

## **A Word Tracking Task as an alternative to horizontal eye movements in the reduction of vividness and emotionality of aversive memories in EMDR**

*Annemarie J.A. Altink, Patricia van Terwisga, Frouke D.G. Helms and Sophia H. Oostenbroek*

*Supervisor Helen K. Hornsveld*

*Clinical and Health Psychology*

### **Abstract**

When treating a patient with PTSD, therapists often use eye movement desensitization and reprocessing (EMDR). In EMDR patients make horizontal eye movements (HEM) while the image of a traumatic memory is recalled. Various studies showed that making HEM during recall of an aversive memory results in a decline in vividness and emotionality of this memory. This study aimed to create an alternative task that would be less physically demanding for the therapist than applying HEM. This task should, according to the working memory (WM) hypothesis, tax the WM as much as HEM. To accomplish this goal, a word-tracking task (WTT) was created in which an oval that moved over a matrix with color-words had to be followed with the eyes. Experiment I showed that the WTT taxes WM, though not as much as HEM. In experiment II, both the WTT and HEM resulted in a decrease in vividness and emotionality of an aversive memory. The results obtained raise questions about a supposed linear relationship between the WM-taxing and EMDR-efficacy of tasks. Further investigation of this relationship is recommended. Also recommended is further study in a clinical population. The WTT seems to be a good alternative for horizontal eye movements in EMDR.

**Keywords:** EMDR; PTSD; working memory

### **Introduction**

Over the course of a lifetime, every human being experiences high-impact life events. A minority of human beings experience events that involve a threat to one's life and a feeling of fear, helplessness or horror (Bisson & Shephard, 1995). Only a minority of the victims of such events develop a posttraumatic stress disorder (PTSD, APA, 2004; Bonannao, 2004). PTSD is defined by the Diagnostic and Statistical manual of Mental disorders (DSM-IV-TR, American Psychiatric Association, 2000) as a psychological disorder that is a consequence

of a traumatic event that includes symptoms such as intrusive memories, reliving the experience, avoidance and an elevated level of arousal. Intrusive memories are one of the most important criterion for a PTSD diagnosis. These are intrusive and aversive memories that can be relived through every sensory modality, though they most often take the form of vivid visual images (Ehlers, Hackmann, Steil, Clohessy, Wenninger, & Heike, 2002; Hackman & Holmes, 2004; in Engelhard, van Uijen & van den Hout, 2010). Approximately twenty years ago, Shapiro (1989) developed Eye Movement Desensitization and Reprocessing (EMDR) as

a treatment for PTSD. Ever since then, this method has gained increasing popularity worldwide.

In the EMDR-protocol (De Jongh & Ten Broeke, 2009) the patient is asked to imagine the aversive event (accompanied by the corresponding cognitions and emotions) while focusing attention on an external stimulus. Often lateral eye movements are used as an external stimulus, which involves the patient visually following the horizontal movements of the therapist's fingers. Sets of approximately twenty eye movements are alternated by the patient reporting current sensations, cognitions and affect, until the patient reports experiencing less tension while reliving the memory.

Next the patient is instructed to replace the negative dysfunctional cognition about the aversive memory with a positive, more functional cognition. In the meta-analysis of Bisson, Ehlers, Matthews, Pilling, Richards, and Turner (2007), several studies showed the effectiveness of EMDR in reducing the symptoms of PTSD. EMDR turns out to be as effective as cognitive behavioral therapy (CBT) for patients with a diagnosis of PTSD (Bradley, Greene, Russ, Dutra & Westen, 2005; Gunter & Bodner, 2009; van den Hout et al. 2010b). In a review of meta-analytic findings, Olatunji, Cisler and Deacon (2010) report that rates of change in diagnostic status (i.e., no longer meeting criteria for PTSD) across treatment conditions were better for EMDR (60%), exposure therapy (53%) and CBT (46%) than for wait-list control (14%) and supportive control (36%). The multidisciplinary guideline for anxiety disorders of the Dutch Mental Health Care organization (GGZ, 2003) describes both EMDR and CBT as 'treatments of choice for PTSD.'

