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

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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 imageability cues, but did not affect retrieval times. In Experiment 2, irrelevant pictures reduced the number of specific memories but only in response to low imageability cues. Irrelevant pictures also increased response times to both high and low imageability cues. The findings are in line with previous work suggesting that disrupting executive resources may impair generative, but not direct, retrieval of autobiographical memories. In contrast, visual distractor tasks appear to impair access to specific autobiographical memories via both the direct and generative retrieval routes, thereby highlighting the potential role of visual imagery in both pathways.

Keywords: autobiographical memory; visual imagery; visual working memory; dual task paradigm.

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1. Introduction

Autobiographical memory 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), autobiographical memories 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). The ability to retrieve specific memories also acts as a protective factor against mood disorders such as depression (Williams et al., 2007) and dysphoria (Anderson, Goddard, & Powell, 2010).

According to Conway and Pleydell-Pearce's (2000) hierarchical model, specific autobiographical memories 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, to event specific knowledge. In contrast, direct retrieval is a non-effortful process involving spontaneous activation of event specific knowledge. Support for this distinction comes from findings that the manner in which autobiographical memories are retrieved depends on the nature of the retrieval cues. For example, Addis, Knapp, Roberts, and Schacter (2012) found that participants relied mainly on generative retrieval when asked to retrieve autobiographical memories in response to generic verbal cues. However, when the cues were personalised to match specific autobiographical memories collected in a pre-test, participants were more likely to exhibit direct retrieval. Addis et al. also found differences in neural activity in response to generic and personalised cues, whereby generic cues recruited brain regions associated with search processes and the retrieval of generic autobiographical information.

A defining characteristic of specific autobiographical memories 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 autobiographical memories were rated as more vivid than semantic facts. More recently, Rubin, Schrauf, and Greenberg (2003) found that ratings of visual imagery were the strongest predictor of the sense of *reliving* an AM. In a behavioural study, Kavanagh, Freese, Andrade, and May (2001) demonstrated that concurrent eye movements reduce the vividness and emotionality of emotionally negative memories. Damage to brain regions involved in the processing of visual imagery has also been shown to impair autobiographical memory retrieval (Conway & Fthenaki, 2000; Greenberg & Rubin, 2003). More generally, in the source monitoring framework (see Johnson, Hashtroudi, & Lindsay, 1993), the presence of perceptual detail is one of the cues that allows an individual to distinguish real from imagined events.

The role of visual imagery in autobiographical memory is further illustrated by findings that the imageability of retrieval cues influences the manner in which autobiographical memories are retrieved. For instance, Williams, Healy, and Ellis

(1999) found that high imageability cues led to faster retrieval and more specific memories than low imageability cues or cues related to other sensory modalities. They concluded from this that high imageability cues facilitate the direct retrieval route by automatically activating multimodal representations of past events. In contrast, low imageability cues do not activate such representations and instead lead to a generative and effortful search. More recently, Uzer, Lee, and Brown (2012) found that object cues (e.g., *pencil*, *radio*) were associated with faster retrieval times than emotion cues (e.g., *bored*, *happy*). Based on findings from three experiments, Uzer et al. concluded that direct retrieval is faster than generative retrieval and that object cues are more likely than emotion cues to initiate direct retrieval.

The studies discussed above suggest that high imageability and low imageability cues elicit direct and generative retrieval, respectively. However, if sensory-perceptual information is a key feature of specific memories then it is likely that such memories will feature visual imagery regardless of how they are retrieved. 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 autobiographical memories. In the two experiments reported below, we investigated the role of visual working memory (Baddeley & Hitch, 1974, Logie, 1995) on the direct and generative retrieval of specific autobiographical memories. In order to achieve this, we used a dual task paradigm in which participants retrieved autobiographical memories either with full attention or whilst completing a secondary task chosen to recruit imagery-based processes.

Two previous studies have used a dual task paradigm to investigate the relationship between working memory and the retrieval of specific autobiographical memories. Williams et al. (2006) found that retrieval of specific memories was impaired by a concurrent task of random button pressing when cues were low imageability, but not when cues were high imageability. More recently, Anderson, Dewhurst, and Nash (2012) found similar interference effects using the concurrent task of random number generation (RNG). In terms of the hierarchical model of autobiographical memory proposed by Conway and Pleydell-Pearce (2000), these findings suggest that concurrent tasks interfere with the generative retrieval but not direct retrieval. However, the tasks used in these studies were ones that typically recruit executive resources. It is impossible to determine whether the effects observed were due to interference with imagery or with more general executive processes. The question addressed in the current studies, therefore, is whether visual working memory processes are important for the retrieval of specific autobiographical memories via both direct and generative retrieval pathways. Akin to previous research (Anderson et al., 2012; Williams et al., 2006), we used a dual task paradigm that required participants to retrieve specific autobiographical memories in response to high imageability and low imageability 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 working memory processes; irrelevant pictures and dynamic visual noise (DVN).

