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What versus where: Investigating how autobiographical memory retrieval differs when accessed with thematic versus spatial information

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ABSTRACT

Autobiographical memory research has investigated how cueing distinct aspects of a past event can trigger different recollective experiences. This research has stimulated theories about how autobiographical knowledge is accessed and organized. Here, we test the idea that thematic information organizes multiple autobiographical events whereas spatial information organizes individual past episodes by investigating how retrieval guided by these two forms of information differs. We used a novel autobiographical fluency task in which participants accessed multiple memory exemplars to event theme and spatial (location) cues followed by a narrative description task in which they described the memories generated to these cues. Participants recalled significantly more memory exemplars to event theme than to spatial cues; however, spatial cues prompted faster access to past memories. Results from the narrative description task revealed that memories retrieved via event theme cues compared to spatial cues had a higher number of overall details, but those recalled to the spatial cues were recollected with a greater concentration on episodic details than those retrieved via event theme cues. These results provide evidence that thematic information organizes and integrates multiple memories whereas spatial information prompts the retrieval of specific episodic content from a past event.

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There are many different ways we can be reminded of an autobiographical memory. The activities we engage in and the environment around us can both serve as reminders of past experiences. For example, attending a birthday celebration or having coffee in a local café can lead to recollections of comparable past festivities or events that took place in a similar location. In the present study, we investigated the distinctions between memories that are recalled to these different reminder cues. The underlying theme of this investigation is that remembering the past is a reconstructive process that is influenced by how a memory is accessed (Addis, Pan, Vu, Laiser, & Schacter, 2009; Hassabis & Maguire, 2007; Schacter, Norman, & Koutstaal, 1998; Sheldon & Levine, 2016). Thus, characterizing how memories are accessed by different retrieval cues can provide insight into the way autobiographical knowledge is structured and organized.

Autobiographical memory organization

A prominent model of autobiographical memory is that it is organized in a hierarchy, from general event information to specific episodic memories, which are context-specific past personal events (Conway, 2000; Conway & Pleydell-Pearce, 2000; Tulving, 2002). This model proposes three distinct levels of autobiographical knowledge representation: lifetime periods, general events, and event-specific knowledge. Lifetime periods consist of our thematic knowledge of a period in our lives (e.g., "when I completed my undergraduate degree"), general events represent memories by an overall theme (e.g.,

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"romantic relationships"), and event-specific knowledge is the sensory and perceptual details associated with a single past event. Evidence for this form of organization comes from work with clinical populations, such as individuals with depression (Dalgleish et al., 2007; Williams & Broadbent, 1986). A typical finding is that patients with depression are more likely to access general event memories in response to retrieval cues than are healthy control participants. This finding has been taken as evidence that memory is organized hierarchically and that people with depression terminate memory access at an earlier stage than people without depression (e.g., Haque, Juliana, Khan, & Hasking, 2014).

Although there may be multiple forms of information that can organize our memories (for example, see Barsalou, 1988), early behavioural work has suggested a primary role for event activities or themes in structuring overall autobiographical knowledge (for a classic read, see Schank & Abelson, 1977). For example, one study found evidence that event activities (e.g., shopping) compared to event actions (e.g., paying at a register) were better organizers of autobiographical information (Reiser, Black, & Abelson, 1985). There is also more recent evidence that event themes provide a broad framework for memory organization (e.g., Zacks & Tversky, 2001). For example, using a diary method to investigate how people organize life events, Burt, Kemp, and Conway (2003) found that people used event themes to index past episodes and to relate together a set of similar experiences from their lives. Another study found that thematic information was important for representing cohesive autobiographical episodes and framing these episodes within a larger lifetime context (D'Argembeau & Demblon, 2012).

A parallel line of memory research has focused on the role of spatial information in accessing autobiographical events (Andrews-Hanna, Reidler, Sepulcre, Poulin, & Buckner, 2010; Burgess, Maguire, & O'Keefe, 2002; Maguire & Mullally, 2013). Among these studies are those that have tested how effective spatial locations are at cueing specific episodic memories in comparison to other cues, like activities or people (Horner & Burgess, 2013; McLelland, Devitt, Schacter, & Addis, 2015). For example, Arnold, McDermott, & Szpunar (2011) gave location and activity cues that varied in familiarity to participants and asked them to imagine a related autobiographical event. They found that events cued by familiar locations were rated as clearer and easier to imagine than those cued by unfamiliar places or activities. More recently, Robin, Wynn, and Moscovitch (2016) used spatial locations and names of people as retrieval cues for encoded fictitious events. Even when participants were cued to remember these events with a person cue, they would spontaneously add spatial location information to their recollections. These findings suggest that spatial information is an important element for accessing specific past events.

