Eye-movements reduce the vividness, emotional valence and electrodermal arousal associated with negative autobiographical memories

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ABSTRACT The aim of this study was to examine the effect of eye-movements on subjective and psychophysiological measures of arousal and distress associated with positive and negative autobiographical memories. These memories were ‘brought-to-mind’ whilst engaging in eye-movement or eyes-stationary conditions in a counterbalanced within subjects design, with pre and post eye-condition subjective ratings of emotional valence and image vividness. Participants also rated current symptomatology associated with negative memories using the Impact of Events Scale. Engagement in eye-movements compared to the eyes-stationary condition resulted in significant reductions on measures of vividness and emotional valence for both positive and negative autobiographical memories. Reductions in electrodermal arousal were only observed when engaging in eye-movements following elicitation of the negative memory. This effect was observed independently of symptom severity.
INTRODUCTION

Many people in forensic mental health services present with Post-Traumatic Stress Disorder (PTSD), both due to negative life experiences and in terms of a reaction to their own offence (Gray, Carman, Rogers, MacCulloch, Hayward & Snowden, 2003; Pollock, 1999; Steiner, Garcia & Matthews, 1997). The effect of negative life experiences is especially evident in people with a personality disorder (Kruppa, Hickey & Hubbard, 1995), with Lonie (1993) suggesting that borderline personality disorder represents those aspects of trauma repressed at a preverbal stage of development, expressed as PTSD symptoms when conscious awareness of the trauma is present. As highlighted by Harry and Resnick (1986), the identification and treatment of trauma and PTSD in forensic populations is likely to facilitate rehabilitation, thus appropriate methods of treatment for trauma in forensic settings are required. One method of treatment for trauma that may be particularly suited to forensic settings is Eye-Movement Desensitization and Reprocessing (EMDR), as it elicits less distress from patients than traditional exposure based intervention (e.g. Pitman, Orr, Altman, Longpre, Poire & Macklin, 1996) and requires no homework to be completed between sessions.

EMDR was introduced as a rapid psychotherapeutic intervention for the treatment of trauma and anxiety based disorders (Shapiro, 1989a, 1989b). It is described as an eight-phase treatment method comprising history taking, client preparation, assessment, desensitization, installation, body scan, closure and re-evaluation (Shapiro, 2001). Accounts of the EMDR method have been presented elsewhere (e.g. Shapiro, 1995; 2001) and thus are not duplicated here, although it worth summarizing aspects of the desensitization phase on which the current review and study are focused. The desensitization phase of the EMDR protocol requires the client to firstly identify an image that is representative of a dysfunctional target memory, rate the emotional significance of the image and identify concomitant physiological sensations. Cognitive appraisal of the target memory is then made (current perceptions and desired outcome statements), with the degree of currently experienced distress rated on a 0–10 subjective rating of distress scale (Wolpe, 1982). Finally, the client is engaged in a series of rapid eye-movement sweeps (left to right to left) at a rate of 120 beats per minute (Shapiro, 2001). Whilst the efficacy of EMDR in the treatment of trauma is now generally acknowledged (e.g. the Practice Guidelines of the International Society for Traumatic Stress Studies; Foa, Keane & Friedman, 2000), there remains some debate regarding the role of the eye-movement
component, both in respect of overall impact of treatment (e.g. Davidson & Parker, 2001) and theoretical rational regarding possible mechanisms of action (e.g. Hyer & Brandsma, 1997). The purpose of the current study is to examine further the mechanism(s) that underlie reported emotional processing effects associated with, specifically, eye-movements as detailed in the desensitization component of the EMDR protocol.