Despite the proven effectiveness of EMDR, this method has recently been subject to debate. For example, some researchers concluded that the effects of EMDR are

mainly due to exposure, which is a consequence of the retrieval of aversive memories (Russell, 2008). However, this point of view is inconsistent with the results of experimental studies in which eye movements resulted in a decrease of vividness and emotionality of autobiographical memories, while the retrieval of memories without eye movements did not result in such a reduction (Andrade, Kavanagh & Baddeley, 1997; van den Hout et al., 2001; Maxfield, 2008; in Engelhard et al., 2010). The efficacy of EMDR and the contribution of eye movements to this effectiveness has been amply demonstrated in the studies mentioned above. This however, does not end the controversy surrounding EMDR, because it remains unclear how eye movements produce the proven effects. Gunter and Bodner (2008) have studied the following three hypotheses concerning the efficacy of EMDR: the working memory account, the investigatory reflex account and the inter-hemispheric communication account. The results of the present study support a working memory account of the eye movements as being responsible for the benefits of EMDR. The working memory account proposes that the two tasks that the patient performs cognitively compete for the limited capacity of working memory. Tracking the therapist's fingers calls for memory capacity that is necessary to recall the memory in a vivid manner (Gunter & Bodner, 2008; Engelhard et al., 2010). As a consequence of this lack of memory capacity, the vividness of the visual image decreases, which is possibly an explanation for reduced emotionality (Engelhard et al., 2010). Subsequently, a reconsolidation process takes place that involves once more storing the memory that is reduced in vividness and emotionality in long-term memory. When someone recalls this reconsolidated memory at a later time, this memory will be less aversive and vivid than before (Suzuki et al.,

2004; Gunter & Bodner, 2009; van den Hout et al., 2010b). The current study is theoretically based on the working memory hypothesis.

In 1974, Baddeley and Hitch developed the multi-component model for working memory (Baddeley & Hitch, 1974). Originally the multi-component model proposed three components, of which the main component is the central executive. The central executive is involved in relatively complex cognitive tasks, and in dividing attention. According to the model, the other two components of the working memory are the phonological loop (storing auditory information) and the visuospatial sketchpad (cognitively retaining visual images) (Baddeley, 2000). Among researchers, there are two approaches to the working memory hypothesis concerning EMDR. One states that eye movements specifically tax the visuospatial sketchpad, while the other approach suggests that eye movements simply serve as a task that taxes the central executive (Gunter & Bodner, 2008; Engelhard et al., 2010). These explanatory differences influence the acknowledgement of the role of eye movements in EMDR. The first approach states that the secondary task needs to be visually demanding, which is the case for eye movements. The second approach however states that every task that activates the central executive is a potential secondary stimulus. In this approach, eye movements are not a vital part of the EMDR method, but only one of the many possible tools used for taxing working memory.

This last approach seems to be the one most supported by recent studies. Gunter and Bodner (2008) and Engelhard et al. (2010) concluded that eye movements were not the only effective mechanism in reducing the vividness and emotionality of an aversive memory. Tasks such as calculating, counting, drawing a complex figure and auditory tasks appeared to be effective as well, even though

these tasks engage the visuospatial sketchpad to a lesser extent than eye movements. In conclusion, for EMDR to be effective, it is not important which of the subcomponents is taxed, as long as it results in the taxing of the central executive.

The results of the study of Gunter and Bodner (2008) do not support the other important theory that interhemispheric communication (Christman, Garvey, Propper & Phaneuf, 2003) is the explanatory factor regarding the effectiveness of EMDR. This theory proposes that horizontal eye movements stimulate the communication between the left and right hemispheres of the brain. Traumatic events are said to be better recalled because of this increased communication (Christman et al., 2003). Specifically, language processes in the left hemisphere are said to reduce fear and excitement in the right hemisphere (Heller, Etienne & Miller, 1995), which causes desensitization of the aversive memories. Based on this theory, several bilateral tasks have been introduced in research and practice, such as alternating auditory beeps (Maxfield, 2008; in Engelhard et al., 2010). However, Gunter and Bodner (2008) and Engelhard et al. (2010) discovered that the non-bilateral tasks mentioned above, such as counting, are also effective in reducing the vividness and emotionality of aversive memories. Even though the communication between the left and right hemispheres as a result of bilateral stimulation possibly contributes to the recollection of a memory (Christman & Propper, 2001), it can be concluded that it is not the main explanatory factor in the efficacy of EMDR regarding the reduction of vividness and emotionality (Gunter & Bodner, 2008). In fact, vertical eye movements appear to be equally as effective as horizontal eye movements, while these vertical eye movements do not stimulate communication between the hemispheres. The efficacy of both kinds of

eye movements can be explained by the working memory being taxed (Gunter & Bodner, 2008).