Functionally distinct memory retrieval networks

Memory research has been increasingly interested in the neural mechanisms that support different forms of memory access, focusing on how the medial temporal lobes (MTL) are recruited during memory-guided behaviour (Ranganath & Ritchey, 2012; Ritchey, Libby, & Ranganath, 2015; Sheldon & Levine, 2016). One theory is that there are separate anterior and posterior MTL systems for memory retrieval, which is guided by conceptual (i.e., thematic) versus spatial information (Ranganath & Ritchey, 2012; Ritchey et al., 2015). Specifically, there is an anterior MTL memory system that represents retrieving and integrating past memories with existing semantic or conceptual information (e.g., knowing that your friend's name is Alan). In contrast, the posterior MTL memory system is thought to support contextually guided retrieval, binding together elements of a memory to an environment or spatial location (e.g., recalling visiting the coffee shop next door with Alan). We recently proposed a similar framework that suggests that anterior and posterior hippocampal contributions to remembering are driven by thematic and spatially guided memory (Sheldon & Levine, 2016). This framework is based on anatomical and functional differences along the long axis of the hippocampus (Poppenk, Evensmoen, Moscovitch, & Nadel, 2013; Sheldon & Levine, 2013; Strange, Witter, Lein, & Moser, 2014). The anterior hippocampus is proposed to support memory retrieval that is oriented around a broader conceptual or thematic "node", and the posterior hippocampus supports accessing memories that are oriented around a more specific perceptual or spatial contextual "node" (Sheldon & Levine, 2016). Interpreting the above-cited behavioural work with this framework, we suggest that event theme information is related to memory representations with the conceptual hippocampal/MTL

network whereas event spatial information is related to memory representations with the contextual hippocampal/MTL network.

The current study

The aim of the current study was to directly contrast event theme and spatially cued memory-guided behaviour. To do so, we created a new experimental procedure that simultaneously examined the effects of event theme and spatial cues to two aspects of memory retrieval: the ability to access memories from one's autobiographical knowledge structure and the ability to elaborate on the details of a memory. We incorporated an autobiographical memory fluency task to measure the ability to generate, search, and retrieve memories (Dritschel, Williams, Baddeley, & Nimmo-Smith, 1992; Parker, Parkin, & Dagnall, 2013; Piolino, Desgranges, Benali, & Eustache, 2002; Rathbone & Moulin, 2014) and a memory narrative task in which participants describe in detail past personal events and measured the ability to richly recollect these events (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; for examples see Addis, Wong, & Schacter, 2008; Rosenbaum et al., 2011; Sheldon, McAndrews, & Moscovitch, 2011; St-Laurent, Moscovitch, Levine, & McAndrews, 2009). This design allowed us to directly compare the effectiveness of event theme versus spatial cues for accessing memories and elaborating on the details of past personal episodes.

We also incorporated a method to investigate the impact of *when* a memory is accessed on the way it is recalled. During the narrative task, we asked participants to describe both the first and last memories that were generated during the fluency task (i.e., the memory that first came to mind and the final memory that was mentioned) and contrasted the specificity with which these memories were retrieved. The interest in this comparison is based on reports that the way MTL-mediated memory processes are involved in information access is dependent on when an item is generated, with more prominent exemplars generated earlier on in retrieval (Sheldon & Moscovitch, 2012). Although this idea has not been tested with autobiographical memory, there are studies that have compared differences in autobiographical recall for memories that are accessed directly versus those that are recalled with more effort, which are akin to those that are first and later accessed to a given cue (Addis, Knapp, Roberts, & Schacter, 2012; Harris, O'Connor, & Sutton, 2015; Rubin & Berntsen, 2009; Uzer, Lee, & Brown, 2012). A common finding is that directly accessed memories (i.e., earlier generated items) are remembered more clearly than memories accessed with effortful generation (Harris et al., 2015), such as those later generated items in our experimental design.

In summary, the main aim of our study was to test two predictions regarding how memories are accessed and retrieved to event theme and spatial information. First, if autobiographical knowledge is organized hierarchically with thematic information higher up in this hierarchy, event theme cues will lead to a greater fluency of autobiographical events than spatial memory cues (Barsalou, 1988; Lancaster & Barsalou, 1997). Second, if spatial context is important for accessing specific details of a past memory, then memories cued by spatial information will be accessed more quickly and recalled with more specific details (i.e., episodic content) than those accessed via event theme information.

Experimental Study

Method

Participants

Thirty-eight young adults completed the study. The participants either were recruited through McGill University's psychology participant pool or responded to an online advertisement. Participants were included in the study if they (a) were free from any neurological or psychiatric conditions, (b) spoke fluent English, and (c) had normal or corrected vision. Three participants were excluded for not meeting these criteria, and thus the analysed sample included 35 participants (28 females and 7 males, mean age = 21.4 years, $SE = 0.38$, range = 18–29 years; mean years of education = 15.5, $SE = 0.39$, range = 12–23 years). All participants provided informed consent prior to the study and were treated according to the code of ethics established by the ethics review board at McGill University. Participants were compensated for their time with either course credit or payment of $10 an hour.

Stimuli

Eight event theme and eight spatial word cues were created based on information from prior autobiographical memory research (Levine et al., 2002) and by the authors. These cues were designed to represent event activities/themes and locations that were familiar to the participants (Table 1).

Table 1. Event theme and spatial location cues used in the autobiographical fluency task.

Event theme	Spatial location
Accomplishments	Concert venue
Social outings	Market
Romantic experiences	Park
Travelling	Mall
Memorable meals	Coffee shop
Holiday celebrations	Kitchen
Getting or giving a gift	Classroom
Work or school tasks	Waiting room

Procedure

The experimental design included two tasks, the autobiographical fluency task and memory description/narrative task, which were administered to the participants in the same session (Figure 1).

Autobiographical fluency task. The 16 cues were presented in a randomized order on a computer screen, one at a time. Participants were instructed to generate as many past personal memories as they could in 90 s. Prior to the task, participants were trained on the meaning of a specific memory and were instructed that these memories had to meet the following three criteria: (a) It was a remembered event that happened to the participant and not someone else; (b) the remembered event was not a mix of multiple memories and was specific to a time and place; (c) the participant could recall when and where the event happened.

