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The effects of saccadic bilateral eye movements and multi-trial recall on eyewitness testimony

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ABSTRACT

The effects of saccadic bilateral (horizontal) eye movements and repeated testing on memory concerning eyewitness testimony were investigated. In the study phase, participants were exposed to an event narrative detailing the investigation of a crime scene. This consisted of 45 basic images along with verbal commentary describing the events of the narrative. Next, after a brief 3 minute distraction period, the testing phase began. The testing phase consisted of three recall trials, with participants being exposed to eye movement conditions after trials one and two. In such conditions, participants engaged in 30 seconds of bilateral vs. vertical vs. no eye movements. It was found that repeated testing increased accurate recall overall, whilst no such effects were found for bilateral eye movements. Furthermore, there was no interaction effect between repeated testing and bilateral eye movements. The findings are discussed in terms of potential reasons for why this is the case.

KEY WORDS:	BILATERAL EYE MOVEMENTS	REPEATED TESTING	EYEWITNESS TESTIMONY	HEMISPHERIC INTERACTIONS	HYPERMNESIA

Despite being a complex process, human memory is easily influenced creating unintentional distortions and inaccuracies (Bartlett, 1932). Therefore within psychological research, memory improvement techniques have been implemented to try and improve accurate recall and reduce inaccurate recall. For instance, techniques such as pairing words with pictures (Israel & Schacter, 1997), using distinctive encoding such as reading aloud (Dodson & Schacter, 2001), and using different visual/verbal contexts for encoding (Bruce, Phillips-Grant, Conrad & Bona, 2004) have been used in previous research to generate more accurate recall. However, such attempts to reduce false recall and improve accurate testimony have witnessed limited success, by not entirely eliminating false recall. For example, Gallo, Roberts and Seamon (1997) went as far as explicitly instructing participants to avoid making a false recall error, and yet despite such forewarning, false recall still occurred. Therefore, there is a need for further research on memory improvement techniques, in order to improve accurate recall, and to reduce false recall. This forms the basis for the current experiment.

Repeated testing is an interesting technique employed within research, such as Roediger and Payne (1982), and demonstrates such accurate recall and memory improvements. Repeated testing involves participants recalling previously learned stimuli over a number of trials. Therefore in this experiment, participants were asked to recall as many items as possible from a stimulus of sixty items, over a period of three trials. Findings indicated that accuracy and recall were significantly improved in a later recall trial, compared to accuracy and recall in an earlier trial. In short, recall tended to improve, in terms of the amount of information recalled, as the experiment progressed from trial one to trial three. Other supporting research comes from experiments such as Dunning and Stern (1992) and Bornstein, Liebel and Scarberry (1998). Within such experiments, participants viewed videotapes depicting crimes, such as an assault, and were instructed to recall information from the videotapes over three trials. Findings indicated that the number of facts accurately recalled increased, from the first trial to the third trial by 10-20%. Furthermore, despite this increase in accurate recall, no such effect for false recall was found in any of the mentioned experiments.

However, once such a technique is placed into an applied setting, i.e. using recollection tasks of an eyewitness testimony nature, repeated testing produces a mixture of results. Whilst some researchers have found repeated testing to improve accurate recall and decrease false memory (Scrivner & Safer, 1988; Turtle & Yuille, 1994), others have found no such improvements or reductions (Burke, Heuer & Reisberg, 1992). Burke *et al.'s* (1992) findings suggest that repeated testing fails to improve recall, in relation to remembering details of an episodic event, whereas Scrivner and Safer (1988) found contrasting results. In Scrivner and Safer's (1988) experiment, the effects of repeated testing upon eyewitness recall were examined. The results obtained showed net gains in recall, via an increase in the successive recall of previously unreported information, whilst the forgetting of retrieved information was at a minimum. In other words, participants gradually recalled more information as the trials progressed, whilst forgetting hardly occurred, if at all.

It is believed that results such as these can be explained in terms of 'hypermnesia' (the opposite of 'amnesia'). 'Hypermnesia' is described as a phenomenon in which the performance of memory improves throughout the use of repeated testing. It is believed to be a combination of reminiscence (item gain) and forgetting (item loss) of the same study material, throughout the repeated testing (Erdelyi, 1996). As the performance of memory is increased through the use of repeated testing, the effects of reminiscence are therefore greater than those of forgetting, resulting in hypermnesia. (Otani, Von Glahn, Goenert *et al.*, 2009; Payne, 1987).