THE ROLE OF EYE-MOVEMENTS IN EMDR

EMDR developed from the serendipitous observation by Shapiro that her intrusive thoughts changed when she moved her eyes in a ‘multi-saccadic’ manner whilst thinking about an anxiety provoking situation (Shapiro, 1989a; 1995). Therefore EMDR initially lacked a clear theoretical foundation, although many models have since been proposed to account for the role of these eye-movements. These include Shapiro’s (2001) Adaptive Information Processing model, Dyck’s (1993) conditioning model, attentional processing accounts (e.g. Kuiken, Bears, Miall & Smith, 2002), and theories of reverse learning (Hassard, 1996). Whilst a review of these models is beyond the scope of the current article, we suggest that a proposed mechanism recurrent in a number of these accounts is that of the orienting reflex. We consider this component in greater detail here with particular focus on the investigatory response model of MacCulloch and Feldman (1996).

MacCulloch and Feldman (1996) argue that eye-movements (or other lateral tasks) trigger the investigatory component of the orienting reflex (Sokolov, 1963; 1990) in the organism, representing an evolved safety response to threatening stimuli. It is posited that where external threats are identified in an organism’s environment a negative visceral response branch of this investigatory response is triggered, resulting in fear or avoidance type responses (e.g. fight or flight). However, when the investigatory response is activated through active search behaviour (stimulated by the potential for threat), yet no danger is identified, it is proposed that the positive visceral branch is activated leading to a functional reduction in arousal below the threshold of activation necessary for a defensive response. For example, an animal must be able to proceed to a drinking hole despite the constant and ever present threat of predators. If every cursory glance activated a flight response, their evolutionary track would be a short one as dehydration would be sure to follow.

Empirical support for this reassurance response in non-clinical participants, using external auditory stimuli to elicit a psychophysiological response, has been presented elsewhere (Barrowcliff, Gray, MacCulloch, Freeman & MacCulloch, 2003). In summary, Barrowcliff et al. (2003)
reported a consistently diminished level of electrodermal arousal when participants engaged in eye-movements following the presentation of externally generated auditory stimuli compared to when engaging in an eyes-stationary task. This indicated that engagement in eye-movements similar to those used in the EMDR procedure reduced levels of psychophysiological arousal elicited by aversive stimuli in comparison to not engaging in eye-movements. Whilst similar effects have been reported during clinical intervention with post-traumatic stress disordered clients (Wilson, Silver, Covi & Foster, 1996), it has been difficult to identify specific mechanisms due to additional treatment variables. Therefore, whether the psychophysiological component of this reassurance response applies also to internally generated stimuli has yet to be clearly examined.

Alternative approaches to investigate the role of eye-movements in EMDR have focussed on reports of image vividness, levels of distress, and physiological arousal following the presentation of distressing images in non-clinical participants. For example, Merkelbach, Hogervorst, Kampman and de Jongh (1994a) compared an eyes-moving condition to finger-tapping following exposure to a slide of a mutilated hand. Both groups showed significant reductions on measures of heart rate, image vividness and aversiveness from pre to post-intervention, although the authors concluded, ‘neither physiological data (heart rate) nor self-report data . . . substantiated the claim that EMD reduces the emotional impact of aversive memories’ (Merkelbach et al., 1994a, p. 334). An alternative explanation is that the residual effects of the traumatic picture would have reduced naturally (i.e. without intervention) and these effects are due not to either task but a general effect of habituation when these images had no personal significance or relevance.

Addressing the issue of image significance, Merckelbach, Hogervorst, Kampman and de Jongh (1994b; experiment 2; cited in Muris & Merckelbach, 1999) utilized the same design as the previous study, but replaced the slide image with negative autobiographical memory images. As an additional dependent variable, measures of corrugator electromyographic (EMG) activity were recorded before and after the two tasks (eye-movements versus finger-tapping) whilst imaging selected scenes. As found in the previous study (Merkelbach et al., 1994a) both conditions resulted in a reduction in image vividness and distress ratings. EMG measures, too, did not discriminate between the two groups although they also failed to show an effect of processing (indicated by a lack of change in levels of EMG activity) across the study.