During the 90-second fluency period, participants pressed "1" on the keyboard each time a memory was generated, thus establishing an estimate of the time to produce each memory. They also verbally reported a short description of each memory, which was recorded by the experimenter via an electronic audio recording device. If a participant forgot to press "1", the experimenter reviewed the audio recording of the session to time-stamp each memory.

After the participant completed the fluency task for all 16 cues, the researcher read back each generated memory, and the participant estimated the age of the memory, in months or years, and rated how vividly they could recollect the memory on a scale of 1 to 5.

Autobiographical fluency scoring. First, the total number of memories generated to each cue across the 90-s retrieval period was tallied and then averaged for each cue condition (event theme and spatial). Next, we calculated how these responses were generated across the retrieval period by dividing the 90-s time period into six 15-s sections (i.e., time bins) and we calculatied the proportion of the total responses that were made in each time bin. Finally, all of the short memory descriptions were scored using the Autobiographical Memory Test scoring procedure (Williams & Broadbent, 1986). Using this procedure, descriptions were classified as:

1. A specific memory (correct response): a description of an event that occurred at a particular time and place, lasting less than one day (e.g., "Attending a symphony at the local concert hall").
2. An extended event (incorrect response): a description of an event that lasted more than a day (e.g., "Travelling to Paris").
3. A repeated event (incorrect response): a description of an event that took place on multiple occasions (e.g., "Family dinner every Sunday").
4. A semantic memory (incorrect response): A description that contained only factual information (e.g., "I am from New Jersey").

Autobiographical memory description task. Following the autobiographical fluency task, participants completed a modified version of the Autobiographical Interview (AI; Levine et al., 2002). Participants were asked to describe in detail the first and last memories that they generated to the two spatial and two event theme cues that had the greatest number of items generated. If one of these first and last responses was not a specific memory (i.e., a correct response), then the next generated memory was chosen for the description task. If that memory was also not specific, then memories from the cue that had the next greatest number of generated items was selected. These steps were applied to 14 trials across all participants.

Participants were read back their brief memory description from the fluency task and were asked to describe in as much detail as possible the content of their memory. They were given up to three minutes to freely recall these details. These descriptions were audio recorded and later transcribed for scoring.

Autobiographical memory description scoring. The standardized scoring procedure of the AI (Levine et al., 2002) was applied to the memory descriptions. The descriptions were segmented into details: distinct pieces of information that relayed an occurrence, thought, or observation, often expressed as a phrase

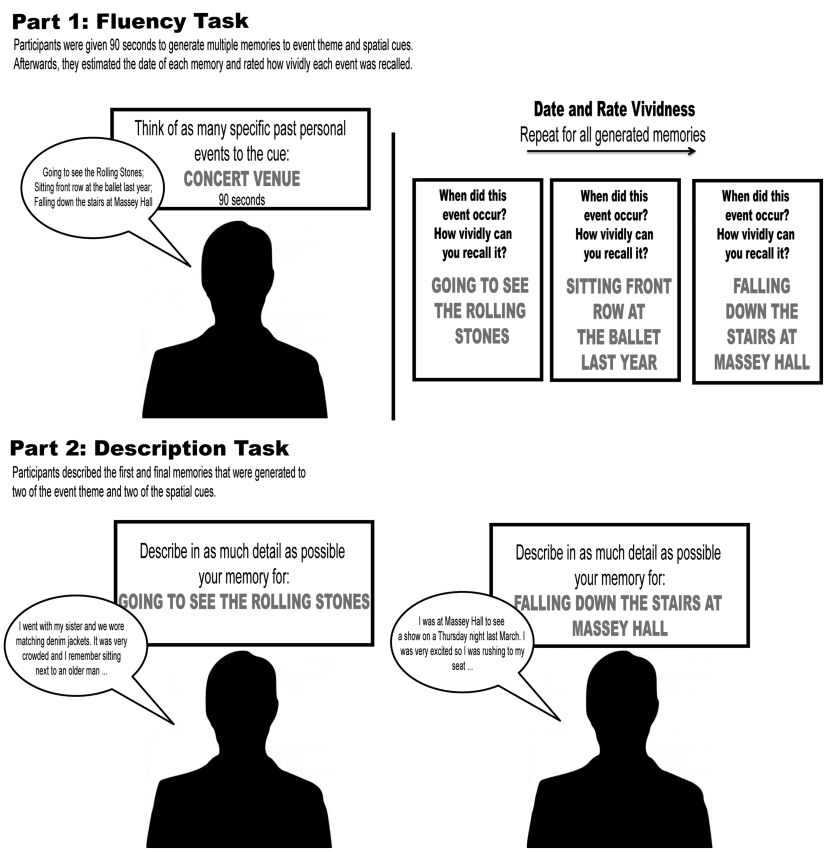

Figure 1. A depiction of the experimental procedure that incorporated an autobiographical fluency task (top row) followed by a memory description task (bottom row). In this figure, the bolded red phrases illustrate an example of a cue (upper left) and example memories generated in response to that cue. To view this figure in colour, please visit the online version of this Journal.

or expression. These details were classified as internal or external. Internal details are pieces of information that pertain to the main event described and are specific to the spatial and temporal context (e.g., "I sat next to Alan at dinner"; "I was wearing a blue shirt"). The number of internal details is a main measure for the use of episodic memory processes for recollection. External details are event details that are tangential to the main event as well as details from a related event, and personal semantic, factual, or metacognitive statements (e.g., "I have never liked sweet potatoes"; "I always make time for my family"; "This is a fond memory"). The number of external details measures the contribution of non-episodic memory processes to recollection.