For the daily practice of EMDR-therapists, this implies that, during EMDR, several alternative secondary tasks can be applied. These tasks need to tax the working memory, but need not necessarily be of a bilateral nature. Even though the proven effectiveness of eye movements in EMDR alone gives no reason to search for alternatives, there are still practical reasons for doing so. First and foremost, the arm movements that the therapist applies to establish lateral eye movements in the patient are physically demanding. Furthermore, the arm movements obstruct the possibility of making notes. This calls for a useful alternative task that is cognitively distracting for the patient. For some time, therapists have used alternating bilateral beeps that are produced by headphones worn by the patient. Research by Van den Hout et al. (2010b) however concludes that these beeps are less effective than eye movements in diminishing the vividness and emotionality of aversive autobiographical memories. In addition, when using the alternating beeps or other cognitively distracting tasks (e.g., calculating and counting), the therapist is not able to check whether the patient continues to perform the distracting task when the recalled memory becomes very intrusive and demands a lot of attention.

The current study sought to compare the effect of an alternative cognitively engaging task with the effect of eye movements in EMDR. A task was chosen that calls for visual capacity and can be applied in a way that grants the therapist control over the speed of applying the stimulus. For this aim, a word tracking task (WTT) was used that was designed specifically for the current study. This task is based on the Stroop task

(Stroop, 1935), because it taxes working memory (McLeod, 1991). In the designed task, random eye movements take place within the context of visually tracking an oval on a computer screen. By adding incongruent word-color combinations to the background, additional working memory taxing is achieved.

This study examined whether the word tracking task (WTT) taxes working memory to the same degree as horizontal eye movements (HEM) do and whether both tasks engage the working memory more than a stationary dot (SD) does. Degree of taxing was assessed with a reaction times (RT) task involving auditory cues. It was predicted that, relative to the SD, both WTT and HEM would tax the working memory to a higher degree, while WTT and HEM would tax working memory to the same degree. This was expected to result in longer RT's during WTT and HEM than during SD.

Besides testing the degree to which both tasks engage working memory, the effects of the WTT and HEM on vividness and emotionality of an aversive memory was examined. It was predicted that applying the WTT and HEM as a secondary task while the subject recalled an aversive personal memory would result in this memory becoming less vivid and emotional.

Next, this study aimed to examine whether a relationship could be found between the working memory capacity of participants and the degree to which their aversive memory decreased in vividness and emotionality. The working memory account predicts that individuals who have difficulties applying different tasks at the same time, and thus have a limited working memory capacity, will experience a larger EMDR-effect (Gunter & Bodner, 2008, van den Hout et al., 2010a).

Concerning individual differences, it was predicted that an effect of working memory capacity on the effectiveness of the

secondary tasks would be observed. It was also expected that individuals with limited working memory capacity would experience larger effects of the HEM and WTT. Van den Hout et al. (2010b) suggest in the discussion of a recent study that this relationship between working memory capacity and EMDR effectiveness is possibly not of a linear nature, but instead takes the form of an inverse U-curve. They suggest that, if working memory is overly taxed, this will interfere with the process of reconsolidation. Taxing working memory is efficacious to a certain point, but becomes deleterious beyond that point. Consequently, the alternative hypothesis of this study is that there is a quadratic relationship between working memory capacity and decrease of vividness and emotionality. This was predicted to result in a smaller decrease in vividness and emotionality of the aversive memory when taxing working memory to a greater or lesser degree, compared to a larger decrease when taxing working memory intermediately.

## Experiment I

### *Introduction*

Experiment I aimed to examine whether the alternative secondary task, the word tracking task (WTT), would tax the working memory to the same degree as horizontal eye movements (HEM) do. A valid method to assess the presence and amount of cognitive load of a certain task is to let someone apply this task while accomplishing a reaction time (RT) task (Bower & Clapper, 1989, in: van den Hout et al., 2010b). The more the alternative task taxes the working memory, the slower the RT's would be. HEM are known to decrease the speed of RT's (e.g. van den Hout, 2010b). The question remained as to whether WTT would result in a similar decrease of RT speed.