Furthermore, findings suggest that hypermnesia is a stronger phenomenon when images, in comparison to words, are used as the study stimuli, as shown by Defeyter, Russo and McPartlin (2009), Erdelyi and Becker (1974) and Payne (1986). For example, Erdelyi and Becker (1974) reported that repeated testing generated greater improvements, in terms of recall, for words presented with imagery instructions in comparison to words shown without imagery instructions. Due to this, research conducted into the phenomenon of hypermnesia tends to use memorable pictures and film clips for recall purposes, instead of words. However, it is unclear as to why this effect occurs with pictures and not words. Hypotheses have been developed whilst experiments have been conducted in an effort to assess this occurrence but, as with any experiment, there have been confounding results. For example, Erdelyi and Becker (1974) believed that hypermnesia is somehow caused by information being encoded and represented in an pictorial fashion, whereas the same results regarding increased net gains, have been found when words have been used instead of images (e.g. Belmore, 1981). However, for the purposes of the current experiment, as this effect has been more prominently found with pictures, participants were required to recall picture stimuli in the form of a visual event narrative. This is simply a narrative accompanied by images, which participants then had to recall over a number of trials (as seen in Parker, Buckley & Dagnall, 2008).

Another memory improvement technique that has developed a great deal of interest in more current research is a technique highlighted by Christman, Garvey, Propper and Phaneuf (2003) and Christman, Propper and Dion (2004). In such research, the experimenters were interested in demonstrating the effects of eye movements on episodic memory retrieval and recall. Participants were tested on events relating to episodic memory after undergoing thirty seconds of saccadic bilateral eye movement. Saccadic bilateral eye movements simply involves participants moving their eyes from side to side, horizontally. Findings indicated that episodic memory and accurate recall significantly improved when inducing bilateral eye movement in comparison to vertical, or no eye movement conditions. Furthermore, participants who engaged in bilateral eye movement showed a significant reduction in false recall in comparison to those undergoing the alternative eye movements.

Research using saccadic bilateral eye movement has been further extended into areas such as autobiographical and false memory (Parker & Dagnall, 2007), early childhood memory (Christman, Brown & Propper, 2006) and misinformation effects (Parker, Buckley & Dagnall, 2008). It was illustrated in experiments such as Parker *et al.* (2008), that saccadic bilateral eye movement enhances the accurate recall of previously studied material. Bilateral eye movements are often used as an experimental manipulation, whilst vertical eye movements or no eye movements are generally employed as a control condition. For example, following the study of a narrative event, participants performed thirty seconds of saccadic bilateral eye movement. Findings showed that bilateral eye movements result in a significant increase in the retrieval of complex visual information, such as a narrative event, but also reduce inaccurate recall in comparison to other eye movement conditions. The findings of this experiment not only support the findings of Christman *et al.* (2003) and Christman *et al.* (2004), but also support the idea that bilateral eye movements not only enhance accurate recall, but also reduce false or inaccurate recall as previously stated.

As an effort to explain why this occurs, it has been suggested that successful performance on episodic memory tests, such as free recall and recognition, may depend upon interactions between the cerebral hemispheres. Such interactions are hypothesised to be enhanced or increased by experimental manipulations, such as bilateral eye movements (Christman *et al,* 2003). More general support for the idea that these interactions are important derives from the findings that saccadic bilateral eye movements generate more cortical activity in comparison to smooth pursuit eye movements (O'Driscoll, Strakowski, Alpert *et al.*, 1998). More specific support that hemispheric interaction is important for episodic memory, comes from experiments in which the encoding and retrieval of words was manipulated within (vs. across) hemispheres. For example, Christman and Propper (2001) presented participants with words to either their left or right hemisphere and tested their memory, using either the same, or opposite hemisphere. Episodic memory was found to be improved when the encoding and retrieval of the words took place in opposite hemispheres. However, the precise neural reasons for such results remain to be explored and may be of interest for future investigation.

