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Recall of Thematic and Perceptual Information Following Episodic Specificity Induction and Instructed Eye Closure

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ABSTRACT

Techniques to improve episodic memory such as eye-witness events have been the focus of much research in psychology. The present experiment investigates the effect of two techniques, episodic specificity induction (ESI) and eye-closure (EC) to assess if their conjoined effects are additive or interactive regarding the recall and subjective ratings of thematic and perceptual information of short video clips. It was found that both ESI and EC enhanced recall and that the effects were primarily additive. This was found for both thematic and perceptual details. ESI and EC interacted for subjective ratings of perceptual vividness but not story coherence. For the former, EC increased vividness ratings in the control but not the ESI group. The cognitive basis of these effects and possible applications are discussed.

1 | Introduction

Memory can often fail us at crucial moments. This can range from minor inconveniences, such as forgetting a person's name, to more significant issues like struggling to recall details of a witnessed event like a crime. Researchers have examined whether various techniques improve retention. These include the method of loci (Baltes and Kliegl 1992), elaboration (Klein and Kihlstrom 1986) and deep processing (Lockhart and Craik 1990). These alter the nature in which information is encoded and thus need to be implemented prior to or during the learning phase.

While these methods are effective, the significance of accurate memory is not always realised during learning. Thus, techniques that enhance retrieval processes are also crucial. These could involve the use of cues (Williams et al. 1999), reinstatement of contextual attributes of the learning episode (Smith and Vela 2001), or testing (Roediger and Karpicke 2006). The success of retrieval-based methods for memory enhancement indicates these memories may not always be accessible but can be retrieved under specific circumstances.

The research presented here is concerned with improving the accessibility of visual event narratives through the combination of two *retrieval-based* techniques, eye-closure (EC) and episodic specificity induction (ESI). To date, these have not yet been investigated in combination and have the potential for wide applicability across persons and situations.

1.1 | Combining Memory Techniques

Typically, the use of mnemonic strategies to improve retention are employed in isolation. However, it has been suggested that memory enhancing techniques may actually work best when used in conjunction with one another (Dunlosky et al. 2011; McDaniel 2023). Experimental work exists that has assessed this idea across a range of strategies, materials and population types. For instance, it has been found that the combination of the keyword mnemonic (that involves the derivation of interactive imagery between keywords and the memoranda) and retrieval practice (in which retrieval, as opposed to restudy, of the to-be-learned material is required) led to superior performance on the learning of a foreign vocabulary after a delay (Fritz et al. 2007; Miyatsu and McDaniel 2019). Beyond language learning, it has been found that the face–name mnemonic technique (McCarty 1980), when added to the participants preferred method of memorising biographical information also produced retention benefits beyond that of either alone (Carney and Levin 2003, 2012).

Of course, it is not suggested that any combination of memory enhancing procedures will be beneficial. Instead, careful consideration needs to be given to the precise nature of those techniques and the cognitive processes that underpin them. For example, Miyatsu and McDaniel (2019) hypothesise that when used in conjunction, the keyword mnemonic and retrieval practice augment encoding and retrieval processes respectively. In this, the keyword technique enhances associative encoding between cues and memoranda, while retrieval practice strengthens subsequent retrieval through the generation of target information by an active (vs. passive restudy) retrieval process.

In this context, combining multiple techniques needs to consider the relative similarities and differences in the cognitive operations engaged to predict memory outcomes. For instance, if two procedures work by the same processes, then these mechanisms are essentially redundant. Consequently, little or no benefit would be expected by their combination. Alternatively, if the cognitive operations are different, then additive influences should be observed, and the conjoining of the tasks should produce the highest memory performance. Another outcome is also possible where the introduction of one task *catalyses* the effect of the other (Miyatsu and McDaniel 2019). In this situation, the presence of one task is required to make the other effective.

Relatedly, other work has referred to effects like this as *superadditive* (Morris et al. 2005; Nash et al. 2009). This term denotes performance outcomes that are greater than the sum total of their respective independent effects. For example, the effect of one type of mnemonic strategy might produce outcome x and another strategy produce y. Where x and y refer to the amount recalled. Superadditive, effects are those where performance is *greater* than $x+y$. This issue is revisited later in the outline of the current experiment and the predictions. Prior to this, the mnemonic techniques used in the present experiment are outlined.

1.2 | Episodic Specificity Induction

Episodic specificity induction refers to a procedure in which individuals are required to recall detailed information from a specific past episode (e.g., a video clip) viewed earlier in the experiment (Madore et al. 2014). Various prompts are used to guide participants in the generation of mental images and report everything they can remember about the episode. However, this induction is not an end in itself, rather the aim is to assess the influence of this ESI induction (compared to various control tasks) on subsequent cognitive functions. These induction effects have been found to facilitate performance on a range of other tasks that are closely related to the ESI induction in terms of retrieving event-specific information. The influence of induction has also been found on seemingly unrelated tests such as creativity or divergent thinking (Madore et al. 2015). It has been hypothesised that these task differences are more apparent than real and that induction influences are to be found when only when the task in question requires the use of episodic memory such as the construction or reconstruction of detailed memory episodes (e.g., autobiographical memory) or when memory is required to generate solutions to problems or unusual uses of common objects (divergent thinking).

