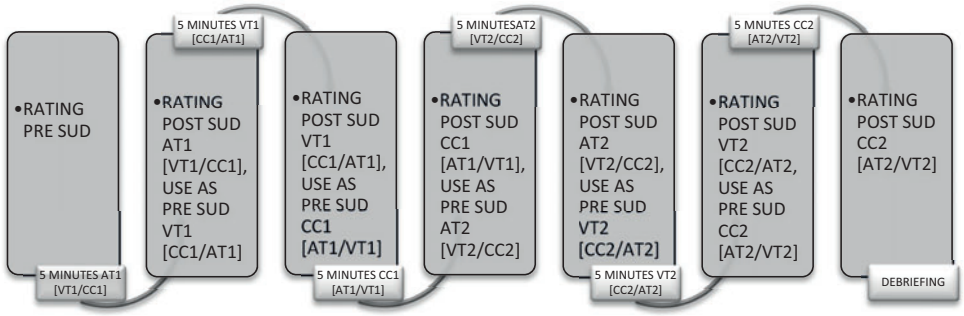

Figure 1. Timeline of the procedure (Abbreviations: SUD, SUD scores; VT, Visual Taxation; AT, Auditory Taxation; CC, Control Condition).

when an additional task was given. This resulted in a quantitative index of the degree to which the additional task was cognitively taxing. In these studies the delay in response time as a result of EM with 1 cycle per second (RT of 115 ms) and the response delay as a result of a 1000-to-1 countdown (RT of 97 ms) were comparable. These two tasks were therefore considered as equally taxing the WM.

Design

The study had a 2 (Time: pre vs. post) x 3 (Condition: VT, AT & CC) repeated measures within-subject design, with SUD scores as a dependent variable. Data from patients, who received all conditions at least once, were included in the analyses, resulting in including data from 33 patients. For many of the participants who did not reach a SUD score of zero after all conditions were offered once (i.e., 'the first round'), the SUD scores were substantially reduced at the end of the first round, which limited room for (differential) effect during the second round. Only in 22 patients all conditions were presented twice. This was a clinically very welcome and encouraging result, demonstrating reduction in SUD scores. However, this resulted in discarding part of the data and including only data obtained in 'the first round' in the analyses.

Materials

PSYRATS-AH. (Haddock, McCarron, Tarrier & Faragher, 1999) a semi-structured interview with a five-point ordinal scale which measures the severity of different dimensions of auditory hallucinations. The AH scale consists of 11 items and has been found to have excellent inter-rater reliability, good validity and is sensitive to change (Haddock et al., 1999).

BAVQ-R. ([Chadwick, Lees & Birchwood, 2000], Dutch version: Vragenlijst Opvattingen over Stemmen [VOS-R]). A 35-item self-report questionnaire with a four-point ordinal scale with five sub-scales, three of which focus on a person's beliefs about the dominant voice (omnipotence, malevolence and benevolence) and two scales that focus on emotional and behavioural responses (resistance and engagement). The subscales have good internal reliability, with correlations between malevolence and resistance, and benevolence and engagement suggesting construct validity (Chadwick, Lees & Birchwood, 2000).

Subjective Units of Disturbance (SUD). The SUD score is a self assessment score with a scale that assesses the subjective intensity of disturbance or distress felt by the patient at the moment of recalling the auditory memory of the auditory hallucination and ranges from 0 (no disturbance) to 10 (maximal disturbance). The effect of each condition was measured by the SUD-difference score, which was calculated by subtracting the SUD-score of the memory post-condition from the SUD-scores pre-condition.

Data analyses

Data were analyzed using Bayesian statistics[1]. Bayesian approach provides relative support for a pre-specified model or models (Klugkist, Laudy and Hoijtink, 2005) instead of depending on dichotomous decisions as provided by p-value significance testing. It enables direct testing of theoretical expectations without the need for *post hoc* pairwise comparisons. Furthermore, one can test different models at once. The results are expressed in terms of Bayes factors (BFs), which represent the level of evidence for one model compared to a model without constraints or against its complement (another pre-specified model). A BF value greater than 1 indicates the data support the model, and the higher this factor, the more support. A BF value less than 1 indicates no support for the model. For

[1] Null Hypothesis Significance Testing is added in the appendix.

further reading on Bayesian analyses see Wetzels et al. (2011) and Krypotos, Blanken, Arnaudova, Matzke and Beckers (2017). Data were analyzed using BIEMS (see Mulder, Hoijtink, & Klugkist, 2010; Mulder, Hoijtink, & De Leeuw, 2012). Four pre-specified models were formulated to asses the effect of the conditions (Model 1, 2, 3, 4):

- Model 1: AT (pre-post) = VT (pre-post) > CC (pre-post); There is a general taxation effect but no modality specific effect, resulting in SUD decreases in the AT and VT conditions, but not in the CC or larger SUD decreases in the AT and VT conditions compared to the CC.
- Model 2: AT (pre-post) > VT (pre-post) > CC (pre-post); There is a modality specific effect and a general taxation effect. This results in larger SUD-decreases in the AT and VT conditions than the CC, and a superimposed effect of the AT condition over the VT condition.
- Model 3: AT (pre-post) > VT (pre-post) = CC (pre-post); There is only or mostly a modality specific effect. This results in larger SUD-decreases in the AT, but no decrease or smaller decreases in the VT condition and the CC.
- Model 4: AT (pre-post) = VT (pre-post) = CC (pre-post); There is no effect of general taxation and no effect of modality specificity. This results in the same SUD difference scores in all conditions.

Results

Findings are graphically represented in Figure 2.

General working memory taxation

To investigate if the emotional intensity of a memory of an auditory hallucination could be reduced by working memory taxation model 1, 2 and 4 were taken into account. Support for model 1 would indicate the active conditions (AT & VT) would show larger decreases from pre to post than the control condition, indicating support for a general working memory taxation effect. Support for model 2 would indicate a general working memory taxation effect and modality specific effect and support for model 4 would indicate no difference of the active conditions compared to the CC. Support for working memory taxation in general was found (BF_1 = 5.8, model 1: AT [pre-post] = VT [pre-post] > CC [pre-post]). According to Lee and Wagenmakers (2013) this reflects moderate support (BF's > 3 are categorized as moderate evidence). However, support was also found for the lack of difference between the three conditions (AT [pre-post] = VT [pre-post] = CC [pre-post]; BF_4 =

1.95), suggesting that there was neither a general nor a modality specific effect. However, the support for this model was substantially lower and classified as anecdotal (Lee and Wagenmakers, 2013). Also model 2 (AT [pre-post] > VT [pre-post] > CC [pre-post]), which takes general taxation into account besides a modality specific effect shows anecdotal support (BF_2 = 2.21). (Further elaboration on this model can be found under Modality Specificity.)

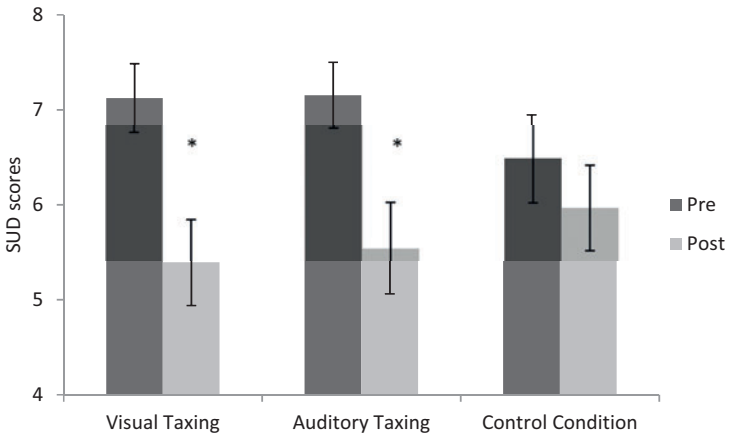

Figure 2. Pre- and post SUD scores per condition. Error bars depict +-1 S.E.M. (* = p < .05)

Modality specificity

For testing the effect of modality specific taxing two models were taken into account. Support for model 2 (AT [pre-post] > VT [pre-post] > CC [pre-post]) would indicate dual taxing in general would result in larger decreases in emotionality and there would be an effect of modality specific taxing resulting in larger decreases in the AT condition than the VT condition, thus implying impact of dual taxing in general and a modality specific taxing effect. Anecdotal support (Lee & Wagenmakers, 2013) for the model was found (BF_2 = 2.21). Support for model 3 (AT [pre-post] > VT [pre-post] = CC [pre-post]) would also indicate support for a modality specific taxation effect, but less or no effect of general working memory taxation by finding only or larger SUD decreases in the AT condition. Model 3 was not supported (BF_3 = .97).

Discussion

The first aim of the present study was to test whether emotionality of an auditory memory of an auditory hallucination could be reduced by applying dual tasking during recall of the auditory memory. Patients suffering from auditory hallucinations were asked to recall an emotional auditory memory of an auditory hallucination under three conditions: visual taxation (VT; making horizontal eye movements) as usually performed in EMDR, auditory taxation (AT; counting) and a control condition (CC; staring at a non-moving dot). The second aim was to assess if a modality matching dual task (auditory taxation + recall of the auditory memory) would be more effective in reducing emotionality than a modality mismatching dual task (visual taxation + recall of the auditory memory). A customized Dutch version of the standard EMDR protocol was used. The protocol was adapted to refer to auditory content (as opposed to the usual visual content). To the best of our knowledge, this is the first study to examine if and to what extent the emotional intensity of auditory hallucination memories can be reduced by dual tasking.

Results showed that emotional intensity (measured with the Subjective Units of Disturbance; SUD) of auditory hallucination memories can be reduced and the model in which a superior equality was presumed between the effect of auditory burden and visual burden in reducing emotionality compared to the control condition was most supported by the data (BF_1 = 5.8) and seen as moderate support (lee & Wagenmakers, 2013). This corresponds to null hypothesis significance testing (see appendix) were emotional intensity shows a significant decrease over time and a trend is observed when comparing both active conditions (visual taxation and auditory taxation) to the control condition (p = .07)

The second aim of the study was to assess whether modality specific taxing was more effective in reducing SUD scores than cross modal taxing. Analyses show no modality-specific benefit. The auditory and visual taxation conditions both reduce emotionality. Some support was found for equal effects in all the conditions (BF_4 = 1.95) and some support was found for superiority of auditory taxation over visual taxation in reducing emotionality and both over the control condition (BF_2 = 2.21), but both levels of support are classified as anecdotal (Lee & Wagenmakers, 2013). Furthermore, outperformance of modality specific taxation shows no support (BF_3 = .97).

The fact that the emotionality of auditory memories could be reduced in autobiographical memories with (some) auditory content is in line with the results of

previous studies with non-clinical samples (Kemps & Tiggemann, 2007; Kristjánsdóttir and Lee, 2011; Matthijssen, van Schie & van den Hout, 2018) and PTSD patients (Matthijssen et al., 2017). This present study differed from the previous studies, because it focused specifically on auditory hallucination memories. Results are partly in line with the working memory taxation hypothesis. Bayesian analyses show the most support for larger decreases in emotionality of the memory in the active (auditory and visual) taxation conditions, which were supposed to be more taxing than the control condition, as well as in null hypothesis testing which showed a trend indicating more effect of the active conditions compared to the control condition. A study by van Veen et al. (2015) showed that the greater the amount of taxation during recall, the larger the decrease in vividness and emotionality of an emotional disturbing memory. In the present study, both active conditions were supposed to evoke an equal amount of taxation on the working memory, and more so than the control condition, which would explain similar results in these conditions. There was, however, *moderate* support for the outperformance of the active conditions over the control condition. One explanation for not finding a very clear difference of effect between the control condition and the active conditions can be due to the effect of and the specifics of the control task. The control task, staring at one point on the light bar, was experienced and executed quite different by patients. Some patients mentioned seeing the dot change in color, others tried very hard to focus on the non-moving dot. Possibly the control task also taxed working memory and perhaps more so in patients suffering from auditory hallucinations compared to healthy controls, since working memory is often affected in patients diagnosed with schizophrenia (Lee & Park, 2005). That the control condition could evoke effects was also found in comparable conditions in other studies. In a study by Sack et al. (2016) patients suffering from PTSD were randomly allocated to either exposure with EM, exposure with fixating on a nonmoving hand and exposure without the explicit task of fixating on an external focus of attention (e.g. eyes closed or eyes open and looking unfocused in the room). Exposure with EM and exposure with fixation on a nonmoving hand showed the same effect on reduction of PTSD symptoms. They concluded that performing EM had no advantage over fixation on a nonmoving hand and they highlighted the need for further research on the exact mechanism why an external focus of attention (moving or nonmoving hand) might help to increase treatment effects during exposure therapy. Dunn, Schwartz, Hatfield and Wiegele (1996) and Yaggie et al. (2015) report similar results of these

types of control conditions. Stickgold (2008) points out that eye fixation maintained for 30 seconds appears to produce a shift in mental state and "if such a state shift also facilitates trauma processing, then its use as a control condition would reveal no relative benefit for bilateral movements, leading to a false rejection of their efficacy". On the other hand Stickgold points out this could also be the contrary in which this shift in mental state could be detrimental to trauma processing. The correct control condition therefore should be the absence of intentional EM or nonmovements (Stickgold, 2008). The type of control condition used in the current study should be considered a limitation.

The lack of a modality-specific taxing-effect suggests that the sheer memory taxation overshadows any effects from modality specificity. It contradicts studies where superior effects of modality specific taxing were found (Andrade, Kavanagh & Baddeley, 1997; Baddeley & Andrade, 2000; Kavanagh, Freese, Andrade & May, 2001; Kemps & Tiggeman, 2007; Lilley, Andrade, Turpin, Sabin-Farrell & Holmes, 2009; Matthijssen, van Schie & van den Hout, 2018). However, it is in line with several earlier studies failing to find a modality-specific effect (Kristjánsdóttir & Lee, 2011, Matthijssen et al., 2017). Several explanations can be given for the lack of finding a modality specific effect. The effect of modality specificity could be absent. However, this seems highly unlikely, since a very strict experimental study (Matthijssen, van Schie & van den Hout, 2018) did find this effect and it was found in multiple studies. A second explanation is that the effect of modality specific taxation is small. This is in line with results from Kemps and Tiggemann (2007) who suggest a large general working memory taxation effect and a smaller superimposed modality specific effect. A patient sample was used in the current study, which could have led to more confounding factors than the use of undergraduates as a participant sample. Some patients were not able to follow the moving dot which was set a standard speed, some experienced difficulty in counting. Also, some patients were bothered by AH during the intervention. These variables were not taken into account, but it is not unlikely it affected the results.

The results show that emotionality of the disturbing auditory hallucination memories decreased, but the effects on the frequency, severity or perceived distress of the auditory hallucinations themselves were not taken into account. When administering EMDR therapy in the treatment of PTSD, patients are asked to recall an emotional disturbing visual memory of the trauma and rate its emotional adversity. The visual intrusions experienced

outside treatment are voluntarily activated in treatment. It seems plausible that the positive outcome of EMDR is the result of generalizing recued aversiveness of the voluntarily recalled visual memory within the session to the visual memory recalled outside the treatment context. In the present study patients were asked to recall their most upsetting hallucination memory. Yet how similar was the experienced voluntarily activated emotional disturbing auditory memory of the auditory hallucination within the session to real life involuntary auditory hallucinations? It seems plausible that the same reduced aversiveness of the voluntarily recalled auditory memory within the session is generalizable to the auditory memory recalled outside the treatment context. Earlier studies showed that PTSD symptoms are reduced concomitantly with an EMDR-induced reduction of the emotional intensity of visual memories in patients with PTSD (Bisson et al., 2007). This could suggest that emotionality reductions of the auditory memories in patients with auditory hallucinations may also decrease symptoms of auditory hallucinations. Though feedback from individual therapists suggested a strong effect on the hallucinations for some of the patients included in the study, no post-measurements or follow-up assessments of the PSYRATS-AH and BAVQ-R were included to objectify the effect on the auditory hallucinations and this makes it impossible to determine whether treatment gain on the frequency, severity or perceived distress of auditory hallucinations was achieved. The study, being experimental in nature, consisted of one intervention session only. Most patients experienced multiple auditory hallucinations and it was hypothesized that for most patients one intervention session on one auditory memory would not be sufficient to significantly affect (auditory memories of) all auditory hallucinations. Therefore, no post-measurements of symptoms of auditory hallucinations were taken into account. Future research is necessary to examine whether EMDR on emotional disturbing auditory memories in patients with auditory hallucinations also has an effect on the auditory hallucinations themselves (e.g., frequency, severity or perceived distress).

It was unexpected, but also encouraging, that SUD reductions occurred so quickly during the intervention. However, this resulted in a limitation in the use of analyzable data. Only data from the first round of conditions were used in the analyses, because SUD scores were substantially lowered at the end of the first round, limiting room for (differential) effect during the second round or even resulting in not being able to perform a second round. It is, however, unclear in what way this has affected the results. Another limitation of

the study is the sample size. To obtain sufficient power 36 patients needed to be included in the analyses, but data from only 33 patients could be taken into account. It is also unclear how this affected the results.

In the study no differentiation was made between subtypes of AH. All memories of AH were included as long as the patient could recall an auditory memory of an auditory hallucination with sufficient emotional disturbance. McCarthy-Jones et al. (2014) suggest there are many different types of AH and also they also show the prevalence of the AH subtype "Nonverbal AHs". They point out that it seems plausible that the mechanism underpinning such AH are distinct from the mechanisms underpinning AVH. (McCarthy-Jones et al., 2014). Also Woods, Jones, Alderson-Day, Callard and Fernyhough (2015) point out that although auditory hallucinations are usually understood as predominantly perceptual experiences, nearly half of the participants in their study described their voices either as thought-like or as having both auditory and thought-like qualities. This implies differentiation in AH. The existence of AH subtypes suggests that therapeutic interventions may benefit from adaptations according to the subtype. It would be interesting to investigate if different subtypes react to different interventions. Treating AH subtypes, however, may often not be clinically feasible, due to the high number of patients with multiple AH subtypes. It would however be interesting to look in more detail if there is a difference in effect of dual tasking during recall of auditory memory of different types of auditory hallucinations and if there is a super-imposed effect of modality specific taxing.

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Author contributions

SM, LV and MvH designed the research; SM and LV collected the data; SM analyzed the data; SM wrote the paper; MvH and IH critically reviewed the paper and SM, MvH and IH approved the final manuscript.

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Appendix

Null Hypothesis Significance Testing Data were analyzed with SPSS (version 23). A repeated-measures within subject ANOVA was conducted, with Condition (VT, AT & CC) and Time (pre and post) as independent variables and SUD-scores as dependent variable. SUD pre scores between conditions did not differ from each other (F (2, 64) = 1.08, p = .35, η_P^2 = .03). The data was analyzed with a 2 (Time: pre vs. post) by 3 (Condition: VT, AT and CC) repeated measures within-subject ANOVA. There was a significant main effect of Time (F (1, 32) = 70.38, p < .001, η_P^2 = .69), but no significant main effect of Condition (F (2, 64) = .05, p = .96, η_P^2 = .00). Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated for the Time x Condition interaction (χ^2 = 7.05, p = .03). Therefore the Greenhouse-Geisser interaction was used. This showed the Time x Condition interaction was non-significant (F (1.66, 53.19) = 2.53, p = 0.10, η_P^2 = 0.07). SUD scores, regardless of the condition, decreased from pre to post. Calculating difference scores for all conditions and combining the AT and VT difference scores and comparing these 'active' conditions *together* with the CC in a one way ANOVA showed a trend (F (1, 32) = 3.46, p = .07, η_p = .10).

CHAPTER 06

Psychological Mechanisms in EMDR: The effect of modality specificity in taxing working memory

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Submitted

Abstract

Both auditory and visual emotional memories can be made less emotional by loading working memory (WM) during memory recall. Taxing WM during recall can be *modality specific* (giving an auditory [visuospatial] load during recall of an auditory [visual] memory) or *cross modal* (an auditory load during visual recall or vice versa). We tested whether modality specific loading taxes WM to a larger extent than cross modal loading. Ninety-six participants undertook a visual and auditory baseline Random Interval Repetition (RIR) task (i.e., responding as fast as possible to a visual or auditory stimulus by pressing a button). Then, participants recalled a distressing visual and auditory memory, while performing the same visual and auditory RIR task. Increased reaction times (compared to baseline) were indicative of WM loading. Using Bayesian statistics, we compared five models in terms of general and modality specific taxation. There was support for the model describing the effect on WM of dual tasking *in general*, irrespective of modality specificity, and for the model describing the effect of *modality specific* loading. Both models *combined* gained the most support. The results suggest a general effect of dual tasking on taxing WM and a superimposed effect of taxing in matched modality.

Keywords: modality specific taxing, auditory memories, working memory taxation, Random Interval Repetition Task, Bayesian statistics, EMDR

Introduction

Eye movement desensitization and reprocessing (EMDR) therapy is an evidence-based therapy for post-traumatic stress disorder (PTSD; e.g., Bisson et al., 2007; Bradley, Greene, Russ, Dutra & Westen, 2005; Chen et al., 2014; Lee & Cuijpers, 2013; Seidler & Wagner, 2006). EMDR aims to reduce PTSD symptoms by decreasing the emotionality of intrusive memories. In EMDR therapy, the therapist asks the patient to simultaneously recall a distressing trauma related memory and move the eyes back-and-forth horizontally.