All tasks in the current study are of a visual nature. Since it is not possible to apply a visual task and at the same time respond to a visual RT-task, an auditory RT-task was used.

### *Method*

**Participants.** Thirty-six students (27 women) from Utrecht University participated for course credits or a financial reward. In order to determine the sample size, a power-analysis was done with *G\*Power* (Faul, Erdfelder, Lang & Buchner, 2007), based on a 2 x 3 within subject design. To determine the effect size, results from a study by Van den Hout et al. (2011) were used, in which a main effect of partial eta squared ( $\eta^2_p$ ) = .12 was found. *G\*Power* calculated an effect size of .36. In order to reach a power of .80, 18 participants were needed. Since there were 36 condition orders in experiment II, a total of thirty-six participants was preferred.

**Design and randomization.** The current experimental study used a within-subject design with three conditions: a RT-task with horizontal eye movements (HEM), a RT-task with the word-tracking task (WTT) and a RT-task with a stationary dot (SD) as a control condition. The participants successively participated in all three conditions, in which the same RT-task was used to determine RT as the dependent variable.

Counterbalancing was used to determine the order in which the three conditions were presented to the participants, in order to control for carryover effects. One of 36 lots were taken by the participant right before starting with the first condition, so that the condition order was not (unconsciously) manipulated.

**Task conditions and materials.** In the ‘RT-task with HEM’-condition, participants tracked with their eyes a black dot that moved from left to right and back across a white computer screen, at one cycle per second. Participants were seated about 30 cm in front of the screen, in order to optimize the eye movements.

In the ‘RT-task with WTT’-condition, participants visually tracked an oval that moved in random horizontal, vertical and diagonal fashion across a black computer screen. On this computer screen, a matrix with color words was presented behind the oval. The words *red*, *yellow*, *green* and *blue* were presented in a red, green, yellow or blue color. Some word-color combinations were congruent (e.g. the word *red* written in red), while most word-color combinations were incongruent (e.g. the word *green* written in blue). The participants were told not to read the words consciously, but to track the oval that moved across those words.

In the control ‘RT-task with SD’-condition, participants watched a stationary black dot on a white computer screen.

During the three condition tasks, participants performed a RT-task. This task consisted of 148 tones of 50 ms, presented via a computer, with an alternating interval of 900 or 1500 ms. The participants were told to press a key as soon as they heard a tone. In total, this task took 180 seconds. RT’s were measured with E-Prime 1.2 software.

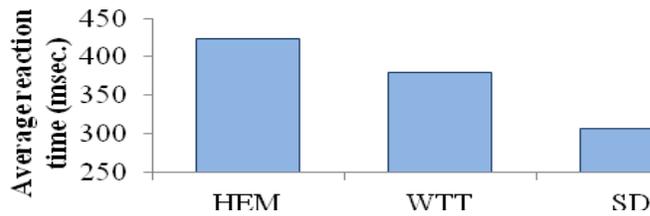
**Procedure.** After obtaining informed consent of the participants, the HEM, WTT and SD conditions were introduced. Each participant drew a number to determine the condition order. Next each participant was seated behind a table with two computers, with his or her face behind the screen on which the condition task would be presented. The right or left hand of the participant (depending on preference) was placed on the keyboard of the second computer on which the RT task would be presented. After a trial in which the participant could practice the task for 30 seconds, the RT task was administered in the three conditions. Within a span of 180 seconds, 148 auditory tones were presented, with the participant being required to respond quickly to each of these by pushing the spacebar. In the same time, the participant was told to track with his eyes the dot or oval on the computer screen. There was a pause of 60 seconds between each condition.

The mean RT’s for the three conditions are presented in Figure 1 and Table 1.

In comparison to the control condition, subjects in both the HEM and WTT conditions had slower RT’s.

**Table 1.** Mean reaction times (RT) in ms for horizontal eye movements (HEM), a Word Tracking Task (WTT) and a control condition with a stationary dot (SD)

	HEM	WTT	SD
<b>Reaction time</b>	423 (88)	379 (80)	306 (63)



**Figure 1.** Mean reaction times (RT) in ms for horizontal eye movements (HEM), a Word Tracking Task (WTT) and a control condition with a stationary dot (SD).

