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What is the Role of Eye Movements in Eye Movement Desensitization and Reprocessing (EMDR) for Post-Traumatic Stress Disorder (PTSD)? A Review

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Background: Controversy continues to exist regarding how EMDR works and whether its mechanisms differ from those at work in standard exposure techniques. **Aims:** To investigate first whether eye movement bilateral stimulation is an essential component of EMDR and, second, the current status of its theoretical basis. **Method:** A systematic search for relevant articles was conducted in databases using standard methodology. **Results:** Clinical research evidence is contradictory as to how essential EMs are in PTSD treatment. More positive support is provided by analogue studies. With regards to potential theoretical support, some evidence was found suggesting bilateral stimulation first increases access to episodic memories; and second that it could act on components of working memory which makes focusing on the traumatic memories less unpleasant and thereby improves access to these memories. **Conclusions:** The results suggest support for the contention that EMs are essential to this therapy and that a theoretical rationale exists for their use. Choice of EMDR over trauma-focused CBT should therefore remain a matter of patient choice and clinician expertise; it is suggested, however, that EMs may be more effective at reducing distress, and thereby allow other components of treatment to take place.

Keywords: Posttraumatic stress disorder, eye movement desensitization and reprocessing, components of therapy, theoretical support.

Introduction

Several treatments for PTSD persisting beyond 3 months (see NICE, 2005) exist, two of which (Trauma-focused CBT and EMDR) are recommended as first line responses in England and Wales (NICE, 2005). Trauma-focused CBT consists of exposure (normally through imaginal exposure, narrative writing or in vivo exposure) combined with cognitive interventions that focus on the meanings attached to the memory (described in more detail in NICE, 2005).

EMDR is an eclectic therapy incorporating a set of structured procedures and protocols (Shapiro, 2001). Many of these appear to overlap with trauma-focused CBT (NICE, 2005). NICE states that the two approaches were separated as its originator "considers it (EMDR) a distinct treatment (Shapiro, 2001), and specific training programmes are required" (NICE, 2005, p. 55). Rogers and Silvers (2002) describe in detail differences between how Exposure

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Therapy (a component of trauma-focused CBT) and EMDR are carried out and how the principles that each is based on differ.

One of the more distinctive elements of EMDR is the use of a dual attention (DA) task. This involves the client focusing on part of a traumatic memory whilst concurrently engaging in an external task, typically rhythmic, bilateral, saccadic eye movements (EMs). EMs were originally described as the "crucial component" of EMDR (Shapiro, 1989a, p. 220), although this was subsequently revised (Shapiro, 2001) following evidence of other effective stimuli and concluding that dual attention may be the responsible mechanism rather than any mechanism unique to EMs.

As NICE (2005) describes, there are many similarities between trauma-focused CBT and EMDR as well as some important differences. This position is common to many psychotherapies, as is the notion that psychotherapies are often complex in content and contain several component parts that make up the whole process. The present review attempts to deconstruct EMDR to help understand the role of one specific component that distinguishes EMDR from trauma-focused CBT; this was limited to EMs, first because this is an important distinguishing feature of EMDR, and second because a dismantling of all components would have required a much larger piece of work than was possible here. EMDR has several component parts, but as with other psychotherapies deconstruction may potentially play an important part in making a therapy more effective.

EMDR is reported to require fewer periods of intense exposure compared to alternative exposure-based therapies for PTSD (Shapiro, 1989a). Research by Ironson, Freund, Strauss and Williams (2002) and a study by Power et al. (2002) both showed EMDR as producing more rapid elimination of symptomatology than exposure. A recent study of an intensive trauma-focused CBT programme over 5 days (Ehlers et al., 2010) suggests equal effectiveness with weekly or biweekly CBT sessions, but this still appears to contain more periods of exposure than found in the EMDR programmes reviewed. An added advantage to EMDR over CBT may be that there is no need for the client to describe the trauma as the procedure involves the client holding it in mind rather than verbalizing their experience. The procedure may therefore improve treatment compliance as this has been suggested as a possible cause of treatment drop-out (e.g. Kilpatrick and Best, 1984).