A meta-analysis by Lee and Cuijpers (2013) showed the added value of eye movements (EM) in EMDR in both clinical and analogue studies. Different theories were proposed in an attempt to provide an explanation for the underlying working mechanism(s) of EMDR therapy by stressing the horizontal direction of EM (e.g., evocation of the orienting response, Armstrong & Vaughan, 1996; enhanced interhemispheric functional connectivity, Bergmann, 1998; triggering of a rapid-eye-movement–like state that facilitates the processing of traumatic memories, Stickgold, 2002, 2008; depotentiating limbic fear memory synapses, Rasolkhani-Kalhorn & Harper, 2006; dearousal, Aubert-Khalfa, Roques & Blin, 2008). It should be noted that other tasks during recall yield comparable effects besides EM (e.g., spatial tapping, Andrade, Kavanagh & Baddeley, 1997; playing Tetris, Engelhard, van Uijen & van den Hout, 2010; progressive counting, Greenwald, McClintock, Jarecki & Monaco, 2015; auditory shadowing, drawing a complex figure, Gunter & Bodner, 2008; watching visual stimuli changing color, Kavanagh et al., 2001; counting, Kemps & Tiggemann, 2007; van den Hout et al., 2010; attentional breathing, van den Hout et al., 2011a; mental arithmetic, Engelhard, van den Hout & Smeets, 2011). The working memory (WM) taxation hypothesis provides an explanation for the beneficial effect induced by those other tasks. Keeping a memory in mind after retrieval uses the limited capacity WM resources (Baddeley, 2012). The WM taxation hypothesis states that emotional memories in PTSD patients can be made less emotional by simultaneously recalling an emotional memory and performing a dual task (van den Hout & Engelhard, 2012). EM are considered such a dual task. The observation that memories become less disturbing and less vivid after execution of EM, but also after a range of other dual tasks therefore is consistent with the WM taxation hypothesis (van den Hout & Engelhard, 2012).

An area of debate is how optimization of EMDR therapy can be achieved. One option may be 'to do more' of WM loading (i.e., to increase WM loading). Maxfield, Melnyk, and

Hayman (2008) conducted two experiments in which they asked participants to recall negative memories consecutively while engaging in three dual-attention tasks of increasing complexity (no EM, slow EM and fast EM). Slow EM and Fast EM decreased ratings of vividness, thought clarity, and emotional intensity. Moreover, fast EM resulted in larger decreases than the slow EM. In a study by van Veen et al. (2015) participants were asked to recall three highly vivid aversive autobiographical memory images or three less vivid images under three conditions: fast EM, slow EM, or recall only. The fast EM (pre-established to have more working memory interference than slow EM) led to less emotional, less vivid and more difficult to retrieve images than the slow EM and recall only. Furthermore, the effects of slow EM were larger than for recall only. The authors concluded that dual-tasks that tax WM more result in larger decreases in emotionality of aversive memories. Van Schie, van Veen, Engelhard, Klugkist, and van den Hout (2016) also asked participants to recall three emotional memories and rate vividness and emotionality before and after three conditions (recall only, recall + slow EM, recall + fast EM). The results showed dual tasks that taxed WM more resulted in larger decreases in emotionality and vividness ratings of memories. Therefore, there appears to be a dose-response relation: the larger the working memory loading, the larger the effects on emotionality and vividness ratings. Note however that there is also some evidence that this dose-response relationship may not necessarily be linear: it may follow an inverse U-curve. Engelhard, van den Hout, and Smeets (2011) manipulated the amount of WM loading by requiring participants to perform a simple, intermediate, complex mental subtraction task or no dual task at all while holding a distressing memory in mind. For the emotionality scores there was some support for an inverse U-curve dose-response relationship: a simple and intermediate mental arithmetic subtraction task showed more beneficial effects on emotionality scores than no task or the complex task. However, there was no support for an inverse U-curve for vividness.

Another possible way of optimizing EMDR therapy is by adjusting the modality of the dual task to the memory's modality. According to the WM model, modality specific information is processed preferentially in one of two subsystems: the visuospatial sketchpad (VSSP), responsible for processing visual and spatial information and the phonological loop (PL), responsible for auditory and verbal processing (Baddeley, 2012; Baddeley & Hitch, 1974). Therefore, the VSSP is involved in visual imagery and the PL in auditory imagery (Kristjánsdóttir & Lee, 2011). The WM model (Baddeley & Hitch, 1974) also comprises a non-

modal central executive (CE), which is engaged when attention needs to be divided between tasks. On the one hand, it may be argued that changing modality specific memories will benefit from modality specific loading (vs. cross modality loading). In other words, a visual dual-task will more effectively reduce emotionality of visual memories compared to an auditory task, and vice versa for auditory memories (e.g., Kemps & Tiggemann, 2007). Alternatively, one could argue that it is general task load – taxing the CE – that reduces emotionality and vividness of emotional memories (Gunter & Bodner, 2008), and therefore any task that sufficiently taxes WM should be effective, regardless of modality.

There is evidence for both hypotheses. Some analogue studies have found (partial) support for the modality specificity account. Andrade, Kavanagh, and Baddeley (1997) found that concurrent visuospatial tasks reduced emotionality and vividness ratings of visual images of personal memories. However, no concurrent phonological load on auditory personal memories was taken into account. Kemps and Tiggemann (2007) did take auditory memories into account and asked undergraduates to recall a specific visual or auditory image of a memory. They showed vividness and emotionality ratings were reduced to a greater extent with modality specific loading. Apart from the modality specific effect, they also found a large general effect of working memory loading: vividness and emotionality ratings were reduced after a visuospatial condition (EM), verbal condition (counting), or a control condition.

Some analogue studies have only found support for the CE account. Gunter and Bodner (2008) asked participants to hold distressing memories in mind while performing an auditory shadowing task (listening to a recording), or one of two visuospatial tasks (making EM or drawing a complex figure). They found that all dual tasks were effective in reducing distress associated with negative memories, suggesting that the central executive was being taxed. Drawing figures was more effective in reducing distress than making EM or listening to a recording, leading them to suggest that drawing figures was more taxing on the central executive. In addition to this, they concluded there was no effect of modality specific loading. Gunter and Bodner, however, did not specify how demanding the dual tasks were. Kristjánsdóttir and Lee (2011) asked participants to recall an unpleasant autobiographical memory while performing EM, listening to counting or a control condition (short exposure). They found that EM led to a greater decrease in vividness than listening to counting, that EM and listening to counting were equally effective in reducing emotionality and both

effects were found irrespective of the modality of the memory. Kristjánsdóttir and Lee (2011) concluded that this supported the crucial role of the CE.

Clinical studies have shown comparable results to analogue studies. In a study by Matthijssen, Verhoeven, Heitland, and van den Hout (2017), PTSD patients recalled two disturbing memories, one mainly visual, the other one mainly auditory and rated the emotionality of the memories before being exposed to two alternating supposedly equally demanding conditions and one control condition (EM, counting out loud, staring at a non-moving dot). Both memories (visual/auditory) showed a decline in emotionality of the memory in all conditions and there was no modality specific effect. Another study of Matthijssen, Heitland, Verhoeven, and van den Hout (2018) showed the emotionality of aversive auditory memories of auditory hallucinations in patients suffering from auditory hallucinations reduced after being exposed to either EM or counting, more so than by staring at a non-moving dot, but no modality specific effect was found. In summary, there are different hypotheses about WM loading: one led by the CE account, another one by a modality specificity account, and a third one, which combines the two preceding accounts.

There is a crucial problem with many of the studies that have investigated effects of modality specific loading. Typically, tasks that are supposed to tax the VSSP or PL have been compared on some outcome measure (e.g., vividness and/or emotionality). When different modality tasks are compared directly, such as EM or counting, it is often assumed that they tax WM to a comparable degree, but this assumption has never been tested. However, this can be tested with an Random Interval Repetition (RIR) task (van den Hout et al., 2011a; 2011b; Vandierendonck, de Vooght, & van der Goten, 1998; see Methods; materials). In an RIR task participants respond as soon as possible to a stimulus while doing an additional task (e.g., making EM) or without this task. The difference in reaction time is a measure of WM loading of the additional task. The studies of Matthijssen et al. (2017; 2018) tried to take the amount of WM loading into account by selecting an auditory and visual taxing task previously used in other experiments and known to be comparable in reaction time delay. However, although these two tasks were considered as equally taxing on working memory, they did not test this, nor did they test their control condition (staring at a non-moving dot) on the amount of WM loading. Stickgold (2008) has also pointed out a concern with the type of control condition used (i.e., that eye fixation could also have effect). In summary, differences between tasks may be due not to their modality, but to the degree of WM

loading. Additionally, finding a proper control condition is challenging and it is crucial that WM loading is either measured or preferably that participants are their own controls, i.e., by adding a baseline measurement of the taxing dual tasks used.

An unresolved debate is whether the modality of loading in EMDR (visual or auditory) should be matched to the (visual or auditory) modality of the memory to achieve the best results in reducing the emotionality of emotional memories? PTSD patients suffer from traumatic memories. These are predominantly visual, but other sensory modalities may also be involved (Ehlers et al., 2002; Hackmann, Ehlers, Speckens, & Clark, 2004). Gaining understanding on how to treat memories predominantly in other sensory modalities is therefore valuable. A first step in treatment optimization is to experimentally test whether autobiographical memories of different modalities do indeed tax modality specific subsystems of the WM model differentially. As mentioned, there appears to be a dose-response relationship between load and effect (Maxfield et al., 2008; van Veen et al., 2015; van Schie et al., 2016). For optimizing treatment it would be helpful to know, whether loads matched in modality tax WM more than cross modal loads. Therefore, the aim of the present study was to test whether modality matched loads taxed WM to a larger extent than cross modal loading. We used an objective measure (reaction time) to assess the degree of WM load. In line with the WM taxation hypothesis one would expect both a benefit of WM loading in general and a modality specific dual taxing benefit.

Hypotheses

Five different models can be deduced from the literature. Model 1 states that dual tasking (recalling a memory and performing an RIR task) in general taxes WM. Thus, if recalling a memory while being engaged in an RIR task is more taxing for the WM, this should, irrespective of modality, result in larger delays in reaction times than being engaged in the RIR task solely. Model 1 is depicted in Figure 1. Model 2 states that a modality matched dual task is more taxing on WM, so larger reaction time delays are expected on modality matched RIR tasks than on cross modal RIR tasks. This is depicted in Figure 2. Model 3, depicted in Figure 3 states that matched-modal and cross-modal dual tasks have an equivalent impact on the WM, therefore no difference should be expected in reaction time delays between recalling a memory while being engaged in a matched modality RIR task and recalling a memory while being engaged in a cross modality RIR task.

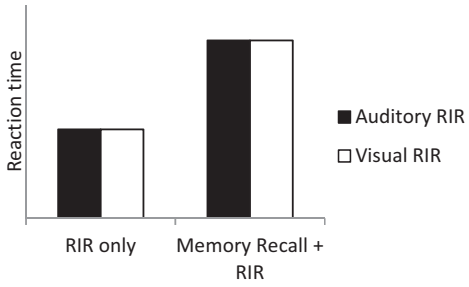

Figure 1. Model 1: Performing a RIR during memory recall results in larger reaction times than performing a RIR only.

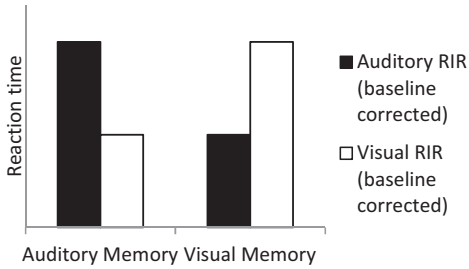

Figure 2. Model 2: Modality matched RIR + memory recall results in larger reaction times than RIR + cross modality memory recall.

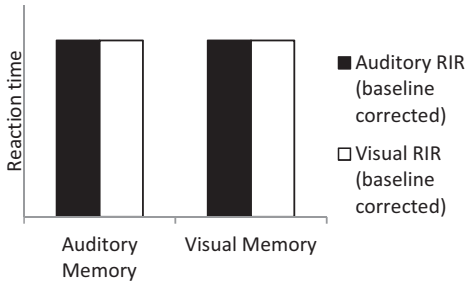

Figure 3. Model 3: Modality matched RIR + memory recall results in equal reaction times as RIR + cross modality memory recall.

Model 2 and 3 are specifically focused on modality specific taxation, exploring the impact of modality-matched vs. cross-modal dual taxing, while ignoring general taxation.

Model 4 and 5 are similar to model 2 and 3 respectively, but take into account the general taxation effect as depicted in model 1 (See Methods; data analysis for more detail).

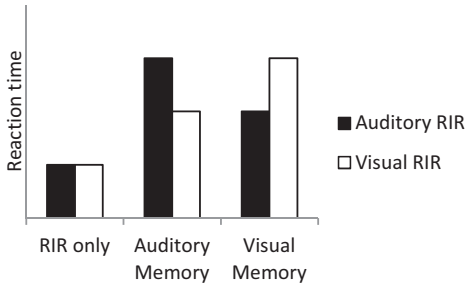

Figure 4. Model 4: Performing a RIR during memory recall results in larger reaction times than performing a RIR only & modality matched RIR + memory recall results in larger reaction times than RIR + cross modality memory recall.

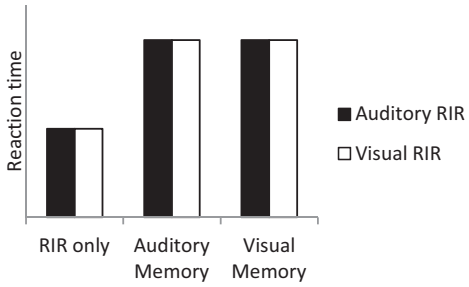

Figure 5. Model 5: Performing a RIR during memory recall results in larger reaction times than performing a RIR only & modality matched RIR + memory recall results in equal reaction times as RIR + cross modality memory recall.

Methods

Participants

The study was approved by the Ethics Committee of the Faculty of Social and Behavioral Sciences at the Utrecht University (FETC16-095). Ninety-six individuals took part (65 women, 31 men, *M* = 22.04, *SD* = 2.51, range 18-32). Participants were recruited at Utrecht University and participated in return for course credits or financial compensation.

Design

The study had a 2 × 3 design with and Load (Visual RIR vs. Auditory RIR) and Memory (No memory vs. Visual Memory vs. Auditory Memory) as within subject factors. Reaction time in milliseconds (ms) was measured by means of an RIR Task (see below). All participants selected one visual and one auditory memory and performed both a visual and an auditory RIR-task three times: once during a baseline phase (RIR only; no memory recall), once while recalling a visual memory and once while recalling an auditory memory (see procedure). Counterbalancing was used both for the sequence of the memory (auditory/visual) and the load (auditory/visual RIR task), resulting in 16 conditions to which participants were randomly assigned.

Materials

Modality specific RIR task. The RIR (Vandierendonck, de Vooght, & van der Goten, 1998) task was adapted from van den Hout et al. (2011a; 2011b) and was presented using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). In the RIR task participants were instructed to press the letter B on the keyboard with the index finger of their dominant hand as soon as they detected a stimulus. The nature of this stimulus depended on the modality of the RIR task (auditory or visual). In the auditory RIR task participants listened to a 200Hz beep that was played via headphones for a duration of 50 ms. In the visual RIR task participants saw a white circle that was 2 centimeters in diameter and was presented on a black computer screen for a duration of 500 ms. Stimuli from visual and auditory RIR tasks were presented in separate blocks (i.e., not intermixed). The interstimulus interval (ISI) was either 900 ms or 1500 ms (and included the time of stimulus presentation which was presented at the start of the ISIs) and no more than four consecutive ISIs of the same duration were used in a row, to prevent any expectation or prediction and to rule out automated responses. It is important to note that the difference in the duration of the presentation of the auditory and visual stimulus did not interfere with the possibility to respond during the stimulus. Participants could respond during presentation of the stimulus and the remainder of both ISIs. This resulted in an equal opportunity to respond to both stimuli in all the RIR tasks.

Procedure

After signing an informed consent, a screening checklist was completed to check age, education level, sex and also to check if no exclusion criteria were met. Participants were

excluded when they reported one of the following: (1) visual impairment, (2) hearing impairment, (3) being under influence of sedative drugs, alcohol or drug intoxication, (4) current psychological complaints interfering with response latency (e.g., depressive symptoms), (5) severe fatigue, or (6) extreme stress. Participants were seated in front of a computer and were instructed to perform two short practice blocks of the RIR task in which they responded to 8 auditory and 8 visual stimuli. Participants read the following instruction on the screen: "When you see the white circle (hear the beep) press the letter B as quickly as possible." RIR practice block order (visual/auditory) was counterbalanced. Participants always wore headphones during the RIR tasks. Following practice, participants performed an auditory and visual RIR only with the order of blocks (visual/auditory) counterbalanced. In each block participants were presented with 48 stimuli. There was a 30s interval between each block. After the RIR only phase participants turned away from the computer screen and were instructed by the experimenter to recall two emotional memories that were at least one week old; one predominantly visual in nature and the other predominantly auditory. Participants were asked: "Try to recall a for you, vivid, negative memory from an event that made you anxious or sad for example and that still has emotional impact on you when you recall it. It must be a memory that still, at this moment, gives you a nasty feeling or tension, and it must be a memory that you mainly see (hear)." They were asked to write down a few key words of these memories and to indicate if the memory was at least 50% visual respectively auditory in content. Emotionality of the memories was rated by the participants by giving a number ranging from 0 (*not at all unpleasant*) to 100 (*very unpleasant*). Memories rated below 60 were excluded and participants were asked to select another memory in the same modality. The researchers are unaware of the number of memories rated below 60, because they were not registered. After selecting two memories with an emotionality score of 60 or higher, participants started with one of the two and were instructed to describe the memory roughly, select the memory's hotspot (worst sound for an auditory memory; worst image for a visual memory) and to label the hotspot with a working title and write this working title down. Then, the experiment was set up, the experimenter entered the working title and participants turned their chair again to sit facing the computer. Participants were instructed to recall the image of the visual (auditory) memory and to focus on what they saw (heard) in the image (fragment) and to simultaneously respond as quickly as possible when the visual (auditory) stimulus was

presented. The working title appeared shortly on the screen cueing the participant to recall the auditory (visual) memory hotspot. Subsequently, the auditory and visual RIR tasks were performed while recalling the auditory (visual) memory hotspot. After this, participants completed the same tasks (selecting the worst part, specify a working title and conducting both RIR tasks while recalling the hotspot) for the visual (auditory) memory. The order of memories was fully counterbalanced. After completing the RIR tasks participants were given a debriefing. Lastly, participants received monetary compensation or course credits. The experiment lasted approximately 30 minutes.

Data preparation

Reaction times were operationalized as the time between stimulus onset and a participant's response to the (auditory or visual) stimulus. It should be noted that participants could respond to a stimulus while it was being presented, or in the ISI following stimulus display. All individual reaction times were plotted to establish a lower bound cutoff-point for the reaction time. Visual inspection of the data showed a random distribution of reaction times below 139 ms and a smooth trend of rising reaction times from 139 ms. Therefore all reaction times below 139 ms were considered as errors and were deleted (cf. van den Hout et al., 2011a). One could argue the reaction times below 139 ms are a reflection of the expectancy the stimulus, but this is also considered an error, since it does not reflect the true response to the presented stimulus. Due to a programming error, no data were obtained in a part of the short ISI of the visual RIR. It should be noted that participants could respond during the presentation of the stimulus in all RIR conditions and in the remainder of the ISI. In the latter case (short ISI), this meant that participants could only respond during stimulus display (i.e., the white circle: 500ms) but not in the remainder of the short ISI (400ms). As a consequence of the programming error, reaction times above 500 ms in this condition were not recorded. We decided to remove the short trials all together instead of discarding only the data above 500 ms. This strict measure was taken because of the ex-Gaussian distribution of reaction times, in which the tail has a large effect on mean reaction time (Schmiedek, Oberauer, Wilhelm, Süß & Wittmann, 2007; Shahar, Teodorescu, Usher, Pereg, & Meiran, 2014). Discarding data below 139 ms resulted in deleting 29 (0.42%) visual reaction times and 34 (0.49%) auditory reaction times of the 1500 ISI. Also there were 109 (1.58%) missings in the visual reaction times and 75 (1.09%) missings in the auditory reaction times.

Data analysis

The hypotheses were defined in five models (and exact constraints can be found in the appendix): Model 1 tested whether recalling any kind of memory together with any kind of RIR task was more taxing than only performing the RIR task. Therefore, this model tested an effect of general loading. Model 2 tested whether simultaneously performing memory recall and an RIR task in the same modality (corrected for baseline) was more taxing than performing memory recall and an RIR task in a different modality (corrected for baseline). Therefore, this model specifically tested whether modality specific loading (independent of the effect of general loading) was more taxing than cross-modality loading. Model 3 tested whether simultaneously performing memory recall and an RIR task in a different modality (corrected for baseline) was equally taxing than performing memory recall and an RIR task in the same modality (corrected for baseline). Therefore, this model specifically tested whether cross-modal loading (independent of the effect of general loading) was equally taxing than matched modality loading. Model 4 is a combination of model 1 and 2. Therefore, this model specifically tested whether dual loading taxed WM more and whether modality specific loading was more taxing than cross modality loading. Model 5 is a combination of model 1 and 3. Therefore, this model specifically tested whether dual loading taxed WM more and whether cross-modality loading was equally taxing as matched modality loading.

Support for the five different models was tested using Bayesian model selection. In contrast to the frequentist statistics, which depends on dichotomous decisions, Bayesian model selection provides relative support for a pre-specified model or models (Klugkist, Laudy, & Hoijtink, 2005). Furthermore, it has the advantage that different models can be tested at once, which allows data in support of competing hypotheses to be compared (Béland, Klugkist, Raîche, & Magis, 2012). The results of Bayesian model selection are expressed in terms of Bayes factors (BFs). A BF represents the level of evidence for one model compared to another and the higher this factor, the more support for the pre-specified model. A BF value greater than 1 indicates that the data support the model or hypothesis. A BF value less than 1, indicates no support for the model or hypothesis. Support for an informative hypothesis is evaluated against a model without constraints. One can also compare two informative hypotheses mutually by computing the ratio of the two BFs for the informative hypotheses against the unconstrained model. Analyses were

performed using the software BIEMS (see Mulder, Hoijtink, & Klugkist, 2010; Mulder, Hoijtink, & De Leeuw, 2012). Though the BF is a continuum it may be categorized to facilitate scientific communication. According to Lee and Wagenmakers (2013) a BF between 1 and 3 may be interpreted as 'anecdotal' support, between 3 and 10 as 'moderate', larger than 10 can be interpreted as 'strong' support and a BF larger than 30 as 'very strong support.' BFs above 100 are viewed as 'extreme' support.