The decrease in RT speed was 1.5 times larger during HEM as it was during the WTT. The conditions differed significantly:  $F(2, 70) = 52.58; p < 0.001, \eta^2_p = 0.60$ . The RT's in the WTT condition were significantly slower than in the control (SD) condition ( $F(1, 35) = 42.77; p < 0.001, \eta^2_p = 0.55$ ), but faster than in the HEM condition ( $F(1, 35) = 19.88, p < 0.001, \eta^2_p = 0.36$ ). In addition, the HOB and control condition differed significantly:  $F(1, 35) = 78.20, p < 0.001, \eta^2_p = 0.69$ .

### Conclusion

That horizontal eye movements (HEM) tax the working memory has been shown in various studies. Experiment I examined if the word tracking task (WTT) would tax the working memory to the same degree as eye movements. In addition, both tasks were compared to a stationary dot (SD) control condition to see if they would tax the working memory to a higher degree. Both HEM and WTT turned out to result in a decrease in RT speed compared to the control condition. This confirms our hypothesis. However, HEM and WTT also differed significantly, with HEM yielding a larger decrease in speed than WTT. It can be concluded that HEM taxes the working memory in a larger degree than WTT. The hypothesis that both tasks would tax the

working memory to the same degree was therefore disconfirmed.

## Experiment II

### Introduction

The working memory account proposes that taxing the working memory while recalling a specific memory makes it hard to experience the latter in a fully vivid and emotional manner. As the working memory is taxed more by cognitive activity, vividness and emotionality of a recalled memory will decrease. In experiment I, the degree to which three different tasks (horizontal eye movements (HEM), the word tracking task (WTT) and a stationary dot (DT)) tax the working memory was examined.

The aim of experiment II was to compare the effects of the three tasks on vividness and emotionality of an aversive memory. It was predicted that the pattern that was found in experiment I also would be found in the decrease of vividness and emotionality in experiment II. Tasks that yield a slower reaction time and thus ask for more working memory capacity are expected to result in a larger decrease in vividness and emotionality of the memory that the participant recalls.

## **Method**

**Participants.** The same thirty-six participants (27 women) that participated in experiment I also participated in experiment II.

**Design and randomization.** The current experimental study used a 2 (time: pre- vs. post) x 3 (condition: HEM vs. WTT vs. SD) within subject design with repeated measures. The dependent variables Vividness and Emotionality of the memory of an aversive event were measured.

**Task conditions and materials.** In experiment II, participants performed the same tasks that were used in experiment I: HEM, WTT and SD as a control condition. But in the experiment II, the tasks were not combined with a RT task, but with the retrieval of an aversive memory. Vividness and emotionality of the memory were rated on a Visual Analogue Scale (VAS) from 0 to 100 (0=not vivid-, not emotional at all; 100=extremely vivid, as emotional as possible). Each subject was asked: How vivid is this memory for you at this moment? How emotional is this memory for you at this moment?

**Procedure.** All subjects were subjected to experiment II after they had finished experiment I. The procedure was based on the EMDR-procedure by Ten Broeke and De Jongh (2009) and the procedure in a study by Van den Hout et al. (2010). During phase I, the participant was asked to recall three aversive autobiographical memories that had at one time made him or her afraid or sad and that still had an emotional impact. Each participant then took some minutes to recall the memories and write down some labels and notes. Subsequently, he or she was asked to form

an image of the occasion, to describe it and to rank it in terms of emotionality. The order of conditions and assigned memories to conditions was counterbalanced in order to control for carryover effects.

During phase II, the participant was instructed: *'You just told me how this memory is stored in your mind. Now I ask you: what is at this moment the most aversive image of this memory? Where do you see yourself in the memory? What is the image like? If you recall the image, which emotions do feel? Where in your body do you feel these emotions?'*

Subsequently, each subject was asked to rate the autobiographical memory in terms of its vividness and emotionality, for which a Visual Analogue Scale from 0 to 100 (0=not vivid-, not emotional at all; 100=extremely vivid, as emotional as possible) was used. During phase III, the participant was told to imagine the memory, while visually tracking the dot (HEM and SD) or oval (WTT), the specific task performed depending on the assigned condition-order. The task was presented in four trials of 24 seconds, with a break of 5 seconds in between trials. After the 4 trials, each participant was asked to rate the memory for a second time on vividness and emotionality. He or she was also asked to rate the memory with respect to vividness and emotionality retrospectively (i.e., in terms of their intensity prior to the task).