NICE guidelines on PTSD, however, do not distinguish between which treatment to use; presumably client choice and availability are used in practice. Both types of interventions are deemed successful by NICE and in the absence of adequate health economic data, they are assumed to be of equal cost effectiveness. A more recent Cochrane review has confirmed this view (Bisson and Andrew, 2007). EMDR has generated considerable debate, partly due to uncertainty about whether EMs are an active ingredient of treatment and partly around the mechanisms responsible for the effectiveness of EMDR and whether they differ substantially from those operating in standard exposure (Schubert and Lee, 2009).

Method

Articles were initially identified by the use of search terms EMDR, PTSD and EMs in relevant databases. Articles were retained if they specifically examined EMs or were relevant to the story of the development of the debate. This review focused only on those papers where EMDR was being used to treat PTSD but included sub-clinical PTSD (analogues of PTSD in healthy participants). Further relevant articles cited in the literature were obtained.

Results

The beginnings of EMDR

After her chance observation that saccadic EMs appeared to resolve disturbing memories, Shapiro (1989a) administered one session of EMD to 22 diagnosed PTSD sufferers. She found that subjects' anxiety levels decreased and the appraised validity of a positive self-belief increased, compared to a control group who received a procedure similar to flooding. These results were maintained at 1- and 3-month follow-up.

Shapiro's (1989a, 1989b) studies supported the hypothesis that EMs facilitated the desensitization of trauma memories. Shapiro (1989a) suggested that 75% of individuals with a traumatic memory could be treated successfully (i.e. complete desensitization of the memory) in one 50-minute session. Shapiro (1989b) suggested that between one and three individual traumatic memories could be treated in a single session of EMD.

Shapiro's Adaptive Information Processing theory

Shapiro's Adaptive Information Processing Model (AIP; Shapiro, 2001) guides EMDR treatment and offers an explanation for the existence and recovery of trauma symptoms. According to this model, humans have an innate information processing system that processes our experiences and stores them in an adaptive state (Shapiro, 2002). Memory networks link the thoughts, images, emotions and sensations associated with experiences. New information that comes in is forged with material already stored in these networks. When someone experiences a traumatic event, information processing may be incomplete, and new information may not be adequately forged with more adaptive information that is held in our memory networks. Thus elements of experiences are stored as they were input, along with the distorted thoughts, sensations and emotions that are associated with them. Traumatic memories are isolated and not adequately integrated with other memory networks or semantic knowledge. External cues that are similar to the trauma experience are able to trigger sensations and images from the traumatic event, so that the person re-experiences feelings or bodily sensations. If these memories remain unprocessed, they become the basis of symptoms of PTSD (Shapiro and Maxfield, 2002). AIP theory hypothesizes that symptoms may be eliminated when the memories are adequately processed and integrated. Shapiro (2001) proposed that EMDR can assist in processing the traumatic memories, and that forms of bilateral stimulation, such as EMs, could facilitate this processing.

Research investigating the effect of EMs on the outcome of EMDR

EMDR has been shown to be better than no treatment (e.g. Högberg et al., 2007), as good as exposure therapy (e.g. Bisson and Andrew, 2007) and has been shown to be faster at being effective than other treatments for PTSD (e.g. Ironson et al., 2002; Power et al., 2002). For a review of efficacy literature on EMDR see Schubert and Lee (2009).

Although initial studies provided some evidence that EMs contributed to outcome, subsequent ones did not. Boudewyns and Hyer (1996) conducted a brief review of controlled studies in the first few years of EMDR's development, as well as carrying out their own 3-year ongoing investigation of EMDR and its use with combat related PTSD. They found little evidence for the utility of any form of DA task, including EMs. Lohr, Lilienfeld, Tolin and

Herbert (1999) also reviewed efficacy studies of EMDR and concluded that the eye movement component of EMDR was not supported by the evidence they reviewed. Cahill, Carrigan and Frueh (1999) reviewed dismantling studies of EMDR and suggested that there was no convincing evidence that EMs significantly contribute to treatment outcome. In the EMDR studies that Cahill et al. (1999) examined in relation to PTSD, there was some evidence that EMs reduced within-session ratings of fear and physiological measures of distress. However, all but one of the seven studies they reviewed did not show a clear difference in outcome when comparing EMDR with and without EMs. Davidson and Parker (2001) conducted a meta-analysis of 34 studies of EMDR used with a variety of populations. The authors examined 13 studies that compared EMDR to the same procedure but without the EM component. Their analysis showed no significant incremental benefit on outcome due to EMs. It should be noted, however, that their analysis included studies examining EMDR with a range of disorders, not just PTSD.