Results

Data from 96 participants were used for the analyses. Originally, data were obtained from 98 participants, however data from two participants were excluded. Both participants suffered from tinnitus, and it was unclear how much this affected the results. The average emotionality score for the auditory memory was 76.93 (*SD* = 10.35) and for the visual memory it was 78.26 (*SD* = 9.72). Examples of auditory memories that were reported were: being 'booed' of stage while giving a performance, a screaming mother after hearing the news that grandfather past away and hearing the gun that was used at a robbery at work. Visual memories reported were for example: being left alone at the school yard and standing alone there crying against the fence, seeing a conductor of the orchestra die during a performance on stage and being involved in an accident. Reaction times are shown in Table 1 and the mean reaction times while recalling an auditory memory and visual memory with baseline scores subtracted are visualized in Figure 6. Both Table 1 and Figure 6 show that in the case of auditory memories (left bars in Figure 6) responses on the auditory RIR were slower than on the visual RIR and the pattern was reversed for the visual memory (right bars).

Table 1

Mean reaction times and standard deviations on the visual and auditory RIR tasks at baseline and during auditory and visual memory recall

	RIR only	**Auditory Memory**	**Visual Memory**
Visual RIR task	290.19 (*34.62*)	338.66 (*79.17*)	351.02 (*80.80*)
Auditory RIR task	270.72 (*45.86*)	341.42 (*108.83*)	317.41 (*93.86*)

Model 1 stated that dual taxing in general - performing any kind of RIR task and recalling any kind of memory - would result in larger delays in reaction time than performing a single task (RIR only). The results supported this, and showed the impact of general loading. (BF_1 = 8.75). Model 2 stated that matched modality taxing would result in larger reaction times than cross modal taxing. This pattern was supported by a BF of 5.36. Model 3 stated that that matched taxing would result in equal reaction time delays as cross modal taxing. There was no support for this model (BF_3 = 0.32). Comparing model 2 and 3 (BF_{23} = 16.75) showed there was substantially more relative support for a benefit of modality specific taxing.

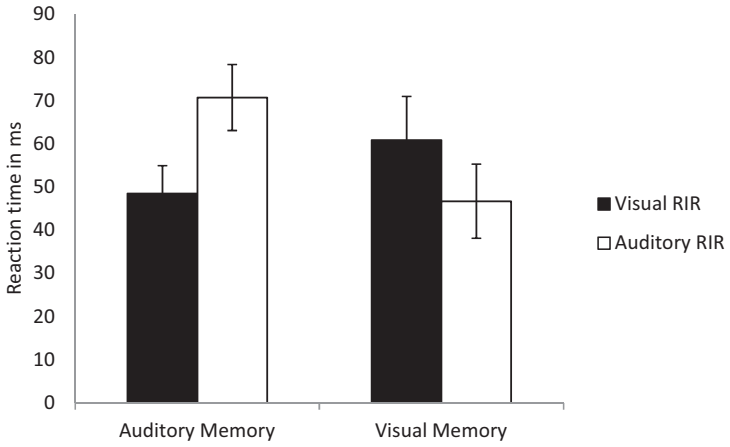

Figure 6. Mean (with ±1SEM) reaction times in ms while recalling an auditory memory and visual memory with baseline scores subtracted.

Model 4 was supported with a BF of 39.96. This suggests very strong evidence for loading in general combined with a modality specificity effect: there was a larger delay in reaction time when the RIR task and memory were in the same modality, compared to when they were in different modalities and a large delay in reaction time when performing a dual task in general. No support was found for model 5 - which combined general WM loading and equal effects for modality specific and cross-modal taxing – (BF_5 = 1.05). Comparing model 4 and 5 resulted in very strong evidence for a general WM loading effect with a modality specific effect superimposed on that (BF_{45} = 38.06).

Discussion

We tested whether performing a dual task in the same modality as a recalled emotional memory was more taxing than performing a dual task in cross modality in order to explore ways to improve the effects of EMDR. This was assessed by letting participants recall a visual and an auditory emotional memory while performing a visual and auditory RIR task. The results were clear: a larger impact on WM (operationalized in stronger effects on delay in reaction time) was found when the RIR task was performed in the same modality as the recalled memory than when the RIR task was performed in cross-modality (BF_2 = 5.36). The results also showed an impact of dual tasking on WM in general – regardless of the modality in which the dual task was performed (BF_1= 8.95). The strongest evidence was found for the model in which dual tasking in general was *combined* with the model that showed a greater effect of modality-specific loading (BF_4 = 39.96). It should be noted this does not imply anything about the size of the effect, only about the support for the model. The results showed that dual-tasking during memory recall in general had an impact on WM (which is in line with the CE account), and that there was a larger effect of modality-specific dual-tasking compared to cross-modality loading (which is in line with the modality specificity account). The findings are surprisingly consistent with earlier research by Kemps and Tiggemann (2007), which demonstrated a large benefit of WM loading in general and a smaller and super-imposed modality-specific benefit. The BF of both general taxing (BF_1 = 8.95) and modality specific taxing (BF_2 = 5.36) combined was 39.96, indicating *very strong* support of the combined value of both general and modality specific loading (Lee and Wagenmakers, 2013). This indicates that the CE account and the modality specificity account are *complementary* and thus suggests that the used dual tasks both tax the CE and subsystems; the VSSP in case of the visual RIR and the PL in case of the auditory RIR.

The current study adds important information compared to earlier ones (e.g., Gunter & Bodner, 2008; Kemps & Tiggemann, 2007; Kristjánsdóttir & Lee, 2011; Matthijssen et al., 2017, 2018). Both the *degree* of WM loading and the *modality* of loading were taken into account. Earlier studies often failed to test the presence and degree of WM loading and have concluded – where there was no modality-specific effect in the presence of dual tasks in different modalities that the effect was due to taxing the central executive. This, in fact, could be just a consequence of difference in degree of task loading (e.g., Gunter & Bodner, 2008; Kristjánsdóttir & Lee, 2011; Matthijssen et al., 2017, 2018). Furthermore, no modality

specificity can be inferred if working memory loading is not taken into account and where only one memory modality (e.g., visual memory) is employed (e.g., Andrade, Kavanagh, & Baddeley, 1997). Kemps and Tiggemann (2007) inferred modality specificity without assessing the amount of WM loading by using a design in which both modalities were used for the selection of the memory and dual task.

Although a programming error led to our decision to delete all responses in the short ISIs and discard half of the data, such a measure was justified to be able to take reaction times in the tail of the distribution into account. It is not likely that the taken measure affected the results, because there were more than enough reaction times. A potential limitation of the study however is that the emotionality of the memory was only obtained at memory selection, so no definite conclusions can be drawn about the effect of the more demanding loading on emotionality of the memories. Both measures (emotionality scores and reaction time) should be taken into account in future research.

The outcome of this study may have implications for the understanding and practice of EMDR therapy. One way to optimize EMDR therapy could be by taxing WM more during memory recall. Earlier studies have shown a larger effect of a higher load of WM taxation on the decrease of emotionality of aversive memories (Maxfield et al., 2008; van Veen et al., 2015; van Schie et al., 2016). Another option could be to tax WM differently during memory recall, thereby inducing interruption in the specific WM subsystem (VSSP or PL) causing more loading, which was investigated in this study. The data suggest a potential modality-specific concurrent task effect in EMDR therapy: focusing on the specific memory modality and targeting the specific WM subsystem, could therefore possibly lead to a more effective treatment. However, at the present time, this is a suggestion based on the outcome of experimental studies on reaction time data and lacks validation on emotionality ratings and in clinical studies. Nevertheless, it may be assumed that, to the extent that the results generalize to traumatic imagery, patients with predominantly auditory intrusions (e.g., remembering the sound of a crash or somebody screaming) would benefit from concurrent auditory dual tasks (e.g., counting aloud) during memory recall, whereas patients with predominantly visual intrusions would benefit from engaging in visual loading (e.g., EM).

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Author contributions

SM and MvH developed the study concept. SM and KvS contributed to the study design, KvS programmed the RIR task, SM was responsible for data collection and SM and KvS for data analysis. SM drafted the manuscript, KvS and MvH provided critical revisions.

Conflict of interest and funding

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Appendix

Model 1: Memory Recall + RIR > RIR only

(Auditory Memory + Auditory RIR) > Baseline Auditory RIR

(Auditory Memory + Visual RIR) > Baseline Visual RIR

(Visual Memory + Auditory RIR) > Baseline Auditory RIR

(Visual Memory + Visual RIR) > Baseline Visual RIR

Model 2: (modality matched memory recall + RIR) - baseline RIR > (cross modality memory recall + RIR) – baseline RIR

(Auditory Memory + Auditory RIR) – Baseline Auditory RIR > (Auditory Memory + Visual RIR) – Baseline Visual RIR

(Visual Memory + Visual RIR) - Baseline Visual RIR > (Visual Memory + Auditory RIR) - Baseline Auditory RIR

Model 3: (modality matched memory recall + RIR) - baseline RIR = (cross modality memory recall + RIR) – baseline RIR

(Auditory Memory + Auditory RIR) – Baseline Auditory RIR = (Auditory Memory + Visual RIR) – Baseline Visual RIR

(Visual Memory + Visual RIR) - Baseline Visual RIR = (Visual Memory + Auditory RIR) - Baseline Auditory RIR

Model 4: (memory recall + RIR > baseline RIR) & (modality matched memory recall + RIR) - baseline RIR > (cross modality memory recall + RIR) – baseline RIR

All constraints of model 1 & model 2.

Model 5: (memory recall + RIR > baseline RIR) & (modality matched memory recall + RIR) - baseline RIR = (cross modality memory recall + RIR) – baseline RIR.

All constraints of model 1 & model 3.

SECTION 03

Exploring a novel route: Visual Schema Displacement Therapy

CHAPTER 07

Effects of "Visual Schema Displacement Therapy" (VSDT), EMDR therapy and a control condition on emotionality and vividness of aversive memories: two critical analogue studies

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Abstract

Background and objectives. Visual Schema Displacement Therapy (VSDT) is a novel therapy for treating stress and dysfunction caused by a traumatic event. Although its developers claim this therapy is quicker and more beneficial than other forms of trauma therapy, its effectiveness has not been tested. **Methods.** We compared the efficacy of VSDT to EMDR therapy and a non-active control condition (CC) in two studies. In Study 1 participants (*N* = 30) were asked to recall three negative emotional memories under three conditions: VSDT, EMDR, and a CC, each lasting 8 minutes. Emotional disturbance and vividness of the memories were rated before and after the (within group) conditions. The experiment was replicated using a between group study. In Study 2 participants (*N* = 75) were assigned to one of the three conditions, and a follow-up after 6-8 days was added. **Results.** In both studies VSDT and EMDR were superior to the CC in reducing emotional disturbance, and VSDT was superior to EMDR. VSDT and EMDR outperformed the CC in terms of reducing vividness. **Limitation.** Results need to be replicated in clinical samples. **Conclusions.** It is unclear how VSDT yields positive effects, but irrespective of its causal mechanisms, VSDT warrants further clinical exploration.

Keywords: VSDT, Visual Schema Displacement therapy, EMDR, trauma therapy, PTSD

Highlights

- Visual Schema Displacement Therapy reduces emotionality in aversive memories.
- VSDT is more effective than EMDR in reducing emotionality of aversive memories.
- VSDT and EMDR are equally effective in reducing vividness of aversive memories
- The effects of VSDT and EMDR are maintained at follow up after 6-8 days.

Introduction

Posttraumatic stress disorder (PTSD) is classified as a trauma disorder, which one can develop after exposure to a traumatic event (American Psychiatric Association, 2015). Though many people are exposed to traumatic events in their life, and a variety of symptoms can be experienced following such a confrontation, PTSD develops in approximately 10 to 20% of individuals exposed to extreme stressors and is associated with significant impairment in functioning (Norris & Slone, 2007).

Psychological treatments available for PTSD are numerous. A recent meta-analysis demonstrated efficacy of exposure therapy (including prolonged exposure) for improving PTSD symptoms. The evidence also supported the efficacy of cognitive therapy, including cognitive processing therapy, cognitive behavioral therapy, mixed therapies, eye movement desensitization and reprocessing (EMDR) therapy, and narrative exposure therapy (Cusack et al., 2016). The effect sizes were large for each of these therapies, but head-to-head comparative effectiveness evidence is limited (Cusack et al., 2016).

EMDR therapy was introduced in 1989 (Shapiro, 1989) and was received with skepticism at first (e.g. Lohr, Kleinknecht, Tolin & Barrett, 1995; Herbert et al., 2000). For example, according to Lilienfeld (1996) the continued widespread use of EMDR therapy for therapeutic purposes was “only another example of human mind’s willingness to sacrifice critical thinking for wishful thinking.” However, over the past decades several meta-analyses have shown EMDR to be highly effective in the treatment of PTSD (Bisson et al., 2007; Bradley, Greene, Russ, Dutra & Westen, 2005; Chen et al., 2014; Lee & Cuijpers, 2013; Seidler & Wagner, 2006) and, as a result, EMDR has been recommended as a first-line treatment for PTSD in treatment guidelines in the Netherlands, United Kingdom, France, United States, Israel, Northern Ireland and by the World Health Organization (American Psychiatric Association, 2004; Bleich, Kotler, Kutz & Shalev, 2002; CREST, 2003; Dutch National Steering Committee Guidelines Mental Health Care, 2003; Haute Autorité de la Santé, 2007; National Institute for Clinical Excellence, 2005; World Health Organization, 2013).

A crucial element in EMDR therapy is the recall of emotionally disturbing memories while engaging in eye movements (EM), typically induced by following the therapist’s fingers moving the hand back and forth in front of the patient’s eyes. Lee and Cuijpers (2013)

conducted two separate meta-analyses, one including laboratory and the other clinical studies, showing the effectiveness of employing EM while holding a memory in mind with medium to large effect sizes in laboratory studies, and medium effect sizes in clinical studies.

The claim that Recall+ EM is effective in reducing the emotionality of disturbing memories was not based on earlier scientific studies and was unconventional. An even more unconventional claim, not derived from science either, has been made by Nik and Eva Speakman (http://www.speakman.tv/#!/page_home). They claim that emotionally disturbing memories can be successfully processed by instructing patients to follow a watch with their eyes. More specifically, the therapist draws a circle with a watch in front of the patient, and asks the patient to bring up an image of a person or a memory of an event which made them laugh, and indicate where in the circle - while recalling this mental representation and following the watch –they feel the urge to laugh the most. This procedure is repeated for the emotionally disturbing memory. The therapist then moves the watch quickly from the most disturbing point (the 'trauma point') to the point where the patient feels the urge to laugh (the 'laughter point') while saying 'Whoosh!' out loud. The patient is instructed to keep their eyes focused on the watch, blink and sigh (see 'Procedure' for a more elaborative description of the Visual Schema Displacement Therapy, or VSDT, formally called Visual Coding [https://www.youtube.com/watch?v=y3nRRMVHpWI]).

This claim about its effectiveness has many elements of pseudo-science, particularly the claim of being a miracle cure for a wide array of mental disorders (e.g., PTSD, obsessive compulsive disorder, agoraphobia, specific phobia) and with an unclear theory about the working mechanism (Cuijpers & Cristea, 2016). More importantly, there is complete lack of empirical evidence concerning the efficacy of this therapy. Yet, as Meyers (2007) pointed out "a large number of significant discoveries in medicine arose, and entirely new domains of knowledge and practice were opened up, not as a result of painstaking experimentation, but rather from chance and even outright error." Some accidental discoveries (e.g. X-rays, the first antibiotic, chemotherapy drugs and Dramamine as a drug in preventing and relieving motion sickness) stem from observations that were curious and may very well have been unreliable (Meyers, 2007). This warrants keeping an open-mind about the extraordinary claims, such as made in the case of VSDT.

The authors, decided to put the procedure to a critical test to assess its effectiveness in reducing the disturbance of emotional memories. As mentioned, the Recall + EM versus a Control Condition (CC) procedure has been a well-accepted paradigm to study (e.g. Andrade, Kavanagh & Baddeley, 1997; de Jongh, Ernst, Marques & Hornsveld, 2013; Maxfield, Melnyk & Hayman, 2008; Wilson, Becker & Tinker, 1995). An even more stringent condition was used here. That is, we decided to test not only whether VSDT was superior to a non-active control condition (CC), but also whether VSDT effects could be similar or even superior to the effects observed in laboratory models of EMDR, i.e. Recall + EM. Two experiments were conducted: The first used a within-group design comparing recall + EM with VSDT, and a CC; the second experiment employed a more stringent between-group design to allow for assessment of follow-up results.

Experiment 1

Methods

Participants

Data from 30 participants (22 female, 8 male) from Utrecht University (*M* = 22.53, *SD* = 3.69) were included in the analyses. Forty-four participants, who received either course credits or financial compensation for participating, were recruited initially, but six participants did not complete the procedure; five were unable to select three negative memories, and one appeared not to be a student, which was an inclusion criterion. Eight further participants were excluded after completing the procedure (see Results).

Materials

Subjective intensity of disturbance. Subjective intensity of disturbance or distress felt by the individual due to an image or an emotional memory being recalled was indexed by a 11-point Likert-type subjective anxiety scale, the Subjective Units of Disturbance (SUD) scale. The scale ranges from 0 (“none at all”) to 10 (“maximum distress”). The SUD scale was introduced by Wolpe (1969) and incorporated in the standard EMDR protocol (Shapiro, 1995). In the present study, participants were requested to indicate the SUD score verbally to the research assistant at the start of and after each condition.

Vividness. Perceived intensity of vividness of an image or emotional memory being recalled was measured using vividness scores ranging from 0 (“not vivid at all”) to 10 (“very

vivid"). Participants indicated this score verbally to the research assistant at the start of each condition, and after each condition.

Subjective urge to laugh. The subjective urge to laugh felt by the individual attributed to a happy emotional memory or a person being recalled was indexed using a laughter-point-score. The laughter point had to be at ≥7 on a scale of 0 ("no urge to laugh") to 10 ("maximum urge to laugh") (*M* = 8.33, *SD* = .88). Participants indicated this score verbally to the research assistant at the beginning of the VSDT condition.

Procedure

Study procedures were approved by the Facultairy Medical Ethics Committee of the Utrecht University (The Netherlands) (FETC16-101). Students were recruited at Utrecht University. They were asked whether they were interested in participating in an experiment concerning emotional memories for either credits or money. The duration of the experiment was 50 minutes. The experiment was carried out by a research assistant, who was part of the author team and was trained in VSDT by the originators of VSDT. Training in the EMDR procedure was provided by an EMDR Europe accredited trainer. Fidelity checks were based upon video recordings that were carried out on a pilot sample to ensure the procedure was carried out properly. When participants agreed to participate, an appointment was made for a later date. Once the experiment started, they were given an information letter which informed them about the procedure of the experiment, anonymity procedures, the right to stop the experiment at any time without consequences, and included instructions to inform the research assistant if they were feeling too uncomfortable to recall the emotional memories. If the participants had no questions, an informed consent was given for signing. After signing, a screening checklist was completed which included questions about age, education level, sex, and exclusion criteria. Participants were excluded if they were not students, had disrupting visual problems which made it unable to see the research assistant's actions necessary for the experiment, or when they had a possible interaction between their attention or concentration and medication, alcohol, drugs, current psychiatric treatment, fatigue or extreme stress. After the checklist, three emotional memories were selected and were rated as "somewhat disturbing", "reasonably disturbing", "fairly disturbing", "quite disturbing" or "very disturbing". Only memories rated as "fairly disturbing", "quite disturbing" or "very disturbing" were included. In total, 90 memories were selected, of which 57.8% were rated as "fairly disturbing", 32.2% as "quite disturbing"

and 10% as "very disturbing". The participants formulated a (few) keyword(s) per memory and they estimated the duration passed since the memory event had taken place. The research assistant asked every participant for a summary of the event to check for any irregularities (e.g. a fake memory or a psychotic episode). For the next procedure, they were asked to choose the keyword that best suited the memory.

Memories were ranked by emotional disturbance (by asking the participants to indicate the rank order). Counterbalancing was then applied for the memories (most, middle, least disturbing) and the conditions (VSDT, EMDR, CC). This resulted in 36 different sequences, to which participants were sequentially allocated. All three conditions took 8 minutes. In this time, the most disturbing part of the selected memory ("target") was recalled, rated on a scale of 0 to 10 on emotional disturbance and vividness, and then either EMDR, VSDT or the CC was applied, depending on the sequence.

The EMDR procedure consisted of an abbreviated version of the Dutch version of the EMDR Standard protocol (de Jongh & ten Broeke, 2012). In the EMDR Standard protocol patients are requested to describe a memory in global storylines and select the most disturbing image of the memory ("target") in present time. In the present study participants recalled a memory, but were not specifically asked for the global storylines. They were asked to select the most disturbing part of the memory (target) in the present time, which also included an image in this procedure. Similar to the EMDR protocol they were asked to rate the Subjective Units of Disturbance (SUD; see Materials) of the target and to point out the location in the body where this disturbance was felt the most. For this study, the participants were also asked to rate the vividness of the target. Then, while recalling the target, EM were evoked by the research assistant. She moved her fingers horizontally in front of the participant for sets of 30 s each, about 30 cm from the participants' eyes. After each set of EM, the research assistant asked for associations, and directly after she instructed the participants to concentrate on that what came to mind. When no associations occurred, or the participant mentioned the same association three times the SUD of the target was re-rated, after which the sets of 30 s EM were continued. After 8 minutes, the alarm went off and the participant was asked to re-rate the target on SUD and vividness.

In the VSDT condition participants were told which memory was being targeted, but before this, they were asked to select a mental representation of a person or a memory of

an event which made them laugh. They had to select a keyword for this memory or person. The research assistant stood in front of the participant at approximately 1.25 m, while the participant was seated. The assistant held a watch with the clock face towards the participant and drew a circle with a diameter of about 1.5 m in a clockwise motion from the assistants' point of view. The participant was instructed to follow the watch with their eyes, and to indicate where in the circle the strongest urge to laugh was felt. This point was indicated as the "laughter point", which was given the name of the keyword. The participant calibrated the urge to laugh at the laughter point on a scale of 0 ("no urge to laugh") to 10 ("maximum urge to laugh"). Then the same procedure was repeated for the emotional memory. The participant was asked to select the most disturbing part of the memory ("target"), and to indicate where in the circle the "trauma point" – the point where he felt the most disturbance - was located. The participant rated the SUD and the vividness of the target. After that, the assistant explained the procedure. Then, she moved the watch quickly from the trauma point to the laughter point and instructed the participant to keep their eyes focused on the watch. Next, the participant had to blink repeatedly, to squeeze the eyes tight and to make two deep sighs. After repeating the procedure three times participants rated by how much the SUD score associated with the target was reduced compared to the previous rating. This procedure was repeated. After 8 minutes, the alarm went off and the target was re-rated on SUD and vividness.

