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Direct and generative retrieval of autobiographical memories: The roles of visual imagery and executive processes

Rachel J. Anderson, Stephen A. Dewhurst and Graham M. Dean

University of Hull

Author Note

Rachel J. Anderson, Stephen A. Dewhurst and Graham M. Dean, Department of Psychology, University of Hull, UK.

Correspondence concerning this article should be addressed to Rachel J. Anderson, Department of Psychology, University of Hull, Cottingham Road, Hull, HU6 7RX, UK. Email: Rachel.Anderson@hull.ac.uk

Abstract

Two experiments used a dual task methodology to investigate the role of visual imagery and executive resources in the retrieval of specific autobiographical memories. In Experiment 1, dynamic visual noise led to a reduction in the number of specific memories retrieved in response to both high and low imagery cues, but did not affect retrieval times. In Experiment 2, irrelevant pictures reduced the number of specific memories but only in response to low imagery cues. Irrelevant pictures also increased response times to both high and low imagery cues. The findings confirm previous findings that disruption to executive resources impairs the generative retrieval of autobiographical memories but not the direct retrieval pathway. In contrast, visual distractor tasks impair access to specific autobiographical memories via both the direct and generative retrieval routes, thereby highlighting the role of visual imagery in both pathways.

Autobiographical memory (AM) contains "facts and events that have been interpreted and integrated into a consistent story about one's self" (Buckner & Fivush, 1998, p.407). According to Conway and Pleydell-Pearce (2000), AMs are organised hierarchically and can be retrieved at different levels of specificity. For instance, memories can relate to personal semantic information (e.g., references to "my family") or general events, which comprise repeated experiences (e.g., when I go to the hairdressers: categoric memory) or events lasting longer than one day (e.g., a holiday in Spain: extended memory). Alternatively, one can remember a specific event that happened on one particular day (e.g., a day-trip to the zoo). These specific memories are thought to be particularly useful because they serve as analogies when planning and problem-solving (e.g. Williams et al., 2006).

A defining characteristic of specific AMs is the presence of sensory-perceptual details, usually in the form of visual images. For example, using an image generation task, Conway (1988) found that AMs were rated as more vivid than semantic facts. Furthermore, Rubin, Schrauf, and Greenberg (2003) found that ratings of visual imagery were the strongest predictor of the sense of reliving an AM. In the source monitoring framework (see Johnson, Hashtroudi, & Lindsay, 1993), the presence of visual imagery is one of the cues that allows an individual to distinguish real from imagined events.

If imagery constitutes a defining characteristic of specific AMs, one would expect imagery to play a central role in their retrieval. According to Conway and Pleydell-Pearce's (2000) hierarchical model, specific AMs can be retrieved through two mechanisms. Generative retrieval involves a controlled and effortful memory construction, beginning with more abstract personal semantic information, moving through to general memories and, finally, event specific knowledge. In contrast,

direct retrieval is a non-effortful process involving spontaneous activation of event specific knowledge. To date, research suggests that imagery plays an important role in direct retrieval. For instance, Williams, Healy, and Ellis (1999) found that high imagery (HI) cues led to faster retrieval and more specific memories than low imagery (LI) cues or cues related to other sensory modalities. They concluded that HI cues automatically activate multimodal representations of experienced events. Thus, HI cues tend to activate direct retrieval, while LI cues lead to a generative and effortful search. More recent work, using self-reports of retrieval strategies and verbal protocols during retrieval, has also suggested that concrete, compared with abstract, cues promote direct retrieval (Uzer, Lee & Brown, 2012).

Further support for the role of imagery in promoting direct access to specific memories comes from two studies using a dual-task paradigm (Anderson, Dewhurst, & Nash, 2012; Williams et al., 2006). These studies found that retrieval of specific memories was impaired by concurrent load (random number generation and random button pressing respectively) when cues were LI, but not when cues were HI. These findings suggest that retrieval in response to LI, but not HI, cues constituted a generative search process requiring executive resources.

Previous literature suggests a clear role for visual imagery within the direct retrieval of specific AMs. In contrast, the role of imagery within the generative retrieval process is less clear. This pathway seems to be activated most frequently by LI cues. However, the assertion that sensory-perceptual information is a key feature of specific memories suggests that imagery may still play an important role within the generative retrieval of such memories. For instance, when abstract or non-visual cues evoke a generative search, a key part of this process may be the effortful generation of visual images that subsequently form part of a specific memory. The current studies

aim to explicitly test the assertion that visual imagery plays an important role within both direct and generative retrieval of specific AMs.