More recently, Lilley, Andrade, Turpin, Sabin-Farrell and Holmes (2009) assessed three treatment conditions (EMs, a counting task, and no distracter) with exposure to traumatic images in 18 sufferers with clinical PTSD. EMs reduced the vividness and distress ratings of exposure relative to the counting task and exposure only, but did so only at the treatment session. No differences were found at one-week follow-up. The authors conclude that a concurrent task that matches the modality of trauma images is successful at reducing distress compared to tasks that serve as distracters only. No conclusions are made, however, about the task needing to effect bilateral stimulation. The importance of this study is more about the support it gives for the specificity hypothesis - derived from the working memory model described later – that EMs will reduce the vividness (and associated distress) of visual trauma images by loading the visuospatial information holding component of working memory, whereas a task that occupies the phonetic loop (as with the counting task) will not. The conclusion from this is that EMs do not work as a general distracter. Intriguingly, the authors speculate that a stepped-care approach to PTSD may be indicated. EMs might be used during exposure initially as a way of reducing distress attached to the image in order to then move on to other components of treatment that rely on the sufferer being able to tolerate accessing these emotional trauma memories.

What analogue studies contribute

A few early analogue studies are supportive of the suggestion that EMs might have a unique contribution to outcome in EMDR in clinical populations. Andrade, Kavanagh and Baddeley (1997) asked university students to think of neutral and negative images in a series of four experiments. Participating in a concurrent task (either EMs or a spatial tapping task) decreased the vividness and emotional intensity of these images, thus supporting the use of a DA task in EMDR. Kavanagh, Freese, Andrade and May (2001) replicated the result that EMs and a tapping task carried out whilst holding a distressing image in mind decreased the vividness and emotionality of the image.

Van den Hout, Muris, Salemink and Kindt (2001) investigated the effect of EMs on the vividness and emotionality of autobiographical memories on healthy volunteers. Recollections during and after engaging in EMs were less vivid and emotionally intensive than a finger-tapping condition and a condition involving no dual task, suggesting that EMs may be effective at reducing the vividness of memories. Lee and Drummond (2008) also

found that university students' recollections of a stressful experience after distancing/reliving coupled with EMs were less distressing than after distancing/reliving coupled with eyes stationery. Wilson, Silver, Covi and Foster (1996) reported that subjects receiving EMDR showed significantly more improvement on ratings of distress than subjects who received EMDR where EMs were substituted with tapping, or EMDR with an eyes fixed condition. However, only half of the subjects met full criteria for PTSD. Lee and Drummond (2008) replicated this finding with healthy university students.

Finally, Schubert, Lee and Drummond (2011), compared one session of EMDR with and without EMs in 62 non-clinical participants (who had negative autobiographical memories). Although there are clearly questions as to how applicable such an analogue study is to clinical samples, the study demonstrated greater reductions in subjective distress with EMs compared to the same exposure but without EMs. Consistent with this, a range of psychophysiological measures indicated that the EM group had greater decreases in arousal compared to the no-EM group. These authors conclude that EMs increase the efficacy of habituation to the analogue trauma exposure.

Methodological issues in previous research

The role of EMs in EMDR remains a contentious issue. As discussed above, there is research to suggest that EMs are not an important component of EMDR. However it is hard to combine results and draw conclusions as outcome studies to date have differed substantially with regards to their design, participants, and outcome measures. As yet there has not been a rigorous randomized control trial (RCT) that compares EMDR-with-EMs to EMDR-without-EMs in a large enough sample of adults with a diagnosis of PTSD (Schubert and Lee, 2009). Most of the studies outlined above do not state how they randomized participants, and generally studies had small sample sizes (Shepherd, Stein and Milne, 2000). In the seven dismantling studies that Cahill et al. (1999) reviewed, none used an independent rater to assess treatment fidelity. Differences in administration of the therapy across studies may have contributed to the lack of an effect of EMs on outcome. Thus the conclusions that some researchers made that EMs do not contribute to outcome in EMDR may be unwarranted.