In the non-active control condition (CC), participants were asked to select the most disturbing part ("target") of the emotional memory, and rate its disturbance and vividness. Next, the participants were instructed to do nothing and relax and were told it did not matter what they thought about. After 8 minutes – when the alarm went off –the target was re-rated on SUD and vividness.

After completing all three conditions the participants were given a debriefing, in which they received more information about the experiment, and were asked to not disclose any information to others. In the final stage, the students were given their financial reimbursement or student credits. The procedure from memory selection to the post rating is visually depicted in Figure 1.

Design

The experiment had a 3 (Condition: Eye Movement Desensitization and Reprocessing [EMDR] and Visual Schema Displacement [V] and Control Condition [CC]) by 2 (Time: pre-

and post intervention) repeated measures design. Dependent variables were "Subjective Units of Disturbance" (SUD), and "Vividness" of the most disturbing part of the memory. To eliminate order effects, the order of the conditions was counterbalanced. There was also a counterbalance in order of the selected memories on disturbance, i.e. there was an alternation in the order based on the extent to which the memories felt disturbing.

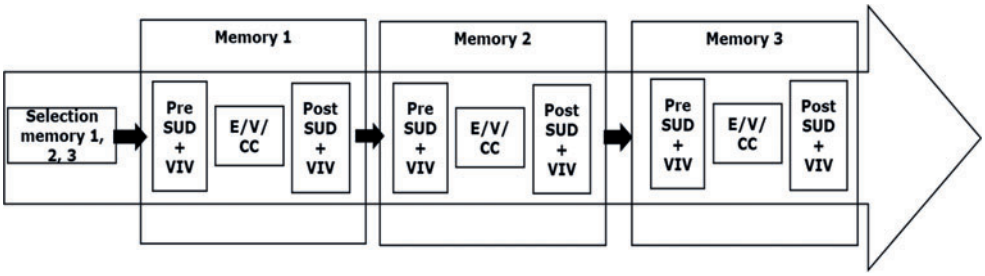

Figure 1. The experiment timeline for Experiment 1 (*N* = 30). (Abbreviations: SUD, SUD scores; VIV, vividness scores; E, EMDR; V, VSDT; CC, Control Condition).

Data analyses

A power analysis showed that to obtain a power of 0.8 with a probability error of .05 and an estimated effect size of .25, 36 participants would be needed. The data were analyzed using both Bayesian statistics and classical statistics.

Bayesian statistics. Different expectations about the means were formulated as informative hypotheses (provided below) that were evaluated using Bayesian model selection. An advantage of the Bayesian approach is that it does not depend on dichotomous decisions (significant Y/N), but provides relative support for a pre-specified model or models (Klugkist, Laudy and Hoijtink, 2005). This enables direct testing of theoretical expectations without the need for *post hoc* pairwise comparisons. Furthermore, different models can be tested at once. The results of the Bayesian model selection are expressed in terms of Bayes factors (BFs). A BF represents the level of evidence for one model compared to another. To evaluate the support for an informative hypothesis, it can be evaluated against a model without constraints. A BF lower than 1 indicates no support, whereas BFs above 1 indicate support for the informative hypothesis obtained from the data. A higher BF represents more support for the hypothesis. A BF of 1 means that both models receive equal support, and therefore that the data are indecisive with respect to the

informative hypothesis. Finally, one can compare two informative hypotheses mutually by computing the ratio of the two BFs that evaluated the informative hypotheses against the unconstrained model. The Bayesian approach was added to the classical one, not because the authors believed it would favor any particular hypothesis, but because of the inherent problems in H0 testing that are reduced by a Bayesian approach (Mulder, Hoijtink & Klugkist, 2009; van de Schoot, Hoijtink, & Doosje, 2009; van de Schoot et al., 2014). Analyses were performed using the software BIEMS (see Mulder, Hoijtink, & Klugkist, 2010; Mulder, Hoijtink, & De Leeuw, 2012). Wetzels et al. (2011) and Krypotos, Blanken, Arnaudova, Matzke, and Beckers (2017) provide more background information on Bayesian analyses and the comparison with p-value significance testing.

In the present experiment four models were compared for both SUD and vividness-scores. All analyses were conducted separately on SUD and Vividness. In all models, the assumption was made that EMDR would outperform the CC. This expectation is based on earlier laboratory studies and clinical studies which showed the added value of EM in reprocessing emotional disturbing memories (e.g., Lee & Cuijpers, 2013). As this was the first VSDT experiment, no theoretical assumptions on the effect could be made. Nevertheless, there was no assumption that VSDT would have a detrimental outcome compared to the CC condition. The four compared models were:

1: (VSDT pre- post) > (EMDR pre- post)> (CC pre-post)

2: (VSDT pre-post) = (EMDR pre-post) > (CC pre-post)

3: (EMDR pre-post) > (VSDT pre-post) > (CC pre-post)

4: (EMDR pre-post) > (VSDT pre-post) = (CC pre-post)

Classical Statistics. Besides Bayesian statistics, data were analyzed using SPSS (Version 22.0). A repeated measures (3 x 2) ANOVA was conducted, with Condition (VSDT; EMDR; CC) and Time (pre-and post) as independent variables. The dependent variables were SUD and vividness scores. All analyses were conducted separately on SUD and Vividness. *Post hoc* analyses were conducted when significant main or interaction effects were found.

Results

Data were obtained from 38 participants, although data from 8 participants were excluded, resulting in including 30 participants in the analyses. One student reported psychotic memories and was paranoid during the experiment (more specifically, the

participant thought the research assistant had recorded the whole procedure). The other student was excluded because he stated he had been meditating during the CC. Six other patients were excluded because of procedural reasons. These participants reached "SUD 0" – meaning there was no emotionality left – in the VSDT condition before the 8 minutes were over (varying from between 7 minutes and 20 seconds to 7 minutes and 55 seconds). This resulted in a procedural error where the participants ended with the question posed at the end of the VSDT procedure. This meant the wording differed slightly from the wording of the question for those who participated in the full 8 minutes. Excluding these participants from the analyses meant leaving out participants who responded the quickest to the VSDT condition which, if anything, would be detrimental to VSDT compared to the other conditions.

Participants had the VSDT procedure carried out 2 to 4 times (the 'Whoosh!' was carried out 3 times per procedure; *M* = 2.77, *SD* = .63) and sets of EMDR (performed 30 s) 5 to 8 times (*M* = 6.60, *SD* = .86). Table 1 displays the means and standard deviations of the pre- and post-SUD and vividness scores.

Table 1

Means and standard deviations pre- and post-measurement scores of SUD and vividness per condition (N = 30)

Condition	**Pre-SUD**	**Post-SUD**	**Pre-vividness**	**Post-vividness**
EMDR	7.40 (*1.33*)	5.10 (*1.83*)	7.97 (*1.54*)	6.07 (*1.60*)
VSDT	7.50 (*1.28*)	3.50 (*1.93*)	7.63 (*1.54*)	5.97 (*1.87*)
CC	7.27 (*1.17*)	6.20 (*1.81*)	8.07 (*1.08*)	7.47 (*1.48*)

Emotionality scores

Bayesian analyses. Bayesian analyses showed a clear pattern in that VSDT was superior to EMDR and the CC, whereas EMDR was found to be superior to the CC. This was supported by the BF value for Model 1 (VSDT > EMDR > CC; $BF_1 = 6.54$). No support was found for superiority of EMDR over both VSDT and the CC (Model 3 and Model 4 both show a BF of .00). Furthermore, no support was found for Model 2 (VSDT = EMDR > CC; $BF_2 = .01$).

Classical analyses. A oneway repeated measures ANOVA showed that SUD pre-scores did not differ between the three conditions (F (2, 58) = .38, p = .69). A 2x3 repeated measures ANOVA showed there was a main effect for Time, F (1, 29) = 91.33, p < .001, η_p^2 = .76 and Condition, F (2, 58) = 10.37, p < .001, η_p^2 = .26 and a crucial interaction effect of Time x Condition, F (2, 58) = 29.99, p < .001, η_p^2 = .51. *Post hoc* pairwise comparisons adjusted with Bonferroni correction indicated that VSDT difference scores outperformed EMDR (p < .001, d = .84) and the CC (p < .001, d = 1.7), and that EMDR outperformed the CC (p = .02, d = .69).

Vividness scores

Bayesian analyses. There was support for Model 2 (VSDT = EMDR > CC; BF_2 = 4.53) and Model 3 (EMDR > VSDT > CC; BF_3 = 3.86), which indicated superiority of EMDR and VSDT over CC, with only slightly more evidence for the model showing equal efficacy of EMDR and VSDT (BF_2 : BF_3 = 1.17). There was also some support for Model 1 (VSDT > EMDR > CC; BF_1 = 1.92), but no support for Model 4 (EMDR > VSDT = CC; BF_4 = .14).

Classical analyses. Pre-vividness scores did not differ per condition F (2, 58) = 1.41, p = 0.25. For vividness, the results showed a main effect for Time F (1, 29) = 63.96, p < .001, η_p^2 = .69, Condition F (2, 58) = 8.91, p < .001, η_p^2 = .24 and the interaction effect of Time x Condition F (2, 58) = 7.61, p < .001, η_p^2 = .21 was also significant. *Post hoc* comparisons found VSDT and EMDR to be equally effective in reducing vividness of the emotional memories (p= 1.00), whereas VSDT and EMDR both outperformed the CC (p = .01, d = .82, p = .01, d = .89 respectively).

Discussion of Experiment 1 and Introduction to Experiment 2

The results of Experiment 1 showed that VSDT and EMDR were superior to the CC in reducing emotionality and vividness. Surprisingly, considering the lack of rationale of VSDT and the fact that it was compared to an effective therapy (EMDR), VSDT was just as effective as EMDR in reducing vividness and more effective than EMDR in reducing emotionality. The pattern was statistically reflected in both Bayesian and classical analyses. As mentioned earlier, in the VSDT condition 6 out of 36 participants reported a SUD score of 0 before the 8 minutes that ended the intervention. Although for these early responders the question about the SUD score had been formulated as “How much is the disturbance reduced? It was ‘X’, what is it now?’’ it should have been formulated as “When you think about the worst

part, how unpleasant does it feel or how much disturbance do you feel on a scale from 0, no disturbance, to 10, maximal disturbance?". This is because this was the final question for all participants in all three conditions. Note also that only one of the participants reached "SUD 0" in the EMDR condition and none reached "SUD 0" in the CC. The participant with the "SUD 0" score in the EMDR condition was one of the six that was removed. Removal of the 6 subjects who responded so quickly and favorably to VSDT has, arguably, induced an underestimation of the VSDT effect. To avoid any discussion about the integrity of the findings we decided to remove these individuals from the data set.

To test the robustness of the observations we decided to carry out a replication experiment. The question arose whether, if replicated, the favorable effect of VSDT would survive the passage of time. In order to evaluate the long-term effects, the design of Experiment 2 was changed into a between-group design. To be fully transparent about data collection, hypotheses and analyses, the study was preregistered on the Open Science Framework (https://osf.io/kuenp/).

Experiment 2

Methods

Participants

Data from 75 participants (53 female; *M* = 22.93, *SD* = 3.03) were obtained and included in the analyses. They joined the experiment in reward for course credits or financial compensation. Initially, 77 participants entered, but 2 participants were excluded from the analyses. One did not finish the procedure and one applied mindfulness during the control condition, which was considered a violation of the study protocol.

Materials

The second experiment also used SUD scores and vividness scores (see "Materials" Experiment 1 for a detailed description). The laughter point scores were not considered in this experiment, because the scores were not to be used in the analyses.

Procedure

Study procedures were approved by the Facultairy Medical Ethics Committee of the Utrecht University (The Netherlands) (FETC17-030). Procedures for Experiment 2 were identical to Experiment 1, except that participants were exposed to one randomly assigned intervention rather than three. The allocation to the conditions was sequential. Exposure to

one intervention resulted in a shorter time span of approximately 30 minutes. After the checklist, one emotional memory was selected which was rated on a SUD scale from 0 ("not disturbing") to 10 ("maximum disturbance"). Memories rated with a SUD score of ≥7 were included in the experiment. In contrast to Experiment 1 "being a student" was not part of the inclusion criteria. The experiment was conducted by a graduate student who was not part of the author team and who was trained in VSDT by the VSDT developers, and in EMDR by an EMDR Europe accredited trainer. Fidelity checks were carried out on a video-recorded pilot sample to ensure the procedure was carried out properly.

After finishing the experiment, participants were asked for contact details and a follow-up (FU) telephone appointment was planned in a time range of 6 to 8 days after the intervention. The research student phoned the participants, and asked the participants to re-rate the SUD and vividness of the worst part of their memory. Next, a debriefing was send to them by email, which contained more information about the experiment. Participants were asked not to disclose any information to other persons, and the financial reimbursement or student credits were accredited. The procedure from memory selection to the post rating is visually depicted in Figure 2.

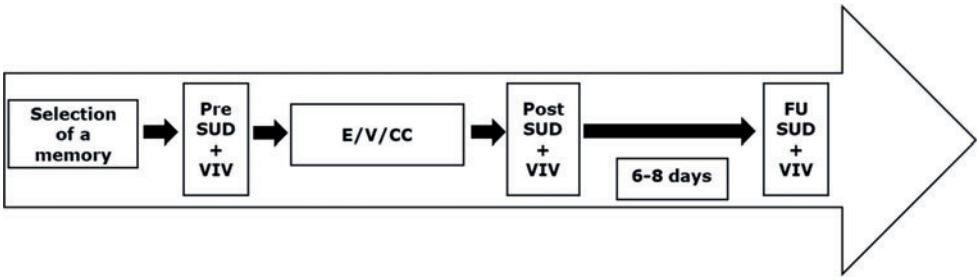

Figure 2. The procedure timeline for Experiment 2 (*N* = 75). (Abbreviations: SUD, SUD scores; VIV, vividness scores; E, EMDR; V, VSDT; CC, Control Condition; FU, Follow-Up.)

Design

The study had a 3 (Condition: Eye Movement Desensitization and Reprocessing (EMDR), Visual Schema Displacement (V) and Control Condition (CC) by 3 (time; pre, post and follow-up) between- repeated measures design, with Time as the within-subjects factor and Condition as the between-subjects factor. Dependent variables were "Subjective Units of Disturbance" (SUD; Emotionality) and "Vividness" of the memory.

Data analyses

A power analysis showed that to obtain a power of 0.8 with a probability error of .05 and an estimated effect size of .3, 75 participants would be needed.

Bayesian statistics. Similar to Experiment 1 the data were analyzed using both Bayesian statistics and classical statistics. Because of the outcome of Experiment 1, two models were added (Models 5 and 6), with the EMDR outcome being equal to the outcome of the CC. All models were used for comparing both SUD and Vividness from pre- to post, from pre-to follow-up and from post to follow-up. Although no difference was expected from post to follow-up – which would only require Model 6 - for completeness also Model 1-5 were tested.

1: VSDT > EMDR > CC

2: VSDT = EMDR > CC

3: EMDR > VSDT > CC

4: EMDR > VSDT = CC

5: VSDT > EMDR = CC

6: EMDR = VSDT = CC

Classical statistics. The data were analyzed using SPSS (Version 22.0). The repeated measures -between subjects (3 x 3) ANOVA was conducted, with Condition (VSDT; EMDR; CC) and Time (pre; post and follow-up) as independent variables. The dependent variables were SUD and Vividness scores. Post hoc analyses were conducted when significant main or interaction effects were found.

Results

Data were obtained from 75 participants. Participants had the VSDT procedure carried out 2 to 5 times (the 'Whoosh!' was carried out 3 times per procedure; *M* = 3.28, *SD* = .89) and sets of EMDR (performed 30 s) 5 to 8 times (*M* = 6.16, *SD* = .84). Table 2 displays the means and standard deviations of the pre, post and follow-up SUD and Vividness scores.

Emotionality scores

Bayesian analyses. Bayesian analyses showed the same pattern as in Experiment 1 for the results from pre-to post. VSDT was superior to both EMDR and the CC, while EMDR was superior to the CC. This was supported by the BF values for Model 1 (BF_1 = 6.41). There was no support for superiority of EMDR over both VSDT and the CC. Model 3 (EMDR > VSDT

> CC) showed a BF_3 of .03 and Model 4 (EMDR > VSDT = CC) showed a BF_4 of .00. There was also no support for equality of VSDT and EMDR over the CC (Model 2 [VSDT = EMDR > CC]: BF_2 = .13). In addition, the supplementary models in Experiment 2 were not supported by the results (Model 5 [VSDT > EMDR = CC]: BF_5 = .76; Model 6 [EMDR = VSDT = CC]: BF_6 = .00]). When comparing the pre-SUD scores with the follow-up SUD most support was found for Model 1: VSDT > EMDR > CC; (BF_1 = 4.85). Although the support for Models 2 and 5 was no longer below 1 (resp. 1.05 and 1.26), Model 1 was still the model that received most positive support. No support was found either for all other models (Model 3: EMDR > VSDT > CC, Model 4: EMDR > VSDT > CC and Model 6: EMDR =VSDT = CC) (BF_3 = .33, BF_4 = .02, BF_6 = .05). From post to follow-up the data did not support Model 1 (VSDT > EMDR > CC; BF_1 = .01), Model 2 (VSDT = EMDR > CC; BF_2 = .04), Model 3 (EMDR > VSDT > CC; BF_3 = .04), Model 4 (EMDR > VSDT = CC; BF_4 = .19), Model 5 (VSDT > EMDR = CC; BF_5 = .03) or Model 6 (VSDT = EMDR = CC; BF_6 = .22), indicating that there was another pattern or model, not pre-specified in this study, which could support the data better.

Table 2

Means and standard deviations of the pre, post and follow-up measurement scores of SUD and vividness per condition

Condition	Pre-SUD	Post-SUD	FU-SUD	Pre-vividness	Post-vividness	FU-Vividness
EMDR	7.92 (*.70*)	5.76 (*1.42*)	5.48 (*1.45*)	8.68 (*1.18*)	6.92 (*1.35*)	5.88 (*1.74*)
VSDT	7.84 (*.80*)	3.92 (*1.98*)	4.60 (*1.29*)	8.08 (*1.26*)	5.92 (*2.10*)	5.44 (*1.47*)
CC	7.64 (*1.00*)	6.56 (*1.16*)	6.00 (*1.56*)	8.00 (*1.50*)	7.28 (*1.57*)	6.72 (*1.57*)

Classical analyses. A oneway ANOVA revealed that the SUD pre-measurement scores did not significantly differ per condition (F (2, 72) = .74, p = .48). A 3 (Time) by 3 (Condition) ANOVA was conducted revealing a main effect for Time, (F (2, 144) = 111.14, p < .001, η_p^2 = .61), and Condition (F (2, 72) = 12.79, p < .001, η_p^2 = .26), and a significant Time x Condition effect (F (4, 144) = 9.91, p < .001, η_p^2 = .22). A oneway ANOVA on difference scores from pre-to post showed an effect for Condition (F (2, 72) = 17.70, p < .001, η_p^2 = .33). *Post hoc* analyses adjusted with Bonferroni correction showed that VSDT outperformed both EMDR

(p = .001, d= .93) and the CC (p < .001, d= 1.52), but no difference was found between EMDR and the CC (p = .08). From pre-to follow-up a oneway ANOVA on difference scores showed an effect for Condition (F (2, 72) = 6.60, p = .002, η_p^2 = .16). *Post hoc* analyses adjusted with Bonferroni correction showed a significant difference between VSDT and the CC (p < .01, d= .97), which was in favor of VSDT, but no significant difference was found between VSDT and EMDR (p = .22). In addition, no difference was found between EMDR and CC (p = .22). To analyze the effect on the SUD from post to follow-up a oneway ANOVA on the SUD difference scores from post to follow-up was carried out showing a significant effect for Condition (F (2, 72) = 4.17, p = .02, η_p^2 = .10). The *post hoc* analyses adjusted with Bonferroni correction showed a difference between VSDT and the CC (p = .02, d= .70), with a significant better result for the CC. No difference was found between EMDR with either VSDT and the CC (p = .11, p = 1.00).

Vividness scores

Bayesian analyses. Bayesian analyses of pre-to post showed the strongest support for Model 1 (VSDT > EMDR > CC) with a BF_1 of 5.17, reflecting the fact that VSDT outperformed EMDR and that EMDR was superior to the CC. There was also support for Model 2 (VSDT = EMDR > CC) with a BF_2 of 3.96, and there was a relative benefit for Model 1 of (BF_1:BF_2) 1.30. There was less, but still some support for Model 3 (EMDR >VSDT > CC) which was expressed in a BF_3 of 1.40. For Models 4, 5 and 6 no support was found (Model 4: EMDR > VSDT = CC, Model 5: VSDT > EMDR = CC, Model 6: EMDR = VSDT = CC) with BF's of .10, .72 and .13. When comparing the pre-vividness scores with the vividness scores at follow-up most support was found for Model 2: VSDT = EMDR > CC (BF_2 = 4.36), implying that VSDT and EMDR were equally effective and both more effective than the CC in decreasing vividness from pre-to FU. But there was also support for Model 3 (EMDR > VSDT > CC) which was expressed in a BF of 3.92. Model 2 had only slightly more relative support than Model 3 (BF_2:BF_3 = 1.11) and Model 1 (VSDT > EMDR > CC) also had a BF which indicated support (BF_1 = 2.27). Similarly, in Model 1, 2 and 3 both EMDR and VSDT were superior to the CC. No support was found for Model 4, 5 and 6 (Model 4: EMDR > VSDT = CC, Model 5: VSDT > EMDR = CC, Model 6: EMDR = VSDT = CC) with BF's of .22, .10 and .06. From post to the follow-up measurement the results corroborated Model 4 (EMDR > VSDT = CC; BF_4 = 3.64) the most, but there was also support for Model 6 (VSDT = EMDR = CC; BF_6 = 2.98), with only slightly more evidence for EMDR being more successful in the decrease in

vividness while VSDT and the CC were equal in their effect (BF_3:BF_6 =1.22). There was also some support for Model 3 (EMDR > VSDT > CC; BF_3 = 1.85) and Model 2 (VSDT = EMDR > CC; BF_2 = 1.82). The data did not corroborate Model 1 (VSDT > EMDR > CC; BF_1 = 0.57) and Model 5 (VSDT > EMDR = CC; BF_5 = 0.88).