For each participant, the number of internal and external details was averaged for each cue condition. To obtain an index of the preference for using internal details when describing an event at the level of the memory (i.e., not averaging across cue condition), we calculated the proportion of the total details that were internal details (number of internal details/number of total details) for each memory and then took the average of this number for each cue condition. This measurement gives an indication of the concentration on episodic content during autobiographical recall.

Results

Autobiographical fluency task

Average number of generated memories. Comparing the overall number of memories accessed in each cue condition, participants generated a greater number to event theme cues ($M = 7.3$; $SE = 0.49$) than to spatial cues ($M = 6.4$; $SE = 0.42$), $F(1, 31) = 25.22$, $MSE = 0.45$, $p < .001$; $\eta_p^2 = .45$.

Average rating of vividness. There was also a difference between the cue conditions when we compared

the average vividness rating of all the memories recalled to each cue type, $F(1, 31) = 4.56$, $MSE = 0.19$, $p = .04$, $\eta_p^2 = .13$. Overall, memories generated to the event theme cues (4.2, $SE = 0.1$) were rated as slightly more vivid than memories generated to the spatial cues (3.9, $SE = 0.1$).

Ratings of memory vividness may index different variables under different forms of access, measuring the availability of multiple traces of a memory or the ease with which an image is evoked (e.g., D'Angiulli et al., 2013). Thus, to determine whether the above-reported difference in vividness was driven by how memories were accessed in each cue condition, we calculated the Pearson's correlations between average vividness ratings and the average number of generated memories for the event theme and spatial cue conditions. We found that the average vividness rating was negatively correlated to the number of memories generated to spatial cues ($r = -.43$, $p = .02$) but was not correlated at all to the number of generated memories to the event cues ($r = .02$, $p = .92$). In other words, memories were recalled more vividly when fewer events were recalled during spatially guided retrieval.

Average memory age. There was no difference in the average age of the memories generated to the event theme and spatial cues, $F(1, 31) = 3.06$, $MSE = 315{,}959$, $p = .09$; $\eta_p^2 = .09$, although there was a trend towards memories generated to the event theme cues being rated as more recent (909 days, $SE = 128$) than towards those generated to the spatial cues (1155 days, $SE = 161$).

Average number of specific and non-specific memories. As noted in our methods, each memory description from the fluency task was scored according to the Autobiographical Memory Test (AMT) scoring protocol and classified as one of three event types (specific events, extended events, repeated events) or as a semantic response (not an event, but a factual statement). Specific events represent correct responses on the fluency task. When the average number of specific events was compared between the two cue conditions, the same above-reported difference resulted such that event theme cues resulted in a higher number of specific memories generated than for spatial cues (event theme = 6.3, $SE = 0.46$, spatial cues = 4.6, $SE = 0.32$), $F(1, 31) = 27.91$, $MSE = 1.54$, $p < .001$, $\eta_p^2 = .47$.

We compared the number of non-specific events (i.e., incorrect responses) that were generated in each cue condition as an indicator of possible differences in how autobiographical information was accessed during these two forms of retrieval. Given that there were differences in overall output between the two conditions, we compared the average percentage of memories that belonged to each of the AMT categories (specific, repeated, extended, semantic). A cue condition (2) by memory type (4) repeated measures analysis of variance (ANOVA) analysis revealed that memory type, $F(3, 31) = 666.99$, $MSE = 0.015$, $p < .001$, $\eta_p^2 = .96$, and the interaction between cue condition and memory type were both significant, $F(3, 93) = 13.94$, $MSE = 0.004$, $p < .001$, $\eta_p^2 = .31$. Post hoc comparisons showed that there was no difference in the average percentage of specific memories between the event theme and spatial cues (84%, $SE = 3\%$, and 83%, $SE = 2\%$, to spatial and event theme cues, respectively), $t(31) = 0.38$, $p = .71$, suggesting that participants were equally likely to generate a specific memory in each condition (although the *number* of specific memories differed, as reported above). The significant interaction effect was driven by differences in the percentage of responses that were non-specific memories (i.e., the remaining 15%). Participants were more likely to generate extended memories to event theme cues ($M = 10\%$, $SE = 1.3\%$) than to spatial cues ($M = 1.6\%$, $SE = 0.7\%$), $t(31) = 6.35$, $p < .001$, but were more likely to generate repeated memories for spatial cues ($M = 11\%$, $SE = 1.8\%$) than for event theme cues ($M = 4\%$, $SE = 1.1\%$), $t(31) = 4.23$, $p < .001$ (Figure 2). There was no difference in the percentage of memories classified as semantic (spatial: $M = 3.6\%$,

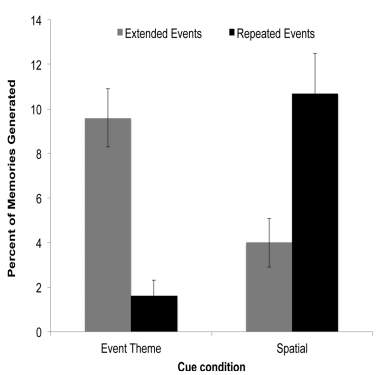

Figure 2. The percent of extended and repeated memories (scored according to the Autobiographical Memory Test procedure, Williams & Broadbent, 1986) that were generated to the event theme and spatial cues for the autobiographical fluency task. Error bars represent standard error of the mean.