Andrade, Kavanagh and Baddeley (1997; experiment 4) compared eye-movements with an eyes-stationary + motor task (tapping) and an eyes-stationary no-motor task control condition, using both positive and negative autobiographical memories. Participants were instructed to, firstly, rate how vivid and distressing the images were, then engage in the task (eye-movements, tapping, or nothing) for 8 seconds, and then again provide
ratings of memory image vividness and emotiveness. Both the eye-
movement and the motor task conditions resulted in greater reductions in
vividness and emotionality than the no-task control condition. This effect
was reported for both the positive memories (i.e. they were more positive
and clear in the no-task control condition and least so in the eyes-moving
condition) and the negative memories (i.e. they were more negative and clear
in the no-task control condition and least so in the eyes-moving condition).
They argue that this effect is due to the requirements the eye-movement and
tapping conditions place on the visuospatial sketchpad of working memory,
suggesting that the reduction in image vividness leads to a reduction in its
emotional valence. Andrade et al. (1997) concluded that EMDR relies on a
distraction effect and, despite acknowledging that ‘there may be something
special about eye-movements’ (p. 220), state that any task with a visuospatial
component should suffice. Similar effects on the VSSP are reported
elsewhere (e.g. Kavanagh, Freese, Andrade & May, 2001).

A third study examining the effects of eye-condition with positive and
negative autobiographical memories is that of van den Hout, Muris,
Salemink and Kindt (2001). As in the previous study (Andrade et al., 1997),
eye-movements were compared to two control conditions, tapping and an
eyes-stationary no-task condition utilising a between subjects design.
Exposure to the memory image and subsequent engagement in each
experimental condition is extended over a period of 1½ minutes, allowing
examination of self-report indices over a more protracted time period than
previous studies. This study also extends on the Andrade et al. (1997) study
by gaining ratings of vividness and emotiveness after imaging had ceased,
based on the premise that memory images in EMDR should be less vivid
and emotive after successful processing. A significant reduction in both
positive and negative image vividness and emotionality following eye-
movements compared to other control conditions is reported (van den Hout
et al., 2001). Additionally, van den Hout et al. (2001) report reduced
memory vividness and emotionality during imaging a few minutes after
completion of an experimental task, an effect not predicted by the
visuospatial sketchpad model of Andrade et al. (1997). They posit that this
effect may be due to either an effect of continued disruption of the
visuospatial sketchpad after cessation of eye-movements, or truly altered
phenomenological experiences through a mechanism such as reciprocal
inhibition (van den Hout et al., 2001).

In summary, these studies report a reduction in the vividness and
emotional distress associated with disturbing images and negative auto-
biographical memories following eye-movements, in comparison to eyes-
stationary no-task control conditions, and mixed results regarding eyes-
stationary lateral tapping conditions. Where psychophysiological measures
are included, results are unclear. Van den Hout et al. (2001) provide an
interesting appraisal of the visuospatial sketchpad model of Andrade et al. (1997) and speculate that the effects reported in both studies may alternatively be due to a process of reciprocal inhibition (Wolpe, 1982). The theory of reciprocal inhibition maintains that two incongruent responses cannot coexist; an elicited relaxation response will, for example, inhibit a fear response. This theory is applicable to the reassurance reflex model of EMDR (MacCulloch & Feldman, 1996) in which it is posited that eye-movements elicit a de-arousing safety response through engagement of an orienting response in a non-threatening environment.

THE CURRENT STUDY

The current study examines the effects of eye-movements compared to an eyes-stationary condition with both positive and negative autobiographical memories. Whilst we use a non-forensic population here, the proposed mechanisms to be examined are considered reflexive, thus applicable to forensic and non-forensic populations. As well as attempting to replicate effects reported elsewhere in terms of image vividness and emotionality, we also examine changes in electrodermal arousal during engagement of the eye-condition whilst imaging autobiographical memories. Significant reductions in electrodermal arousal following engagement in eye-movements (compared to an eyes-stationary control task condition) have been reported when the arousing stimulus used is a range of externally generated tones (Barrowcliff et al., 2003). We hypothesise that this effect will be also be observed when using internally generated autobiographical stimuli (Hypothesis 1), as the mechanism should be the same (MacCulloch & Feldman, 1996) and that this will also be reflected in subjective responses.