The current research is concerned with ESI effects on episodic memory retrieval. To exemplify, it has been found that ESI enhances the retrieval of specific and detailed biographical information in the Autobiographical Interview (Madore and Schacter 2016). This effect was not found when subsequent tasks did not depend on episodic memory (e.g., describing the contents of a picture), or when the induction involved non-episodic operations, such as solving mathematical problems or general impressions (Madore et al. 2014, 2019a).

Although much research has focussed on the impact of ESI on autobiographical cognition (e.g., Jing et al. 2017; Madore and Schacter 2016; Madore et al. 2016), other experiments have assessed the influence of brief specificity training on laboratory-acquired memories that can be checked for accuracy. For instance, Grilli et al. (2019) had participants retrieve detailed autobiographical memories (vs. a gist-based version that did not require detailed recall) as an ESI task prior to *encoding* and retrieving a set of video clips. Thus, in comparison to typical experiments, the tasks were reversed so that the effect of detailed autobiographical recall on memory for the video clips could be observed. They found, ESI improved memory for episodic and especially perceptual details of the videos.

Later work has shown that ESI prior to *retrieval* can enhance episodic memory for material acquired in laboratory tests. Purkart et al. (2022), reported that an imagination specificity induction (in which participants had to imagine a scenario in a detailed and precise manner), increased accuracy in a memory task that required fine-grained discrimination between studied and highly similar non-studied information.

Findings such as these can be explained by the assumption that when two tasks are performed consecutively, the first influences the second if they draw on shared cognitive processes. In this case, if the second task relies on episodic memory, then performance should be influenced by ESI. Conversely, for tasks that do not rely on episodic retrieval (Schacter and Madore 2016). As such, brief periods in which detailed recollection is obligatory (the ESI task) has downstream consequences for the retrieval of unrelated information. In this sense, the ESI procedure can be used as a technique for targeting and enhancing episodic memory.

The ESI task has generally been employed in the context of research examining the *constructive episodic simulation* hypothesis of episodic memory (Schacter and Addis 2007). This idea stipulates that the function of episodic memory is not simply the reproduction of the past, but rather to use the past to support constructive memory and the simulation or mentalising of future events.

Principally, the ESI task induces an *episodic mode of thinking* in which subsequent tasks benefit if they also depend on episodic memory (Schacter et al. 2017; Grilli et al. 2019). When implemented prior to recall, it targets retrieval orientation (Madore et al. 2016), and leads to the adoption of a goal to retrieve information in a more detailed manner. More specifically, Schacter and Madore (2016) argued that ESI facilities the process of event construction. Event construction (or reconstruction) refers to the flexible assembly of information stored in memory (including scenes, people and actions), into a coherent representation that contains that information (Romero and Moscovitch 2012). Evidence for this comes from work in which ESI effects are particular to tasks that involve event construction (Madore et al. 2019b). Consequently, the ESI procedure is one means by which certain types of constructive memory can be enhanced at retrieval. Consideration is now given to another technique; that of eye-closure.

1.3 | Eye-Closure Effects and Memory

Eye-closure (EC) effects refer to the influence of closing one's eyes on various cognitive and neural measures of performance and processing (Vredeveldt and Penrod 2013; Weng et al. 2020). An early demonstration of this on cognitive performance found EC to improve memory for general knowledge questions and answering arithmetical questions (Glenberg et al. 1998). The EC effect was found only when the problems were of moderate difficulty. As argued by the authors, this is due to remembering general knowledge or solving problems with open eyes can be considered a dual-task situation. That is, while engaging in mental activity the cognitive system monitors the environment for potentially significant events. When the cognitive task is routine or automatised, there is no decrement on performance and processing can proceed successfully with minimal resources. When the task is difficult, internal allocation of remaining resources might be insufficient to ensure successful performance.

Eye-closure effects have also been found on standard laboratory tests of episodic memory. For instance, Einstein et al. (2002) found EC effects at both encoding and retrieval for lists of related and unrelated words in both younger and older individuals. More recent work has found EC effects of equivalent size for individuals with either high or low short-term/working memory spans (Parker et al. 2022), and for both visually and auditorily presented word (Ebersbach 2023). Eye-closure has also been shown to reduce false memory for non-presented pictures that were semantically related to studied items (e.g., two different pictures of an acorn of which only one was encoded) (Parker and Dagnall 2020). Consequently, the range of conditions and stimuli for which EC effects can be found appears to possess a good degree of generality.

Importantly for the present research, EC effects extend to memory for more complex materials including extended visual event narratives such as film clips and eye-witness testimony. To exemplify, Perfect et al. (2008) found EC to improve episodic memory for a videoed bank robbery (Exp 1), news bulletin (Exp 2), television programme (Exp 3) and a staged event (Exp's 4 and 5). More specifically, memory was enhanced for both visual and auditory information when tested by both free-recall and cued-recall. The effects found were not due to a shift in response bias as memory for non-studied information was neither influenced nor reduced by EC.

Eye-closure effects have also been found in children. Particularly, greater accuracy in memory for studied details of film clips and staged eye-witness events have been found (e.g., Mastroberardino et al. 2012; Mastroberardino and Vredeveldt 2014; Natali et al. 2012). At the other end of the age spectrum, Wais et al. (2012) found EC to improve memory in older individuals (in addition to college aged persons). Like Parker and Dagnall (2020), this was particularly the case for memory for item-specific visual details.