Literature investigating the possible mechanisms of EMs

Whilst further research into the contribution of EMs to outcome of EMDR is needed, more recently researchers have begun to investigate why EMs may be useful in EMDR. Without a theoretical base, the case for EMs as an essential component of therapy is weakened, given the conflicting results as to its efficacy. Recently there has been a new wave of research looking into the mechanisms by which unpleasant memories are reduced in order to better understand how EMDR might work. This has been predominantly research with non-clinical populations, justified in that normal processes are being investigated with the intention of then extrapolating this to how these memory processes might explain therapeutic changes in clinical PTSD. There are a number of accounts of how EMs may ameliorate negative reactions to memories using healthy volunteers (see Gunter, 2009 for a review). This present review will discuss three accounts that currently seem to have the most research to support them: the orienting response hypothesis, the increased interhemispheric interaction account, and the working memory account.

The Orienting Response (OR) hypothesis

Armstrong and Vaughan (1996) proposed that the therapist's hand movements trigger an "orienting response", a specific behavioural response that is an evolutionary development enabling humans to effectively assess the environment for opportunities or threats (see Barrowcliff, Gray, MacCulloch, Freeman and MacCulloch, 2003 for a detailed discussion of the orienting response theory in relation to EMs in EMDR). ORs occur when attention has to be reoriented to a different stimulus (Stickgold, 2002). An investigatory OR can be elicited in humans when they are undertaking a visual search, usually consisting of lateral EMs (MacCulloch and Feldman, 1996).

The OR involves two types of eye movements (Sokolov, 1990). One type of eye movement is induced by an external stimulus (alerting response); another is induced by an active search of the environment (investigatory response). In the context of EMDR, it is purported that the OR induced by, for example, bilateral eye movements, facilitates attention to the trauma memory without avoidance and allows for input of new trauma-related information (Armstrong and Vaughan, 1996).

Research suggests that more intense ORs occur when a response to a stimulus is required (e.g. Maltzman and Raskin, 1965). Therefore, more passive modes of stimulation such as watching flashing lights would be less effective at eliciting the OR than more active modes such as tracking a finger or hand tapping. Armstrong and Vaughan (1996) suggest that EMs are the ideal mode for eliciting the OR as the therapist is able to observe when the patient's attention may be flagging and actively re-engage them with the task.

The OR hypothesis is further supported by Stickgold (2002) who suggests that PTSD occurs when the traumatic episodic memory has not been appropriately consolidated and integrated into the semantic system. As a result, associations between the traumatic event and other, related events do not develop. Sleep can play a critical role in this process of memory consolidation (Stickgold, Hobson, Fosse and Fosse, 2001) and Rapid Eye Movement (REM) sleep in particular provides appropriate conditions for this process of memory transfer and integration to occur (see Stickgold, 2002, for a detailed description). Stickgold (2002) suggests that the OR induces a REM sleep-like neurobiological state. The continuous reorienting of attention required by bilateral tasks of EMDR activates the brain systems that shift the brain into a memory processing mode similar to that found in REM sleep. This neurobiological state permits the consolidation of traumatic episodic memories into semantic cortical networks, a process that has not yet occurred in the case of PTSD.