SE = 0.9%, event theme cues: *M* = 3%, *SE* = 0.6%), *t*(31) = 0.67, *p* < .51).

Response time to generate memories. To examine the distribution of responding over time, we calculated the number of memories generated in 15-second epochs of the fluency task. This time bin analysis method has been used to analyse fluency performance in various populations (e.g., Friesen, Luo, Luk, & Bialystok, 2015; Rohrer, Wixted, Salmon, & Butters, 1995; Schweizer, Alexander, Susan Gillingham, Cusimano, & Stuss, 2010). We focused our analysis on these first two time bins (0–15 and 15–30) given that we were specifically interested in how memories were accessed at these early time periods. To control for overall differences in output between the conditions, we used the percentage of memories generated in these bins as our dependent variable.

A repeated measures ANOVA with condition (event theme versus spatial) and time bin (0–15 vs. 15–30 time bins) revealed no main effect of condition, $F(1, 31) = 1.46$, $MSE = 0.002$, $p = .24$, $\eta_p^2 = .05$, nor of time bin, $F(1, 31) = 2.78$, $MSE = 0.002$, $p = .10$, $\eta_p^2 = .08$, but a significant interaction between condition and time bin, $F(1, 31) = 4.68$, $MSE = 0.002$, $p = .04$, $\eta_p^2 = .13$. Upon further inspection, we found that a greater percentage of memories generated to the spatial cues were provided in the first time bin (0–15 s) than to the event theme cues (spatial cues: *M* = 24%, *SE* = 0.8%; event theme cues: *M* = 21%, *SE* = 1.1%), *t*(31) = 2.36, *p* = .02. The percentage of memories generated in the second time bin (15–30 s) did not significantly differ between conditions (spatial cues: *M* = 20%, *SE* = 0.8%; event theme cues: *M* = 21%, *SE* = 1.0%; *p* = .45).

To confirm this pattern, we compared the average response time to generate the first specific event memory in response to each cue. Given the high variability in response time across the participants and cues, we took two steps to reduce noise in our sample. First, we did not include the trials for the cue word *Travelling* because the majority of participants (18/32) did not generate a specific memory as their first response. Second, we removed any trial in which the response time was a significant outlier as defined as two standard deviations above the average reaction time (>21,000 ms). Given that the response times were non-normally distributed as determined by a Shapiro–Wilk test (spatial cues *p* = .003; event theme cues, *p* = .049), these scores were log transformed prior to comparison. A *t*-test on these transformed average response times to event theme and spatial cues revealed a significant difference, $t(31) = 2.25$, $p = .03$; $\eta_p^2 = .14$. The response time to generate the first memory to the spatial cues was significantly faster than the response time to generate the first memory to the event theme cues (Figure 3).

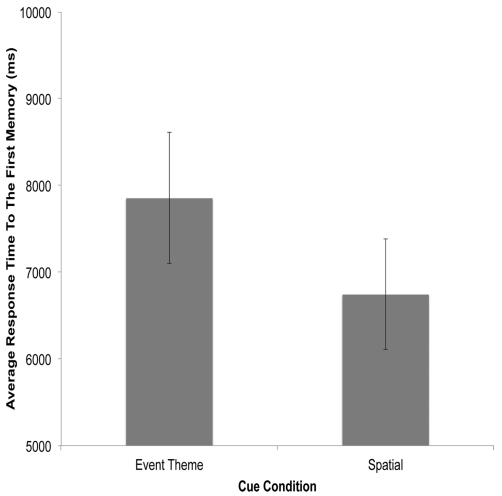

Figure 3. The average response time to generate the first memory during the autobiographical fluency task for event theme cues and spatial cues. Error bars represent the standard error of the mean.

Autobiographical memory description task

Average number of generated details. We first determined whether the cue condition and the order of the recalled memory affected the average number and type (i.e., internal and external) of details generated on the description task. We ran a repeated measures ANOVA on the average number of details with cue condition (event theme versus spatial), detail type (internal versus external), and order (first versus last) as within-subject factors. The three main effects (detail type, order, and condition) were all significant. The main effect of detail, $F(1, 31) = 100.81$, $MSE = 82.74$, $p < .001$, $\eta_p^2 = .77$, was driven by a higher number of internal details than external details generated for all memories (*M* = 21.2, *SE* = 1.2; *M* = 9.8, *SE* = 1.1, respectively). The main effect of order, $F(1, 31) = 5.06$, $MSE = 21.16$, $p = .02$, $\eta_p^2 = .16$, was driven by a higher number of details generated to the first than to the last accessed memory (*M* = 16.2, *SE* = 1.04; *M* = 14.8, *SE* = 0.97, respectively).

As directed by our study objective, our main interest was in the main effect of condition, $F(1, 31) = 8.28$, $MSE = 26.27$, $p = .007$, $\eta_p^2 = .2$. Post hoc comparisons

revealed that this main effect was due to greater number of details, irrespective of type, generated to the event theme ($M = 16.4$, $SE = 1.14$) than to the spatial cues ($M = 14.5$, $SE = 0.89$). We found a non-significant interaction effect between detail type and condition, $F(1, 31) = 0.41$, $MSE = 45.85$, $p = .53$, $\eta_p^2 = .013$, as well as a non-significant effect between condition, order, and detail, $F(1, 31) = 0.32$, $MSE = 23.29$, $p = .58$, $\eta_p^2 = .01$, which indicates that there was a greater average number of internal and external details for event theme than for the spatial cued memories. However, when we inspected the effect of condition on detail type by running pair-wise comparisons between the sum total of internal and external details generated to the memories for the event theme and spatial cue conditions, it appeared that the effect of cue condition was stronger for external details than for internal details [internal event theme ($M = 88.4$, $SE = 5.8$; spatial, $M = 80.1$, $SE = 4.9$) $t(31) = 1.60$, $p = .12$; external event theme ($M = 45.5$, $SE = 5.3$; spatial, $M = 33.0$, $SE = 3.9$), $t(31) = 3.00$, $p = .005$].