After a break of two minutes, the participant repeated phase III until all three conditions were completed. During the break, he or she was told to let the previous memory go and was offered a distracting drawing-task. Finally, each subject was asked to fill in a short questionnaire concerning previous knowledge about EMDR and the way the participant had experienced the 3 tasks. Each participant was then debriefed and given his or her reward.

The changes in Vividness and Emotionality are presented in Table 2 and Figure 2. For Vividness ratings, there was a significant main effect for time, which shows that the memories became less vivid during post-rating than during pre-rating ( $F(1, 35) = 10.82; p = 0.002, n^2_p = .24$ ). There was no significant main effect for Condition ( $F(2, 70) = 2.18; NS$ ). The crucial Time X Condition interaction was significant ( $F(2,$

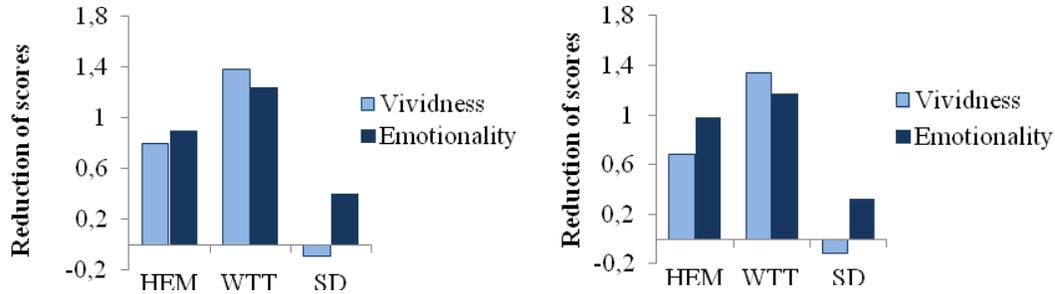
$70) = 7.63; p = 0.002, n^2_p = .18$ ). In both HEM ( $F(1, 35) = 5.44; p = 0.026, n^2_p = .13$ ) and the WTT ( $F(1, 35) = 13.43; p = 0.001, n^2_p = .28$ ), a significantly larger decrease in vividness than in the control condition (stationary dot, SD) was found. There was no significant difference between HEM and WTT in change of vividness ( $F(1, 35) = 2.18; NS$ ).

**Table 2.** Scores on Vividness and Emotionality of an aversive memory: pre-rating, retrospective pre-rating and after recalling the memory during horizontal eye movements (HEM), a word tracking task (WTT) or a control condition with a stationary dot (SD) (post-rating)

	Vividness				Emotionality		
	Pre	Retro	Post		Pre	Retro	Post
Horizontal eye movements	7.3 (1.4)	7.3 (1.3)	6.5 (2.0)		6.2 (1.8)	6.3 (1.9)	5.3 (2.2)
Word Tracking Task	7.5 (1.4)	7.5 (1.3)	6.2 (2.0)		6.3 (1.7)	6.3 (1.6)	5.1 (1.7)
Control condition	7.3 (1.7)	7.2 (1.4)	7.3 (1.8)		5.8 (2.6)	5.6 (2.4)	5.3 (2.5)

The same pattern was found for Emotionality. There was a main effect for Time ( $F(1, 35) = 19.86; p < 0.001, n^2_p = .36$ ) and no difference between conditions ( $F(2, 70) = .07; NS$ ). The Time X Condition-interaction was significant ( $F(2, 70) = 3.41; p = 0.039, n^2_p = .09$ ). Both the HEM and WTT showed a larger decrease in emotionality than the control-condition (SD). With respect to HEM this difference was true when using the retrospective pre-

rating ( $F(1, 30) = 4.82; p = 0.036, n^2_p = .14$ ), but not when using the regular pre-rating ( $F(1, 35) = 2.57; NS$ ). For WTT this difference was true in both pre-ratings, respectively ( $F(1, 30) = 5.40; p = 0.027, n^2_p = .15$ ) and ( $F(1, 35) = 6.80; p = 0.013, n^2_p = .16$ ). In Emotionality as well, no significant difference was observed between the HEM and WTT in change of vividness ( $F(1, 35) = 0.86; NS$ ).