Increased interhemispheric interaction account

Following research suggesting that retrieval of episodic memories is enhanced by increased interhemispheric interaction (Christman and Propper, 2001), Christman, Garvey, Propper and Phaneuf (2003) examined the effects of EMs on episodic memory retrieval, using bilateral EMs as a means of temporarily increasing the amount of interaction between the two hemispheres. In two experiments, undergraduate students participated in tests of episodic memory. Before the tests, the participants engaged in EMs. The movements were either saccadic or smooth pursuit, and either horizontal or vertical. Retrieval of episodic memories was facilitated only when preceded by bilateral horizontal saccadic EMs. The authors suggest

that bilateral saccadic EMs enhance interhemispheric interaction, which in turn facilitates retrieval of episodic memories. The authors in addition suggest that the role of EMs in EMDR may be to help clients retrieve episodic memories for their traumatic experiences. Christman et al. (2003) highlighted the fact that it was only horizontal saccadic and not smooth pursuit EMs that produced significant improvements in episodic memory retrieval. In previous research, the bilateral aspect of EMs has been emphasized; however there has been little discussion of the difference between saccadic and smooth pursuit EMs. Shapiro's (2001) protocol asks clients to follow the therapist's finger back and forth whilst accessing the trauma in a particular way and suggests that vertical EMs can also be used. According to Propper and Christman (2008), this is more likely to elicit smooth pursuit, rather than saccadic EMs. Therefore, presumably research following Shapiro's (2001) protocol has utilized smooth pursuit EMs. More research is needed to distinguish whether different types of EMs have different effects on episodic memory retrieval.

Propper and Christman (2008) concluded that a growing body of literature suggests that EMs increase interaction between the left and right hemispheres. The authors proposed that since previous research has shown an interhemispheric basis for episodic memories, episodic memory should be improved if there is more communication between the two hemispheres. Thus bilateral EMs may produce changes in the accuracy of episodic memories, leading to an increased ability to recall non-traumatic memories and hence organize memories into networks that include adaptive information. Propper and Christman (2008) also suggest that EMDR may decrease levels of distress associated with the memory as previous research has demonstrated that increased hemispheric interaction is associated with decreased stress (e.g. Compton and Mintzer, 2001).

Brunyé, Mahoney, Augustyn and Taylor (2009) also found that participants' performance on a test of episodic memory improved when preceded by horizontal EMs compared to vertical EMs or an eyes-stationary condition. Additionally, EMs only improved performance on tasks that required a large amount of right and left hemisphere processing. These results support the notion that bilateral horizontal EMs increase interhemispheric interaction. Therefore the EM component of EMDR could facilitate the recollection and integration of episodic memories through the mechanism of interhemispheric interaction.

It is still not possible, however, to conclude exactly how EMs enhance episodic memory retrieval. Previous research has shown an interhemispheric basis for episodic memories: the Hemispheric Encoding/Retrieval Asymmetry (HERA) model of episodic memory (Tulving, Kapur, Craik, Moscovitch and Houle, 1994) purports that the left and right cerebral hemispheres are specialized for the encoding and retrieval of episodic memories respectively. Since lateral EMs lead to increased activation in the contralateral hemisphere (Bakan and Svorad, 1969), it has been assumed that bilateral EMs would result in simultaneous activation in both hemispheres (e.g. Christman et al., 2003). However, there may be mechanisms other than interhemispheric interaction at play; EMs in EMDR may affect a variety of neural and psychological processes as well as increasing interhemispheric interaction (Christman et al., 2003). Additionally, Propper and Christman (2008) acknowledge that not enough research has been conducted to establish whether other forms of bilateral stimulation produce the same increase in interhemispheric interaction. Recent research by Samara, Elzinga, Slagter and Nieuwenhuis (2011) found no increase in interhemispheric EEG coherence, suggesting more research is needed to confirm firstly whether EMs do increase interhemispheric interaction and, if so, exactly how they do so.

Working memory account

Working memory (Baddeley, 1986) consists of a central executive that is responsible for higher order cognitive functions such as planning; a phonological loop that stores verbal and auditory information for later use; and the visuospatial sketchpad (VSSP), which stores visuospatial information for later use. The working memory account of the role of EMs in EMDR hypothesizes that images of unpleasant memories are held in the VSSP. These images become less vivid as EMs use up processing resources concurrently; working memory becomes less efficient when doing two tasks at once. Thus benefits occur when the client is forced to divide their attention between the traumatic memory and another competing task. Andrade et al. (1997) suggested that EMs may be more effective than other DA tasks because they include a visual and spatial component. They are therefore more taxing on working memory than other DA tasks, such as tapping, which only have a spatial component. Kavanagh et al. (2001) also emphasized the importance of a visuospatial element of the task in interfering with the image in working memory and suggested that EMs may be an effective DA task to use.