The above-reported repeated measures ANOVA also indicated a significant interaction between condition and order, $F(1, 31) = 6.26$, $MSE = 12.53$, $p = .02$, $\eta_p^2 = .17$. This interaction was further explored with pairwise comparisons that revealed that more details, irrespective of type, were generated to the first than to the last memories (first memory: $M = 32.3$, $SE = 2.08$; last memory: $M = 29.5$, $SE = 1.95$), but there was a greater number of total details generated for first-accessed memories to the event themes cues ($M = 35.3$, $SE = 2.58$) than for the last-accessed memories to the event themes cues ($M = 30.2$, $SE = 2.25$), $t(31) = 3.31$, $p = .002$. The total details generated did not significantly differ between first and last accessed memories to the spatial cues ($M = 29.36$, $SE = 1.90$; $M = 28.77$, $SE = 1.83$, respectively), $t(31) = 1.13$, $p = .27$ (Figure 4).

Proportion of internal details. The above analysis examined the average number of internal and external details generated across memories for each participant. In other words, detail generation was examined at the level of the individual rather than the level of the memory. Such an approach may have obscured a preference for using one form of detail over another when describing a particular event. This is because averaging across memory description does not fully account for the variability in the total number of details generated for each description. Thus, to examine the preference for using episodic content (i.e., internal details) at the level of the memory, we calculated the ratio of internal to total details for each description and then averaged this ratio/proportion for each participant. This method of analysis has been used to measure "episodic specificity" in similar memory narratives (Lenton-Brym, Kurczek, Rosenbaum, & Sheldon, 2016). As illustrated

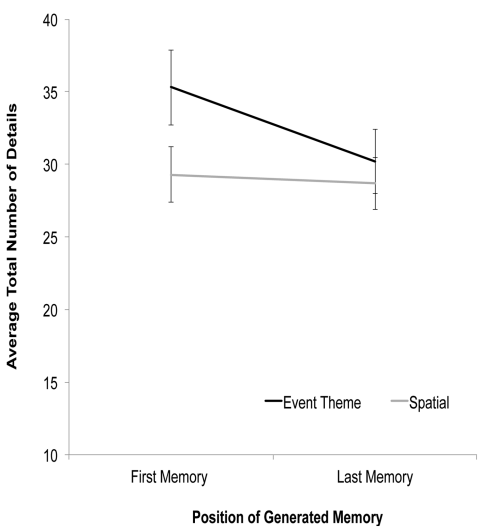

Figure 4. The average number of details (internal and external) given in the descriptions of the first and last memories generated in response to event theme and spatial cues. Error bars represent standard error of the mean.

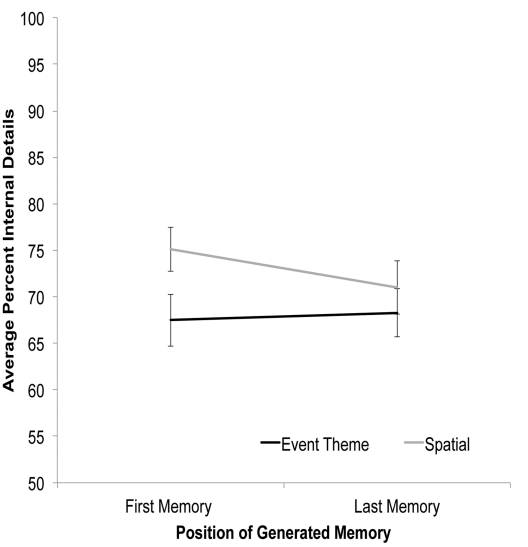

Figure 5. The average percent of details that were classified as internal in the descriptions of the first and last memories generated in response to event theme and spatial cues. Error bars represent standard error of the mean.

in Figure 5, there was a significant main effect of condition, $F(1, 31) = 5.14$, $MSE = 0.015$, $p = .03$, $\eta_p^2 = .14$, but no main effect of order, $F(1, 31) = 1.08$, $MSE = 0.01$, $p = .31$, $\eta_p^2 = .03$, nor an interaction between order and condition, $F(1, 31) = 0.41$, $MSE = 0.24$, $p = .11$, $\eta_p^2 = .08$. Pair-wise comparisons revealed that for both first and last memories generated, those recounted in the spatial cue condition were done so with a greater proportion of internal details ($M = 72.9\%$, $SE = 2.3\%$) than those generated in the event theme cue condition ($M = 67.9\%$; $SE = 2.5\%$); $t(31) = 2.27$, $p = .03$.