**Figure 2a & 2b.** Reduction in Vividness and Emotionality of an aversive memory during horizontal eye movements (HEM), a word tracking task (WTT) and a control condition with a stationary dot (SD), with the use of regular pre-rating (a) and a retrospective pre-rating (b).

To find out if there was a relationship between working memory capacity, measured in experiment I, and the change in vividness and emotionality, measured in experiment II, a Pearson product-moment correlation coefficient was calculated. Only one significant correlation was found: differences in working memory capacity measured in experiment I in the HEM-condition appeared to be related to differences in change of Vividness during HEM in experiment II ( $r = -.45$ ,  $N = 31$ ,  $p = .010$ ). Participants with slower RT's (less working memory capacity) on the HOB task, showed a greater reduction in vividness of an aversive memory when recalling this memory while making horizontal eye movements (HEM).

### Conclusion

Previous studies showed that the application of horizontal eye movements (HEM) while retrieving an aversive memory resulted in a reduction of the vividness and emotionality of this memory (Andrade et al., 1997; van den Hout et al., 2001; Maxfield, 2008; in Engelhard et al., 2010). The results of experiment II were consistent with the results of these studies. Experiment II also showed that the implementation of a word

tracking task (WTT) had the same effect. Furthermore, the implementation of the WTT resulted in a slightly greater reduction of the vividness and emotionality of retrieved aversive memories than the implementation of the HEM. But the difference between the effects of these tasks was not significant. Thus, the goal of the current study, which was to develop a task that would be as effective as eye movements in reducing the vividness and emotionality of aversive memories, was accomplished. One can conclude that the implementation of the HEM and the WTT vitally contributed to the importance of the procedure, since the implementation of the control condition (which involved only looking at a stationary dot) actually resulted in an increase in vividness and significantly less reduction of emotionality. Also, since both the HEM and the WTT showed a greater taxing of WM as compared to the control condition, the current study seems to confirm the assumption that the WM-taxing explains the efficacy of eye movements in EMDR. The correlation between working memory capacity, as measured in experiment I, and the reduction of vividness during eye movements while retrieving a memory, which was apparent in experiment II, suggests a linear relationship. Individuals

with a more limited working memory capacity experienced a greater reduction of vividness. This relationship, however, was not found in the WTT and the control task. Also noteworthy is that the WTT, which evidently taxed the working memory less than HEM, as shown by experiment I, still resulted in an equally substantial and even greater reduction of vividness and emotionality. This suggests that the relationship between the WM-taxing of a task, and the effects of this task on vividness and emotionality, is non-linear. Another explanation could be that other aspects of the task (i.e., other than the taxing of working memory), contribute to this process.

## Discussion

The purpose of this study was to compare the effect of an alternative cognitively engaging task to the effects of horizontal eye movements in EMDR. Previous studies had shown that eye movements were effective in reducing the vividness and emotionality of a retrieved memory, compared to a control condition with no stimulus (Andrade et al., 1997; van den Hout et al., 2001). An explanation for this efficacy of horizontal eye movements in EMDR can be found in the Working Memory (WM) account (Gunter & Bodner, 2008; Engelhard et al., 2010). This account states that eye movements tax the working memory and as a result prevent a memory from becoming too vivid and emotional. Subsequently it proposes that by increasing the degree to which a task engages working memory, EMDR effects are increased as well. Research has shown that complex tasks that tax the working memory substantially (e.g. horizontal- and vertical eye movements, calculating and playing Tetris) result in a larger reduction of vividness and

emotionality of the memory than simple tasks (e.g. simple calculating) (Gunter & Bodner, 2008). Research also showed that another commonly used EMDR method, alternating bilateral beeps, is less effective than eye movements.