Classical analyses. A oneway ANOVA showed pre-vividness scores did not differ per condition (F (2, 72) = 1.99, p = .15). A 3 (Time) by 3 (Condition) ANOVA was conducted and revealed there was a main effect for Time (F (2, 144) = 65.64, p < .001, η_p^2 = .48), Condition (F (2, 72) = 3.64, p = .03, η_p^2 = .09), and the interaction effect of Time x Condition (F (4, 144) = 3.72, p = .01, η_p^2 = .09) was also significant. A oneway ANOVA on Vividness difference scores from pre-to post showed an effect for Condition (F (1, 72) = 5.15, p = .01, η_p^2 = .13). Post hoc analyses adjusted with Bonferroni correction revealed no differences between the conditions VSDT and EMDR (p = 1.00) and between EMDR and the CC (p = 0.83), but VSDT and the CC differed significantly (p = .01, d= .82). A oneway ANOVA on Vividness difference scores from pre-to FU showed an effect of Condition (F (2, 72) = 6.38, p = .003, η_p^2 = .15). *Post hoc* analyses adjusted with Bonferroni correction showed that both VSDT and EMDR were superior to the CC (p= .01, d= .84, $p \leq .01$, d= .54) but that EMDR and VSDT did not differ (p= 1.00). A oneway ANOVA on Vividness difference scores from post to the follow-up measurement showed no effect for Condition (F (2, 72) = .64, p = .53).

Discussion

The purpose of the present study was to critically test the claim that VSDT is capable of reducing the emotionality and vividness of negative memories. As well as comparing VSDT to a non-active control condition, we also determined whether the effects would be similar, or even superior, to those of a laboratory version of EMDR therapy (Recall + EM). Two experiments were conducted. In the first experiment VSDT was compared to EMDR and a Control condition (CC). In the second (replication) experiment a follow up measurement was added to determine whether the results would be maintained over time. Both experiments showed VSDT was superior to EMDR and the CC, while EMDR had stronger effects than the CC in reducing emotional disturbance of disturbing memories. VSDT and EMDR were equally effective in reducing vividness and both were shown to be more effective than the CC.

The results were unexpected, robust and in favor of VSDT. In terms of emotionality scores, the only time-span where VSDT did not excel, was in effecting SUD scores from post to the follow-up measurement in the second experiment. This raises the question as to why VSDT was so effective. The procedure is curious, to say the least, whereas the originators of this method have little clue about how the procedure might work. We determined the differences between VSDT with an active control condition (EMDR) with a paradigm often used in experimental psychopathology research. However, there are a few hypotheses which might partially explain the effectiveness of VSDT. First, the unconventional nature of VSDT may have generated, at the very beginning of this treatment, the *expectation* that this would be helpful. But it is far from obvious that unconventionality breeds positive expectations. Also, empirically it was shown in an experimental set-up like the present one, that participants with (experimentally induced) negative expectations about recall+ EM reported the same positive effects as individuals with induced positive expectations (Littel, van Schie & van den Hout, 2017). Second, much of the effects of EMDR can conveniently be explained by the working memory theory (e.g. Gunter & Bodner, 2008; van den Hout & Engelhard; 2012). For reasons of parsimony it is tempting to try and explain VSDT effects in the same theoretical terms. On the one hand, one could argue that this effort to do so is farfetched, stretching working memory theory beyond its limits. On the other, VSDT has a number of procedural steps ensuring that while the memory is activated, patients' working memory is taxed. This is particularly the case during the interval when the participants eyes are directed at a point of which he/she indicates that the emotions attached to the memory are most strongly felt, and the 'Whoosh!' is introduced. The latter step has a number of similarities with the desensitization phase of EMDR therapy, but both procedures seem to differ strongly in terms of intensity. That is, whereas in EMDR, after the memory has been activated, the therapist's hand is introduced to help employ horizontal eye movements to tax working memory resources, the VSDT therapist applies a massive dose of working memory taxation by using a combination of an unannounced exclamation of the word 'Whoosh!' (i.e., an auditory task), and an unexpected and quick oblique movement of his arm (i.e., visual task). Third, there is another unique aspect of VSDT that might at least partially explain some of its effectiveness, and that is the addition of arousal. Unlike EMDR, in VSDT distress and arousal is created since the patient does not know when the therapist will suddenly call out loud the word 'Whoosh!' and he has to quickly follow the therapist's

arm movement. To this end, the latter is particularly interesting given that a recent study showed that individuals who first underwent a stress inducing task to increase their arousal showed reduced vividness of emotionally neutral memories after the dual tasking, while those who carried out a recall only task, did not (Littel et al., 2017a). In the same vein, a placebo controlled study showed that reducing arousal by beta blockers reduces the positive effects of Recall + EM (Littel et al., 2017c). In future studies it would be enlightening to test several variations of the procedure to tease out which of the various elements (e.g. blinking, eye closure, saying "Whoosh") contributes to the effects. Testing variations lends itself to dissection of (non)-effective ingredients.

Some limitations need to be noted. Firstly, the follow-up period of the second experiment was rather short (6 to 8 days). It is unclear what would have happened to the SUD scores if the follow-up period had been longer, or if the telephone interview had been replaced by a face-to-face follow-up interview. Although a face-to-face interview may have been more reliable, this was not undertaken due to the anticipated drop out. However, it is unlikely that this would explain why EMDR and the CC show better results than VSDT from post to the follow-up measurement, as the same type of assessment was made in these conditions. Secondly, the measurements taken consisted of self-reports about subjective mental states, i.e., ratings of experienced vividness and emotionality. Note however that these very same measures are well accepted in memory research (Benjamin et al., 2010; Bremner et al., 1999; Devilly & Spence, 1999; Heeren, Reese, McNally & Philippot, 2012; Osuch et al., 2001; Littel, Remijn, Tinga, Engelhard & van den Hout, 2017). Support for the use of the SUD scale to index emotionality of memories was found in a study among 61 individuals (with PTSD [55%], major depressive disorder [20%], other anxiety disorder(s) [8%] or another disorder [16%]) showing good psychometric properties for this measure (Kim, Bae & Chon Park, 2008). Therefore there is no reason to doubt the usefulness of such measures in the experiments reported here.

A strength of the study is the design of the experiments, which was rather strict and comparable to experiments carried out in related areas (Engelhard, van den Hout, Janssen & van der Beek, 2010; Engelhard, van den Hout & Smeets, 2011; van Veen, Engelhard & van den Hout, 2016; van Veen et al., 2015). It is difficult to see how the methods used may have favored the positive outcomes for VSDT. In fact, and if anything, the method may have been detrimental towards the VSDT-condition. For example, the exclusion of the six most positive

responders to the VSDT condition from the analyses in the first experiment, could easily have led to an underestimation of the true VSDT effects. Furthermore, applying a strict Bonferroni correction for multiple testing is a conservative strategy (Rothman, 2014) and the fact that VSDT survived most of the Bonferroni corrected comparisons, argues *a fortiori* for the effectiveness of the intervention. Moreover, the VSDT condition was at a disadvantage compared to the EMDR condition, as a larger part of the time of the intervention was used for preparation and explanation. The duration of strict VSDT was thereby somewhat smaller than the duration of EMDR. This translated in a lower number of VSDT sets (M = 2.77, M = 3.28, respectively) compared to EMDR sets (M = 6.60, M = 6.16, respectively), averaged over both experiments. During both the VSDT and EMDR condition participants were regularly asked to report SUD scores related to the target, but the formulations, derived from the two protocols, were slightly different. In the VSDT condition participants were asked how the emotional response to the target (i.e. SUD-score) was reduced compared to the last reported rating, while in the EMDR condition the participants were asked how disturbing the target (i.e. SUD-score) was at the moment of recalling the image representing the worst part of memory. This difference in the procedure could – just like any other part – have contributed to reporting a decrease. But then, at pre-test, post-test and follow-up, the question formulation was identical in all conditions. Another strength was the use of two forms of statistical analyses, which contributes to the robustness of our findings. In the first study, there was a great overlap between the Bayesian and Classical analyses, and this was also true for the second study, albeit that small differences were found. Because of the relative support that Bayesian Statistics can provide we tend to favor the conclusion based upon the Bayesian Statistics.

In summary then, in two laboratory experiments, we studied effects of an unusual procedure that was held to reduce the emotionality and vividness of unpleasant memories. Had we not found any effects we may have been reluctant to report the data to the scientific community: nothing new with falsifying yet another power-therapy's claim. Effects were, however, observed: They were powerful and survived replication. A further step should be to test the procedure in patients and to include measurements of PTSD symptoms and longer follow-up periods. It may be too early to call for a large RCT as yet, although the latter would be warranted if controlled n=1 studies and/or well-documented clinical case series were to corroborate the present data.

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Author contributions

Experiment 1: SM and AdJ developed the study concept, SM and AdJ and MvH contributed to the study design. SM and AdJ developed the study material and SM and LvB were responsible for data collection and for data analysis. SM and LvB drafted the manuscript, AdJ, MvH and IK provided critical revisions. All authors approved of the final manuscript. Experiment 2: SM and AdJ developed the study concept, SM and AdJ and MvH contributed to the study design. SM and AdJ developed the study material and SM and LvB were responsible for data collection and for data analysis. SM and LvB drafted the manuscript, AdJ, MvH and IK provided critical revisions. All authors approved of the final manuscript.

Conflict of interest and funding

AdJ receives income from published books on EMDR therapy and for training postdoctoral professionals in this method. None of the other authors have a conflict of interest in this study. A small grant from the Dutch EMDR association was awarded in May 2017 to SM. IK is supported with a Vidi grant (452-12-010) from the Netherlands Organization for Scientific Research (NWO). MvH is supported by a TOP grant (number: 40-00812-98-12030) from the Netherlands Organization for Health Research and Development (ZonMw).

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CHAPTER 08

General Discussion

General Discussion

The aim of the thesis was to contribute to developing effective trauma treatment strategies and refining existing ones. Three different ways were used to achieve this goal. The first was to critically test one specific element of an existing treatment protocol, with the purpose of testing its effectiveness. Chapter 2 and 3 were dedicated to this subject. The second way to contribute to this goal was to gain more understanding of the working mechanism of a specific trauma therapy, thereby coming closer to the key potential of optimizing this treatment form. Chapter 4, 5 and 6 handled this theme. The third way of delivering a contribution to the goal was to explore a novel route, possibly culminating in new treatment strategies. Chapter 7 was devoted to this subject.

EMDR in positive verbal material

Dissecting treatment protocols and testing their elements on efficacy and consequently adapting protocol by discarding non-working ingredients is beneficial for treatment efficiency and efficaciousness. **Chapter 2** and **chapter 3** tested the efficacy of one element in a treatment protocol; the procedure 'Positive Closure' in the Dutch EMDR protocol. EMDR therapy, a trauma treatment in which negative emotional memories are desensitized by recalling the memory and simultaneously engaging in horizontal eye movements, or performing other dual tasks that tax the limited capacity of working memory, is conducted by following a strict protocol, comprising several procedures. The last procedure of the standard Dutch EMDR-protocol, referred to as the 'Positive Closure' procedure, is performed at the end of every EMDR-session. A positive verbal statement about oneself is formulated by the patient and recalled, meanwhile being engaged in performing eye movements. The expectation when incorporating the procedure in the protocol was that it might reinforce any positive changes that had occurred during trauma reprocessing, stimulate positive responses, and "anchor" identified changes (de Jongh & ten Broeke, 2003, pp. 124–129), but no research was conducted on the presence of such an effect of the procedure itself, nor on the efficacy of the eye movements in the procedure.

The first two experiments, combined in the presented manuscript in **Chapter 2** (Matthijssen & van den Hout, 2016a), tested the effects of eye movements on positive verbal statements as used in the procedure in the protocol. In both experiments, undergraduates rated the belief in possessing two positive personality traits, and in

experiment 2 also the emotionality of the traits. Subsequently, they performed fifteen to twenty seconds of eye movements or fifteen to twenty seconds of keeping the eyes stationary while focusing on a statement of a positive relevant personality trait (e.g., "I'm persistent"). In experiment 1 the slightly adapted 'Positive Closure' procedure was preceded by an EMDR session to maximize ecological validity and in experiment 2 it was preceded by making a Sudoku puzzle. From a working memory taxation perspective - which implies dual tasking while engaging in recall desensitizes the recalled memory - one would predict negative consequences of the eye movements performed in the procedure, since research shows effects of working memory taxation during recall on negative, but also on prospective and positive memories by making them all less emotional (e.g., Barrowcliff, Gray, Freeman, & MacCulloch, 2004; Engelhard, van den Hout, Janssen, & van der Beek, 2010; van den Hout, Bartelski, & Engelhard, 2013; van den Hout, Muris, Salemink, & Kindt, 2001; Engelhard, van Uijen, & van den Hout, 2010). So, it was hypothesized that eye movements - by having a taxing effect on working memory - would reduce the believability of possessing the positive relevant personality trait ('weaken' the strength of the positive statement.) Results reported in chapter 2 however, showed that fifteen to twenty seconds of eye movements did not enhance or diminish participants' belief in possessing the trait. In both experiments, the eye movement and the eyes stationary condition showed no effect on the belief in possessing the trait. The argument that dual tasking is not efficacious on non emotional material (van den Hout, Eidhof, Verboom, Littel, & Engelhard, 2014) and could therefore result in no effect was refuted by adding the variable 'emotionality' in the second experiment. The results showed statements were experienced as emotional material. Also, the argument that participants accredited positive effects to eye movements, resulting in counter-pressure on the actual hypothesized detrimental effect of the eye movements on belief, was disproved in experiment 2. By exposing participants to a Sudoku puzzle instead of an EMDR session they were unable to form any positive attribute to the eye movements. Still, the same (null) result was found.

In **Chapter 3** (Matthijssen & van den Hout, 2016b) patients diagnosed with PTSD rated the belief in possessing and emotionality of two positive personality traits. After an EMDR session targeting a negative memory, patients recalled and re-rated the belief in possessing and emotionality of the traits. Subsequently, they recalled one trait while dual tasking (eye movements) and the other trait without dual tasking. Afterward, they re-rated

the belief and emotionality. The results showed no effect of eye movements during the procedure on the belief in possessing the positive personality trait, or on the perceived emotionality, but there was an effect of the EMDR session *itself* on the belief in possessing the trait. Patients with a strong decrease in SUD scores during the desensitization phase (indicating a successful desensitizing of the targeted disturbing memory) had an increase in belief in possessing the trait during the session. A successful EMDR session however did not affect the perceived emotionality of the traits.

In sum, eye movements appear to be ineffective in the procedure, not only in undergraduates (Chapter 2), but also in PTSD patients (Chapter 3). Also, the control condition - keeping eyes stationary - showed no effect on the belief in possessing or emotionality of the traits. The results make the use of eye movements in the procedure doubtful and even more so, the procedure itself. Positive closure did not show any additional effect on belief and emotionality of positive self-statements, but the belief in a positive self-statement was correlated with the decrease of distress due to the EMDR procedure.

Of course, null findings can be due to the absence of a phenomenon. In this case, this would signify the absence of the ability to influence positive verbal statements by working memory taxation. Other explanations for not finding results are of a methodological nature. Testing on a non clinical sample in experiment 1 and 2 could taint ecological validity for example, but this does not seem a plausible explanation for not finding an effect of eye movements because similar effects were found in a patient sample. One could argue that the eye movements were very brief (fifteen to twenty seconds) and that the manipulation was too short to induce any effect. This is a valid argument when considering the effect of eye movements on positive verbal material in general, but not when considering the eye movements in the 'Positive Closure' procedure, since this *is* the amount of time the eye movements are performed in actual treatment settings when using the standard Dutch protocol. Also, the control condition used was rather unfortunate since it could induce working memory taxation by itself. (Further elaboration on this can been read in discussion of the studies presented in chapter 4 and 5.) However, this can potentially explain the absence in difference between the conditions, this does not explain the absence of effect itself.

The main difference between the positive closure procedure in the studies and in the regular treatment setting is that the therapist in the regular treatment continues dual tasking after each positive association until no more positive associations occur, while the studies focused solely on the trait and left out further taxation on associations. One could argue that also taxing the associations could result in an effect on the believability of possessing the traits and the emotionality. However, it is not clear if this would be a positive or detrimental effect on the belief and emotionality. It is recommended to validate the existence of one of both lines of reasoning by conducting a study in which associations are taken into account. A last explanation for the null result is provided by the hypothesis of modality specific taxation. In the experiments cross-modality taxation was used (visual taxation [eye movements] on an auditory/verbal recollection [verbal statement]). This subject is explored in the second section of the thesis.

In summary, the lack of finding effect of the eye movements, either because of the briefness of the taxation, the lack of modality specific taxation, leaving out the focus on associations or the absence of the ability of verbal statement being influenced by working memory taxation, the procedure as it is performed in the protocol does not seem to achieve its goal in reinforcing the positive statement.

Clinical implications

As a result of the conducted experiments elaborated on in chapter 2 and 3, the Dutch EMDR protocol was changed. Where it used to be a standard intervention to use eye movements when patients mentioned a positive verbal statement about themselves, it is *no longer mandatory* to use eye movements when one focusses on the positive verbal statement. In the 'Positive Closure' procedure in the most recent version of the protocol (ten Broeke, de Jongh & Hornsveld, 2018) patients are asked the most positive or valuable thing they learned about themselves during the last hour in relation to the last session/theme/memory. If relevant, the therapist can add "What does this say about you as a person?" or "What do you call somebody like that?" (e.g., patients answer "*I am strong*"). Then, the therapists asks the patient to sit as somebody who is *strong* and after that to *either* concentrate on the positive self speech (e.g., "I am strong") and the corresponding posture and mimicry for 10 seconds *or to use a set of distracting stimuli*. In the latter case the remark is made in a footnote of the protocol that research "does not show positive

effects of the use of distracting stimuli, but no negative effects either." After 10 seconds the therapist asks the patient if something positive arises to mind. If this is the case, the therapist asks the patient again to concentrate on the positive association for 10 seconds and the procedure repeats itself. The process continues until no further positive changes occur.

The first and recently added option on how to perform this procedure according to the most recent protocol is based on Competitive Memory Training (COMET), a training aimed at the enhancement of retrieving beneficial information from memory. The COMET protocol is based on the work of Lang (1985, 1994) on cognitive emotional networks in order to strengthen an emotional network. COMET assumes an emotional network could be activated by matching external perceptions with information already stored, by priming specific elements therein (Ekkers et al., 2011). Studies showed COMET was successful in addressing low self-esteem in different patient populations (e.g. Korrelboom, de Jong, Huijbrechts, & Daansen, 2009; Korrelboom, Maarsingh, & Huijbrechts, 2012; Korrelboom, Marissen, & van Assendelft, 2011). There seems to be a fair amount of evidence to suggest the procedure based on COMET principles could enhance the belief in possessing a trait, but it is not tested in its current form in the protocol. Furthermore, the option to *use a set of distracting stimuli* is still present in the most recent protocol. The basis that 'no negative effects of the eye movements were found in the experiments is however no reason to evoke any burden on patients by using bilateral stimuli. One could even question if the procedure should be conducted at all if the effort actually rather be put in performing a successful EMDR session, since this *does* seem to affect the belief in possessing the trait.

Modality specificity in working memory taxation

The second part of the thesis focused on gaining more understanding of the working mechanism(s) underlying EMDR. There seems to be consensus - for the larger part - that taxing working memory during memory recall is at least one of the working mechanisms by which EMDR elicits its effect. The working memory taxation hypothesis states that dual tasking during recall of a memory - which is sensitive to change during a labile period when recalled - would result in competition between recall of the memory and performing the dual task. This induced interference would result in not being able to hold on to the memory with the same emotional load and the memory is being reconsolidated with less

emotionality. Many different dual tasks showed an effect on emotionality and/or vividness (e.g., Andrade, Kavanagh & Baddeley, 1997; Engelhard, van Uijen, & van den Hout, 2010; Greenwald, McClintock, Jarecki, & Monaco, 2015; Gunter & Bodner, 2008; Kavanagh, Freese, Andrade, & May, 2001; Kemps & Tiggemann, 2007; van den Hout et al., 2010; van den Hout et al., 2011; Engelhard, van den Hout & Smeets, 2011). Also, several studies showed an increasing effect of augmenting dual task load on decreasing emotionality or vividness of emotional memories (Maxfield, Melnyk, & Hayman, 2008; van Veen et al., 2015; van Schie, van Veen, Engelhard, Klugkist, & van den Hout, 2016), which is in line with the working memory taxation hypothesis. This effect however is not conclusive, since there is also some support found for an inverse U-curve dose-response relationship for the effect on emotionality scores (Engelhard, van den Hout, & Smeets, 2011). However, there was no support for an inverse U-curve for vividness (Engelhard, van den Hout, & Smeets, 2011).

While there is consensus on the working memory taxation hypothesis, there is no consensus on the debate of modality-specificity. Working memory comprises the central executive, episodic buffer, visuospatial sketchpad (VSSP) and phonological loop (PL) (Baddeley, 2010). The latter two subsystems preferentially process modality specific information (respectively spatial information and auditory/verbal processing) (Baddeley, 2012; Baddeley & Hitch, 1974). On the one hand, there is support for a central executive account which states that the effect of working memory taxation is due to the central executive. In this case, dual tasking in general is important and matching the modality of the dual task would not result in an augmented effect. The modality specificity account states the subsystems play a crucial role in the effect of working memory taxation and dual tasks should therefore best be matched in modality to the modality of the memory.