1.4 | Explaining Eye-Closure Effects

The mechanisms that underpin EC effects are the subject of ongoing debate. Regarding *cognitive* accounts, these differ in whether the effects are domain general or modality specific (Craik 2014). The former assumes that individuals have limited attentional processing resources (Baddeley 2012; Kane et al. 2007). According to this explanation, visual information draws attention involuntarily. When attempting to recall information from long-term memory, this diverts essential processing from the act of retrieval and produces a memory impairment. This is likely to have an impact when retrieval is difficult and demands dedicated processing resources (Glenberg et al. 1998). Thus, eye-closure eliminates competition for the limited resources and enhances memory. In contrast, the modality or domain specific explanation hypothesises that EC works by the reduction of interference between similar representations (e.g., visual or imagistic). Although resourced based, this account emphasises competition between modality-specific processes (Craik 2014).

These explanations make different predictions regarding whether EC effects should be limited to memory for visual-imagistic information (modality-specific) or include non-visual information (domain-general). Evidence has accumulated consistent with both predictions. For instance, EC effects have been found for visual and auditory information (e.g., Ebersbach 2023; Natali et al. 2012; Perfect et al. 2008, 2011) and therefore is congruent with the domain-general account. Other work has reported EC effects for only visual details (Vredeveldt et al. 2012; Vredeveldt and Penrod 2013). Although disappointing from the perspective of theoretical clarity, it is perhaps to be expected that multiple outcomes are likely and that modality-specific and general mechanisms might operate under different conditions. Consequently, both accounts have viability (Vredeveldt et al. 2011).

1.5 | The Current Experiment

The rationale for the present experiment was twofold. Firstly, it was important to consider the effectiveness of *retrieval*-based techniques for memory enhancement as the significance of the to-be-recalled material is not always evident during exposure to information or events. Consequently, any improvement that could be achieved by optimising encoding-based strategies is not a possibility. Second, both ESI with EC have been used previously, and separately, to increase complex memories in the form of eye-witness and episodic autobiographical memory (see the above sections for details). These forms of memory typically involve the retrieval of temporally extended events and the reconstruction of narratives, visuo-spatial scenes and persons. Accordingly, combining these techniques makes sense from the perspective of memory enhancement to assess the nature of their joint contribution.

The most important question for this research is the joint effect on memory of ESI and EC. To provide a higher degree of ecological validity, a set of film clips were chosen that have been used in past studies of complex and perceptually rich episodic memory (e.g., Grilli et al. 2019; St-Laurent et al. 2014). These depict interactions between people, sometimes involving other objects, in particular spatial–temporal contexts in a continuous unfolding narrative.

The recall of such personally experienced episodes entails the reprocessing of both perceptual details and inferences regarding the thematic nature of those episodes mediated by different neural structures and regions (e.g., Robin and Moscovitch 2017; Sheldon et al. 2019; St-Laurent et al. 2014). As such, recall can be scored in terms of the main story elements embodied by the clip as well as associated (but not story related) elements (Sekeres et al. 2016). Variously, the former has been termed thematic, gist, or narrative details and the latter as perceptual, sensory, or peripheral details (Sacripante et al. 2023; St-Laurent et al. 2014; Sekeres et al. 2016). In this manner, the stimuli and type of recall mimicked aspects of everyday autobiographical episodic memory but within a controlled laboratory context.

In the current experiment, participants were first asked to view a series of film clips. Following a delay, half of the participants underwent an ESI induction task or performed a control task. Then, participants were asked to recall the thematic and then perceptual details of the film clips with eyes open or closed. They were then asked to rate how well they thought they had recalled the general story content and perceptual vividness of the clips.

Regarding the predictions for memory, one hypothesis assumes that ESI and EC enhance different cognitive processes. If so, then it is predicted that their combined effect will be additive. Specifically, the magnitude of the EC effect will be the same across both levels of the ESI manipulation. The rationale for this is that ESI may facilitate the initial reconstruction of detailed memory episodes (Schacter et al. 2017), while EC could enhance subsequent elaboration through visualisation or mental imagery (Herff et al. 2021; Vredeveldt et al. 2015). This suggests that both processes contribute independently to memory recall.

Another hypothesis assumes ESI and EC are interactive. If this is true, participants who first engage in ESI will show greater benefits from EC compared to those who do not. The reason is that initial engagement in episodic thinking (the ESI task) activates goal-directed search processes (e.g., Madore et al. 2015; Madore et al. 2016), making it easier to retrieve and elaborate on memories when external distractions are minimised by eye closure.

To the extent, subjective experience of story and perceptual detail were based on the amount recalled, the predictions for the story and perceptual ratings were expected to mirror those of memory.

2 | Method

2.1 | Design

The experiment had two between-subject factors of episodic specificity induction (induction vs. control) and eye-closure (open vs. closed). The dependent variables were corrected recall, total recall, and false recall of thematic and perceptual details. Additionally, ratings of story coherence and perceptual vividness were measured to assess the subjective characteristics of the information recalled.

2.2 | Participants

Sample size was determined by a consideration of both past research (Grilli et al. 2019; Madore et al. 2014, 2019a, 2019b; Perfect et al. 2011; Vredeveldt and Penrod 2013) and calculations using MorePower 6.0 (Campbell and Thompson 2012). For a small to medium-sized interaction ($\eta_p^2 = 0.04$) between ESI, eye-closure and item type, with $\alpha = 0.05$, for 80% power, a sample size of 192 was estimated. A total of 220 subjects were tested with 216 used in the final analysis due to the failure of some individuals to comply with experimental instructions.