Both of the aforementioned techniques, i.e. repeated testing and saccadic bilateral eye movements, have real life applications. One such application would be within the criminal justice system and the field of forensic psychology, as both techniques can be employed to acquire evidence for prosecution purposes. Evidence can take a variety of forms, such as forensic evidence, but also eyewitness identification and 'expert' testimony (Townley, 2004). Eyewitness identification, or eyewitness testimony as it is more commonly known, refers to the account of a witnessed event, such as a crime, and holds great importance within human memory research (Goldstein, 2003). Memory is especially significant with regards to eyewitness testimony, as research from this perspective greatly relies upon an individual being able to accurately recall memories of criminal activity (Loftus, 1996). This is of particular importance in the legal system, as eyewitnesses are often cross-examined by the police, courts, and other legal officials throughout the duration of the legal proceedings (Bornstein *et al*., 1998). Therefore, accurate recall of an event is necessary as it can assist towards the prosecution of an innocent or guilty party. Moreover, eyewitness testimony is believed to be the most unreliable and untrustworthy piece of evidence, and yet despite this, 74% of 850 cases were found to have been convicted on such testimony alone (Devlin Committee Report, 1976). Therefore, research has examined the potential reasons for why this may be, such as Cutler, Penrod and Dexter (1990), who for example, believed juror sensitivity and the confidence of the eyewitness to be possible reasons for why this is the case.

Therefore, the objective of the current research was to assess whether saccadic bilateral eye movement and repeated testing could be combined to improve testimony accounts regardless of such factors. Such aims are based upon the premise that saccadic bilateral eye movements and repeated testing improve true memory (accurate recall) and decrease false recall. From this, it was hypothesised that saccadic bilateral eye movements, combined with repeated testing, would generate more accurate recall. The basis for this prediction stems from Payne (1987) who claims that “a relatively consistent finding in the hypermnesia literature is that in many cases, any variable that raises performance levels also leads to a greater hypermnesic effect” (p. 12). Because eye movements increase performance, it is expected that it will create a greater hypermnesic effect. Furthermore, the reason for focusing on these two techniques is because past experiments have never considered using them both in combination. Such research has highlighted these techniques individually, and also in arrangement with other techniques, but never in the specific combination chosen in the current research.

Thus, based upon previous research into the effects of eye movements, 60 participants were randomly allocated to one of three eye movement conditions (bilateral vs. vertical vs. no movement). Next, participants were required to repeatedly recall information from a visual event narrative over three trials. Recall was measured in terms of overall recall scores, the number of items gained between trials, and the number of items lost between trials. Following this, assessments were made regarding the effectiveness of using repeated testing and eye movements to improve accurate recall. Furthermore, the current research can be seen as an attempt to extend previous research into memory improvement techniques and eyewitness testimony.

Method

Design

The research took the form of a 3X3 factorial design with the experiment having one between participants’ independent variable with three levels: bilateral eye movement, vertical eye movement and no eye movement. The experiment also had one within participants’ independent variable with three levels: recall after trial one, recall after trial two and recall after trial three.

The dependent variables for the experiment were: (i) The number of correct items recalled (a measure of true memory). (ii) The number of items gained, by which an item is recalled in a later trial but was missed in an earlier trial (reminiscence). (iii) The number of items lost, by which items were recalled in earlier trials but not in later trials (forgetting).

Participants

The experiment consisted of 60 volunteers chosen via an opportunity sample. The chosen participants consisted of both male and female students from a university campus. Within the experiment, 20 participants were randomly allocated to each of the between participant conditions. The participants used did not partake in any similar research beforehand.

Materials and Apparatus

The materials comprised of a participant response booklet, a self constructed visual event narrative and software such as the eye movement programme. These will be further described below.

The Participant Response Booklet

The participant response booklet began with a general cover sheet which required participants to provide biographical details such as age and gender, but also asked for their consent to partake in the research. The cover sheet provided details regarding anonymity, rights to withdraw and also reassured participants that no harm would come to them during the experiment.

Next, an instructions page followed describing the procedure of the experiment. Therefore, participants were told that they would see a visual event narrative, along with certain images, and that they would then be exposed to, and asked to perform, a specific eye movement (depending on which condition they were allocated). Next, participants were told to recall as many images as possible over three recall trials.

The booklet then had three separate pages following on from the instructions page. These pages represented recall trials 1, 2 and 3, with each page consisting of two columns of lines running the length of the page where participants could report their recall responses.

The final page of the booklet was a debriefing. In the debriefing participants were told the nature of the experiment and of their role within it. It also provided the opportunity for participants to ask any questions and/or request the results.