Additionally, as questions have been raised here regarding the personal significance of imagery material, we also assess current symptoms of distress associated with the negative memories elicited here using the Impact of Event Scale (IES; Horowitz, Wilner & Alvarez, 1979). It is predicted that symptom severity should have little interaction with any observed effects, due to the proposed automatic nature of the orienting response when presented with negative stimuli (MacCulloch & Feldman, 1996) (Hypothesis 2).

METHOD

Participants

Eighty naïve volunteers (consisting of 20 community participants and 60 undergraduates) participated for course credit or financial reward. This
sample comprised of 50 females (age range 18 – 29 years; $\bar{x} = 21.3$, SD = 2.7) and 30 males (age range 19 – 37 years; $\bar{x} = 24.3$, sd = 4.7). Group mean scores on the IES are below levels indicative of clinical problems ($\bar{x} = 17.93$, sd = 16.25) (Neal, Busuttil, Rollins, Herepath, Strike & Turnbull, 1994).

**Design**

The study examines the effect of eye-movement versus no eye-movement on the vividness, emotional valence, and physiological arousal of recalled positive and negative autobiographical memories. All participants recollected the same idiosyncratic positive and negative memories in both eyes-moving and eyes-stationary conditions, the order of which was counterbalanced. Analysis of vividness, emotional valence, and general electrodermal arousal is based on this within subject design. Additional analysis of the negative memories utilizes a mixed factorial design, using electrodermal levels as the within subjects variable and scores on the IES (Horowitz et al., 1979) used to split the sample into above and below median groups.

**Apparatus**

**Visual stimulus**

A white circle of 5 mm diameter presented on a black background was produced through a VSG 2/3 graphics board on an IBM desktop computer. The starting point of the stimulus was the same in both conditions, being the centre of the 20-inch Hitachi EM812-ET monitor. In the eyes-moving condition, the white circle moved sinusoidally from side-to-side at 1 Hz (120 beats/minute).

**Electrodermal response**

A Maclab/8 (Powerlab systems) analogue-digital (A/D) converter connected to a Power Macintosh 6100/60 running Chart v.3.6.1 software was used for continuous online digital recording. Skin conductance levels were collected by means of a constant voltage system produced through an ADInstruments GSR Amplifier through electrodes placed on the medial phalanx of the second and fourth fingers of the participant’s non-dominant hand.

**Procedures**

**Memory selection**

Participants were instructed to firstly bring to mind a positive memory image (‘a memory of a happy or joyous occasion’) followed by a negative memory
image (‘a memory of a fearful or anxiety provoking situation’). These memories were to be of events that really happened and for which they had a clear visual image. Participants were also instructed that these memories should still evoke relevant feelings (i.e. either of joy/happiness or fear/anxiety) as they were brought to mind now. Finally, participants were asked to assign descriptive labels to these memories, to act as cues during the imaging exercise.

**Current vividness, emotional strength, and trauma symptomatology**

Following the labelling of a memory, participants were asked to rate the emotional valence of that memory as they brought it to mind now on a 0 (not at all distressing or positive) to 10 (extremely distressing or extremely positive) scale. They were then asked to rate how vivid that memory image was for them, again on a 0 (not at all clear) to 10 (extremely clear) scale. Then, as is used with memory images in the EMDR protocol, participants were asked to describe which emotions went with that memory image and to describe any bodily sensations that were also present. Once both positive and negative memories had been identified, participants were asked to complete the IES (Horowitz et al., 1979) using the negative target memory as the event in question.

**Imaging task**

Participants were then placed in front of a 22” computer monitor, at a distance of 16” with the eyes positioned central to the screen. Electrodes for electrodermal readings were attached. Following a 5-minute rest period (to allow acclimatization of the electrodermal response) the imaging exercises began. Both images were used twice, each in an eyes-moving and an eyes-stationary condition. Order of image sequencing was counterbalanced, with two presentations of each positive memory always together and two presentations of each negative memory always together (resulting in eight permutations).

