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Does Episodic Retrieval Contribute to Creative Writing? An Exploratory Study

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ABSTRACT

Previous research indicates that episodic retrieval contributes to divergent creative thinking. However, this research has relied on standard laboratory tests of divergent creative thinking, such as generating creative uses for objects; it is unknown whether episodic retrieval also contributes to domain-specific forms of creativity. Here we start to explore whether episodic retrieval contributes to content generation on one such domain-specific task: creative writing. In two experiments, we use an episodic specificity induction (ESI) that selectively impacts tasks that draw on episodic retrieval. If episodic retrieval contributes to content generation during creative writing, then ESI should selectively increase the number of episodic details that people subsequently generate on a creative writing task. In our first experiment, we found evidence that ESI increased the number of episodic details participants generated. We observed a similar, though non-significant, trend in the second experiment. These findings constitute a starting point for examining the contribution of episodic retrieval to creative writing, but additional studies will be needed to more definitively characterize the nature and extent of these contributions.

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Introduction

Episodic memory allows individuals to recall and reconstruct their past experiences. Thinking about the past, however, is not the only function of episodic memory. A large body of research has shown that episodic retrieval also supports our ability to imagine future and other specific events. For example, many individuals with impaired episodic memory performance, including amnesic patients (e.g., Hassabis, Kumaran, Vann, & Maguire, 2007; Tulving, 1985; Race, Keane, & Verfaellie, 2011; but see Dede, Wixted, Hopkins, & Squire, 2016) and older adults (e.g., Addis, Wong, & Schacter, 2008; for review, see Schacter, Devitt, & Addis, 2018), have difficulty imagining specific events and novel scenes, and many brain regions involved in episodic retrieval comprise a *core brain network* (Schacter, Addis, & Buckner, 2007) that is also involved in imagining the future (e.g. Addis, Wong, & Schacter, 2007; Szpunar, Watson, & McDermott, 2007; for a meta-analysis, see Benoit & Schacter, 2015).

Several lines of evidence now suggest that participants may also rely on episodic retrieval when engaging in divergent creative thinking (for an overview, see Ditta & Storm, 2018). Divergent creative thinking, or the ability to combine different types of information to generate novel ideas (Guilford, 1967), is a form of domain-general creative thinking. To respond to prompts in the Alternative Uses Task (AUT), a divergent creative thinking task in which participants provide alternative uses for everyday objects, participants sometimes report directly remembering alternative uses and invoking mental imagery to imagine uses for these objects (Gilhooly, Fioratou, Anthony, & Wynn, 2007). Both direct retrieval and mental imagery can be supported by episodic retrieval. In addition, patients with episodic retrieval deficits as a result of hippocampal amnesia score lower on a battery of divergent creative thinking tasks when compared to controls (Duff, Kurczek, Rubin, Cohen, & Tranel, 2013). Further, scores on the AUT correlate with the number of episodic details that participants provide on a future imagination task (Addis, Pan, Musicaro, & Schacter, 2016). These findings contrast with other work on the contributions of memory to divergent creative thinking that has emphasized the importance of searching for associations in semantic memory (e.g. Kennet & Faust, 2019; Mednick, 1962). According to these theories, semantic memory provides a base of general knowledge that supports creative solutions on the AUT that arise by combining multiple semantic concepts into new ideas. These theories emphasize the role of combining abstract concepts to support divergent thinking, whereas research on episodic retrieval suggests an additional role for retrieval of event-specific details. Importantly, these perspectives are not mutually exclusive, and recent work has

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examined the respective roles of both semantic and episodic processing during divergent creative thinking (Beaty et al., 2020).

While these studies suggest that episodic retrieval and divergent creative thinking are related, Madore, Addis, and Schacter (2015) conducted a stronger test of the causal contributions of episodic retrieval to divergent creative thinking in a healthy population by using an Episodic Specificity Induction (ESI) to manipulate participants' reliance on episodic retrieval before they performed the AUT. ESI involves a brief training in detailed episodic memory retrieval and is based on the Cognitive Interview (Fisher & Geiselman, 1992), which was designed to improve eyewitness recall of autobiographical memories (for method, see description in the *Methods* section). In ESI experiments, researchers administer an ESI or control induction before the task of interest, then compare the performance on that task after the two inductions. If episodic retrieval contributes to the task immediately following the inductions, performance should be higher following ESI than following the control induction. If episodic retrieval does not contribute to the task, performance should be the same after an ESI and a control induction. A series of studies have demonstrated the efficacy of the ESI (for review, see Schacter & Madore, 2016). These studies have shown, for example, that the ESI impacts the generation of episodic details during episodic memory retrieval and episodic future simulation while having no impact on the number of non-episodic details generated (Madore, Gaesser, & Schacter, 2014). In addition, the ESI does not have an effect on general retrieval and description tasks believed to be independent from episodic retrieval, such as retrieving semantic associates for objects (Madore et al., 2015), generating sentences with specific objects (Madore & Schacter, 2016) and describing pictures (Madore et al., 2014). Together, these studies suggest that the ESI can be used to identify tasks that rely on episodic retrieval, while having no effect on non-episodic tasks.