The Visual Event Narrative

The visual event narrative created for this research was loosely based on those developed and used in experiments such as McCloskey and Zaragoza (1985) and Parker, Buckley and Dagnall (2008).

The narrative consisted of 45 images representing everyday objects, such as a cup, and reflected those presented by Snodgrass and Vanderwart (1980). The pictures presented by Snodgrass and Vanderwart are standardized images, specifically for use within experiments such as the current research, and were therefore easily identifiable to participants. However, to make the images more realistic and represent real life, pictures of the real objects were used rather than their animated counterparts.

The narrative itself was based around a crime scene investigation to allow closer association to eyewitness testimony. The narrative images were shown upon a computer screen with specific images being presented at pre-determined intervals (E.g. a cup being shown when mentioned). Furthermore, the narrative text itself was pre-recorded by a male voice and was listened to, via voice clips, alongside the images. The pictures and voice clips were shown together for a total duration of 8 seconds to ensure standardised exposure throughout the narrative, followed by a brief blank screen.

The Software Programme

The software programme was made by a technician at Manchester Metropolitan University concerning the eye movement conditions. The programme simply showed a sizable black circle which moved along a white screen either horizontally, vertically or remained motionless, depending on the participants eye movement condition. This programme was used to ensure that participants did the correct eye movements for 30 seconds only.

Procedure

All participants were individually allocated to an eye movement group prior to taking part in the experiment. Participants were seated an appropriate distance away from a computer screen and were asked for their informed consent via the participants response booklet. Participants were instructed about anonymity, their right to withdraw and also notified that results would be subject to third parties. However, participants were reassured that no personal information would be disclosed. Before the testing phase, the experimenter made sure that the participants understood the test instructions provided.

After completing the booklet, participants were instructed to listen to a story presented by the computer. In addition to hearing a verbal story, participants were shown a set of images corresponding to the story (e.g. whilst hearing a sentence about a cup, a cup would be shown). The experimenter sat close by and initiated the narrative on the computer screen, whilst telling participants to observe both the story and the images. Each slide of the narrative contained one image and one voice clip containing the relevant sentence. Once combined, all voice clips detailed an entire story concerning a crime scene investigation team processing the scene(s) of a burglary. Each slide lasted for 8 seconds before moving onto the next slide and image.

Once the narrative had finished, participants were told to wait three minutes before attempting to recall any of the images shown. During this three minute period, participants were supplied with a blank piece of paper and told to write down as many animals as possible. This distracter task was used here to prevent participants from recalling the images prematurely, and therefore biasing the results through rehearsal. Once the three minutes had elapsed, participants were then given a further five minutes in which they were told to recall as many images as possible. After these five minutes, participants were then shown the eye movement software relevant to their earlier condition allocation. This software portrayed a sizeable dot moving either horizontally, vertically or remaining motionless for a total of thirty seconds. For the bilateral eye movement condition, instructions were provided stating to follow the dot as it appeared to the left and right of the screen. For the vertical eye movement condition, instructions were provided stating to follow the dot as it appeared at the top and bottom of the screen. For the no eye movement condition, instructions were provided stating to simply stare at the dot as it flashed on and off in the centre of the screen. Participants were told to follow the dot with just their eyes for this period, and the experimenter observed whether these instructions were adhered to. Once participants had successfully completed the required eye movements, they were then given another five minutes to try once more to recall as many images as possible (known as recall trial 2). Once the five minutes were up, participants viewed the eye movement software one last time, and were then given another five minutes for recall trial 3 and repeated the task.

Finally in order to avoid deception, after the three recall trials, participants were debriefed about the experiment and of their role within it. They were given the opportunity to ask any questions and were also given details concerning requesting results.

Results

Overall Recall Score*.* For the results, before conducting any statistical analyses, recall had to be corrected for intrusions. Once the intrusions had been accounted for, the corrected recall score was then inserted into a 3 (recall trial; recall trial 1 vs. recall trial 2 vs. recall trial 3) X 3 (eye movement condition; bilateral vs. vertical vs. no eye movement) Mixed ANOVA, with repeated testing being the within participants factor and the eye movement condition being the between participants factor. The means and standard deviations for all conditions over all measures can be seen in Table 1.