Participants were firstly asked to elicit the memory image and give ratings of vividness and emotional valence. Following these ratings, they were again instructed to get the image, this time with the associated emotions and bodily sensations and asked to give a verbal ‘yes’ response when they had this image clearly. As soon as this verbal response was given, a stationary (centrally positioned) or moving white circle (horizontal at 1 Hz) was presented on the monitor for 25 seconds. Participants were instructed to either fixate on the dot, or follow the dot with their eyes for the duration of the presentation. Immediately following cessation of the visual stimulus, participants were again asked to rate how emotional and how vivid the image was for them. They were given a one-minute break before proceeding to the next image.
RESULTS

Positive and negative memories

*Image vividness*

Changes in the vividness of memories were calculated by subtracting the vividness rating at completion of each eye-condition task from that given immediately prior to task engagement. Mean ratings of image vividness for before and after imaging are presented in Table 1. The changes in vividness ratings pre and post eye-condition were subjected to a repeated measure ANOVA, with factors of Eye-Condition (eyes-moving *versus* eyes-stationary) and Memory Type (positive memory *versus* negative memory). As displayed in Figure 1, image vividness is significantly reduced following eye-movements for both positive and negative images. Reductions following eye-movements were greater than when engaged in the eyes-stationary condition as indicated by a main effect of Eye-Condition ($F(1,79)=37.27$, $p<0.001$). Neither the main effect of Memory Type ($F<1$) nor the interaction ($F<1$) approach significance.

*Emotional valence*

As for vividness ratings, changes in the emotional valence of memories were calculated by subtracting the rating given on completion of the eye-condition task from that given immediately prior to task engagement. Mean ratings of emotional valence for before and after eye-condition task are also presented in Table 1. These changes in emotional valence ratings were subjected to a repeated measure ANOVA, with factors of Eye-Condition (eyes-moving vs. eyes-stationary) and Memory Type (positive memory vs. negative memory). We observe a main effect for Eye-Condition ($F(1,79)=25.98$, $p<0.001$), but not for Memory Type ($F<1$). The interaction also fails to reach significance ($F(1,79)=2.66$, $p>0.1$). As Figure 2 indicates, there was an overall reduction in emotional valance following eye-movements with a mean increase in valance in the eyes-stationary condition for both memory types.

*Electrodermal arousal*

Electrodermal data were calculated as changes in the mean level of arousal during the 25-second period of either eye-fixation or eye-movement, from the mean of five seconds immediately preceding the instruction to image. It should be noted that electrodermal data do not represent absolute levels of arousal, but are used to represent direction of task specific levels of change.
Table 1 Mean image vividness and emotional valence ratings obtained immediately before and after engagement in the eye-condition task (i.e. imaging whilst either eyes-moving or eyes-stationary). Scores for emotional valence made on a scale of 0 (‘not at all distressing’ or ‘not at all positive’) to 10 (‘extremely distressing’ or ‘extremely positive’). Scores for vividness made on a scale of 0 (‘not at all clear’) to 10 (‘extremely clear’). Standard deviations given in parentheses.

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<th>Vividness</th>
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<td>Pre</td>
<td>Post</td>
<td>Pre</td>
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<tr>
<td>Positive memory</td>
<td>7.66 (1.52)</td>
<td>6.90 (1.93)</td>
<td>7.46 (1.70)</td>
<td>6.54 (2.22)</td>
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<td>Negative memory</td>
<td>7.76 (1.62)</td>
<td>7.39 (1.90)</td>
<td>6.85 (2.13)</td>
<td>6.18 (2.45)</td>
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<td>Eyes-moving</td>
<td>7.57 (1.76)</td>
<td>7.50 (1.97)</td>
<td>7.34 (1.79)</td>
<td>7.31 (2.05)</td>
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<tr>
<td>Eyes-stationary</td>
<td>7.64 (1.60)</td>
<td>7.74 (1.73)</td>
<td>6.63 (2.20)</td>
<td>6.60 (2.17)</td>
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Note: All pre-task measures comparative between conditions ($p > 0.05$)
Figure 1 Mean changes in vividness ratings from pre to post eye-condition with positive and negative memories. Means shown with standard error bars (± 1 sem). A negative value represents a decrease in vividness.