One way to examine the importance of imagery for AM retrieval would be to investigate the cognitive processes typically used in the generation and manipulation of images. It would, therefore, seem relevant to examine the role of working memory (WM: see Baddeley, 2007, for a recent review), particularly the visual components, in AM retrieval. Indirect evidence can be drawn from neuropsychological studies demonstrating that individuals with deficits of visual imagery also have difficulties generating specific memories (Greenberg & Rubin, 2003). Furthermore, other studies have demonstrated that eye movements, which are thought to engage visual components of WM, reduce the vividness and emotionality of emotionally negative memories (e.g. Kavanagh, Freese, Andrade, & May 2001). However, these studies have not explicitly examined the role that visual WM plays in the retrieval of specific AMs.

The question addressed in the current studies, therefore, is whether visual WM processes are important for the retrieval of specific AMs via both direct and generative retrieval pathways. This question was addressed using a dual-task paradigm to interfere with WM processes during the retrieval of specific AMs. Akin to previous research (Anderson et al., 2012; Williams et al., 2006), the dual-task paradigm required participants to retrieve specific AMs in response to HI and LI word cues whilst performing a secondary task. However, in contrast to the previous dual-task studies, we used secondary tasks known to interfere with visual WM processes; irrelevant pictures and dynamic visual noise (DVN).

The irrelevant pictures task was developed by Logie (1986) who found that the presentation of line drawings of common objects interfered with the use of a

visual mnemonic. Logie proposed that pictures have obligatory access to the visual-spatial sketchpad component of WM and interfere with performance in a manner analogous to the interference of verbal processes by irrelevant speech (Salame & Baddeley, 1982). A problem acknowledged by Logie, however, was that irrelevant pictures may also interfere with executive processes. In order to overcome this problem, Quinn and McConnell (1996) developed DVN as a purely visual interference task. DVN consists of an array of small black and white squares that randomly switch colour over time. Previous research has shown that DVN interferes with tasks that involve the generation and manipulation of visual images, such as use of visual mnemonics (Quinn & McConnell) and symbolic distance judgements involving size comparisons (Dean, Dewhurst, Morris, & Whittaker, 2005).

We report two experiments in which participants were cued to retrieve specific AMs with and without a visual secondary task: DVN in Experiment 1 and irrelevant pictures in Experiment 2. The overall aim was to investigate whether a secondary task that recruits visual resources would impair the retrieval of specific AMs, above and beyond the impairment caused by disrupting executive resources. If visual imagery plays an important part in both direct and generative retrieval then DVN should disrupt the retrieval of specific AMs to both HI and LI cues; we would, therefore, expect fewer specific memories and longer latencies to retrieve specific memories with DVN, with this effect apparent for both cue types. In contrast, irrelevant pictures tap executive resources in addition to visual resources and should have a greater disruptive effect when AMs are cued by LI, rather than HI, cues.

We also examined the phenomenological quality of the specific memories retrieved. Previous studies using a dual-task methodology (e.g. Anderson et al, 2012; Williams et al., 2006) have focused on the ease of retrieval (number of specific first

responses and latencies to retrieve specific events). However, the qualities of the specific event representations could, themselves, provide information regarding the retrieval process. There may be a trade off between adherence to task instructions (to retrieve a memory that occurred on one particular day) and the extent to which retrieval is accompanied by the autonoetic consciousness that makes the experience truly episodic (e.g. level of sensory detail, vividness, bodily reliving). In such circumstances, the quantity and/or speed of specific retrievals would not differ, yet the phenomenological qualities of the memories retrieved would. Thus, it is important to also examine the phenomenological nature of specific memories retrieved under conditions where WM processes have been compromised. Previous work examining the impact of eye movements on the vividness of traumatic memories (e.g. Kavanagh et al. 2001) suggests that a concurrent visual task will impair the phenomenological experience of the specific memories retrieved.

Experiment 1

Method

Participants. 24 undergraduates participated for course credit. One participant failed to engage with the concurrent task and was removed from analyses. The remaining sample consisted of 5 males and 18 females, with ages ranging from 18-42 years (M=24.00, SD=7.24).

Design. A 2x2 within-subjects design was employed, with independent variables of cue type (HI vs. LI) and concurrent task (control vs. DVN). The dependent variables were memory specificity (mean latency to retrieve a specific memory and number of first responses describing a specific event) and ratings of memory quality (emotionality, vividness, sensory detail, bodily reliving).