Table 1: Mean (SD) proportion of recall trial scores as a function of eye movement condition

	Eye Movement Condition		
	Bilateral	Vertical	Central
Recall Trial			
One	25.45 (5.56)	25.40 (5.08)	22.85 (5.61)
Two	26.95 (5.20)	26.00 (5.01	24.05 (5.96)
Three	29.00 (5.00)	27.60 (4.95)	25.95 (5.42)

The analysis revealed that there was a significant main effect of the recall trial on the number of images recalled (the total recall scores), $F(2,114) = 52.42$, $p < .001$, indicating that a participants' recall score increased from trial 1 to trial 3. The effect of recall trial was investigated by paired samples t tests collapsing across the eye movement condition. This indicated a significant difference between trial 1 and trial 2, *t*(59) = 3.88, *p* < .001 and also a significant difference between trial 2 and 3, *t*(59) = 8.26, *p* < .001.

Furthermore, the analysis also revealed a non-significant effect of eye movement condition on the number of images recalled (the total recall scores), *F*(2,57) = 1.61, *p* = .21, indicating that eye movements had no effect on recall scores.

Analyses showed that the interaction effect between recall trial and eye movement condition on the total recall scores was also not significant, *F*(4,114) = 0.92, *p* = .45, suggesting that in combination, the recall trial and eye movement condition had no effect on participants' total recall scores.

In summary, repeated testing appears to have improved participants' overall recall scores, whereas eye movements had no such effect.

***Item Gain Scores*.** Item gain scores are defined as those items not recalled in an earlier recall trial, which are then recalled in a later recall trial. For example, an item not recalled in trial 1, but then recalled in trial 2, would classify as an item gain. Similarly, an item forgotten in trial 2, but then recalled in trial 3, would also classify as an item gain. Therefore, a 3 (eye movement condition; bilateral vs. vertical vs. no eye movement) X 2 (item gain; trial 1 to trial 2 vs. trial 2 to trial 3) Mixed ANOVA was used for such scores. The means and standard deviations for all conditions over all measures can be seen in Table 2.

Table 2: Mean (SD) proportion of item gain as a function of eye movement condition

	Eye Movement Condition		
	Bilateral	Vertical	Central
Item Gain			
Trial 1 - 2	2.90 (2.00)	3.00 (2.00)	2.65 (1.81)
Trial 2 - 3	2.95 (2.30)	3.10 (1.45)	2.80 (1.11)

Analyses showed that the main effect of item gain between trials 1 and 2 and trials 2 and 3 was not significant, *F*(2,57) = 0.09, *p* = .76. Although there were item gains overall, as indicated by the overall recall score, this ANOVA demonstrated that the gains between trials 1 and 2, and trials 2 and 3, were not different from each other.

The results also show that the main effect of eye movement condition was also not significant, *F*(2,57) = 0.32, *p* = .73. Furthermore, results showed that there was a non-significant interaction effect between eye movement conditions and recall trial on the number of items gained, *F*(2,57) = 0.01, *p* = .99.

In summary, neither repeated testing, nor eye movement conditions, had an effect on the number of items gained overall.

Item Loss Scores*.* Item loss scores are defined as items initially recalled in an earlier recall trial, which are then no recalled in a later recall trial. For example, an item recalled in trial 1, but then not recalled in trial 2, would classify as an item loss. Similarly, an item recalled in trial 2, but then not recalled in trial 3, would also classify as an item loss. Therefore, a 3 (eye movement condition; bilateral vs. vertical vs. no eye movement) X 2 (item loss; trial 1 to trial 2 vs. trial 2 to trial 3) Mixed ANOVA was used for such scores. The means and standard deviations for all conditions over all measures can be seen in Table 3.

Table 3: Mean (SD) proportion of item loss as a function of eye movement condition

	Eye Movement Condition		
	Bilateral	Vertical	Central
Item Loss			
Trial 1 - 2	1.45 (1.30)	2.45 (1.15)	1.45 (1.00)
Trial 2 - 3	0.95 (1.00)	1.50 (1.43)	0.90 (1.02)

Analyses showed that there was a significant main effect between the number of items lost between trials 1 and 2 and trials 2 and 3, $F(2,57) = 11.10$, $p < .01$. This indicated that the number of items lost is greater between trials 1 and 2 than it is between trials 2 and 3.