All were recruited from within Manchester Metropolitan University or from the wider local community and took part on a voluntary basis. None had taken part in any similar research. All procedures performed in the experiment reported here were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethical approval was granted by independent scrutineers from the Department of Psychology at Manchester Metropolitan University. Informed consent was obtained from all individual participants included in the study.

2.3 | Materials

2.3.1 | Film Clips

A total of 14 film clips were used as originally compiled by St-Laurent et al. (2014). These stimuli have been used in previous investigations of ESI (Grilli et al. 2019) or thematic/gist and perceptual memory (e.g., Bonasia et al. 2018; St-Laurent et al. 2014, 2016; Sekeres et al. 2016) and were thus considered ideal for the present investigation. Of these, 12 were selected for use as target stimuli and the remaining two as primacy and recency buffers. Each clip was between 20 and 25 s in length, colour, contained little or no spoken dialogue and sometimes contained music. All were source from non-American films. The clips always depicted one or more individuals engaged in a variety of situations, locations and performing various activities. The clips spanned a range of themes including friendship, conflict and cooperation. Both outdoor and indoor contexts were present, and some were more serious, with others possessing a light humorous touch (for full details see St-Laurent et al. (2014)).

The clips were selected to be reasonably distinct from each other, given the range of those available. Associated with each clip was a title (e.g., The Balloon Story), that also served as the recall cue in the memory test, and a set of phrases that described the thematic contents of the clip (e.g., Boy and girl each have large balloons, the Boy walks away, the Girl's balloon floats towards boy, etc.). Participants were exposed to the titles but not the descriptive phrases as these were used for scoring.

2.3.2 | Response Booklets

Booklets were prepared to record biographical information about the participants, signatures for their consent, and debrief information with space to create an anonymous code should they wish to withdraw from the experiment later. Additional pages provided spaces for responses for the distractor task (writing down the names of towns and cities in the UK) and a series of arithmetic problems for the control (no ESI) task.

2.3.3 | Apparatus

A computer was used to present the film clips that were embedded in a slide show and to record the verbal responses of participants during the auditory recall task.

2.4 | Procedure

All participants were tested individually with the experimenter present. The latter was required to ensure compliance with the experimental instructions and for the effective delivery of the ESI task.

Participants were informed that the experiment was concerned with how people comprehend short stories. The instructions further indicated that they were about to be presented with a sequence of short film clips with each preceded by the title of the clip. They were asked to pay attention to the title and the film clip itself. They were not informed that their memory would be tested. Once they understood what was required and they felt comfortable, the sequence of film clips played automatically. The title of the clip was displayed for 2 s, followed by the clip itself. There was a short delay of 3 s after the clip and the presentation of the next clip title. The first and final clips were primacy and recency buffers and were not tested. The remaining 12 were the target stimuli and were presented in a randomised order per-subject.

Following the encoding phase, a filled delay of 10 min was imposed. Participants were directed to a page in the response booklet and were asked to write down the names of as many towns and cities in the UK as they can for the duration of this task.

The ESI induction (vs. control) phase then took place. Participants were randomly allocated to either condition. In the ESI condition, participants were told that they are now going to be asked to provide some details about an autobiographical memory. They were asked to reminisce back over their life and choose a personal memory that they feel comfortable talking about. They were told that the memory should have occurred within 1 year to 1 week ago and it must involve at least one other person. Once the participant indicated that they had recalled a memory, the experimenter then probed for specific details of the memory by asking questions derived from other ESI studies (e.g., Madore and Schacter 2016). Questions pertained to the people, the setting and other information that differentiates this memory from others. For instance, they were asked to think about the details of any people including what they looked like and what they were wearing. For actions and narrative elements, they were told to think about the details of the events or series of actions as they unfolded. For the setting, they were asked about the types of things that were in the environment, how they were arranged and what they looked like.

For those allocated to the control condition, their attention was directed to another page in the response booklet and were asked to complete a series of arithmetic questions (more were provided than any subject could complete within the time frame). The duration of both the ESI and control task was 5 min.

In the test phase, participants were randomly allocated to either the eyes open or closed condition. They were informed that the titles of 12 of the film clips would be spoken aloud in turn and that for each they should try to recall the details of that clip in response to a set of four questions for each clip. Two questions pertained to the recall of the film clips (thematic and perceptual) and two questions related to rating the film clips as described below. The titles were randomly ordered per-participant. The experimenter then asked the participant to close (keep open) their eyes, the title of the first clip was then spoken and the participant asked the first question: 'Please recall out loud what you can recall about the story content of the film clip. For example, what happened, who did what, what was the situation'. They were given 60 s to recall.

After this, and still with eyes closed (open), they were asked the second question; 'How well do you feel that you recalled the general plot line of the story on a 5-point scale with of 1 meaning there is no story content in memory, while 5 meaning they feel their memory contained all of the story elements'. The experimenter then asked the third question: 'What I want you to do now is please recall out loud any perceptual details you can remember from the film clip'. They were given a brief example worded 'For instance, report any visual and/or auditory details such as colours, shapes, sounds, music, objects or people in the video'. Again, they were given 60 s to do this.