Materials & Procedure.

Stimuli. Ten HI nouns (e.g. mountain, rainbow) and 10 LI nouns (e.g. wisdom, attitude) were used as retrieval cues. Words were selected from Williams et al (1999) and Anderson et al (2012) and organised into two sets comprising five words of each type. Mean imageability ratings (from Coltheart, 1981) were 604 and 615 for the HI cues and 342 and 364 for the LI cues. Allocation of the two lists to the DVN and control conditions was counterbalanced.

Dynamic Visual Noise (DVN). The DVN consisted of a grid of 80x80 cells, each measuring 2x2 pixels. At any one time, half the pixels were white and half were black. The pixels changed randomly at a rate of 50% per second with the constraint that the ratio of black and white cells was preserved. Participants were instructed to fixate on the DVN display until they retrieved a specific memory.

Autobiographical Memory Test (AMT). The AMT (Williams and Broadbent, 1986) required participants to retrieve specific AMs as quickly as possible in response to cue words. Participants were instructed that a specific memory constituted an event that occurred on one particular day in the past, with examples of correct and incorrect responses provided. They were instructed to say "stop" as soon as they retrieved a specific memory and then provide a brief verbal description.

Each trial consisted of a 10-s period during which the participant engaged in the concurrent task (the screen remained blank in the control condition), after which a cue word was presented, centrally in 50 point black text within a white textbox, on the screen for 5-s. The participant continued to engage in the concurrent task until they retrieved a specific memory. If a participant described a non-specific memory then the researcher prompted them by asking "Can you think of a specific event? Something that happened on one particular day?" Participants were given 60 s to respond to each cue before proceeding with the next trial. All responses were audio-recorded and

transcribed verbatim. When the response constituted a specific event, participants rated the memory's quality on four dimensions: emotionality, vividness, sensory detail, bodily reliving. All characteristics were assessed using 7-point Likert scales ranging from -3 to +3 (e.g. 'The emotions I ha*ve when I recall the event are… -3, …extremely negative; +3, …extremely positive'*). Participants also estimated how long ago the event occurred.

Participants completed two blocks of ten trials, one with, and one without, the concurrent task. Order of blocks was counterbalanced across participants. Prior to each block, participants were given one practice item. Within each block the presentation of HI and LI cues was alternated.

The time between cue word presentation and the participant's "stop" response constitutes the latency to retrieve a specific memory. When a non-specific response resulted in further prompting, the latency comprised the sum of response latencies between cue/prompt and the "stop" responses. When a participant failed to retrieve a specific memory within the time allowed, a latency of 60s was recorded.

The first response provided for each cue was coded into one of four categories: specific (single event that occurred at a particular time/place, not lasting more than one day), extended (single event that lasted longer than one day), categoric (repeated events, comprising a number of similar episodes), or a semantic associate (personal semantic information). When the individual failed to provide any response within 60s, an omission was recorded. A randomly selected sample, comprising 33.3% of all responses, were second-coded; inter-rater reliability was high (Cohen's Kappa = .96).

Results

Retrieval Latencies. A 2x2 repeated measures ANOVA compared the effects of cue type (HI vs. LI) and concurrent task (control vs. DVN) on mean latency to retrieve a specific event (Table 1). The main effect of cue type was significant, $F(1,22) = 30.96$, $p < .001$, $\eta_p^2 = .59$, with longer retrieval latencies in response to LI, compared with HI, cues. However, the main effect of concurrent task, $F(1,22) = 1.41$, $p = .25$, $\eta_p^2 = .06$, and the interaction effect were not significant, $F(1,22) = 0.07$, $p = .79$, $\eta_p^2 = .003$.

Number of Specific First Responses. A further 2x2 repeated measures ANOVA examined the number of first responses categorised as specific (Table 1). Both the main effects of cue type, $F(1,22) = 26.85$, $p < .001$, $\eta_p^2 = .55$, and concurrent task, $F(1,22) = 12.50$, $p = .002$, $\eta_p^2 = .36$, were significant. Fewer specific first responses were produced in response to LI, compared with HI, cues. Furthermore, DVN significantly reduced the number of specific first responses in comparison to trials with no concurrent task. The interaction was not significant, $F(1,22) = 1.14$, $p = .30$, $\eta_p^2 = .05$.