Van den Hout et al. (2001) replicated the conditions from Andrade et al.'s (1997) experiment but made the sets of DA tasks longer. They also found that EMs reduced vividness of memories, but they found that tapping did not produce that effect. The working memory account would predict that tapping would reduce vividness, but to a lesser degree, as it poses less strain on working memory. However, van den Hout et al. (2001) used an easier tapping task than Andrade et al. (1997), suggesting that there would be less demand on working memory. This may explain why tapping did not reduce the vividness of memories in their study. As discussed above, however, it may be the case that the most salient point is that the modality of the DA may need to concur with the modality of the trauma memory (Lilley et al., 2009).

Gunter and Bodner (2008) investigated why EMs may reduce the vividness and emotionality of traumatic memories and supported the working memory account of how EMs contribute to benefits of EMDR. They found that both horizontal and vertical EMs produced equal benefits, contrary to the interhemispheric interaction account. The authors suggested that the central executive is taxed when the subject performs a distractor task while attempting to hold a memory in mind. EMDR has been shown to produce effects faster than exposure therapies (e.g. Power et al., 2002). Gunter and Bodner (2008) suggest that this may be because the distraction task in EMDR makes focusing on the traumatic memories less unpleasant and therefore speeds up the whole process. Maxfield, Melynk and Hayman (2008) provided further support for the working memory explanation for EMs in EMDR. Non-clinical subjects were asked to engage in either no EMs, slow or fast EMs whilst holding a distressing memory in mind. Consistent with the working memory account, slow and fast EMs resulted in greater decreases in vividness and emotional intensity of memories than no EMs, and fast EMs resulted in greater decreases than slow EMs. The authors suggested that this was due to the fact that fast EMs are harder to perform and are therefore more taxing on the VSSP. Maxfield et al. (2008) also suggested that EMs may be the best DA task because they involve both visual and spatial processing, compared to other DA tasks that involve only spatial processing, although Lilley et al. (2009) suggest the strength of effect is reliant on the modality of the trauma memory and DA being consistent. Thus it follows that EMs would be the optimum form of DA stimuli where the trauma memory is predominantly visual and that other forms such as tapping will produce an effect but to a lesser extent.

Conclusion

Conflicting accounts remain, first as to whether EMs as opposed to exposure are essential in therapy, and second as to the mechanism of action of EMs. Clearly, there has not yet been enough rigorous research to draw reliable conclusions and questions linger regarding whether EMs are more effective than other forms of DA task. However, there is reasonable theoretical support for their inclusion in treatment and as Schubert and Lee (2009) conclude, there is no basis to suggest removing EMs from EMDR since it is part of the procedure used in the studies showing the efficacy of EMDR. Choice of EMDR over trauma-focused CBT should therefore remain a matter of patient choice and clinician expertise; it is suggested, however, that some evidence suggests EMs may be more effective at reducing distress and thereby allow other components of treatment to take place.

A clinical dismantling study with a large number of participants with a PTSD diagnosis is needed to examine reliably the difference in outcome between EMDR with EMs and EMDR without, and EMDR with other forms of DA task. Future research into the effects of different durations, frequency and spatial extent of EMs on episodic memory, and on EMDR outcome would also be useful in order to help clearly define which EMs are most helpful. Researchers could use Platinum Standard criteria (Hertlein and Ricci, 2004) as a framework for designing studies so that a more rigorous research base is available.

The more we learn about the role of EMs, the more confidence practitioners and clients will have in the treatment. As clinicians we should be able to justify the techniques we use, and although we have begun to develop an understanding as to why EMs may be an important component of EMDR, further research is needed. It should be noted that it is not unusual to be uncertain about how any psychotherapy works, not just EMDR (Gunter, 2009). Whilst it may feel uncomfortable to some clinicians to practise EMDR without knowing exactly how it works, the growing research base will aid us in our search for answers.

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