Because of practical problems accompanying horizontal eye movements, in the current study a task was designed and tested that could provide an alternative for eye movements in EMDR. This task had to meet certain criteria: it needed to tax the working memory to the same extent as eye movements. Furthermore, it had to be adjustable in speed, of a neutral nature, accessible for therapists and not too expensive. The word tracking task (WTT) that was designed for the current study meets all of these criteria and is therefore a practical and useful alternative EMDR task. The reaction time (RT) data in experiment I showed that horizontal eye movements (HEM) and the WTT tax the working memory (see Fig. I). The WTT was designed to create a task that taxes the working memory as much as HEM. This, however, did not prove to be the case: the HEM taxed the working memory significantly more than the WTT. As a consequence of these findings, one would expect that the WTT is inferior to HEM when it comes to facilitating a reduction of vividness and emotionality of memories. Thus it is striking that this was not the case in experiment II. In this experiment, the WTT was at least as effective as HEM. During the performance of the WTT as well as during the HEM, the vividness and emotionality of an aversive memory decreased significantly more than during a control task. The WTT resulted in an even greater reduction of vividness and emotionality, though this difference was not significant. In conclusion, in spite of it taxing the working memory to a larger degree, HEM appeared to be no more

effective than the WTT. An alternative task that taxes working memory less than eye movements do can be as effective, and possibly more effective, than EMDR in reducing vividness and emotionality. This does not seem to support the assumption that there is a linear relationship between the degree to which a task engages working memory and the efficacy of the task as an EMDR stimulus. This finding could, however, strengthen the hypothesis that the earlier mentioned relationship is not linear, but has an inverted U shaped curve (Van den Hout et al., 2010b). Possibly the eye movements are somewhat too taxing, at least for individuals with a limited WM capacity, and a slightly less engaging task would be more effective. This would mean that, for eye movements, an inverse relationship would be expected, namely that when a task becomes more taxing for an individual, there is less reduction of vividness and emotionality. This however was not found in the current study. Upon closer inspection, there appeared to be a negative correlation between the RT and the reduction of vividness and emotionality in participants. As for eye movements, individuals with a slower RT showed a larger reduction of vividness and emotionality of their memories (i.e., a linear relationship). It is not clear how these results can be explained. They are possibly influenced by limitations in the design of the current study, namely the sample size and the fact that it consisted of students. Students are expected to show less variation in memory capacity than a random group of individuals drawn from the general population. The relationship between working memory capacity of an individual and the reduction of vividness and emotionality of an aversive memory of this selfsame individual is consequently not easily exposed in the current sample. Also, only one correlation was found. For the other conditions, no relationship was found

between RT and reduction of vividness and emotionality. Another explanation for the conflicting effects could be found in currently unknown co-variables. It is possible that, in addition to WM-taxing, other aspects of a task contribute to the effect of the task in reducing the vividness and emotionality of an aversive memory. The characteristics of the WTT provide the possibility of applying variation in speed of exposure and level of difficulty. For example speed of the oval's movement could be varied, and the participant can be asked to register the word-color combinations more consciously (e.g., by naming the words or colors). In this way, the task could be made more taxing for the working memory. In follow-up studies, the task could be presented with an amount of WM-taxing that is equal to that of horizontal eye movements, for the purpose of investigating the effects on vividness and emotionality. A possible outcome would be that the effects increase, which makes the task more effective than eye movements. It is also possible that a more engaging version of the task exceeds the maximum beneficial amount of WM-taxing and as a consequence reduces in efficacy. These follow-up studies could provide an answer to the question about the linearity of the relationship between WM-taxing and EMDR-effects. In practice, this could mean the possibility of finding a new EMDR stimulus that is equally effective, and possibly more effective, than eye movements. Most of the participants (25) characterized the task as more pleasant than eye movements (6) or a stationary dot (5). But the results of the current study should not be generalized to EMDR. First, the current study used eye movements on a computer screen. It is uncertain whether the computer and manual version of the eye movements are comparable in WM-taxing and in the effect on vividness and emotionality of memories.

Also, the results found in a sample of students cannot be used to draw conclusions concerning individuals with a diagnosis of PTSD. It could be that, in daily practice, because of the nature of the retrieved memories (which would be more traumatic in the case of those diagnosed with PTSD) and possible other symptoms (e.g. intrusive thoughts, concentration problems and dissociation) there are other relations between WM-taxing, the efficacy of a task, and possible third variables. Furthermore, in daily practice, the eye movements are presented to the patient for a longer period of time. It is expected that a longer time of

presenting the HEM and WTT will result in a larger effect. Whether this effect is linear or not, and if both tasks call for an equal duration in order to achieve a maximum effect, should be further investigated. It would be interesting to also investigate long-term effects, which were not studied in the current research. Replication of the current study and similar studies in clinical practice is therefore necessary. The word tracking task seems to have the characteristics to be investigated and implemented as an alternative task in EMDR.

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