Finally, the fourth question was asked; 'Please rate the vividness of your memory for these perceptual details on a 5-point scale with 1 meaning not at all vivid to 5 meaning very vivid'. The experimenter ensured that eyes were closed (open) throughout the recall trial. Following the first trial, the participants in the eyes closed condition were allowed to open their eyes for a short period before the next recall trial and so on until all 12 film clips had been tested. The order of the questions was the same for all participants and followed the procedure outlined by Bonasia et al. (2018), Sekeres et al. (2016), and St-Laurent et al. (2014). The experimenter ensured that eyes were closed (open) during the recall trials and of the importance of following the instructions.

After the retrieval phase, the participants were thanked, reminded of their right to withdraw, and provided with a short debrief.

2.5 | Scoring Procedure

The coding scheme for thematic and perceptual details was based on that used in past work using the same film clips (St-Laurent et al. 2014; Sekeres et al. 2016). Thematic details were part of the clips overall narrative. Each clip had several thematic details identified in the scoring protocol of Sekeres et al. (2016) that was used to score the current data and followed that closely. Participants were given a score of one point for each thematic detail they recalled that corresponded to a detail in the thematic narrative for that clip. Perceptual details were scored as additional items of information that pertained to visual, auditory and contextual information in the film clip. One point was scored for each perceptual detail recalled. Repetition of recall of the same thematic or perceptual details were not counted. If only partial details were recalled a score of one-half was awarded. False memories (recall errors) were small and tallied separately. An example of a scored recall protocol can be found in the Supporting Information accompanying this paper.

Corrected recall was calculated by subtracting false memories from accurate recalls. For each subject, the total thematic and perceptual details were tallied separately across the film clips and the mean number of detailed calculated by dividing by the total number of film clips. Coders had access not only to the scoring protocol for thematic details but were fully familiarised with the film clips and used these to check against the recalls when coding.

3 | Results

3.1 | Overview and General Consideration of the Results

The free-recall responses for each participant were blind scored for thematic and perceptual details using the scheme adapted from Sekeres et al. (2016). Reliability was checked by a random selection of 30% of the recall protocols. Interrater agreement was calculated using Cohen's Kappa and found substantial agreement with a high Kappa coefficient of 0.89 for thematic and 0.83 for perceptual details.

To account for response bias and false memory, corrected recall was calculated by subtracting the number of errors from total recall for both thematic and perceptual details retrieved. A mean corrected recall score was thus calculated for each participant and formed the basis for the main ANOVA. Separate analyses were performed on the ratings scales and false memory (recall errors).

The frequentist analyses were assessed further using Bayesian analyses. This was done to assess the magnitude of support for the null (vs. alternative) hypothesis. Bayesian techniques have been endorsed as an adjunct to traditional null hypothesis testing so as to determine the relative weight of evidence for the experimental/null findings (e.g., Dienes 2014; Rouder et al. 2012). Accordingly, Bayesian ANOVAs were analysed using JASP v 0.17.1.0 (JASP Team 2023), and BF_{10} and BF_{01} (Bayes factor) values were reported. These represent the ratio of the probabilities in support of the alternative versus null and null versus alternative hypotheses, respectively. In this manner, a Bayes factor of 1 means equivalent support for both the null and alternative hypotheses. As such, the findings are inconclusive. A BF_{10}/BF_{01} above 1 indicates that the results provide more evidence in favour of the experimental/null hypothesis and conversely for values below 1 (Morey et al. 2016). To assist interpretation, a Bayes factors of 3 and above is considered to be good evidence in support of the experimental/null hypothesis. Values between 0.3 and 3 are more equivocal and indicate somewhat inconclusive findings and that further work is needed. Where Bayes factors were calculated for interactions, lower-order effects were added to the null model. Finally, all Bayesian ANOVAs were performed using a Cauchy distribution with 0.5 on the prior. Additionally, at the request of a reviewer, Linear Mixed Models were used to analyse the data. These findings did not diverge from the ones reported below and can be found in the Supporting Information related to this paper.

3.2 | Analyses of Corrected Recall

Corrected recall scores for thematic and perceptual information were assessed separately. The recall scores were placed into a 2 (Eye-closure: Open vs. Closed) between-subjects by 2 (ESI condition: ESI vs. Control) between-subjects ANOVA. The summary statistics can be found in Table 1.

The ANOVA for thematic information showed a significant main effect of ESI, $F(1, 212) = 15.97$, $p < 0.001$, $\eta_p^2 = 0.070$, $BF_{10} = 83.787$, showing higher recall in the induction condition. The effect of EC was significant, $F(1, 212) = 18.33$, $p < 0.001$, $\eta_p^2 = 0.080$, $BF_{10} = 228.922$, displaying higher recall with eyes closed. The two-way interaction between ESI and EC was not significant, $F(1, 212) = 0.12$, $p = 0.726$, $\eta_p^2 = 0.001$. This non-significant effect was supported by the Bayes factor, $BF_{01} = 4.936$.

Perceptual details were positively skewed and subjected to a Log10 transformation prior to analysis. The ANOVA for perceptual details showed a significant main effect of ESI, $F(1, 212) = 27.26$, $p < 0.001$, $\eta_p^2 = 0.114$, $BF_{10} = 4933.024$, showing higher recall in the induction condition. The effect of EC was significant, $F(1, 212) = 24.65$, $p < 0.001$, $\eta_p^2 = 0.104$, $BF_{10} = 1577.887$, displaying higher recall with eyes closed. The two-way interaction between ESI and EC was not significant, $F(1, 212) = 0.001$, $p = 0.982$, $\eta_p^2 < 0.001$. This non-significant effect was supported by the Bayes factor, $BF_{01} = 4.955$.