In EMDR therapy, the focus is on treating visual memories or visual aspects of memories, although it is known that memories are often multimodal (Ehlers et al., 2002; Hackmann, Ehlers, Speckens, & Clark, 2004). Only two analogue studies investigated the possibility of affecting emotional auditory memories (Kemps & Tiggemann, 2007; Kristjánsdóttir & Lee, 2011). Both show emotionality and vividness of the memories decreased after dual tasking during memory recall, but the result was attributed to a different underlying process. Kristjánsdóttir and Lee (2011) conclude the effect was due to involvement of the central executive, while Kemps and Tiggemann (2007) found support for involvement of both the central executive *and* the subsystems, thereby supporting the

central executive account and the modality specificity account. Clinical research did not yet evaluate if EMDR could be used to target memories (mostly) auditory in content, while this is a very frequently occurring clinical phenomenon. Therefore, research on this subject was warranted.

In **Chapter 4**, (Matthijssen, Verhoeven, van den Hout, & Heitland, 2017) a study is presented in which patients diagnosed with PTSD were asked to recall two disturbing memories, one mainly visual, one mainly auditory. They rated the emotionality of the memories before and after being exposed to three alternating conditions: visual taxation, auditory taxation, and a staring a non-moving dot (control condition). The patients recalled the memories during exposure to the conditions. Results showed all three conditions were equally effective in reducing the emotionality of both auditory memories and visual memories. The results were surprising. Not because of the effect on the emotionality of both auditory and visual memories, nor because of the absence of a modality specific taxation effect, but because the control condition seemed to be effective in reducing emotionality as well. From a working memory taxation perspective this seemed surprising, but when looking more closely at the specifics of the control condition is it possible that this condition was also perceived as demanding, on which will be elaborated after discussing chapter 5. Another concern was one of power, created by the fact that the intervention was so successful that patients were sometimes not exposed to all three conditions. Their data were discarded in the analyses. The underlying reason for the power problem was however a very welcome one, and one of clinical relevance, since this is the first study showing auditory intrusions can be targeted in EMDR therapy, resulting in less emotional auditory memories. A last explanation for not finding a difference in effect between the conditions is that null hypothesis testing was used, prohibiting room for relative support for a model in other terms than yes or no. This was tackled in Chapter 5, were Bayesian statistics were applied.

In **Chapter 5** (Matthijssen, Heitland, Verhoeven, & van den Hout, 2018) a study with a similar design as the one in chapter 4, is presented. In this study, EMDR was used as a possible treatment strategy for disturbing memories of auditory hallucinations in psychotic patients. Auditory hallucinations, being rather prevalent in many different types of psychiatric disorders (van der Gaag, Staring, van den Berg, & Baas, 2013) and also the general population (Maijer, Begemann, Palmen, Leucht, & Sommer, 2017) can cause a great

burden to daily life. Apart from a large overlap in symptomatology of auditory intrusions in PTSD and auditory hallucinations in psychotic disorders, also the content of the hallucinations often relates to earlier traumatic events in a similar way in PTSD and schizophrenia (McCarthy-Jones & Longden, 2015). Considering this, EMDR therapy may possibly be used to treat the hallucinations, or at least disturbing memories of the hallucinations and thereby possibly affecting frequency, severity or perceived distress of the auditory hallucinations. Patients with auditory hallucinations were asked to recall an auditory hallucination memory and this memory was recalled under the same alternating conditions as described in the study of Chapter 4. The results show that emotionality of the disturbing auditory hallucination memories decreased. Larger decreases in emotionality of the memory in the auditory and visual taxation conditions were found compared to the control condition. Also, null hypothesis testing showed a trend indicating more effect of the active conditions compared to the control condition. The study was designed as an experimental one in a clinical setting. We did not test whether the one session intervention had effects on clinical outcome measures of auditory hallucinations (e.g., frequency, severity or perceived distress of the auditory hallucinations). The reason for not doing this was that the *dosages* of the dual tasking interventions were considerably lower (maximum 10 x 1 minute visual taxation, 10 x 1 minute auditory taxation and 10 x 1 minute control condition) than in clinical EMDR. Given the fact that most patients suffer from more than one type of auditory hallucinations and have multiple aversive auditory hallucination memories, it was estimated the dosage would be too low to yield clinical benefits. A limitation of the study, which was the same as in the study on auditory memories in PTSD patients, was the statistical power. The origin of the power problem was also the same; the intervention appeared to elicit effect so quickly that some patients were not exposed to all three conditions. Therefore, data of these patients were discarded. Again, a very welcome clinical observation, but not a very convenient statistical one.

The results in both studies showed the control condition also elicited effects, resulting in a lack of significant differences between conditions (Chapter 4) or a small difference between the auditory and visual taxation conditions (Chapter 5). The control condition is a major limitation in both studies and – in retrospect – should have been chosen differently. That is, in the control condition patients were required to fix their gaze on a stationary dot and this may have loaded working memory, while the control condition was

intended not to do so. Other studies also report effect from similar control conditions (Dunn, Schwartz, Hatfield & Wiegele, 1996; Sack et al., 2016; Yaggie et al., 2015). Stickgold (2008) points out that eye fixation maintained for 30 seconds appears to produce a shift in mental state and "if such a state shift also facilitates trauma processing, then its use as a control condition would reveal no relative benefit for bilateral movements, leading to a false rejection of their efficacy". The shift however could be beneficial or detrimental. Either way, the correct control condition should be the absence of intentional eye movements or non-movements (Stickgold, 2008).

The possible loading of working memory by the control condition is however no explanation for not finding a modality-specific effect. The lack of a modality-specific taxing-effect suggests that general memory taxation overshadows the effect of modality specificity taxation. It is not in line with studies where superior effects of modality specific taxing were found (Andrade, Kavanagh & Baddeley, 1997; Baddeley & Andrade, 2000; Kavanagh, Freese, Andrade & May, 2001; Kemps & Tiggeman, 2007; Lilley, Andrade, Turpin, Sabin-Farrell & Holmes, 2009). However, it does fit with several earlier studies failing to find a modality-specific effect (Gunter & Bodner, 2008; Kristjánsdóttir & Lee, 2011). Several explanations can be given for not finding a modality specific effect. The most likely explanation is that the effect of modality specific taxation is present, also considering the fact that the effect was found in earlier studies, but that the effect is small. This is in line with results from Kemps and Tiggemann (2007) who reported a large general working memory taxation effect and a superimposed smaller modality specific effect. Another explanation (which could be interwoven with the former explanation) may be related to the fact that we studied patient samples in the studies. Using a patient samples obviously increases ecological (clinical) validity but it also gave rise to potential confounding factors. Some patients had difficulty to make the required eye movements at the standard set speed and some experienced difficulty in counting. Also, in the case of the patients with auditory hallucinations, some reported being bothered by their hallucinations during the intervention. These phenomena potentially affected the results. Furthermore, although the dual tasks were specifically chosen to be equally demanding, the tasks may actually not have been exactly matched and were potentially not equally loading the subsystems or the central executive. Also, there can be individual differences in subsystem functioning. These matters were not considered in the studies and should be addressed by - ideally – mapping individual differences and let

patients be their own controls. Testing the dual tasks on the amount of taxation would optimize the comparability of the tasks and make clear the true load of the dual tasks. Modality specific dual task loading was explored in the study presented in Chapter 6.

In the same manner that an experimental psychopathology approach was combined with clinical studies in the first section of the thesis, also here, in the section on modality specificity, both types of research were combined, although conducted in the reverse order. In the section on positive verbal material experimental studies preceded a clinical study, in the section on modality specificity clinical studies preceded a study with an experimental psychopathology approach. In **Chapter 6** (Matthijssen, van Schie & van den Hout, 2018) an experimental psychopathology study with healthy participants is discussed. The study was set up to test whether performing a dual task in the same modality as a recalled emotional memory was more taxing than performing a dual task in cross modality. This was assessed by letting participants first perform a visual and auditory baseline reaction time task (i.e., responding as fast as possible to a visual or auditory stimulus by pressing a button). Then, participants consequently recalled a distressing visual and auditory memory, while performing the same visual and auditory reaction time tasks. Increased reaction times (compared to baseline) were indicative of working memory loading. Using Bayesian statistics, we compared the effects of general and modality specific taxation. The model in which dual tasking *in general* (irrespective of modality specificity) and the effect of *modality specific* loading were combined gained the most support. The results suggest a general effect of dual tasking on taxing working memory and a superimposed effect of taxing in matched modality.

Clinical implications

Emotionality of auditory disturbing memories can be reduced. This was found in two clinical studies, one with PTSD patients, the other one with patients suffering from auditory hallucinations. Results show dual tasking during recall is effective in reducing emotionality of auditory memories, but also a control condition, which may have loaded working memory, showed effect. Furthermore, albeit the absence of an effect of modality specific taxation in the presented clinical studies, an experimental study measuring working memory load by using reaction time tasks, suggests a large general effect of dual loading on working memory and a superimposed modality specific effect (i.e., visual dual loading is more taxing

when recalling visual memories and auditory dual loading is more taxing when recalling an auditory memory.) Especially when considering the results of the last study one can suggest that working memory taxation in general should be performed when desensitizing disturbing memories and depending on the modality of the memory the therapist could adapt the modality of the dual task to the modality of the memory.

Desensitizing visually disturbing memories in EMDR therapy does elicit positive effects on PTSD symptoms. It is unclear if this effect is generalizable to memories in (mainly) other sensory modalities; in this case, if desensitizing auditory memories would have the same beneficial effect on PTSD symptoms. Also, auditory hallucination memories can be desensitized, but the effect on auditory hallucinations is not taken into account. The clinical implications for PTSD treatment and for the treatment of patients with auditory hallucinations have to be investigated

Exploring a novel route: Visual Schema Displacement Therapy

The third way in which a contribution to the enhancement of trauma treatment was made is described in **Chapter 7** (Matthijssen, van Beerschoten, de Jongh, Klugkist & van den Hout, 2018). Nik and Eva Speakman introduced a new form of therapy called Visual Schema Displacement Therapy (VSDT), and claimed it would be effective in the treatment of trauma. De procedure of the therapy - which is described in detail in Chapter 7 - was highly unconventional. Moreover, there was no theoretical rationale to believe in the effectiveness of the treatment. However, it would not have been the first time that clinicians accidentally stumble upon an intervention that is effective. In fact, despite the lack of a coherent rationale and despite the rather peculiar nature of the intervention, video clips suggested that patients improved. Of course, in science, video clips are not considered scientific evidence of efficacy. However, they made us curious; we wanted to keep an open mind and decided to put the procedure to critical tests. We examined whether the VSDT procedure reduced the emotionality and vividness of negative memories. Two studies were conducted. In the first experiment participants were asked to recall three negative emotional memories under three conditions: VSDT, EMDR, and a control condition (doing nothing). Emotional disturbance and vividness of the memories were rated before and after the conditions. The experiment was replicated using a between group design in the second experiment. Participants were assigned to one of the three conditions, and a follow-up after 6 to 8 days

was added. Surprisingly, both experiments showed VSDT was superior to EMDR and the control condition, while EMDR had stronger effects than the control condition in reducing emotional disturbance of disturbing memories. VSDT and EMDR were equally effective in reducing vividness and both were shown to be more effective than the control condition. How the effects should be explained is an open issue, and some suggestions were given in chapter 7. The results warrant more research, not only in an experimental setting, but also in a clinical setting. The experimental studies, by dismantling elements of the therapy, could reveal the underlying mechanisms of VSDT. The clinical studies are warranted to test the procedure in patients and tot test the effect on PTSD symptoms.

Conclusion

The current thesis is an effort to contribute to enhancing trauma treatment. For the larger part the focus of the thesis has been on an existing evidence-based trauma treatment; Eye Movement Desensitization and Reprocessing (EMDR), and a smaller part of the thesis was concentrated on a new promising therapy; Visual Schema Displacement Therapy (VSDT). Of course, focusing on solely two treatment strategies does not do justice to the wide range of therapies for PTSD. Research recommendations to enhance trauma treatment therefore are many and they spread out over a wide array of subjects. Concerning the three ways on which the focus of the thesis was set, the author hopes she has contributed to the field by testing and adapting treatment protocol, by enhancing the understanding of working mechanisms of EMDR and thereby broadening its scope and last but not least, by studying a new form of trauma treatment. Overall, the author hopes she contributed to enhancing trauma treatment.

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SUMMARY IN DUTCH

Samenvatting in het Nederlands

HET VERBETEREN VAN TRAUMABEHANDELING

Het exploreren van werkingsmechanismen en het testen van een nieuwe route

Iedereen wordt in het leven onvermijdelijk geconfronteerd met nare gebeurtenissen en deze gebeurtenissen kunnen (tijdelijk) veel stress veroorzaken. Sommige gebeurtenissen zijn dagelijkse stressoren of kleine 'set-backs' en andere zijn grotere nare gebeurtenissen welke kunnen worden gecategoriseerd als traumatische gebeurtenissen in termen van de criteria van een posttraumatische stressstoornis (PTSS) in de 'Diagnostic and Statistical Manual of Mental Disorders 5' (DSM 5; American Psychiatric Association [APA], 2013). De definitie van een traumatische gebeurtenis in de DSM 5 is 'blootstelling aan een feitelijke of dreigende dood, ernstige verwonding of seksueel geweld door het zelf ondergaan van de gebeurtenis(sen), het persoonlijk getuige zijn van de gebeurtenis(sen), het vernemen dat (een) psychotraumatische gebeurtenis(sen) een naast familielid of goede vriend(in) is (zijn) overkomen of het ondergaan van herhaaldelijke of extreme blootstelling aan de afschuwwekkende details van de psychotraumatische gebeurtenis(sen). Blootstelling aan (een) traumatische gebeurtenis(sen) kan de ontwikkeling van een PTSS veroorzaken: een stoornis die wordt gekarakteriseerd door intrusieve symptomen, vermijding, negatieve veranderingen in cognities en stemming en veranderingen in arousal en reactiviteit die samenhangen met de gebeurtenis(sen). Hoewel het meemaken van een traumatische gebeurtenis vooraf gaat aan het ontwikkelen van PTSS, ontwikkelt slechts een minderheid van de mensen een PTSS na het meemaken van een traumatische gebeurtenis (5.7%-9.2%, Breslau et al., 1998; de Vries & Olff, 2009; Kessler, Petukhova, Sampson, Zaslavsky, & Wittchen, 2012; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). Bovendien zijn de risico's om een PTSS te ontwikkelen niet even groot voor alle typen traumatische gebeurtenissen. Zo is het risico onder andere groter wanneer er sprake is van seksueel en fysiek geweld (Frans, Rimmö, Åberg, & Fredrikson, 2005). PTSS laat hoge comorbiditeit zien met andere psychische stoornissen (Chapman et al., 2012). Comorbiditeit alsook de ernst van de symptomen (McFarlane, 2000; Zlotnick et al. 1999; Zlotnick et al., 2004) en het meemaken van meerdere trauma's (Kolassa et al., 2010) voorspellen een chronisch beloop van PTSS. Rekening houdend met de hoge percentages comorbiditeit (Kessler et al., 1995) is het onderzoeken van nieuwe effectieve behandelstrategieën en ook optimalisering van

bestaande therapieën belangrijk. Dit proefschrift is een poging om bij te dragen aan het ontwikkelen van effectieve strategieën en aan het optimaliseren van bestaande strategieën.

Er zijn verschillende effectieve psychologische behandelingen voor PTSS, waaronder cognitieve therapie, exposure therapie, Eye Movement Desensitization and Reprocessing (EMDR) en narratieve exposure therapie (Cusack et al., 2016; Watts et al., 2013). Het is vooralsnog niet duidelijk welke therapie het meest effectief is, omdat hier nog weinig onderzoek naar gedaan is (Cusack et al., 2016). Eén van de psychologische interventies die in populariteit groeit onder patiënten en therapeuten is EMDR. Bij EMDR worden patiënten geïnstrueerd om horizontale oogbewegingen te maken terwijl ze een nare herinnering ophalen. De procedure resulteert gewoonlijk in vermindering van levendigheid en emotionaliteit van de herinnering (van den Hout & Engelhard, 2012). EMDR, bedacht door Shapiro in 1987, kon aanvankelijk op veel kritiek rekenen vanuit de wetenschap (e.g., Lohr, Kleinknecht, Tolin, & Barrett, 1995; Lilienfeld, 1996; McNally, 1999; Muris & Merckelbach, 1999; Herbert et al., 2000) en werd gezien als een niet effectieve vorm van therapie. Ongeveer 20 jaar later hebben echter meerdere meta-analyses de effectiviteit ervan aangetoond (bijvoorbeeld Bisson et al., 2007; Bradley, Greene, Russ, Dutra, & Westen, 2005; Chen et al., 2014; Lee & Cuijpers, 2013; Seidler & Wagner, 2006). Dit heeft ervoor gezorgd dat EMDR een eerste keus behandeling werd in meerdere landen, waaronder ook Nederland. Veel wetenschappers hebben geprobeerd het werkingsmechanisme of de mechanismen te ontrafelen die ten grondslag liggen aan het effect van EMDR. Het blootleggen en verklaren van onderliggende mechanismen van een effectieve behandeling schept de mogelijkheid om behandeling te verbeteren en te optimaliseren. De oogbewegingen, waarvan de toegevoegde waarde werd aangetoond in een meta-analyse (Lee & Cuijpers, 2013), kregen veel aandacht in onderzoek. Volgens het EMDR-protocol konden patiënten echter naast oogbewegingen ook profiteren van andere bilaterale stimuli zoals tikken of tonen, wanneer deze gelijktijdig met het ophalen van de herinnering werden uitgevoerd. Er werd aangenomen dat de bilateraliteit van de gepresenteerde stimulus noodzakelijk was om verwerking te stimuleren (Shapiro, 2001). Bilaterale stimulatie zou de interactie tussen de linker- en rechterhersenhelft vergroten (Propper & Christman, 2008), waardoor het ophalen van de herinnering verbeterd zou worden en desensitisatie vergemakkelijkt (Christman, Garvey, Propper, & Phaneuf, 2003). Er werd echter geen significante toename in interhemispherische coherentie gevonden ten gevolge van de

bilaterale stimulatie (Keller, Stevens, Lui, Murray, & Yaggie, 2014; Yaggie et al., 2015). Verder bleek dat ook taken zonder bilaterale stimulatie effectief waren in het desensitiseren van nare herinneringen (bijvoorbeeld Tetris spelen, Engelhard, van Uijen, & van den Hout, 2010; progressief tellen, Greenwald, McClintock, Jarecki, & Monaco, 2015; het kopiëren van een complexe figuur, verticale oogbewegingen, Gunter & Bodner, 2008).

Verschillende onderzoekers betogen dat er meer dan één effect plaatsvindt in EMDR en dat deze effecten gerelateerd zijn aan meer dan één mechanisme (bijvoorbeeld Maxfield, Melnyk, & Hayman, 2008; Keller et al., 2014). Uitkomsten van onderzoek suggereren dat EMDR zijn gunstige effecten ten minste gedeeltelijk ontleent aan het belasten van het werkgeheugen tijdens het ophalen van emotionele herinneringen (Gunter & Bodner, 2008; Maxfield et al., 2008; van den Hout & Engelhard, 2012). Het ophalen van herinneringen uit het langetermijngeheugen induceert een labiele periode, waarin eerder geconsolideerde herinneringen gevoelig zijn voor verandering. Wanneer een herinnering wordt opgeroepen in EMDR-therapie, moet het werkgeheugen dat een beperkte capaciteit heeft (Baddeley, 2012), die beperkte capaciteit verdelen tussen het vasthouden van de opgehaalde herinnering en de andere belastende taak (gewoonlijk het maken van oogbewegingen). Dit veroorzaakt interferentie in het reconsolidatieproces en resulteert in een bijgewerkte herinnering, welke als zodanig opnieuw wordt geconsolideerd. In het geval van EMDR is dit een herinnering zonder negatieve emotionele lading. De verschillende neurale mechanismen voor destabilisatie en consolidatie zijn elders beschreven (zie Lee, Nader, & Schiller, 2017).

Modaliteitsspecificiteit in werkgeheugenbelasting

De hypothese dat werkgeheugenbelasting effectief is bij het desensitiseren van herinneringen stelt dat herinneringen minder emotioneel en levendig worden wanneer een duale taak wordt uitgevoerd tijdens het ophalen van die herinnering. In onderzoek en het klinische veld is er discussie over het optimaliseren van deze werkgeheugenbelasting. Eén mogelijke manier om te optimaliseren is het vergroten van de werkgeheugenbelasting. Uit onderzoek blijkt dat een grotere werkgeheugenbelasting over het algemeen gepaard gaat met grotere dalingen van emotionaliteit en levendigheid van aversieve herinneringen (Maxfield et al., 2008; van Schie, van Veen, Engelhard, Klugkist, & van den Hout, 2016; van Veen et al., 2015).

Een andere mogelijke optie om de belasting van het werkgeheugen te optimaliseren kan het matchen van de modaliteit van de duaal uitgevoerde taak aan de modaliteit van de opgehaalde herinnering zijn. Bij EMDR-therapie ligt de nadruk op het behandelen van visuele herinneringen of visuele aspecten van herinneringen, hoewel bekend is dat herinneringen vaak multimodaal zijn (Ehlers et al., 2002; Hackmann, Ehlers, Speckens, & Clark, 2004). Dit roept de vraag op of herinneringen in (voornamelijk) andere modaliteiten ook kunnen worden bewerkt en of ze modaliteitsspecifiek belast (d.w.z. belast in dezelfde modaliteit) zouden moeten worden tijdens het ophalen van de herinnering. Wetenschappelijk onderzoek richtte zich tot nu toe voornamelijk op auditieve en visuele herinneringen. Vanuit een werkgeheugenperspectief lijkt het aannemelijk dat modaliteitsspecifieke belasting effectief is. Het werkgeheugen omvat verschillende onderdelen; de 'central executive', het visuospatiële schetsblok ('visuospatial sketchpad' of VSSP), de fonologische lus ('phonological loop' of PL) en de episodische buffer. De episodische buffer is een passieve opslag en geen actieve processor en kan visuele en auditieve informatie en mogelijk ook reuk- en smaakinformatie combineren (Baddeley, 2010). De 'central executive' is het besturingssysteem dat in staat is om de aandacht te richten, te verdelen en van taak te wisselen (Baddeley, 2012). Modaliteitsspecifieke informatie wordt bij voorkeur verwerkt in een van de twee subsystemen: de VSSP, verantwoordelijk voor de verwerking van visuele en ruimtelijke informatie en de PL, verantwoordelijk voor auditieve en verbale verwerking (Baddeley, 2012; Baddeley & Hitch, 1974). De VSSP is dus betrokken bij visuele beelden en de PL bij auditieve fragmenten (Kristjánsdóttir & Lee, 2011). Het oproepen van een herinnering die overwegend auditief of visueel is zou, hierop voortredenerend, het best kunnen worden belast met een duale taak in dezelfde modaliteit als de herinnering, omdat dit grotere interferentie zou veroorzaken tijdens het oproepen van de herinnering doordat zij immers hetzelfde subsysteem van het werkgeheugen bezetten.