Number of Omissions and Non-Specific Memories. When participants failed to retrieve a specific memory as a first response this was either because they produced a non-specific response (categoric, extended or semantic associate) or they failed to recall any memory (an omission) (Table 1). To examine whether reductions in specificity were a function of higher levels of erroneous responses or omissions, a 2 (cue type) x 2 (concurrent task) x 2 (error type: non-specific memory vs. omission) repeated measures ANOVA was conducted. Significant main effects of cue type, $F(1,22) = 26.85$, $p < .001$, $\eta_p^2 = .55$, and task type, $F(1,22) = 12.50$, $p = .002$, $\eta_p^2 = .36$, were found; higher numbers of omissions and non-specific responses were produced when the concurrent task was present, compared with absent, and following

LI, compared with HI, cues. Importantly, however, a significant Task Type x Error Type interaction emerged, $F(1,22) = 4.68$, $p = .04$, $\eta_p^2 = .18$. Bonferroni adjusted pairwise comparisons revealed that DVN, compared with control, trials resulted in higher levels of non-specific erroneous responses ($p = .001$). There were no significant differences in the number of omissions between the DVN and control trials ($p = .52$). All other main effects and interactions were not significant ($Fs \leq 1.72$, $ps \geq .20$, $\eta_p^2s \leq .07$).

Phenomenological Characteristics. All four ratings were provided on a 7 point scale of -3 to +3. For ease of data interpretation, all values were converted into values ranging from 1 to 7. Mean values (Table 2) for each rating were assessed using a separate 2 (cue type) x 2 (concurrent task) repeated measures ANOVA. With respect to the influence of cue type, a significant main effect emerged for emotionality, $F(1,22) = 16.47$, $p = .001$, $\eta_p^2 = .43$. Specific memories retrieved in response to HI, compared with LI, cues were accompanied by higher levels of positive emotion. The main effect of concurrent task was significant for bodily reliving, $F(1,22) = 5.23$, $p = .03$, $\eta_p^2 = .19$. Higher levels of bodily reliving accompanied specific memories recalled under concurrent task conditions. No other significant main effects or interactions emerged ($Fs \leq 3.68$, $ps \geq .07$, $\eta_p^2s \leq .14$).

Age of Memories. Standardised scores of memory age were calculated (Table 2). The age of each specific event was converted into months from the time of recall, with events occurring within the last month coded as '1'. This value was divided by the participant's age (in months), and the product subtracted from 1. This method has been used in previous research (e.g. Williams et al, 1999) and expresses memory age as a proportion of a participant's life. Scores range from 0 to 1, with higher scores indicating more recent memories. A 2 (cue type) x 2 (concurrent task) repeated

measures ANOVA assessed standardised scores of memory age. A significant main effect of cue type emerged, $F(1,22) = 16.48$, $p = .001$, $\eta_p^2 = .43$. Specific memories evoked by HI cues were older compared with those evoked by LI cues. Neither the main effect of concurrent task, $F(1,22) = 1.13$, $p = .28$, $\eta_p^2 = .05$, nor the interaction effect, $F(1,22) = 1.95$, $p = .08$, $\eta_p^2 = .13$, were significant.

Discussion

The main finding from Experiment 1 is that DVN disrupted the retrieval of specific AMs via both direct and generative routes, as indicated by the reduced specificity in response to both cues types. As DVN is a purely visual distractor, the findings are consistent with the view that visual images are a critical component of specific AMs, regardless of how they are retrieved. Experiment 2 investigated whether the retrieval of specific AMs is also disrupted by the concurrent presentation of irrelevant pictures, a task previously shown to interfere with visual WM (Logie, 1986). In contrast to DVN, irrelevant pictures also recruit executive resources, thereby allowing us to determine whether the effects of visual interference are independent of the effects of executive interference. If the irrelevant pictures task interferes with both visual and executive resources then it is likely to reduce specificity for both HI and LI cues but with a greater effect in response to LI cues.

Experiment 2

A further 24 undergraduate students (23 female), in the age range 18-25 years (M=19.63, SD=1.97), were recruited. The design, materials and procedure were identical to Experiment 1, except that the concurrent task was irrelevant pictures rather than DVN. The pictures used within the concurrent task were 180 colour line drawings sourced from Rossion and Pourtois (2004). These were presented at a rate of 1 per second and participants were instructed to fixate the display until they retrieved

a specific memory. All pictures were unrelated to the cue words used within the AMT. A different sample of pictures was presented on each trial of the AMT.