3.3 | Analyses of False Recall

Although false recall scores were very low, it was decided it would be prudent to analyse this data separately to assess the effects of ESI and EC on memory errors. This could be of

TABLE 1 | Mean number (SE) of items of information recalled as a function of ESI, eye condition, and recall type.

Recall type	ESI condition	EC condition	*N*	Mean	SE
Corrected thematic	ESI	Closed	53	3.74	0.154
		Open	54	3.03	0.130
	Control	Closed	58	3.07	0.159
		Open	51	2.47	0.168
Corrected perceptual	ESI	Closed	53	4.45	0.458
		Open	54	2.66	0.176
	Control	Closed	58	2.66	0.198
		Open	51	1.68	0.122
Thematic uncorrected	ESI	Closed	53	4.07	0.165
		Open	54	3.50	0.124
	Control	Closed	58	3.50	0.127
		Open	51	2.65	0.146
Perceptual uncorrected	ESI	Closed	53	5.41	0.557
		Open	54	3.56	0.292
	Control	Closed	58	3.44	0.263
		Open	51	1.99	0.115
Thematic error	ESI	Closed	53	0.33	0.080
		Open	54	0.47	0.119
	Control	Closed	58	0.44	0.103
		Open	51	0.18	0.037
Perceptual error	ESI	Closed	53	0.96	0.181
		Open	54	0.89	0.192
	Control	Closed	58	0.78	0.155
		Open	51	0.31	0.051

Note: Uncorrected overall recall was not analysed but is presented here for completeness. The mean maximum number of thematic details that could be recalled was 7.5.

particular concern in certain situations where false recall may have important consequences.

False recall scores were placed into a 2 (Eye-closure: Open vs. Closed) between-subjects by 2 (ESI condition: ESI vs. Control) between-subjects ANOVA. These were positively skewed and subjected to a Log10 transformation prior to analysis. The non-transformed summary statistics can be found in Table 1.

This analysis of thematic errors produced a main effect of ESI, $F(1, 212) = 24.29$, $p < 0.001$, $\eta_p^2 = 0.103$, $BF_{10} = 1282.351$, showing greater false recall after ESI. The main effect of EC was significant, $F(1, 212) = 23.49$, $p < 0.001$, $\eta_p^2 = 0.100$, $BF_{10} = 1143.618$, showing more errors with eyes closed. The interaction between ESI and EC was not significant, $F(1, 212) = 2.70$, $p = 0.102$, $\eta_p^2 = 0.013$, $BF_{01} = 1.591$.

This analysis of perceptual details produced a main effect of ESI, $F(1, 212) = 4.83$, $p = 0.029$, $\eta_p^2 = 0.022$, $BF_{10} = 1.161$, showing greater false recall after ESI. The main effect of EC was not significant, $F(1, 212) = 3.36$, $p = 0.068$, $\eta_p^2 = 0.016$, $BF_{01} = 0.619$. The interaction between ESI and EC was not significant, $F(1, 212) = 0.80$, $p = 0.372$, $\eta_p^2 = 0.004$, $BF_{01} = 3.681$.

3.4 | Analyses of Rating Scores

Rating scores were placed into a 2 (Eye-closure: Open vs. Closed) between-subjects by 2 (ESI condition: ESI vs. Control) between-subjects ANOVA. The summary statistics can be found in Table 2.

For thematic or story ratings, the analyses indicated a significant main effect of ESI, $F(1, 212) = 16.91$, $p < 0.001$, $\eta_p^2 = 0.074$, $BF_{10} = 126.316$, showing a higher overall thematic rating in the induction condition. The effect of EC was significant, $F(1, 212) = 11.62$, $p < 0.001$, $\eta_p^2 = 0.052$, $BF_{10} = 14.609$, showing a higher thematic rating with eyes closed. The

TABLE 2 | Mean (SE) ratings as a function of ESI, eye condition, and rating type.

Rating type	ESI condition	EC condition	*N*	Mean	SE
Thematic	ESI	Closed	53	3.48	0.12
		Open	54	3.29	0.09
	Control	Closed	58	3.22	0.10
		Open	51	2.66	0.12
Perceptual	ESI	Closed	53	3.20	0.12
		Open	54	2.99	0.08
	Control	Closed	58	2.96	0.09
		Open	51	2.30	0.10

two-way interaction between ESI and EC was not significant, $F(1, 212) = 2.86$, $p = 0.092$, $\eta_p^2 = 0.013$, $BF_{01} = 1.359$.

For perceptual ratings, the analyses indicated a significant main effect of ESI, $F(1, 212) = 21.44$, $p < 0.001$, $\eta_p^2 = 0.092$, $BF_{10} = 480.807$, showing a higher perceptual rating score in the induction condition. The effect of EC was significant, $F(1, 212) = 18.85$, $p < 0.001$, $\eta_p^2 = 0.082$, $BF_{10} = 209.022$, showing a higher perceptual rating score with eyes closed.

The two-way interaction between ESI and EC was significant, $F(1, 212) = 4.76$, $p = 0.030$, $\eta_p^2 = 0.022$, $BF_{10} = 1.640$. Follow-up tests for this interaction revealed that the effect of EC was not significant in the ESI group, $t(90.77) = 1.46$, $p = 0.074$ (one-sided), $BF_{01} = 0.974$, Cohen's $d = 0.27$. However, the difference was significant in the control group, $t(107) = 4.82$, $p < 0.001$ (one-sided), BF10 = 6774.030, Cohen's $d = 0.92$. Despite this, BF_{10} for the interaction was weak at 1.640.