The irrelevant pictures task was developed by Logie (1986) and involves the presentation of line drawings of common objects. Logie found that the concurrent presentation of such drawings interfered with the use of a visual mnemonic to learn lists of concrete words. Based on these findings, Logie proposed that pictures have obligatory access to the visual-spatial sketchpad component of working memory 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 memory for visual textures that cannot be verbally recoded (Dean, Dewhurst, & Whittaker, 2008). The claim that DVN interferes selectively with visual processes, rather than executive processes, was also supported by the findings of Dean, Dewhurst, Morris, and Whittaker (2005) that DVN interfered with symbolic distance judgements involving visual comparisons, such as animal size, but not judgements involving semantic comparisons, such as animal ferocity or the relative "goodness" of words (see Friedman, 1978).

We report two experiments in which participants were cued to retrieve specific autobiographical memories 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 autobiographical memories, 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 autobiographical memories to both high imageability and low imageability 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 autobiographical memories are cued by low imageability, rather than high imageability, 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 details that characterise specific memories (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 in which working memory 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.

1. Experiment 1

2.1. Method

2.1.1 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).

2.1.2. Design.

A 2x2 within-subjects design was employed, with independent variables of cue type (high imageability vs. low imageability) 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).

2.1.2. Materials & Procedure

2.1.2.1. Stimuli

Ten high imageability nouns (e.g. mountain, rainbow) and 10 low imageability 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 high imageability cues and 342 and 364 for the low imageability cues. Allocation of the two lists to the DVN and control conditions was counterbalanced.

2.1.2.2. Dynamic Visual Noise (DVN)

The DVN comprised 640 x 480 pixels filled with an equal number of black and white squares of 4x4 pixel dimensions. When displayed on screen the DVN measured 36cm x 27cm. The rate of change of the DVN was 52.5% per second. Over the course of 1s half of the black dots changed to white and half of the white dots to black in order to maintain an equal balance of black and white. This gave an appearance of continuous change. Participants were instructed to fixate on the DVN display until they retrieved a specific memory.

2.1.2.3. Autobiographical Memory Test (AMT)

The AMT (Williams and Broadbent, 1986) requires participants to retrieve specific autobiographical memories as quickly as possible in response to cue words. Participants received the following instructions:

You will see a number of words one at a time on the screen. For each one I want you to remember an event that the word reminds you of. The event may be trivial or important, but it must be a specific event that occurred on one particular day in the past. For example, in response to the word "party" you could respond with "going to a party last Monday in the Student Union". I will be measuring the time it takes you to think of something, so try to think of something as quickly as possible. When you have remembered an event say "stop" and then tell me about the event.

2.1.2.4. Procedure.

Each trial consisted of a 10s period during which the participant attended to the concurrent task (the screen remained blank in the control condition), after which a cue word was presented centrally in the DVN field, in 50-point black text within a white textbox, for 5s. The participant continued to attend to the concurrent task until they retrieved a specific memory, at which point the experimenter paused the powerpoint presentation. 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?" and restarted the presentation. All responses were audio-recorded and transcribed verbatim. Participants were given 60 s to respond to each cue before proceeding with the next trial. When a response constituted a specific event, the presentation was paused and 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 have 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 high imageability and low imageability 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. This procedure was based on previous research investigating the effects of divided attention on autobiographical memory retrieval (e.g., Anderson et al., 2012; Goddard, Dritschel, & Burton, 1996, 1998).

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).

2.2. Results

2.2.1. Retrieval Latencies.

A 2x2 repeated measures ANOVA compared the effects of cue type (high imageability vs. low imageability) 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 low imageability, compared with high imageability, 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, $F(1,22) = 0.07$, $p = .79$, $\eta_p^2 = .003$.

2.2.2. 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 low imageability, compared with high imageability, cues. Furthermore, DVN significantly reduced the number of specific first responses in comparison to trials with no concurrent task. The interaction was not significant, $F(1,22) = 1.14$, $p = .30$, $\eta_p^2 = .05$.

2.2.3. 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 low imageability, compared with high imageability, 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 ($Fs \leq 1.72$, $ps \geq .20$, $\eta_p^2s \leq .07$).

2.2.4. 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 high imageability, compared with low imageability, 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 ($Fs \leq 3.68$, $ps \geq .07$, $\eta_p^2s \leq .14$).

2.2.5. 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 high imageability cues were older compared with those evoked by low imageability 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.

2.3. Discussion

The main finding from Experiment 1 is that DVN disrupted the retrieval of specific autobiographical memories 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 autobiographical memories, regardless of how they are retrieved. Experiment 2 investigated whether the retrieval of specific autobiographical memories is also disrupted by the concurrent presentation of irrelevant pictures, a task previously shown to interfere with visual working memory (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 high imageability and low imageability cues but with a greater effect in response to low imageability cues.