General discussion

In this study, we investigated how autobiographical memories were retrieved when cued by event theme and spatial location information in order to gain insight into the way autobiographical knowledge is organized as well as how retrieval circumstances affect memory access. We used an autobiographical fluency task to measure the number of memories generated in a 90-second time period to cues that were thematic (e.g., "family get-togethers") or spatial (e.g., "coffee shop") in nature. We then used a memory description task to measure how detailed the memories cued by these event themes and spatial locations were remembered. With these tasks, we tested two main hypotheses. First, if thematic information is a predominant element for organizing multiple autobiographical memories, then event theme cues will result in a greater number of generated events than will spatial cues on the fluency task. Second, if spatial information is associated with preferential and direct access to detailed past experiences, then spatially cued memories will be recovered more quickly and with greater episodic content than event-theme-cued memories. The differences we found in both memory quantity and quality between the two cue conditions are broadly in line with these hypotheses.

The quantity of generated memories

Our first main finding from the fluency task was that participants generated significantly more memories to event theme than to spatial location cues. This was true even when we analysed only the number of specific event memories generated, as categorized by the AMT scoring protocol (see Method). The ability to generate more memories in the event theme condition provides insight into how memory is organized (Mace, Clevinger, & Martin, 2010) and lends support for Conway's model of autobiographical knowledge (Conway & Pleydell-Pearce, 2000). In Conway's model, autobiographical events are nested within a broader system that involves themes and goals. Although there are multiple ways to organize autobiographical knowledge (Barsalou, 1988), we suggest that event theme organization is a reliable means to store multiple experienced episodes because themes can efficiently summarize an enormous amount of personal information. By virtue of the breadth of thematic information, themes can connect a number of diverse memories that may not otherwise be connected, thus attracting the fluent recall of event clusters that span different locations, time periods, and characters (Brown, 2005; Brown & Schopflocher, 1998).

We did not systematically distinguish between subtypes of event themes in our study, such as event theme activities (e.g., "holiday events") versus goal themes (e.g., "accomplishments"). We speculate that if we had done so we may have found some interesting differences. Specifically, we would predict that memories cued by goal event theme cues, such as "accomplishments" or "travelling", would activate memories that are linked to self-defining moments that expand widely across one's life. Memories cued by activity-related event themes, such as "holiday events" or "social outings" are potentially less goal oriented and more related to a life narrative. These cues may preferentially activate memories clustered around a specific period in one's personal timeline (i.e., a lifetime period).

We have discussed how participants generated more memories to event theme cues; however, we found that they were quicker to recall a past memory to the spatial location cues. This pattern was evident when we examined the proportion of memories generated in 15-second epochs, but also when we examined the response time to generate the first memory in each cue condition. This result is evidence that spatial location information provided direct access to autobiographical events.

Taken together, this cue-dependent dissociation (i.e., more memories to event theme cues; faster access for spatial cues) is reminiscent of the differences reported between generatively and directly retrieved memories, remembering with and without deliberate search (for some recent reports, see Berntsen & Hall, 2004; Hall et al., 2014; Harris et al., 2015; Mace, 2006). Direct memory retrieval is thought to rely on quick, bottom-up processes that are driven

by shared perceptual features between the memory cue and a recalled memory (Eade et al., 2006). For example, direct and vividly recalled memories are associated with activity in perceptual areas of the brain, such as the parietal and occipital cortices (e.g., Sheldon & Levine, 2013). Generative retrieval, on the other hand, relies on top-down processes and involves a strategic search through one's knowledge base, recruiting prefrontal and lateral temporal brain regions thought to be involved in strategic memory search (Addis et al., 2012). Applying the above-reported findings to our study, we suggest that the spatial location cues trigger memory access by first reinstating a given context in one's mind (e.g., a coffee shop) and activating bottom-up processes to recover memories that share these contextual features. This is why the initial memories generated in this cue condition were faster than those generated in the event theme cue condition. Event theme cues trigger memory access by reinstating a concept (e.g., travel) that relates to several diverse memories, activating a top-down guided search through one's autobiographical knowledge structure. This would explain why this search was initially slower but resulted in more generated memories. Although this interpretation is a promising explanation for why memory retrieval differed between the cue conditions, it is speculative and requires further investigation.

The quality of generated memories

To examine differences in quality of the memories accessed in the two cue conditions, we first used the AMT protocol to classify the brief descriptions of all the memories generated during the fluency task. For both cue conditions, participants generated specific memories on the majority of trials, indicating that participants were doing the task correctly. However, differences between the conditions emerged when we examined the proportion of responses that were non-specific event memories. Specifically, participants were more likely to generate non-specific extended events (e.g., "vacations") to event theme cues but non-specific repeated events (e.g., "going to Starbucks every morning") to spatial cues. Extended events cross both time and space (i.e., multiple time periods and spatial locations) whereas repeated events typically happen in the same spatial location but at different times. Based on this line of thought, we suggest that participants were using different retrieval strategies to access related memories in the cue conditions. For event theme cues, memories were accessed using broader means of retrieval than for those accessed via spatial cues.

We next examined memory quality by scoring the narratives that resulted from our memory description task using a well-validated scoring technique that classified the number and type of details present in the descriptions (Levine et al., 2002). In addition to examining how the cue condition affected the details used to describe memories, we also examined the difference in detail generation between memories that were accessed at different time periods of the fluency task, specifically the first and final generated memory during the 90-second retrieval period. This analysis revealed a significant main effect of when a memory was accessed such that the first memory was recalled with more detail, both internal and external, than the last memory generated for both cue conditions. Standard category fluency tasks (e.g., "animal names") are often associated with fluctuations in the type of items generated across a retrieval period. Initially generated items are often more prototypical or better exemplars of the category than later generated items. For example, for a category like "kitchen utensils", people will often generate "knife", "fork", and "spoon" early on in a fluency task. During later item generation periods, less prototypical items, such as "cherry pitter" or "garlic press", are then generated (Sheldon & Moscovitch, 2012). Here we show that autobiographical memories initially generated to a cue contained more details than those generated at later stages, which may suggest that autobiographical memory recall follows a similar retrieval trajectory.