4 | Discussion

4.1 | General Consideration of Current Findings

The principal finding was that ESI and EC produce additive effects in the recall of thematic and perceptual details. The increase in correct recall following eye-closure is consistent with other work that has shown improvements in memory when visual distraction is reduced (e.g., Craik 2014). In the present experiment, this was found for both thematic and perceptual information and suggests that mnemonic enhancement is not tied to cognitive representations of a particular format. This is more congruent with the modality-free account of EC effects and is dealt with in more detail below.

Independent of EC effects, a short priming phase of recalling unrelated information in a detailed manner established a retrieval mode that transferred to the target memory task. Like EC, the increase in memory was found for both thematic and perceptual details. The positive effect of ESI on recall was similar to the results of Grilli et al. (2019). The difference between this earlier report and the current finding is that ESI was manipulated in different phases of the experiment. Grilli et al. (2019) made use of an induction *prior* to encoding and thus the effects of ESI could relate to changes in encoding, retrieval or both. In the present experiment, it was found that ESI effects can enhance memory when given prior to recall and thus the influence must be due to some alteration in retrieval mode.

The increase in false memories aligns with the idea that remembering is a reconstructive process that, under certain circumstances, can be increased by ESI. For instance, it has been found that ESI can increase the number of related false memories following the study of associated lists of words (Thakral et al. 2019). It is possible that the ESI in the current experiment led to the false recall of non-presented but associatively related details in the film clips. That is, thematic or perceptually associated information.

The increase in false memory in the EC condition may have arisen due to an increase in the reliance on internal imagery and imagination (Vredeveldt et al. 2012). This might have inadvertently encouraged the incorporation of imagined and fabricated details into memory. Irrespective of these findings, it must be noted that the frequency of false memories was very small and that their presence was insufficient to impact on memory accuracy as the primary dependent variable corrected for false alarms. Nevertheless, it remains to be seen whether the effects of ESI and EC under other conditions (such as the study and recall of highly scripted or schematic events) increase false memories to a greater extent that might have more significant implications in forensic contexts.

An interaction between ESI and EC was found for the rating of perceptual details (although the evidence favouring this interaction was relatively weak by Bayesian standards). This showed that the EC effect was significant in the non-induction condition (higher ratings with eyes closed) but not following ESI. In the ESI condition, ratings were higher overall. It is not clear why the effect of ESI and EC in ratings differed from recall. Perhaps ESI provided a sufficient boost to memory to influence ratings irrespective of the amount of visual distraction. It could be that once some minimal threshold of recall has been achieved (prompted by ESI), the contribution of EC is small in terms of how participants evaluate the clarity of those memories. That is, although the level of recall differs between the conditions, enough information has been retrieved to respond with high ratings. In this instance, as ESI facilitated the recall of richer perceptual details, this may have overshadowed any potential benefits of eye closure.

4.2 | Theoretical Perspectives

At this juncture, it is important to consider the processing basis for the additive effects reported. As noted in the introduction, additive effects could arise if ESI enhances the initial construction of memory episodes and EC eliminates distraction and provides a basis for subsequent cognitive processing. To assess this, work on the cognitive-neural correlates of ESI and EC are outlined to identify separable candidate mechanisms that could combine to produce additive influences.

Episodic specificity induction is hypothesised to work via event construction (Schacter and Madore 2016). In fact, remembering complex events, and the mechanisms of ESI go beyond construction and involve subsequent elaboration (Madore et al. 2016; Thakral et al. 2020). In an fMRI study of ESI effects, it was found that the construction phase was related to increased activation in the anterior hippocampus and the inferior parietal lobule (Madore et al. 2016). The activation of the hippocampus was not surprising to the extent episodic retrieval was involved. Perhaps more important are findings that relate hippocampal activity to the processing of event-related episodes that enable the construction of narratives across time (Cohn-Sheehy et al. 2021). Congruent with this are findings that the anterior hippocampus is important in the early constructive phase of retrieval in which event information is being compiled prior to elaboration and later processing (e.g., McCormick et al. 2015). The activity in the inferior parietal lobule is functionally related to the medial temporal lobes (including the hippocampus) and is important for episodic memory that involves scene content and the recall of event details (Andrews-Hanna et al. 2010; Guerin et al. 2012). Additionally, along with the frontal regions, it is involved in the top-down control of episodic memory (Ciaramelli et al. 2008). Taken together, ESI might thus enhance memory by enabling the initial construction of an event or scene-based representation.

Eye-closure has been explained by reference to domain-general and modality-specific processes (see introduction). As evidence exists for both accounts, it is likely that a combination of processes contributes to the effects on memory. Research using fMRI has found eye-closure to increase activations in visual processing regions and likely relate to the retrieval of visual sensory experiences (Marx et al. 2003). Other work has also found differences in activity in sensory regions as a function of eye-closure (e.g., Yuan et al. 2014) but did not assess such effects in the context of memory. However, Wais et al. (2010) found EC effects were related to changes in functional connectivity between the ventrolateral PFC, hippocampus and the lateral occipital cortex. The PFC-hippocampus connectivity was taken to be indicative of enhanced cognitive control during retrieval. Connectivity involving the lateral occipital region was explained as the neural basis for the processing of high-fidelity visual-imagery information pertaining to the recalled memories.