Hoewel er redelijke consensus is over de hypothese van werkgeheugenbelasting in het algemeen, bestaat er geen consensus over het modaliteitsspecificiteitsdebat. De 'central executive account' impliceert dat het belasten van het werkgeheugen met een duale taak, ongeacht de modaliteit ervan, effectief is en dat belasting van de central executive een cruciale rol speelt (Gunter & Bodner, 2008). De 'modaliteitsspecificiteitsaccount' suggereert echter dat duale taken in modaliteit zouden moeten worden afgestemd op de modaliteit

van de herinnering en dat de subsystemen een cruciale rol spelen in het effect. Er zijn onderzoeken bij gezonde participanten die aantoonden dat duale taken die overeenkomen met de modaliteit van de herinnering resulteren in een grotere reductie van levendigheid en emotionele intensiteit in vergelijking met duale taken in een andere modaliteit (Kemps & Tiggemann, 2007), maar andere studies vonden dit modaliteitsspecifieke effect niet (Kristjánsdóttir & Lee, 2011; Tadmor, McNally, & Engelhard, 2016). Studies bij patiënten ontbraken tot dusver. De inconsistente resultaten die in onderzoeken gevonden werden betekenen mogelijk dat zowel de 'central executive account' als de 'modaliteitsspecificiteitsaccount' naast elkaar bestaan en dat beide bijdragen aan het optimaliseren van de werkgeheugenbelasting. Uitsluitsel over het belang en de invloed van modaliteitsspecifieke belasting zou kunnen leiden tot beter begrip van de psychologische mechanismen in EMDR en verbetering van de behandeling. Er werd daarom onderzocht of EMDR überhaupt zou kunnen worden ingezet om herinneringen met (grotendeels) auditieve inhoud bij patiënten te behandelen en of er een additioneel effect van modaliteitsspecifiek belasten zou zijn.

In hoofdstuk 4 wordt een studie besproken (Matthijssen, Verhoeven, van den Hout, & Heitland, 2017) waarin patiënten met de diagnose PTSS werd gevraagd om twee nare emotionele herinneringen op te halen, één voornamelijk visueel, de ander voornamelijk auditief. De patiënten beoordeelden de emotionaliteit van de herinneringen vóór en na blootstelling aan drie wisselende condities tijdens welke ze de auditieve of visuele herinnering ophaalden: visuele belasting (het maken van oogbewegingen), auditieve belasting (hardop terugtellen vanaf 1000) en een controleconditie (het staren naar een niet-bewegend punt). De procedure werd herhaald voor de herinnering in de andere modaliteit. De resultaten toonden aan dat zowel (voornamelijk) auditieve herinneringen als (voornamelijk) visuele herinneringen minder emotioneel beladen konden worden gemaakt. Alle drie de condities (visuele belasting, auditieve belasting en de controleconditie) bleken effectief en er werd geen groter effect door modaliteitsspecifiek belasten gevonden. De resultaten waren verrassend. Niet vanwege het effect op de emotionaliteit van zowel auditieve als visuele herinneringen, noch vanwege de afwezigheid van een modaliteitsspecifiek effect, maar omdat de controleconditie ook effectief bleek te zijn in het verminderen van de emotionaliteit. Vanuit een werkgeheugenperspectief leek dit verrassend, omdat de controleconditie niet belastend zou moeten zijn, maar bij nadere

bestudering van de controleconditie bleek dat deze conditie mogelijk óók belastend was en daarmee eigenlijk ongeschikt als controleconditie. In de controleconditie moesten patiënten hun blik op een punt fixeren. Ook in andere studies wordt effect van vergelijkbare controlecondities gerapporteerd (Dunn, Schwartz, Hatfield & Wiegele, 1996; Sack et al., 2016; Yaggie et al., 2015). Stickgold (2008) wijst erop dat oogfixatie gedurende 30 seconden een verschuiving in de mentale toestand oplevert en "als een dergelijke toestandsverandering ook traumabewerking mogelijk maakt, dan zou het gebruik ervan als controleconditie geen relatief voordeel bieden boven bilaterale bewegingen." De toestandsverandering zou echter gunstig of nadelig kunnen zijn voor traumabewerking. Hoe dan ook zou de juiste controleconditie de afwezigheid van opzettelijke oogbewegingen of fixaties moeten zijn (Stickgold, 2008). Wat daarnaast een opvallende uitkomst in het onderzoek was, was dat de interventie (ongeacht de conditie) zo snel effect veroorzaakte dat sommige patiënten niet aan alle drie de condities werden blootgesteld, omdat de emotionaliteit van de herinnering reeds na de aanbieding van een of twee condities was verdwenen. Dit was een zeer welkome klinische observatie, maar statistisch gezien niet handig, omdat hierdoor data van minder geïncludeerde patiënten kon worden geanalyseerd, wat feitelijk zorgde voor een lage power.

In een tweede soortgelijke studie (Matthijssen, Heitland, Verhoeven, & van den Hout, 2018), waarvan de resultaten worden weergegeven in hoofdstuk 5, werd EMDR geopperd als een mogelijke behandelingsstrategie voor aversieve auditieve hallucinatieherinneringen bij psychotische patiënten. Auditieve hallucinaties, die vrij prevalent zijn in veel verschillende soorten psychiatrische stoornissen (van der Gaag, Staring, van den Berg, & Baas, 2013) en ook de algemene bevolking (Maijer, Begemann, Palmen, Leucht, & Sommer, 2017) kunnen leiden tot een grote last in het dagelijks leven. Afgezien van een grote overlap in symptomatologie van auditieve intrusies bij PTSS en auditieve hallucinaties bij psychotische stoornissen, heeft ook de inhoud van de hallucinaties vaak op een vergelijkbare manier bij PTSS en schizofrenie te maken met eerdere traumatische gebeurtenissen (McCarthy-Jones & Longden, 2015). Dit in acht nemend kan EMDR-therapie mogelijk worden gebruikt om de aversieve herinneringen aan de hallucinaties te behandelen. Dit zou dan mogelijk van invloed kunnen zijn op de frequentie, ernst of ervaren stress van de auditieve hallucinaties. In het onderzoek werd patiënten met auditieve hallucinaties gevraagd om een auditieve hallucinatieherinnering op

te halen. Deze herinnering werd opgehaald onder dezelfde alternerende condities als beschreven in de bovengenoemde studie met PTSS-patiënten. De resultaten tonen aan dat de emotionaliteit van aversieve auditieve hallucinatieherinneringen afnam. In deze studie werd, wanneer geanalyseerd met Bayesiaanse statistiek, de meeste evidentie gevonden voor grotere dalingen in emotionaliteit van de herinnering in de auditieve en visuele duale taak condities in vergelijking met de controleconditie. Dit werd ondersteund door een trend die een groter effect van de actieve condities (visuele en auditieve duale taak condities) in vergelijking met de controleconditie weerspiegelde. Er is niet getest of het experimentele onderzoek effect had op de klinische uitkomstmaten van auditieve hallucinaties (bijvoorbeeld frequentie, ernst of ervaren stress van de auditieve hallucinaties). Er werd geschat dat de dosering van de duale taak belasting te laag zou zijn om klinische voordelen te bieden. Opnieuw bleek, evenals in de studie met PTSS-patiënten, dat de interventie zo effectief was dat een aantal patiënten niet alle condities aangeboden kregen. Dit was opnieuw een zeer welkome observatie, maar statistisch gezien een vrij onhandige. Daarnaast werd ook in deze studie wederom geen modaliteitsspecifiek effect gevonden.

Dat de controleconditie mogelijk te belastend was in bovengenoemde onderzoeken en niet geschikt als controleconditie biedt geen verklaring voor het niet vinden van een modaliteitsspecifiek effect. Het ontbreken van dit effect suggereert dat algemene werkgeheugenbelasting het effect van de modaliteitsspecifieke belasting overschaduwt. Er kunnen verschillende verklaringen worden gegeven voor het niet vinden van het effect. Het effect kan geheel afwezig zijn, maar dit is gezien gevonden resultaten in enkele eerdere studies niet de meest plausibele verklaring. De meest waarschijnlijke verklaring is dat het effect van modaliteitsspecifieke werkgeheugenbelasting aanwezig is, maar dat het effect klein is. Dit is in lijn met de resultaten van Kemps en Tiggemann (2007) die een groot algemeen effect van werkgeheugenbelasting rapporteerden en een gesuperponeerd kleiner modaliteitsspecifiek effect. Een andere verklaring (die verweven kan zijn met de vorige verklaring) kan te maken hebben met het feit dat de studies werden uitgevoerd in een patiëntenpopulatie. Dit verhoogde uiteraard de ecologische (klinische) validiteit, maar gaf ook aanleiding tot mogelijke interfererende factoren. Sommige patiënten hadden moeite om de vereiste oogbewegingen te maken met de standaard ingestelde snelheid en sommigen ondervonden moeite met het tellen. Ook meldden sommigen - in het geval van de patiënten met auditieve hallucinaties - zich gehinderd te voelen door hun hallucinaties

tijdens de interventie. Deze factoren hebben mogelijk de resultaten beïnvloed. Bovendien waren de taken, hoewel de auditieve en visuele duale taken specifiek werden gekozen om even belastend te zijn, mogelijk niet op dezelfde manier belastend voor de subsystemen of de central executive. Daarnaast kunnen er ook individuele verschillen zijn in de werking van de subsystemen en deze factoren werden niet in de studies meegenomen. Idealiter zouden individuele verschillen in kaart gebracht worden. Het testen van duale taken op mate van belasting per individu zou de vergelijkbaarheid van de taken verbeteren. In hoofdstuk 6 (Matthijssen, van Schie, & van den Hout, 2018) wordt een onderzoek met een dergelijk design gepresenteerd. In een experimenteel psychopathologisch onderzoek met gezonde participanten werd onderzocht of het uitvoeren van een duale taak in dezelfde modaliteit als een opgehaalde emotionele herinnering meer belastend was dan het uitvoeren van een duale taak in een andere modaliteit dan de herinnering. Dit werd onderzocht door participanten eerst een visuele en auditieve baseline reactietijdentaak te laten uitvoeren, waarbij ze zo snel mogelijk moesten reageren op een visuele of auditieve stimulus (cirkel of pieptoon) door op een knop te drukken. Vervolgens werd aan participanten gevraagd achtereenvolgens een (voornamelijk) auditieve en een (voornamelijk) visuele herinnering op te halen, terwijl ze dezelfde visuele en auditieve reactietijdtaken nogmaals uitvoerden. Langere reactietijden (vergeleken met de baseline) waren indicatief voor meer belasting van het werkgeheugen. Met behulp van Bayesiaanse statistiek werden de effecten van algemene en modaliteitsspecifieke werkgeheugenbelasting bekeken. De meeste evidentie werd gevonden voor een algemeen effect van duale taken op het belasten van het werkgeheugen en een gesuperponeerd effect van duale taken in gematchte modaliteit. Dit wil zeggen dat het uitvoeren van een duale taak in het algemeen (dus ongeacht modaliteit) het werkgeheugen belastte, maar dat wanneer de herinnering en de duale taak van dezelfde modaliteit waren, de belasting op het werkgeheugen groter was. Hoewel het effect van modaliteitsspecifieke belasting dus afwezig was in de gepresenteerde klinische onderzoeken, laat het experimentele onderzoek zien dat werkgeheugenbelasting wordt vergroot middels duale taak belasting welke dezelfde modaliteit heeft als een opgehaalde herinnering. Omdat eerder onderzoek laat zien dat het vergroten van werkgeheugenbelasting meer effectiviteit laat zien op het desensitiseren van aversieve herinneringen (van Veen et al., 2015) is te verwachten dat het matchen van de modaliteit

aan de duale taak met de modaliteit van de herinnering de effectiviteit van EMDR-therapie kan vergroten.

De klinische implicaties moeten nog worden onderzocht. Het desensitiseren van visueel nare herinneringen in EMDR-therapie genereert gunstige effecten op PTSS-symptomen. Het is onduidelijk of dit effect generaliseert naar herinneringen in (voornamelijk) andere sensorische modaliteiten; in dit geval, of desensitisering van auditieve herinneringen hetzelfde gunstige effect zou hebben op PTSS-symptomen. Ook zou het effect van het verminderen van de emotionele lading van auditieve hallucinatieherinneringen op auditieve hallucinaties zelf moeten worden onderzocht.

EMDR op positief verbaal materiaal

Naast het exploreren van werkingsmechanismen en het aanpassen van interventies op grond van inzichten in de werkingsmechanismen is het onderzoeken en aanpassen van bestaande behandelingsprotocollen een andere manier om behandeling te optimaliseren. Door een protocol te ontleden en verschillende elementen te testen kunnen niet-werkende elementen verwijderd worden en werkende elementen worden behouden. In dit proefschrift is één element van het Nederlandse standaard EMDR-protocol ('Positief Afsluiten') onderzocht. Deze procedure is toegevoegd aan het Nederlandse protocol (welke enigszins afwijkt van het standaard Amerikaanse protocol), met de verwachting dat het positieve veranderingen zou versterken die zich hadden voorgedaan tijdens de sessie, positieve reacties zou aanmoedigen en geïdentificeerde veranderingen zou verankeren (de Jongh & ten Broeke, 2003, p.124-129). Tot dusverre was er geen onderzoek gedaan naar het effect van de procedure ‘Positief Afsluiten’ of de manier waarop deze werd uitgevoerd. De procedure houdt in dat aan het einde van een EMDR-therapiesessie aan de patiënt wordt gevraagd: "Wat is het meest positieve of waardevolle wat u over uzelf hebt geleerd tijdens dit laatste uur / deze laatste sessie met betrekking tot dit thema of deze gebeurtenis?" De patiënt identificeert vervolgens een eigenschap of uitspraak over zichzelf zoals 'Ik ben sterk' of 'Ik ben een vechter'. Vervolgens worden horizontale oogbewegingen door de patiënt gemaakt, terwijl de patiënt zich op de eigenschap of uitspraak concentreert. Als de patiënt na een set oogbewegingen andere positieve associaties rapporteert, worden aanvullende sets oogbewegingen uitgevoerd. De typisch uitgevoerde oogbewegingen in deze procedure zijn - vanuit het oogpunt van de werkgeheugentaxatiehypothese - plausibel. Het

identificeren van een eigenschap of positieve uitspraak en er vervolgens op focussen vereist werkgeheugencapaciteit. Oogbewegingen maken is een duale taak en concurreert om dezelfde beperkte werkgeheugencapaciteit. Er zijn in eerdere onderzoeken niet alleen in nare autobiografische herinneringen, maar ook in neutrale foto's reducties in levendigheid en / of emotionaliteit waargenomen ten gevolge van het uitvoeren van een duale taak (Andrade, Kavanagh, & Baddeley, 1997), evenals in negatieve beelden (van den Hout, Bartelski, & Engelhard, 2013), prospectieve geheugenrepresentaties (Engelhard, van den Hout, Janssen, & van der Beek, 2010) en positieve herinneringen (Barrowcliff, Gray, Freeman, & MacCulloch, 2004; Engelhard, van Uijen, et al., 2010; van den Hout, Muris, Salemink, & Kindt, 2001). Er is echter ook een studie (Keller et al., 2014) die een toename in geheugensterkte en levendigheid in positieve herinneringen na het oproepen van een herinnering met gelijktijdige uitvoering van oogbewegingen laat zien. In die studie werden de oogbewegingen echter gevolgd door een periode van vrije associatie, wat niet gebeurde in andere onderzoeken. Vanuit een werkgeheugenperspectief kan men veronderstellen dat niet alleen visuele beelden, maar ook verbale uitspraken gevoelig zijn voor het verminderen van emotionaliteit en / of levendigheid en dat dit zou leiden tot resultaten die tegengesteld zijn aan de intentie van de procedure ‘Positief Afsluiten’ in het EMDR-protocol. Hoofdstuk 2 en 3 van het proefschrift gaan nader in op het effect van oogbewegingen op positief verbaal materiaal.

De eerste twee experimenten, gecombineerd in het gepresenteerde manuscript in hoofdstuk 2 (Matthijssen & van den Hout, 2016a), testten de effecten van oogbewegingen op positieve verbale uitspraken zoals gebruikt in de procedure ‘Positief Afsluiten’. In beide experimenten beoordeelden participanten het geloof in het bezitten van twee positieve persoonlijkheidskenmerken en in experiment 2 werd daarnaast ook de emotionaliteit van de eigenschappen beoordeeld. Vervolgens voerden de participanten vijftien tot twintig seconden oogbewegingen uit of vijftien tot twintig seconden oogfixatie (staren naar de toppen van de vingers van de onderzoeker die de hand stil hield), terwijl ze zich concentreerden op een positief relevant persoonlijkheidskenmerk (bijv. "Ik ben volhardend"). In experiment 1 werd de enigszins aangepaste 'Positief Afsluiten'-procedure voorafgegaan door een EMDR-sessie om de ecologische validiteit te maximaliseren en in experiment 2 werd deze voorafgegaan door het maken van een Sudoku-puzzel. Vanuit het perspectief van werkgeheugentaxatiehypothese zou men negatieve gevolgen van de

oogbewegingen in de procedure verwachten. Er werd dus verondersteld dat oogbewegingen - door een belastend effect op het werkgeheugen te hebben - de geloofwaardigheid van het bezitten van de positief relevante persoonlijkheidskenmerken zouden verminderen (m.a.w. de kracht van de positieve verklaring zou verzwakken). Resultaten lieten echter zien dat de oogbeweging en het fixeren van de ogen in beide experimenten geen effect op het geloof in het bezit van het kenmerk hadden. Een mogelijke verklaring dat duale taken niet effectief zijn op niet-emotioneel materiaal (van den Hout, Eidhof, Verboom, Littel, & Engelhard, 2014) en daarom geen effect zou zijn gevonden werd weerlegd door de variabele 'emotionaliteit' in het tweede experiment op te nemen. Uit de resultaten bleek dat uitspraken als emotioneel materiaal werden ervaren. Ook werd het argument dat deelnemers positieve effecten aan oogbewegingen zouden hebben toegeschreven tijdens de voorafgaande EMDR-sessie in experiment 1, resulterend in een positieve bias van participanten en compenserende antwoorden op het feitelijk veronderstelde nadelige effect van de oogbewegingen in experiment 2 weerlegd. Door deelnemers aan een Sudoku-puzzel te laten maken in plaats van een EMDR-sessie, waren ze niet in staat om een positieve bias ten opzichte van de oogbewegingen te vormen. Toch werd hetzelfde resultaat gevonden. De bevindingen suggereren in ieder geval dat de procedure zoals deze in huidige vorm wordt uitgevoerd niet effectief is in het versterken van de overtuiging een eigenschap te bezitten.

In hoofdstuk 3 (Matthijssen & van den Hout, 2016b) worden de resultaten besproken van een studie naar ‘Positief Afsluiten’ en het effect van oogbewegingen daarin bij patiënten met PTSS. De patiënten scoorden het geloof in bezit en emotionaliteit van twee positieve persoonlijkheidskenmerken. Na een reguliere EMDR-sessie bij hun eigen therapeut, gericht op een geselecteerde traumatische herinnering, scoorden patiënten opnieuw het geloof in bezit en emotionaliteit van de eigenschappen. Vervolgens haalden ze één eigenschap op tijdens het maken van oogbewegingen en de andere eigenschap zonder oogbewegingen. Daarna werd opnieuw de sterkte van het geloof de eigenschap te bezitten en de emotionaliteit beoordeeld. De resultaten toonden geen effect van oogbewegingen tijdens de procedure op het geloof in het bezitten van de positieve persoonlijkheidskenmerken, of op de waargenomen emotionaliteit, maar er was wél een effect van de EMDR-sessie zelf op het geloof in het bezit van het kenmerk. Patiënten met een sterke afname van emotionaliteitsscores tijdens de EMDR-sessie (wat een succesvolle

desensitisatie van een traumatische herinnering impliceert) lieten een toename van het geloof in het bezitten van het kenmerk tijdens de sessie zien. Een succesvolle EMDR-sessie had echter geen invloed op de waargenomen emotionaliteit van de kenmerken. Kortom, oogbewegingen lijken niet effectief in de procedure, noch bij studenten (hoofdstuk 2), noch bij PTSS-patiënten (hoofdstuk 3). Ook de controleconditie - oogfixatie - toonde geen effect op het geloof in bezit of emotionaliteit van de eigenschappen. De resultaten maken het gebruik van oogbewegingen in de procedure twijfelachtig en zelfs nog meer, de procedure zelf. 'Positief Afsluiten' liet geen effect zien op het geloof en de emotionaliteit van positieve uitspraken, maar het geloof in een positieve uitspraak was gecorreleerd aan de afname van emotionaliteit ten gevolge van de EMDR-procedure zelf.