Figure 2 Mean changes in emotional valence ratings from pre to post eye-condition with positive and negative memories. Means shown with standard error bars (± 1 sem). A negative value represents a decrease in emotional valence (e.g. less distressing or less positive).
in arousal. These data were first subject to square root transformations to reduce skewness and then subjected to a repeated measure ANOVA, with factors of Eye-Condition (eyes-moving vs. eyes-stationary) and Memory Type (positive memory vs. negative memory). We find a main effect for Eye-Condition ($F(1,79) = 4.57, p < 0.05$), but not for Memory Type ($F < 1$). Whilst the interaction between Eye-Condition and Memory Type is non-significant ($F(1,79) = 2.54, p > 0.1$), post hoc analysis indicates a significant difference between conditions for negative memories ($t(79) = 2.50, p < 0.025$), but not for positive memories ($t(79) = 0.22, p > 0.1$). As displayed in Figure 3, we observe little change in arousal levels when participants image positive memories and engage in either eye-condition task. However, we do observe a significant reduction in arousal levels during the imaging of a negative memory whilst engaging in eye movements, with a slight increase in arousal recorded for the eyes-stationary task condition. Thus a significant reduction in arousal following task engagement was observed only for the negative memory and only in the eyes-moving condition.

Figure 3 Mean changes in levels of electrodermal arousal with positive and negative memories. Means shown with standard error bars (± 1 sem). Data should be interpreted with respect to relative changes in arousal, with a negative value indicating a reduction in electrodermal levels of arousal and a positive value indicating an increase in electrodermal arousal.
Current symptoms resulting from negative memories

We now examine the role of current symptomatology associated with the identified negative event, as assessed with the Impact of Events Scale (IES; Horowitz et al., 1979), on subjective measures (vividness and emotional valence) and electrodermal change. This level of analysis allows us to assess the dearousal effect upon dependent variables relative to the extent of trauma symptoms currently experienced. The symptoms currently experienced are directly related to the negative memory images, as participants were instructed to answer items on the IES with regard to the negative memory event they had chosen to image.

Data from the IES was used to perform a median split of the participants (median value = 16). No scores corresponded exactly to the median and so all participants were included in the analysis. Those scoring lower than the median were assigned to the low trauma symptoms group \((n=40; \text{Range} = 0 – 15, \bar{x} = 3.55, \text{sd} = 4.62)\) and those above were assigned to the high trauma symptoms group \((n=40; \text{Range} = 17 – 52, \bar{x} = 32.30, \text{sd} = 9.48)\). Fifteen of the high trauma symptoms group scored at or above the recommended clinical cut-off of 35 for significant trauma symptoms on the IES (Neal et al., 1994). All subsequent analyses use this median split grouping as a between subjects independent variable.

Negative image vividness, and current symptom groups

We performed a mixed ANOVA with factors of Eye-Condition (eyes-moving vs. eyes-stationary) and symptom Group (low trauma symptoms vs. high trauma symptoms). We find only a main effect of Eye-Condition \((F(1,78) = 27.66, p < 0.001)\), with neither the main effect of symptom Group \((F < 1)\), nor the interaction approaching significance \((F < 1)\). This can be observed in Figure 4. Thus, larger decreases in image vividness were found for the eyes-moving condition than for the eyes-stationary condition irrespective of current specific trauma related symptomatology.