Madore et al. (2015) reported that participants who received an ESI (versus a control induction) subsequently generated more categories of appropriate object uses on the AUT. The ESI likewise increases the number of ideas that participants generate on a second divergent creative thinking task, the Consequences Task, which involves imagining novel implications of hypothetical scenarios (Madore, Jing, & Schacter, 2016). Neuroimaging results further indicate that episodic memory processes are involved when generating alternative uses. When participants complete the AUT, an ESI increases activity in memory-related brain regions when compared to the control induction (Madore, Thakral, Beaty, Addis, & Schacter, 2019). In addition, memory retrieval, future simulation, and the AUT all engage several regions in the aforementioned core brain network, including the hippocampus (Beaty, Thakral, Madore, Benedek, & Schacter, 2018). Finally, Thakral, Madore, Kalinowski, and Schacter (2020) recently showed that administering an inhibitory form of transcranial magnetic stimulation to the left angular gyrus, part of the core brain network, disrupted subsequent performance on the AUT and a future imagining task. Together, these studies demonstrate a strong link between episodic retrieval and the domain-general creativity that is assessed with tasks such as the AUT.

Despite this strong evidence that episodic retrieval contributes to content generation during *domain-general* creativity, the role of episodic retrieval in *domain-specific* creativity is unclear. Much of our creativity, such as musical improvisation, painting, and creative writing, is domain-specific. Each of these activities draws on a specific skillset that is different from the others and is not fully dependent on domain-general creativity (Plucker & Beghetto, 2004). Whether episodic retrieval supports more naturalistic, domain-specific creativity – such as creative writing – remains unknown. To begin to explore this empirical gap in the literature, in two experiments we assessed whether manipulating episodic retrieval through ESI impacts performance on a subsequent creative writing task.

Some evidence already suggests that creative writing might benefit from episodic retrieval. Novels are often based on the autobiographical experiences and memories of the author; the writing of *Slaughterhouse Five*, for example, was based in part on author Kurt Vonnegut's experience as a prisoner of war detained in a slaughterhouse. Recent lab-based research has also started to explore the relationship between memory and creative writing. Van Tilburg and Wildschut (2015) showed that retrieving a nostalgic memory before a writing task (when compared to retrieving a non-nostalgic memory) increased story creativity. While this study does not directly address whether episodic retrieval contributes to creative writing, it establishes that memory manipulations can affect performance on a creative writing task. In addition, neuroimaging evidence suggests that brain regions associated with episodic retrieval play a role in creative writing. Participants in an fMRI study showed greater hippocampal activation while writing a creative story than when copying a story (albeit with significance at a liberal statistical threshold; Shah et al., 2011). Together, these observations already suggest a link between episodic retrieval and creative writing.

In this paper, we expanded on these observations by formally testing whether episodic retrieval contributes to content generation during creative writing. We tested whether manipulating episodic retrieval via an ESI affects the number of details participants generate when writing creatively. In both experiments, we adapted a paradigm previously used to study creative writing (Shah et al., 2011) and combined it with the ESI procedure. In this paradigm, participants were presented with excerpts of literature and were asked to continue writing the story they read. We compared performance on these stories after an ESI versus after a control induction, as assessed by the number of details participants produce.

Our specific predictions in these experiments are based on the constructive episodic simulation hypothesis. This hypothesis suggests that elements of episodic memories can be flexibly recombined into new imagined events and scenes (Schacter & Addis, 2007). For this reason, we predicted that boosting episodic retrieval via ESI would increase the number of episodic details, such as event-specific scene, person, and action details, while having no effect on the number of non-episodic details (such as factual background of the characters) in the creative writing stories. If the ESI impacts the number of episodic details in written stories, then we have evidence that episodic retrieval contributes to creative writing. If ESI also has no effect on non-episodic details, we can rule out the possibility that ESI broadly influences any type of detail in a generated story; that is, an effect selective to episodic details would suggest that the results are not attributable to participants simply trying to provide more information after ESI versus a control induction.

To further explore how episodic retrieval shapes creative writing stories, we scored these stories for originality as well. We did not expect to find a significant effect of ESI on originality, because existing research on the effect of ESI on creativity shows increases in the *amount* of original content produced, rather than increases in the originality of that content (Madore et al., 2015; Madore, Jing, et al., 2016; Madore, Thakral, et al., 2019). For example, participants generate more appropriate categories of original uses on the Alternative Uses Task after the ESI (when compared to the control induction), despite no significant differences in the originality of these uses (Madore et al., 2015). Based on this previous research, our primary hypothesis is that episodic retrieval contributes to the *quantity* of creative writing content produced, rather than the *originality* of that content.

Experiment 1 and Experiment 2 both test the hypotheses discussed above. Because effects of ESI on creative writing are compared to those of a control induction, we wanted to ensure that the result was not dependent on the specific control induction used. Thus, we used different control inductions in Experiments 1 and 2. We also increased our target sample size in Experiment 2 to improve our chances of finding the hypothesized effect.