Responses on the AMT were scored in an identical manner to Experiment 1. 33.3% of the responses were second-coded; inter-rater reliability was high (Cohen's Kappa = .98).

Results

Retrieval latencies. A 2x2 repeated measures ANOVA compared the effects of cue type (HI vs. LI) and concurrent task (control vs. irrelevant pictures) on mean latency to retrieve a specific event (Table 3). The main effects of cue type, $F(1,23) = 48.59$, $p < .001$, $\eta_p^2 = .68$, and concurrent task, $F(1,23) = 8.73$, $p = .001$, $\eta_p^2 = .28$, were significant. Participants produced longer retrieval latencies in response to LI, compared with HI, cues and in the presence of a concurrent task. The interaction effect was not significant, $F(1,23) = 0.01$, $p = .91$, $\eta_p^2 = .001$.

Number of Specific First Responses. A further 2x2 repeated measures ANOVA examined the number of first responses categorised as specific (Table 3). Both the main effects of cue type, $F(1,23) = 54.71$, $p < .001$, $\eta_p^2 = .70$, and concurrent task, $F(1,23) = 16.12$, $p = .001$, $\eta_p^2 = .41$, were significant. Fewer specific first responses were produced in response to LI, compared with HI, cues. Furthermore, irrelevant pictures significantly reduced the number of specific first responses in comparison to trials when the concurrent task was absent. A significant interaction effect also emerged, $F(1,23) = 4.43$, $p = .046$, $\eta_p^2 = .16$. Pairwise comparisons revealed that irrelevant pictures significantly reduced specificity relative to control for both cue types; however, this reduction in specificity was greater following presentation of LI ($p < .001$) compared with HI cues ($p = .05$).

Number of Omissions and Non-Specific Memories. To examine whether reductions in specificity were a function of higher levels of erroneous responses (non-specific memory) or omissions, a 2 (cue type) x 2 (concurrent task) x 2 (error type) repeated measures ANOVA was conducted (Table 3). Significant main effects emerged for cue type, $F(1,23) = 54.71$, $p < .001$, $\eta_p^2 = .70$, and concurrent task, $F(1,23) = 16.12$, $p = .001$, $\eta_p^2 = .41$. Higher numbers of omissions and non-specific responses were produced when the concurrent task was present, compared with absent, and following LI, compared with HI, cues. A significant Cue Type x Concurrent Task interaction also emerged, $F(1,23) = 4.43$, $p = .046$, $\eta_p^2 = .16$. Pairwise comparisons revealed that irrelevant pictures significantly increased erroneous responses and omissions across both cue types; however, the increase was greater following presentation of LI ($p < .001$) compared with HI, cues ($p = .05$).

A significant main effect also emerged for error type, $F(1,23) = 14.67$, $p = .001$, $\eta_p^2 = .41$; participants were more likely to not respond (an omission) rather than provide an erroneous, non-specific, response. However, this was qualified by a significant Error Type x Cue Type interaction, $F (1,23) = 11.38$, $p = .003$, $\eta_p^2 = .33$. Higher numbers of omissions, compared with non-specific responses, were evident in response to LI ($p = .001$), but not HI ($p = .12$), cues. Neither the Concurrent Task x Error Type interaction, $F (1,23) = 2.50$, $p = .13$, $\eta_p^2 = .10$, nor the 3-way interaction, $F (1,23) = 0.03$, $p = .87$, $\eta_p^2 = .001$, were significant.

Phenomenological Characteristics. Ratings of phenomenological quality were only provided on production of a specific memory; in Experiment 2, three participants failed to produce a single specific memory in at least one of the four experimental conditions; thus, data was only available from 21 participants (Table 4). Each rating was assessed by a separate 2 (cue type) x 2 (concurrent task) ANOVA.

Significant main effects of cue type emerged for emotionality, $F(1,20)=22.38$, $p <$ .001, $\eta_p^2 = .53$, and level of sensory detail, $F(1,20) = 5.03$, $p = .04$, $\eta_p^2 = .20$. HI, compared with LI, cued recall was accompanied by higher levels of positive emotion and sensory detail. No main effects of concurrent task, or any interaction effects, were significant ($Fs \leq 3.99$, $ps \leq .06$, $\eta_p^2s \leq .17$).