Our main analysis of interest was to compare detail generation between memories accessed via event theme and spatial cues. We found that memories constructed to event theme cues contained, on average, more details (both internal and external) than those constructed to spatial cues, with this effect driven by a higher number of external details generated to theme-cued memories. As noted in our methods, analysing the average number of details to each cue condition may not have been sensitive enough to determine differences in how internal or external details were used to construct memories. This is because the number of details are averaged across memory descriptions and compared at the level of the participant. To investigate cue condition differences in the preference for using internal (episodic) details at the level of the memory, we examined the proportion of total details that were internal for each trial. This

provided us with a metric of the concentration on episodic content while accounting for variability in total detail generation. We found that spatially cued memories were recalled with a greater proportion of internal details than event-theme-cued memories, fitting with prior reports indicating a necessary role for spatial information in recalling episodically detailed events (e.g., Robin et al., 2016).

We summarize our assessment of the difference in the use of details for constructing event theme and spatially cued memories with two main points. First, our results suggest that event-theme-guided retrieval cues lead to memories that are reconstructed with a greater diversity of information, as indicated by a higher average number of total details generated in this condition than in the spatial cue condition. Given that this difference was most prominent for external details, a marker of using information extraneous to a remembered event or another past event for recollection, we speculate that theme-guided retrieval integrates information from related memories and semantic memory to support remembering. Second, our results suggest that spatially cued memories are recalled with a stronger focus on recovering the episodic content of a past event, as indicated by the higher proportion of internal details, probably due to the direct access to specific past events.

These points can also help explain the differences in the average vividness ratings from the autobiographical fluency task. Here, we found that vividness ratings negatively correlated with the number of memories generated for the spatial cue condition, but not the event cue condition. In other words, more vivid recollection resulted when fewer specific memories were recalled (i.e., a greater focus on particular episodes) when retrieval was guided by spatial details.

Considerations and conclusions

Memories are retrieved and constructed differently depending on the retrieval circumstance, and this reflects how memories are organized. Overall, our data support the idea that event themes help organize autobiographical knowledge and can be used to guide memory retrieval via a top-down conceptually guided search, integrating a diverse range of details when constructing past events. This formulation is in line with models that view thematic elements as a global organizational element of multiple memories (Conway & Pleydell-Pearce, 2000).

Our data also support the idea that spatial contextual information is important for organizing the retrieval of episodic information when recalling an experience, possibly by more direct access to memories (Lancaster & Barsalou, 1997). This follows the view that spatial information is an important element for retrieving the episodic content of a memory. Previous reports have indicated that familiar environments cue more richly experienced events than other memory elements (Arnold et al., 2011) and that remembering a spatial context for a specific event memory improves recall (Robin et al., 2016). Thus, we suggest that spatial cues may act as a framework for guiding memory processes to access episodic elements (Burgess, Maguire, Spiers, & O'Keefe, 2001; Maguire & Mullally, 2013), such as sensory–perceptual and emotional details, that lead to rich memories (for a related view, see Bar, 2004).

Overall, our pattern of results fits well with the idea that there are distinct memory mechanisms supporting different forms of memory retrieval. Neuroimaging studies have provided evidence for two MTL networks that support retrieving memories via conceptual information or perceptually based information (Ranganath & Ritchey, 2012; Ritchey et al., 2015; Sheldon & Levine, 2016). These two memory networks align with the forms of retrieval we tested (event theme versus spatially cued retrieval, respectively). Questions about why there are distinct forms of remembering remain open. It could be that distinct types of memory serve different directive functions in our daily life (Barsalou, 2008; Pillemer, 1998; Rathbone & Moulin, 2014; Schulkind & Woldorf, 2005). For example, event themes promote the retrieval of a broad spectrum of memories, which means that one can access multiple scenarios from different contexts. This form of remembering would be useful for long-term goal-oriented planning (e.g., planning a vacation). For example, thinking of thematically related memories means that one can integrate many past experiences and extract the commonalities among these events (e.g., a schema) to help predict potential outcomes of new thematically related events (Preston & Eichenbaum, 2013). Spatial cues, on the other hand, support more automatic access to episodically rich episodes. This form of retrieval may be better when a rapid approach to solving immediate goals is required. For example, when in a particular context (e.g., a restaurant), the goals or purpose of one's current behaviour may be restricted by that environment. Recalling memories that occurred in a similar location can facilitate immediate goal-directed behaviour (e.g., ordering food at a restaurant).

These ideas are conjecture and will require future testing.

Finally, we note another intriguing area that warrants future investigation: the effect of individual differences. While we explored how distinct cues led to differences in the way memories were accessed, there are related questions about how individuals differ in the way memories are intrinsically organized and naturally accessed. For example, it may be the case that for some individuals, event themes are strong reminders for memories but for other individuals, spatial locations can trigger several past recollections (Sheldon, Farb, Palombo, & Levine, 2016).

Overall, the current study determined how memory retrieval guided by event theme versus spatial elements differed with respect to memory access and detail elaboration. Our findings support the hypothesis that autobiographical memories are organized by event theme and that spatial information is effective in guiding the direct recall of a single, specific memory.

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