Emotiveness of negative images, and current symptom groups

We performed a mixed ANOVA with factors of Eye-Condition (eyes-moving vs. eyes-stationary) and symptom Group (low trauma symptoms vs. high trauma symptoms), using change in emotional valence ratings as the dependent variable. We find only a main effect of Eye-Condition \((F(1,78) = 22.71, p < 0.001)\) with the main effect for symptom Group \((F < 1)\) and the interaction failing to approach significance \((F(1,78) = 2.80,\)
Figure 4 Mean changes in vividness ratings from pre to post eye-condition in two symptom groups for negative memory images. Means shown with standard error bars (±1 sem). A negative value represents a decrease in vividness.

Figure 5 Mean changes in emotional valence ratings from pre to post eye-condition in two symptom groups for negative memory images. Means shown with standard error bars (±1 sem). A negative value represents a decrease in emotional valance (e.g. reduction in distress).
Mean values are presented in Figure 5. We observe a reduction in emotional valence following eye-movements regardless of symptom severity, whilst the eyes-stationary condition resulted in a non-significant increase in the high symptom group.

**Electrodermal arousal, negative memory images, and current symptom groups**

Levels of electrodermal arousal were also subject to a mixed ANOVA, with factors of Eye-Condition (eyes-moving vs. eyes-stationary) and symptom Group (low trauma symptoms vs. high trauma symptoms). Values are presented in Figure 6. Again, we find only a main effect for Eye-Condition \( F(1,78) = 6.15, \ p < 0.025 \), with the main effect of symptom Group \( F < 1 \) and the interaction \( F < 1 \) failing to reach significance. This indicates that the effect of eye-movements on levels of electrodermal arousal is observed regardless of reported symptom severity, with engagement in eye-movements resulting in comparable changes in arousal for both symptom groups.

**Figure 6** Mean changes in levels of electrodermal arousal with negative memories for low and high symptom groups. Means shown with standard error bars (± 1 sem). Data should be interpreted with respect to relative changes in arousal, with a negative value indicating a reduction in electrodermal levels of arousal and a positive value indicating an increase in electrodermal arousal.
DISCUSSION

The elicitation of positive and negative autobiographical memories resulted in significantly reduced levels of both the vividness and the emotional valence of those memories following engagement in eye-movements, compared to an eyes-stationary control condition. Thus, both positive and negative memories became less vivid following an eye-movement task than following an eyes-stationary task, with less positive emotions evoked with the positive memory, and less negative emotions evoked with the negative memory following eye-movements. We also report here a significant effect of eye-condition in relation to electrodermal measures, with levels of electrodermal arousal observed when engaging in the eye-movement condition significantly reduced compared to the eyes-stationary condition following elicitation of negative autobiographical memories (but not positive autobiographical memories). The results relating to memory vividness and emotional valence (i.e. reductions in the eyes-moving condition compared to the eyes-stationary condition) are similar to those reported by others when using both positive and negative autobiographical memories (Andrade et al., 1997; Merckelbach et al., 1994a; van den Hout et al., 2001). However, this is the first study to examine levels of electrodermal arousal during eye-condition tasks with autobiographical memories within such a paradigm. Interestingly, a significant dearousal effect is only found for negative memories and not positive memories, leading to a different pattern of results for subjective and psychophysiological measures.

When we examine these responses (vividness, emotional valence, and electrodermal levels) in relation to trauma symptoms currently experienced as a consequence of the selected negative memory, we find that symptom severity appears to have little impact on the effects of eye-movements already reported. This is the first study we are aware of that examines the possible interaction between eye-condition and severity of current trauma symptomatology in a non-clinical sample. We report that the main effect of eye-condition (i.e. greater reductions on dependent variables when engaged in eye-movements compared to an eyes-stationary control condition) is maintained regardless of the severity of currently experienced trauma symptoms related to the negative memory, and this remains true for both subjective measures (vividness and emotional valence) and a measure of psychophysiological arousal. Where we find higher rates of trauma-associated symptoms in forensic groups, as reported by Gray and colleagues (2003) for example, this indicates that an eye-movement based treatment would be preferable to an eyes-stationary based intervention, at least in the short-term. This does, of course, presuppose similar reflexive mechanisms and psychophysiological processes in PTSD and non-PTSD populations, which may not necessarily be the case (e.g. Shalev, Scott, Orr, Peri,
Schreiber & Pitman, 1992). This would therefore need further examination with a clinical sample.