The results also showed that there was a significant main effect between eye movement conditions and the number of items lost, $F(2,57) = 5.61$, $p < .01$. The main effect of eye movement was assessed by means of individual t tests. This was done by collapsing across item loss from trial 1 to trial 2, with item loss from trial 2 to trial 3. Comparing bilateral eye movement to vertical eye movement, this indicated a significant difference, $t(38) = 2.61$, $p = .01$. This indicates that the amount lost overall is less for bilateral eye movement than vertical eye movement. Comparing bilateral eye movement to no eye movement, this indicated a non-significant difference, $t(38) = .10$, $p = .92$. This indicates that there is no difference between the amounts lost overall in the two conditions. Comparing vertical eye movement to no eye movement, this indicated a significant difference, $t(38) = 2.90$, p = < .01. This indicates that the amount lost overall is less for no eye movement than vertical eye movement. Therefore, the number of items lost was less for bilateral and no eye movement conditions, in comparison to the vertical eye movement condition. Finally, the results showed that there was a non-significant interaction effect between eye movement conditions and recall trial on the number of items lost, $F(2,57) = 0.51$, $p = .61$.

In summary, repeated testing, bilateral eye movements and no eye movements have an effect on the amount of items lost overall.

Discussion

The current findings support, but also refute the findings from previous research, and therefore fail to support the hypothesis regarding the effects of saccadic bilateral eye movement and repeated testing on accurate recall.

With regards to repeated testing, the current experiment found a significant increase in the amount of information recalled over a period of three trials, therefore supporting the phenomenon of hypermnesia. This supports previous research such as Roediger and Payne (1982), Dunning and Stern (1992) and Bornstein *et al*. (1998), by indicating that increased recall occurred when progressing through a series of recall trials; specifically, that greater recall occurred in the third trial, in comparison to the first trial, as a function of hypermnesia. Moreover, the current findings compliment those reported by Roediger and Thorpe (1978) who found increased recall to occur for participants given three short recall trials in comparison to one prolonged recall trial. This indicates that improved performance on a later recall trial depends on having an earlier trial, resulting in hypermnesia. Thus, other research such as Otani *et al*. (2009) and Payne (1987) can be supported, as the procedure of using repeated recall tests can be seen to extend the amount of available recall time, allowing for additional items to be recalled. A possible theoretical reason for why this may be, may concern the use of environmental cues (as suggested by Roediger & Thorpe, 1978). It was suggested that even though hypermnesia occurs in a free recall condition, such recall may still be guided by cues in the retrieval environment. Therefore, participants may have been influenced by 'cues' in the environment, such as objects present in the room, whilst recalling items from the event narrative.

Furthermore the current results extend those of previous research. The current research demonstrates hypermnesia occurring in different encoding contexts, by using different materials to those used in earlier experiments. For example, in Dunning and Stern's and Borstein *et al*.'s experiments, participants recalled information from videotapes, whereas in the current experiment, participants recalled visual information from a simple visual event narrative. Using complex materials and procedures, such as videotapes, makes it difficult to establish a parallel between eyewitness testimony and mainstream cognition. In contrast, simple materials and methods easily provide a 'bridge' between the two. Additionally, using a standard cognitive experiment allowed for more control over the nature and structure of the event narrative, therefore permitting greater associations to eyewitness testimony.

Moreover, interpretive problems could be avoided due to the nature of the event narrative. The current procedure required participants to recall simple standardized pictures in an objective manner, whereas in a complex procedure such as using videotapes, participants could potentially interpret events differently and make a greater number of errors. Participants may find viewing videotapes to be an overwhelming experience because of the amount of visual information provided, therefore limiting encoding potential. On the other hand, an event narrative portrays identifiable objects at a more measured pace, allowing for greater memory retention.

Furthermore, the current experiment could potentially resolve the debate set forth by researchers such as Scrivner and Safer (1998) and Burke *et al.* (1992). As previously mentioned, there have been past disputes regarding the effectiveness of using repeated testing in recall experiments; particularly, that this memory technique fails to influence a participants accurate recall. Therefore, the current results would counteract this argument by indicating that accurate recall improved through reminiscence, but also, that false recall decreased through forgetting, supporting Erdelyi (1996). Results obtained in the current experiment show that participants recall was improved, when progressing from trial one to trial three, and furthermore, false recall decreased when examined in terms of the same trial progression. From this, support is provided to the findings of Scrivner and Safer (1988) and Turtle and Yuille (1994), with regards to repeated testing producing more accurate recall and decreasing false recall through hypermnesia.