Bringing these findings together suggests a reason for the additive effects of ESI and EC on recall. The induction could set the basis for a change in retrieval mode, in which the goal is event reconstruction via recall of specific scenarios related to people and settings. Following initial retrieval and construction, details need to be maintained in an active state in working memory for possible subsequent processing and responding. Eye-closure could facilitate this by the exclusion of external distracting information. Closing one's eyes could also enable the more effective use of visual-imagistic strategies to evaluate the retrieved information and derive cues for succeeding retrieval cycles under top-down control.

Consistent with this notion is the finding that the time course of neural activations differs regarding construction and imagination. For instance, cortical regions responsible for visual-imagery processing become activated at a processing stage subsequent to access and initial reconstruction of autobiographical memories (Inman et al. 2018). In this depiction, ESI and EC work together but on different components of the reconstruction of the recalled events and thus produce additive effects.

4.3 | Limitations of the Current Work

The present findings are limited as the joint effects were assessed in only a single experiment with one set of manipulations. It will be important to examine whether these findings generalise across different materials or experimental instructions. Regarding materials, stimuli that contain greater auditory-verbal content would be valuable. The video clips employed here were predominantly visual in nature and thus even thematic content would need to be derived from pictorial cues. Alternatively, direct comparisons between the visual clips as used here and their verbal equivalents (Sacripante et al. 2019), could be useful in teasing apart the role of stimulus characteristics matched for thematic content.

Related to the above, it could be questioned as to whether the memories characterised in this experiment are suitable proxies to those formed outside the laboratory context. Although the term 'episodic memory' has been used equally to describe memory for lists of words, pictures and indeed film clips, memories acquired during one's life will typically be richer and with greater meaning. Additionally, testing of everyday memories (such as for eyewitness and autobiographical events) is almost certain to occur over a much more extended period. Although both eye-closure and ESI effects have been shown to enhance memory over longer periods, it is unclear how their conjoint effects would extend to such situations.

The procedure for the memory test may also have inadvertently produced some of the effects. The current experiment attempted to maintain consistency with prior work by testing thematic and perceptual recall in two phases (e.g., Sekeres et al. 2016; St-Laurent et al. 2014). Consequently, subsequent work may wish to emphasise the retrieval of all information in a single retrieval trial rather than prioritise one type across multiple trials.

More direct tests of how additive effects came about would be a valuable extension of the current work. A possible explanation was outlined above and assessing this account would provide insights into the cognitive operations that underpin the effect. This account depicted the effects of EC to relate to processing following event construction. As such, eye-closure would be predicted to produce greater effects at later stages in the recall process after the initial construction stage. Thus, varying the timing of eye-closure should produce different effects depending on its temporal position in recall trials.

4.4 | Applications and Implications

The current findings are promising from an applied perspective where the focus is on memory enhancement in various contexts such as forensic interviews. Although we are not proposing a specific protocol for the use of ESI and EC in such situations, it could be envisaged that ESI could be built into the early phase of the interview and integrated with rapport building. Following any initial opening the interviewer could introduce the concept of memory by explaining the rationale behind the interview process. Then, the interviewer could say that they are going to ask the witness about some past experiences unrelated to the target memory to get the interview started and explain that this may help them recall details more easily later. The ESI induction could then proceed with eyes closed by prompting the recall of a past experiences.

Prompts could include asking the witness to think about a specific event from their past. For example, 'Can you remember a particular time when you went out for dinner? What details can you recall about that event?' This could be followed by subsequent prompts that encourage thematic and sensory engagement with the event such as, 'Tell me about the events as they unfolded, what did you see, hear, or smell? who was with you?' This could be done for one or more memories to establish a retrieval mode that emphases specific or detailed recall. Following this, would be the transition to the main interview such as 'Now that you have recalled some personal memories, let's focus on the event you witnessed. Can you describe what you remember?'

Some problems with these suggestions arise from findings that closing one's eyes increases the intensity of emotional experiences (Chang et al. 2015; Lerner et al. 2009). Thus, eye-closure combined with an ESI induction might disproportionately lead to the witness reliving a traumatic event. Accordingly, the interviewer would need to be sensitive to such issues and take precautions to mitigate any possible harm.

Similar procedures might be used for assisting individuals with overgeneralised memories. For instance, the elderly and those with depression (e.g., Sumner et al. 2010; Wilson and Gregory 2018). Overgeneral memories are those that lack specificity. The retrieval of specific details provides the foundation for re-experiencing past events and mental time travel (Tulving 2002). These qualities are important from both a subjective and pragmatic perspective (e.g., Barry et al. 2019; Raes et al. 2009). Consequently, the advantage that could be gained by combining mnemonic techniques such as ESI and EC should be an important avenue of investigation.

Author Contributions

Andrew Parker: conceptualization, investigation, writing – original draft, methodology, writing – review and editing, formal analysis, supervision, data curation. **Adam Parkin:** conceptualization, investigation, writing – review and editing, methodology, formal analysis, data curation, supervision. **Neil Dagnall:** writing – review and editing.

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Ethics Statement

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethical approval was granted by independent scrutineers from the Department of Psychology at Manchester Metropolitan University.

Consent

Informed consent was obtained from all individual participants included in the study and was voluntary in all instances.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.