3. Experiment 2

3.1. Method

The Method was the same as Experiment 1 with the following modifications: A new group of 24 undergraduate students (23 female), in the age range 18-25 years (*M*=19.63, *SD*=1.97), were recruited. The design and materials were the same as Experiment 1 except that the distractor 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). The pictures varied in size but were presented centrally within a frame measuring 36cm x 27cm at a rate of 1 per second. 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. No picture occurred more than once within each trial. Each trial began with a 10s period during which the participant attended to the concurrent task (with a blank screen in the control condition), after which a cue word was presented centrally on the screen for 5s. Participants were instructed to fixate the display until they retrieved a specific memory. In the irrelevant pictures condition, the picture presentation continued until participants indicated that they had retrieved a specific memory, at which point the experimenter paused the presentation.

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).

3.2. Results

3.2.1. Retrieval latencies

A 2x2 repeated measures ANOVA compared the effects of cue type (high imageability vs. low imageability) 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 low imageability, compared with high imageability, cues and in the presence of a concurrent task. The interaction effect was not significant, $F(1,23) = 0.01$, $p = .91$, $\eta_p^2 = .001$.

3.2.2. 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 low imageability, compared with high imageability, 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 low imageability ($p < .001$) compared with high imageability cues ($p = .05$).

3.2.3. 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 low imageability, compared with high imageability, 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 low imageability ($p < .001$) compared with high imageability, 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 low imageability ($p = .001$), but not high imageability ($p = .12$), 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.

3.2.4. 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, $F(1,20) = 5.03$, $p = .04$, $\eta_p^2 = .20$. High imageability, compared with low imageability, 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 ≤ 3.99, ps $\leq .06$, η_p^2s $\leq .17$).

3.2.5. 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 high imageability cues were older than those evoked by low imageability 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.

3.3. 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 autobiographical memory retrieval. Consistent with Experiment 1, latencies to retrieve specific memories were longer in response to low imageability than to high imageability 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 low imageability 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 low imageability, compared with high imageability, cues. These findings indicate that the effects of visual interference are independent of the effects of executive interference.

4. General Discussion

Whereas previous research has highlighted the role of visual imagery within the direct retrieval of specific autobiographical memories, 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 autobiographical memories suggests that visual imagery should also play an important role within the generative retrieval pathway. The present research was predicated on findings that direct and generative retrieval are facilitated by high imageability and low imageability cues, respectively. 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 working memory 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 low imageability. 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 high imageability or low imageability 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 working memory impairs participants' ability to distinguish between specific and non-specific memories; 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 autobiographical memories in response to both high imageability and low imageability cues. If irrelevant pictures only interfered with executive resources then we would expect to see this effect only in the low imageability cues. It is possible that irrelevant pictures provide competing visual 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 autobiographical memories retrieved. Contrary to our hypotheses, we did not find that compromising visual working memory 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 autobiographical memories with the highest levels of episodic detail can overcome the visual distractor. These findings contradict previous work using eye movement to compromise visual working memory; these suggested that disrupting visual working memory 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.

The finding from the current study that visual interference tasks such as DVN disrupt the use of imagery in autobiographical memory has potential clinical relevance. For example, negative visual imagery is associated with a number of clinical disorders (see Pearson, Naselaris, Holmes, & Kosslyn, 2015, for a recent review). As discussed by Pearson et al., the frequency of intrusive negative imagery can be reduced by therapeutic techniques that inhibit the generation of imagery, such as eye movement desensitization (van den Hout et al., 2012) and the computer game Tetris (Holmes, James, Kilford, & Deeprose, 2010). The current findings suggest that DVN might serve as a clinical intervention to reduce the imagery associated with the retrieval of negative events. Support for a therapeutic role of DVN come from studies showing that DVN can reduce cravings associated with cigarettes (May, Andrade, Panabokke, & Kavanagh, 2010) and food (e.g., Steel, Kemps, & Tiggemann, 2006).

An unanticipated finding from the current study is that the memories retrieved in response to high imageability cues were, on average, older than those retrieved in response to low imageability cues. This pattern was reliably observed in both Experiment 1 and Experiment 2. If, as suggested by previous research (e.g., Uzer et al., 2012; Williams et al., 1999), high imageability cues lead to direct retrieval, the observed pattern would suggest that directly retrieved autobiographical memories are typically older than autobiographical memories retrieved via the generative pathway. One possible explanation for this effect could be that generative retrieval involves a backwards temporal search. Consider, for example, a participant who is presented with the cue word “greed”. A directly retrieved memory would likely be of an important or self-defining event that may have occurred in the recent or more distant past. If, however, an autobiographical memory is not retrieved directly, the participant might initiate a generative search by attempting to remember the last time they were greedy. Such a search would lead to the retrieval of the most recent memory associated with the cue word. Although this explanation is speculative, the consistent effects of cue type on the age of the memories retrieved suggest that this issue warrants further investigation.

To conclude, the current findings are the first to show that visual imagery is important within both direct and generative retrieval of specific autobiographical memories. 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 autobiographical memory retrieval is impaired.

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