However the current results, specifically those concerning saccadic bilateral eye movements, fail to support results obtained in past research such as Christman *et al.* (2003), Christman *et al.* (2004) and Parker *et al.* (2008). Such exemplary experiments found saccadic bilateral eye movements to significantly improve a participant's accurate recall whilst simultaneously reducing false recall. In contrast, the current results found that saccadic bilateral eye movements had no such significant effect over the number of items recalled by participants. Rather, participants' scores, concerning item gains, were increased overall between trials one and three, as a function of hypermnesia rather than being a function of eye movement. However, the current results did find an unexpected significant difference regarding the number of items lost between the three trials. The results show that participants lost less items in a later trial (e.g. between trials two and three) than they did in an earlier trial (e.g. between trials one and two), yet no explanations as to why this occurred are readily available. This would suggest that saccadic bilateral eye movements somewhat prevent participants from forgetting information already recalled, but do not assist towards participants further recalling any information that was not previously recalled.

A possible explanation as to why saccadic bilateral eye movements failed to influence a participant's accurate recall may concern the use of relational encoding and recall strategies. Participants may have encoded and associated the narrative items together to form a story in their heads. Following this, such strategies would be employed once participants were asked to recall the items, rather than demonstrating the true effects of eye movements. If participants make use of such relational encoding and recall strategies, this may mitigate finding any effects against eye movements. Therefore to test this idea, participants could be given a narrative similar to the story employed within the current research. One participant group could explicitly encode items together, through relational encoding and recall strategies, such as 'Apple' and 'Orange', whereas another group would encode unrelated singular items, such as 'Ball' and 'Spoon'. From this, participants could be placed into one of the three eye movement conditions and undergo a series of recall trials. This would allow the experimenters to assess whether encoding and recall strategies mitigate eye movement effects during repeated testing, and provide further research for both memory techniques.

Another potential explanation for the lack of eye movement effects may concern the fact that forced recall was used during each of the tests. Such procedures may prevent the effective use of source monitoring at retrieval. Previous research by Christman *et al.* (2004) suggested that bilateral eye movements may associate with, and facilitate source monitoring, which is believed to reduce false recall at retrieval. Due to forced recall, participants may not actively engage in source monitoring processes, as under such recall conditions, such processes may be reduced. Therefore in hindsight, forcing participants through three recall trials may have led to the removal of any differences between the eye movement conditions. If people work best in eye movements through the use of source monitoring, forced recall would negate the effects. Additionally, the procedure used in the current research may not have entailed sufficient degrees of source monitoring, and so future improvements could account for this. A potential experiment could employ the use of a narrative spoken by both a male and female voice. As shown by Hicks and Marsh (1999), source monitoring instructions, such as deciding if words are spoken by a male or female voice, reduces false recall. Therefore, one participant group could be forced to recall items from the narrative without thinking, whereas another group would avoid forced recall. Instead, this group would be instructed to think of the source before reporting any items during recall. This would allow experimenters to assess whether forced recall and source monitoring influences a participant's ability to accurately recall information from an event narrative.

The memory techniques employed within the current research were expected to create an effective memory technique to aid recall. However, due to saccadic bilateral eye movements failing to influence recall, implications may arise with regards to how eyewitnesses are questioned. Law enforcement and legal personnel may still question eyewitnesses through the employment of poor memory techniques, which would then have a detrimental effect on testimony accounts. This is because rather than acquiring accurate recall and memory, this would inevitably acquire inaccurate recall, leading to inaccurate testimony. However, it could be argued that no interactions between saccadic bilateral eye movements and repeated testing were found in the current research due to procedural problems and errors. From this, forensic psychology and the criminal justice system will still require an effective memory technique to effectively question eyewitnesses for prosecution purposes. Therefore, the current research encourages further study to be conducted on both of these memory techniques.

Overall, the current results appear partially consistent with those of previous research; by showing that repeated testing has a significant effect on overall recall scores. In combination, saccadic bilateral eye movements and repeated testing were intended to form a successful memory improvement technique. Unfortunately, the findings indicate that, whilst they may be individually effective, they fail to have a significant effect once combined. However, much work remains to be conducted in an attempt to find an effective combination which produces accurate recall whilst eliminating false recall.

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