Natuurlijk kan de afwezigheid van een effect te wijten zijn aan het ontbreken van een fenomeen. In dat geval zou het betekenen dat positieve verbale uitspraken niet te beïnvloeden zijn door werkbelastingheffing. Andere verklaringen voor het niet vinden van resultaten zijn van methodologische aard. Testen op een niet-klinische populatie in experiment 1 en 2 kan bijvoorbeeld de ecologische validiteit aantasten, maar dit lijkt geen plausibele verklaring voor het niet vinden van een effect van oogbewegingen omdat soortgelijke effecten werden gevonden in een patiëntenpopulatie. Verder zou men kunnen stellen dat de oogbewegingen erg kort waren (vijftien tot twintig seconden) en dat de manipulatie te kort was om enig effect te veroorzaken. Dit is een geldig argument bij het bepalen van het effect van oogbewegingen op positief verbaal materiaal in het algemeen, maar niet bij het bepalen van het effect van oogbewegingen in de procedure 'Positief Afsluiten', aangezien de hoeveelheid tijd dat de oogbewegingen werden uitgevoerd de feitelijke tijd is die wordt gehanteerd in het EMDR-protocol. Ook zou de gebruikte controleconditie belasting op het werkgeheugen kunnen hebben veroorzaakt (zie hiervoor de bespreking van de studies gepresenteerd in hoofdstuk 4 en 5.) Dit kan mogelijk de afwezigheid in verschil tussen de condities verklaren, maar niet de afwezigheid van het effect zelf. Wat een belangrijk verschil is tussen de positieve afsluitingsprocedure in de onderzoeken en de reguliere behandelingsetting is dat de therapeut in de reguliere behandeling na elke positieve associatie nogmaals oogbewegingen aanbiedt totdat er geen positieve associaties meer zijn, terwijl de onderzoeken uitsluitend op de eigenschap waren gericht en verdere oogbewegingen en associaties hebben weggelaten. Men zou zich kunnen afvragen of het belasten van de associaties zou kunnen leiden tot een effect op de

geloofwaardigheid van het bezitten van de eigenschappen en de emotionaliteit. Het is echter niet duidelijk of dit een potentieel positief of negatief effect zou hebben op het geloof en de emotionaliteit. Het wordt aanbevolen om het bestaan van een van beide redeneringen te valideren door een onderzoek uit te voeren waarin rekening wordt gehouden met associaties. Een laatste verklaring voor het nulresultaat wordt gegeven door de hypothese van modaliteitspecifieke belasting. In de experimenten werd een duale taak in een andere modaliteit gebruikt dan de opgehaalde uitspraak (visuele belasting op een auditieve / verbale uitspraak), welke mogelijk te beperkt interfereerde om een effect te sorteren.

Hoewel onderzoek naar associaties moet worden uitgevoerd lijkt het ontbreken van een effect van de oogbewegingen, hetzij vanwege de korte aanbieding van de oogbewegingen, vanwege het gebrek aan modaliteitsspecifieke belasting, of vanwege het ontbreken van het vermogen een uitspraak te beïnvloeden middels werkgeheugenbelasting, er in ieder geval op dat de procedure zoals die wordt uitgevoerd in het protocol niet zijn doel bereikt bij het versterken van de positieve uitspraak.

Klinische implicaties

Als gevolg van de uitgevoerde experimenten besproken in hoofdstuk 2 en 3, is het Nederlandse EMDR-protocol aangepast. Waar het vroeger een standaard was om oogbewegingen te gebruiken wanneer patiënten een positieve uitspraak over zichzelf formuleerden, is het niet langer verplicht om oogbewegingen te gebruiken wanneer men zich concentreert op de positieve uitspraak. In de 'Positief Afsluiten'-procedure in de meest recente versie van het protocol (ten Broeke, de Jongh & Hornsveld, 2018) is een optie toegevoegd. Er wordt aan patiënten gevraagd om een houding aan te nemen en mimiek vast te houden die correspondeert met een positieve uitspraak en zich gedurende 10 seconden te concentreren op de uitspraak (bijv. "Ik ben sterk") óf therapeuten kunnen een reeks afleidende stimuli aan bieden tijdens het ophalen van de positieve uitspraak. In het laatste geval wordt in een voetnoot van het protocol opgemerkt dat onderzoek "geen positieve effecten van het gebruik van afleidende stimuli laat zien, maar ook geen negatieve effecten." De recent toegevoegde optie voor het uitvoeren van deze procedure volgens het meest recente protocol is gebaseerd op Competitive Memory Training (COMET), een training gericht op het verbeteren van het ophalen van positieve informatie uit het

geheugen. Er lijkt redelijk wat evidentie te zijn die suggereert dat de procedure op basis van COMET-principes het geloof in het bezitten van een eigenschap zou kunnen versterken (zie bijvoorbeeld Korrelboom, de Jong, Huijbrechts, & Daansen, 2009; Korrelboom, Maarsingh, & Huijbrechts, 2012; Korrelboom, Marissen, & van Assendelft, 2011), maar dat is niet in zijn huidige vorm in het protocol getest. Bovendien is de optie om afleidende stimuli (veelal oogbewegingen) te gebruiken nog steeds aanwezig in het meest recente protocol. Dat er geen negatieve effecten van de oogbewegingen werden gevonden in de experimenten is echter geen reden om patiënten te belasten met afleidende stimuli. Men zou zelfs kunnen overwegen of de procedure überhaupt moet worden uitgevoerd of dat in plaats daarvan de nadruk zou moeten worden gelegd op het uitvoeren van een succesvolle EMDR-sessie, omdat dit het geloof in het bezit van een eigenschap of kenmerk lijkt te versterken.

Het exploreren van een nieuwe route: 'Visual Schema Displacement Therapy'

Een derde manier om bij te dragen aan de verbetering van traumatherapie is door nieuwe interventies te exploreren. Het lijkt een algemeen idee te zijn dat laboratoriumwetenschappers fundamentele studies doen en dat ten gevolge daarvan nieuwe technieken worden ontwikkeld die uiteindelijk door clinici worden gebruikt. In werkelijkheid gebeurt vaak het omgekeerde: clinici stuiten op een techniek en ontwikkelen deze met vallen en opstaan of met intuïtie. Hoewel veel van deze technieken ineffectief blijken, zijn er ook interventies die van grote waarde zijn. EMDR-therapie werd in feite gekenmerkt door een dergelijke ontwikkeling. Zoals Carl Sagan zegt: "Het is een deugd om open te staan bij het evalueren van nieuwe ideeën, alleen niet zo open dat je hersens er uit vallen." Op het gebied van traumabehandeling werd zo een nieuw idee geboden door Nik en Eva Speakman. Zij beweerden dat emotioneel beladen herinneringen succesvol konden worden behandeld door patiënten te instrueren de hand van de therapeut - die voor de patiënt staat - te volgen terwijl deze een horloge als focuspunt vasthoudt. Eerst wordt de patiënt gevraagd om een punt (het 'trauma-punt') te identificeren waar - wanneer de patiënt de ogen daar gericht houdt - de patiënt de meeste spanning of naarheid voelt terwijl de patiënt een emotioneel beladen herinnering ophaalt. Daarna wordt de patiënt gevraagd om een punt (het 'lachpunt') te identificeren waar de patiënt een blij gevoel of gevoel te willen lachen het sterkst ervaart bij het ophalen van een positieve herinnering, persoon of gebeurtenis. Tijdens de procedure beweegt de therapeut het horloge snel van het

traumapunt naar het lachpunt terwijl de therapeut luid 'Whoosh!' zegt. De patiënt wordt geïnstrueerd om de ogen gericht te houden op het horloge en te knipperen en te zuchten. De therapie wordt aangeduid als Visual Schema Displacement Therapy (VSDT) (https://www.youtube.com/watch?v=y3nRRMVHpWI). Hoewel de bedenkers positieve effecten claimden en video's lieten zien dat patiënten onmiddellijke en grote effecten meldden, was de techniek nooit op een gecontroleerde manier geëvalueerd en ontbrak bovendien een coherente theoretische redenering. In overeenstemming met Sagans opmerking over het belang van een open geest, hebben we besloten om deze merkwaardige therapie onder gecontroleerde omstandigheden te bestuderen.

Hoofdstuk 7 (Matthijssen, van Beerschoten, de Jongh, Klugkist & van den Hout, 2018) gaat in op VSDT. Twee experimentele studies werden uitgevoerd waarbij participanten werd gevraagd om drie emotioneel storende herinneringen op te halen, welk ieder werd belast met een van drie condities; VSDT, EMDR en een controleconditie (niets doen). VSDT werd daarmee niet alleen vergeleken met een inactieve controleconditie maar ook een actieve en bewezen effectieve conditie, d.w.z. EMDR. Emotionaliteit en levendigheid van de herinneringen werden beoordeeld vóór en na de condities. Het experiment werd gerepliceerd met een follow-up meting in een tweede experiment. Participanten werden in dit tweede experiment toegewezen aan een van de drie condities en een follow-up na 6 tot 8 dagen werd toegevoegd. Verrassenderwijs toonden beide experimenten dat VSDT superieur was aan EMDR en de controleconditie, terwijl EMDR sterkere effecten liet zien dan de controleconditie bij het verminderen van de emotionele lading van nare herinneringen. VSDT en EMDR waren even effectief in het verminderen van levendigheid en beiden bleken effectiever te zijn dan de controleconditie. Hoe de effecten moeten worden verklaard, is een open kwestie en enkele suggesties werden gegeven in hoofdstuk 7. De resultaten rechtvaardigen meer onderzoek, niet alleen in een experimentele setting, maar ook in een klinische setting. Door elementen van de therapie te ontmantelen, zouden onderliggende mechanismen van VSDT middels experimentele studies kunnen worden onderzocht. Klinische onderzoeken zijn daarnaast gerechtvaardigd om de procedure bij patiënten te testen en om het effect op PTSS-symptomen te evalueren.

Conclusie

De huidige dissertatie is een poging om bij te dragen aan het verbeteren van traumabehandelingen. Er zijn drie verschillende wegen bewandeld om dit doel te bereiken. De eerste was het kritisch testen van een specifiek element van een bestaand behandelprotocol, met als doel het testen van de effectiviteit ervan. Hoofdstuk 2 en 3 waren gewijd aan dit onderwerp en toonden aan dat de procedure 'Positief Afsluiten' in het Nederlandse EMDR-protocol in de huidige vorm geen effect laat zien op het versterken van een positieve uitspraak. Daarmee is de toegevoegde waarde van de procedure in het protocol uiterst twijfelachtig. De tweede manier om bij te dragen aan het doel was om meer inzicht te krijgen in het werkingsmechanisme van een specifieke traumatherapie (EMDR), en zo in potentie deze behandelvorm te kunnen optimaliseren. Hoofdstuk 4, 5 en 6 behandelden dit thema. De onderzoeken in deze hoofdstukken laten zien dat nare auditieve herinneringen minder emotioneel beladen kunnen worden gemaakt. Dit geldt zowel voor PTSS-patiënten als voor patiënten met auditieve hallucinaties. Daarnaast lijkt er enige evidentie voor modaliteitsspecifiek belasten te zijn gevonden in experimenteel onderzoek door het veroorzaken van een grotere interferentie in werkgeheugenbelasting, maar dit kan in klinische populaties (nog) niet worden bevestigd. De derde manier om een bijdrage te leveren aan het doel om traumabehandeling te verbeteren betrof het verkennen van een nieuwe interventie (VSDT). Hoofdstuk 7 was gewijd aan dit onderwerp. Resultaten laten zien dat VSDT effectiever is dan EMDR en een controleconditie in het minder emotioneel beladen maken van nare herinneringen in een niet-klinische populatie en het is daarmee een veelbelovende interventie is die meer onderzoek verdient.

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ABOUT THE AUTHOR

About the Author

Curriculum Vitae

Suzy Matthijssen was born on May 31, 1982 in Roosendaal, the Netherlands. In 2000 she started studying Geography and Planning at Utrecht University. She obtained a Geography Honours Minor certificate and a Masters degree in Urban Geography in 2005 and started studying Psychology at Utrecht University the same year. In 2008 she obtained her masters degree in Clinical Psychology and a University Honours Minor certificate. She started working at Altrecht GGZ and GGZ Centraal as a psychodiagnostic researcher and psychologist. She enrolled the post-doctoral education to become a mental health psychologist in 2010 and obtained this degree in 2012 while working at the anxiety and mood disorder department of GGZ Leiden. In 2012 she started working as a mental health psychologist at the departments for anxiety and personality disorders of Altrecht GGZ and in 2013 she enrolled the post-doctoral education to become a Specialist (Clinical Psychologist). During this specialization she worked at a department for adolescents prone to psychosis, a Faculty Assertive Community Treatment Centre, the Altrecht Academic Anxiety Centre, the Pieter Baan Centre (a forensic observation clinic) and the Dutch Institute for Forensic Psychiatry and Psychology. In 2013, Suzy started with scientific research at Utrecht University and the Altrecht Academic Anxiety Centre as a part of her specialization, and her focus was optimizing trauma treatment. She started her PhD project in 2014 and the goal of optimizing trauma therapy remained the focus of her PhD. In 2016, Suzy became a Clinical Psychologist-Psychotherapist and she obtained her NRGD (Nederlands Register Gerechtelijk Deskundigen) registration and she writes reports for the court of Justice on litigants suspected of a crime. She also has obtained her registration as a Psychotraumatherapist, EMDR practitioner, Cognitive Behavioural Therapist and Emotion Focused Therapist. As a scientist-practitioner it is her ambition to keep combining research and clinical practice. She will continue to work as a clinical psychologist-psychotherapist and a researcher at the Altrecht Academic Anxiety Centre and at Utrecht University. Besides that, Suzy is also a teacher at both the post-doctoral mental health and Clinical Psychologist educational programme at the RINO group.

International Publications

Matthijssen, S. J. M. A., Verhoeven, L. C. M., 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*(1937), 1-7. doi:10.3389/fpsyg.2017.01937

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Submitted Manuscripts

Matthijssen, S. J. M. A., van Schie, K., & van den Hout, M. A. (2018). *Psychological mechanisms in EMDR: the effect of modality specificity in taxing working memory.* Manuscript submitted for publication.

Matthijssen, S. J. M. A., van Beerschoten, L. M., de Jongh, A., Klugkist I. G., & van den Hout, M. A. (2018). *Effects of "Visual Schema Displacement Therapy" (VSDT), EMDR therapy and a control condition on emotionality and vividness of aversive memories: two critical analogue studies.* Manuscript submitted for publication.

Matthijssen, S. J. M. A., Heitland, I., Verhoeven, L. C. M., & van den Hout, M. A. (2018). *Reducing the emotionality of auditory hallucination memories.* Manuscript submitted for publication.

Conferences presentations & Invited presentations

Matthijssen, S. J. M. A. (2018, June). Scientific research on EMDR in the Netherlands. In B. Amann (Chair), *Scientific Research Meeting.* Meeting conducted at the EMDR Europe Conference, Strasbourg, France.

Matthijssen, S. J. M. A. (2018, June). *Geweld en PTSS en de praktijk van de mediator in strafzaken.* Lecture conducted at a meeting of the Association of Mediation in Criminal Cases, Utrecht, the Netherlands.

Matthijssen, S. J. M. A. (2018, May). *EMDR.* Lecture conducted in the bachelor program clinical psychology at the University of Amsterdam, Amsterdam, the Netherlands.

Matthijssen, S. J. M. A. (2018, May). *Optimizing EMDR treatment – The effect of modality specific taxation.* Keynote lecture conducted at the Conference of the German EMDR Association, Berlin, Germany.

Matthijssen, S. J. M. A., van Beerschoten, L. M., de Jongh, A., Klugkist I. G., & van den Hout, M. A. (2018, April). *VSDT vs. EMDR. Time for change?* Poster presentation at the Dutch conference for Clinical Psychologists, Utrecht, Nederland.

Matthijssen, S. J. M. A. (2018, April). Auditieve en visuele herinneringen in PTSS patiënten belast met oogbewegingen en tellen: het effect van modaliteitsspecifiek belasten. In G. Hendriks (Chair), *Innovaties in de behandeling van angststoornissen en PTSS – TOPGGZ netwerk angststoornissen.* Symposium conducted at the Conference of the Dutch Association of Psychiatry, Maastricht, the Netherlands.

Matthijssen, S. J. M. A. & de Jongh, A. (2018, April). *Visual Schema Displacement Therapy.. It's just a whoosh away..* Workshop conducted at the conference of the Dutch EMDR Association, Maarssen, the Netherlands.

Matthijssen, S. J. M. A. (2018, April). Een snellere, betere, effectievere vorm van traumabehandeling? In L. Kranenburg (Chair), *Research Pitches*. Symposium

conducted at the conference of the Dutch EMDR Association, Maarssen, the Netherlands.

Matthijssen, S. J. M. A. (2018, March). *Mediation in strafzaken.* Lecture conducted at a meeting of the association of mediation in criminal cases, Utrecht, the Netherlands.

Matthijssen, S. J. M. A. (2018, March). *EMDR.* Lecture conducted in the bachelor program clinical neuropsychology at the University of Amsterdam, Amsterdam, the Netherlands.

Matthijssen, S. J. M. A. (2017, November). Een snellere, betere en effectievere vorm van traumabehandeling? In S. Matthijssen (Chair), *Lezingencyclus: behandeling van specifieke doelgroepen (Trauma, SOLK, Obesitas).* Symposium conducted at the conference of the Dutch association of Cognitive Behavioural Therapy, Veldhoven, the Netherlands.

Matthijssen, S. J. M. A. (2017, October). *Een snellere, betere, effectievere vorm van traumabehandeling?* Lecture conducted at the NedKAD invitational conference, Amersfoort, the Netherlands.

Matthijssen, S. J. M. A. (2017, September). VSDT vs. EMDR. In I. Fernandez (Chair), ***Trauma and related disorders.*** Symposium conducted at the Conference of the European Association for Behavioural and Cognitive Therapies (EABCT), Llubljana, Slovenia.

Matthijssen, S. J. M. A., van Schie, K., & van den Hout, M. A. (2017, September). *Understanding mechanisms of EMDR: the effect of modality specificity in taxing the working memory.* Poster presentation at the Conference of the European Association for Behavioural and Cognitive Therapies (EABCT), Llubljana, Slovenia.

Matthijssen, S. J. M. A. (2017, June). Scientific research on EMDR in the Netherlands. In B. Amann (Chair), *Scientific Research Meeting.* Meeting conducted at the EMDR Europe Conference, Barcelona, Spain.

Matthijssen, S. J. M. A. (2017, June). *Een snellere, betere, effectievere vorm van traumabehandeling?* Keynote lecture conducted at the Wetenschapsmiddag, Parnassia, Den Haag, the Netherlands.

Matthijssen, S. J. M. A. (2017, June). A quicker, better and more effective form of trauma treatment? In S. Matthijssen (Chair), *Influencing factors.* Lecture

conducted at the Conference of the European Society of Traumatic Stress Studies, Odense, Denmark.

Matthijssen, S. J. M. A. (2017, May). *VSDT vs. EMDR.* Research pitch conducted at the Conference of the Dutch Society for Psychotrauma, Lunteren, the Netherlands

Matthijssen, S. J. M. A., van Schie, K., & van den Hout, M. A. (2017, April). *Understanding mechanisms of EMDR: the effect of modality specificity in taxing the working memory.* Poster presentation at the Dutch conference for Clinical Psychologists, Utrecht, Nederland.

Matthijssen, S. J. M. A. (2017, April). VSDT vs. EMDR. In S. van Veen (Chair), *EMDR Research Track.* Symposium conducted at the conference of the Dutch EMDR Association, Maarssen, the Netherlands.

Matthijssen, S. J. M. A. (2017, April). Modality Specific taxing in EMDR. In S. van Veen (Chair), *EMDR Research Track.* Symposium conducted at the conference of the Dutch EMDR Association, Maarssen, the Netherlands.

Matthijssen, S. J. M. A. & Verhoeven, L. C. M. (2017, February). *Werkt EMDR bij auditieve intrusies & stemmen?* Lecture conducted at the Special Interest Group Psychosis & EMDR of the Dutch EMDR Association, Utrecht, the Netherlands.

Mathijssen, S. J. M. A. (2016, November). Decision Tool Angst; Hoe onderscheid ik mijn angstpatiënten: wie heeft topklinische zorg nodig en wie specialistische GGZ? In J. van der Linde (Chair), *TOPGGZ lezingencyclus.* Symposium conducted at the conference of the Dutch association of Cognitive Behavioural Therapy, Veldhoven, the Netherlands.

Matthijssen, S. J. M. A. (2016, November). Werkt EMDR bij auditieve intrusies en stemmen? In: *Varia Lezingencyclus.* Symposium conducted at the conference of the Dutch association of Cognitive Behavioural Therapy, Veldhoven, the Netherlands.

Matthijssen, S. J. M. A. (2016, June). *EMDR and auditive intrusions.* Lecture conducted at the 6th Eye Movement Doctoral Research seminar, Université de Lorraine, Metz, France.

Matthijssen, S. J. M. A. (2016, June). *EMDR and auditive intrusions.* A. Hofmann (Chair). Lecture conducted at the conference of EMDR Europe, the Hague, the Netherlands.

van Vliet, G., **Matthijssen, S. J. M. A.**, & Spierings, J. (2016, June). *Research meets Practice: the Stabilization Controversy.* I. Bicanic (Chair). Lecture conducted at the conference ofEMDR Europe, the Hague, the Netherlands.

Matthijssen, S. J. M. A. (2016, June). EMDR on auditive hallucinations and auditive intrusions. Preliminary results of a patient study. In A. Onofri (Chair), *Researchtrack – EMDR & psychosis: above and beyond - latest research and developments.* Symposium conducted at the conference of EMDR Europe, The Hague, the Netherlands.

Matthijssen, S. J. M. A. (2015, April). Oogbewegingen bij positief afsluiten, zijn we er nu dan echt klaar mee? In L. Kranenburg (Chair), *EMDR Research Track*. Symposium conducted at the conference of the Dutch EMDR Association, Nijmegen, the Netherlands.

Matthijssen, S. J. M. A. (2014, June). The efficacy of eye movements in positive verbal material. In A. de Jongh (Chair), *EMDR Research Symposium (Netherlands Track)*. Symposium conducted at the conference of EMDR Europe, Edinburgh, United Kingdom.

Matthijssen, S. J. M. A. (2014, April). Het nut van oogbewegingen bij PA. In A. de Jongh (Chair), *EMDR Research Track*. Symposium conducted at the conference of the Dutch EMDR Association, Nijmegen, the Netherlands.

Awards & Prizes

Evidence beast (2017). Prize for best scientific research presented on the Dutch EMDR conference. The Netherlands.