Age of Memories. As with the phenomenological characteristics, memory age was only ascertained for specific memories; thus, analyses only included data from 21 participants. The 2 (cue type) x 2 (concurrent task) repeated measures ANOVA revealed a significant main effect of cue type, $F(1,20) = 7.52$, $p = .01$, $\eta_p^2 = .27$. Specific events evoked by HI cues were older than those evoked by LI cues. The main effect of concurrent task, $F(1,20) = 0.32$, $p = .58$, $\eta_p^2 = .02$, and the interaction effect, $F(1,20) = 0.03$, $p = .86$, $\eta_p^2 = .002$, were not significant.

Discussion

The main findings of Experiment 2 confirm those of Experiment 1 and, additionally, illustrate the combined effects of visual and executive interference on specific AM retrieval. Consistent with Experiment 1, latencies to retrieve specific memories were longer in response to LI than to HI cues. In contrast to Experiment 1, latencies were also affected by the secondary task; irrelevant pictures significantly increased retrieval time relative to the full attention condition. Also consistent with Experiment 1, the number of specific memories retrieved was significantly reduced by both LI cues and the visual secondary task. Unlike Experiment 1, however, a significant interaction indicated that irrelevant pictures impaired retrieval to a greater extent in response to LI, compared with HI, cues. These findings indicate that the effects of visual interference are independent of the effects of executive interference.

General Discussion

Whereas previous research has highlighted the role of visual imagery within the direct retrieval of specific AMs, less is known about its role within the generative retrieval pathway. The presence of sensory details, particularly visual images, as a defining characteristic of specific AMs suggests that visual imagery should also play an important role within the generative retrieval pathway. The two experiments reported here support our hypothesis that visual imagery is important within both pathways. A concurrent visual task (DVN or irrelevant pictures) resulted in fewer specific first responses compared to full attention conditions. Thus, compromised visual WM resulted in a reduction in the specificity of memories retrieved via both the direct and generative pathways. Additionally, the irrelevant pictures task demonstrated a greater effect when the cues were LI. This provides further support for the independent role of executive processes within the generative retrieval pathway.

Latencies to retrieve specific memories also illustrated the effects of imagery within the direct and generative retrieval pathways. DVN had no significant impact on latencies to retrieve specific events in response to HI or LI cues. Instead, DVN only affected participants' ability to produce first responses that were specific. This was further supported by the finding that participants produced more erroneous responses (non-specific first responses), rather than omissions, when completing the AMT alongside DVN. This suggests that compromised visual WM impairs participants' ability to decide whether a memory is specific; thus, the presence of imagery forms part of the decision process regarding the episodic nature of the memory in both the direct and generative pathways. Surprisingly, irrelevant pictures slowed retrieval of AMs in response to both HI and LI cues. If irrelevant pictures only interfered with executive resources then we would expect to see this effect only in the LI cues. It is

possible that irrelevant pictures provide competing visual (HI) cues that interfere with both direct and generative pathways. If so, the participant would need to reject the competing cue first, which requires executive resources, before proceeding with retrieval of a specific memory. Hence, we witnessed the slowing of retrieval via both pathways.

We also investigated whether visual interference affected the phenomenological qualities of the specific AMs retrieved. Contrary to our hypotheses, we did not find that compromising visual WM processes impacted on the phenomenological experience of specific memories. In fact, specific memories retrieved alongside DVN were reported to have higher levels of bodily reliving. This suggests that, whilst DVN impairs the process of retrieving specific memories, the quality of the specific memories retrieved is not degraded. However, only AMs with the highest levels of autonoetic consciousness can overcome the visual distractor. These findings contradict previous work using eye movement to compromise visual WM; these suggested that disrupting visual WM reduced the vividness of memories (e.g. Kavanagh et al, 2001). However, discrepant findings may have arisen due to methodological differences; eye movement studies required retrieval of positively/negatively-valenced memories that have already been generated within an earlier recall task. In contrast, our cue words did not target emotionally charged memories and, furthermore, the concurrent task was presented alongside the initial retrieval process.

To conclude, the current findings are the first to show that visual imagery is important within both direct and generative retrieval of specific AMs. Furthermore, they suggest that visual imagery functions independently of executive processes within these retrieval pathways. The discrepancies between the current findings and

those from eye movement studies suggest it may be profitable for future research to investigate the role of imagery in the direct and generative retrieval of emotional memories. Future research is also required to establish the role of visual imagery in populations in whom AM retrieval is impaired.

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