How do these results relating to subjective measures reflect on current opinion regarding mechanisms of action for eye-movements in the EMDR procedure? Whilst Merckelbach and colleagues (1994a) argue that there is no specific effect of eye-movements, Andrade et al. (1997) suggest that these results can be accounted for by the visuospatial sketchpad model of working memory, where the processing of stimuli of a visuospatial nature is interrupted when a second visuospatial task is engaged. However, van den Hout et al. (2001) suggested that this visuospatial sketchpad model could not accommodate the continued effect of memory processing observed after the cessation of a visuospatial task, and posited that an effect akin to reciprocal inhibition was a more likely explanation of this effect. This implies that emotional processing of the memory occurs as a consequence of the eye-condition task. Results of the current experiment would support such a hypothesis, as we observe a psychophysiological process occurring when engaged in eye-movements, compared to an eyes-stationary condition; this is a process of enhanced electrodermal dearousal. Further, this psychophysiological dearousal process is observed to occur only when negative autobiographical memories are elicited. The eye-movement (reduced arousal) effect is not observed when positive autobiographical memories are elicited. If there were only a general visuospatial sketchpad effect operating here, we would expect to find comparative levels of electrodermal dearousal to both memory types, as we did for measures of vividness and emotional valence. How can a selective effect of dearousal via eye-movements on negative memory imaging be accounted for?

MacCulloch and Feldman (1996) argue that when an organism is presented with potentially threatening stimuli a number of possible responses may be elicited, relating to a positive visceral response loop (e.g. continued activity – no threat) and a negative visceral response loop (e.g. ‘flight or fight’ type responses – threat identified) of the orienting response (e.g. Pavlov, 1927). The novel component of this model is the incorporation of an ‘off-switch’ following the initialization of a negative visceral response. For example, danger does not usually persist indefinitely, thus the negative response loop (e.g. fight-or-flight) must be switched off by some means. The process of visual search, akin to the process of rapid eye-movement in the EMDR procedure, was proposed as such a mechanism and labelled the ‘reassurance reflex’ (MacCulloch & Feldman, 1996). Barrowcliff et al. (2003) compared this model to two competing orienting response accounts of eye-movements in EMDR (Armstrong & Vaughan, 1996; Wilson et al., 1996) using externally generated auditory stimuli to elicit an arousal response prior to the engagement of either an eyes-moving or an
eyes-stationary task. This resulted in a strong dearousal effect of eye-movements, thus providing empirical support for the reassurance reflex model of MacCulloch and Feldman (1996). Independent support for an orienting response activation following eye-movements is also provided elsewhere (Kuiken et al., 2002). The current findings indicate that this ‘reassurance reflex’ component, leading to psychophysiological dearousal, is activated when engaged in eye-movements during negative memory elicitation. This provides support of the proposed necessity of the presence of perceived ‘threat’ for such a dearousal effect to occur (i.e. prior activation of the negative visceral response loop; MacCulloch & Feldman, 1996). The hypothesis of a ‘reassurance reflex’ does not, however, account for the changes in subjective measures observed for both memory types, and it may be that two processes are operating here: both disruption of the visuospatial sketchpad and a process of physiological dearousal. This would account for the continued emotional processing effect of eye-movements after cessation of all experimental manipulations as reported by van den Hout et al. (2001).

Finally, examination of current trauma symptoms associated with negative memories suggested that degree of current symptoms is not a factor in the strength of the dearousal effect of eye-movements, although this represents only a preliminary examination with a non-clinical population. It would be useful in future experiments to compare forensic and non-forensic populations with regard to both symptom type and severity in relation to this eye-movement effect. Additionally, we report here only data recorded following a single period of eye-movements. It would be useful for future investigations to examine the combined effects of repeated exposures and sets of eye-movements to assess the potential accumulative effect of such a process.

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