Materials and methods: experiment 1

Procedure

Each participant in the experiment first completed an ESI or control induction. This procedure involved watching and then answering questions about a brief video. Following the induction, participants completed the creative writing task. In every trial of the task, participants were presented with the start of a story and asked to continue writing it on the computer (Shah et al., 2011). Participants were given six minutes to write each story, with five stories presented in this first segment of the experiment. Each person was then given a math filler task that involved adding and subtracting numbers for ten minutes (for similar procedures, see e.g. Madore, Jing, & Schacter, 2019; Madore & Schacter, 2016; Madore et al., 2019). This filler task focused participants' attention on a non-episodic task with the intent of decreasing potential carry-over effects of the induction. Following this filler task, participants underwent whichever induction they had not completed in the first portion of the experiment (ESI or impressions control induction). The induction order and video order were counterbalanced across participants. After this second induction, participants wrote five more stories. Each session lasted approximately 2 hours. For a visual overview of the experimental procedure, see Figure 1. After the study was completed, details in the stories were counted and submitted to statistical analysis.

Participants

A sample size of 24 participants was chosen based on previous sample sizes of within-subject studies using the episodic specificity induction (e.g. Jing, Madore, & Schacter, 2016, 2017; Madore et al., 2015, 2014). Our sample was recruited from Harvard University and the community and was restricted to individuals between the ages of 18–30 with no neurological or psychiatric impairment at the time of the study. All participants provided written consent in accordance with the ethics protocols approved by Harvard University 's Institutional Review Board. Participants received course credit or payment for their participation.

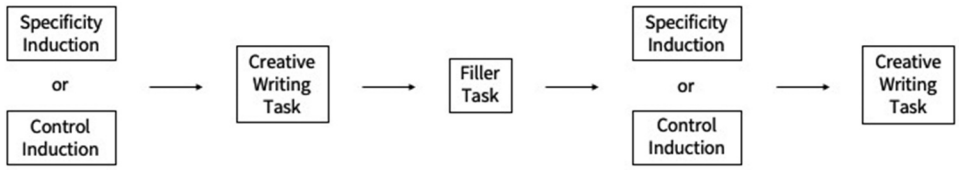

Figure 1. Experimental workflow. Each participant started with one induction (ESI or control) before they wrote creative stories. Participants then completed a ten-minute filler task, which served to decrease carryover effects of the first induction. After the delay task, each participant completed the induction they had not participated in before, then finished by writing a series of creative stories. Experiment 1 used the impressions control induction, whereas Experiment 2 used a math control task.

25 participants were recruited, with 1 participant excluded for having already been in an ESI study. This led to our sample size of 24. One additional participant was removed during analysis for having copied sections of the original stories from the internet into their responses. Our final sample size included 23 individuals (mean age = 22.26 years old, SD = 4.07; 8 male, 15 female).

Tasks

Episodic specificity induction

The ESI is modeled after the Cognitive Interview, which is used to elicit detailed eyewitness memories (Fisher & Geiselman, 1992). In this procedure, participants first watch a short video, which later serves as material for memory retrieval. Immediately afterward, participants complete three minutes of math problems. This filler task is designed to prevent participants from relying on working memory to answer subsequent questions and to prevent rehearsal. Participants are then asked questions about their memory of the video. The researcher instructs the participant to remember the video in as much detail as possible. The participant is then asked to tell the researcher everything they remember about the surroundings. After follow-up questions about the surroundings, participants are asked to describe everything they remember about the people in the video. After follow-up questions about the people in the video, participants are asked to describe the actions in the video in chronological order. This procedure has been shown to increase episodic output but not general verbosity on subsequent tasks in a series of experiments (e.g. Madore et al., 2014, reviewed in Schacter & Madore, 2016). Induction scripts can be found in Madore et al. (2014).

Impressions control induction

We compared the effect of ESI on creative writing to the effect of an impressions control induction. This impressions induction aims to control for participant engagement with the video and questioning while not increasing episodic retrieval. For this reason, the length of the impressions induction is approximately matched to the length of the ESI. To avoid episodic retrieval during the control induction, participants are asked to not provide specific details of what happened in the video. Instead, participants are asked to describe their general impressions of the video. Once participants provide their general thoughts and opinions of the video, a series of questions further probe their general impression of the video (e.g. "what adjectives would you use to describe the setting of the video?"). The full impressions control induction script can be found in Madore et al. (2014).

Creative writing task

In each trial of the creative writing task, participants read a passage from a work of literature and were instructed to continue writing the story. At the start of the experiment, participants were instructed to continue writing in the style that felt most comfortable to them, but to focus on writing as creatively as possible. Participants were further instructed to keep their stories somewhat realistic. After participants were finished with writing the stories, they were told that all prompts were based on published stories. For each prompt, they were asked if they recognized the story. If they did, they were also asked to write the story's name, author's name, or provide a sentence about the plot of the story. This allowed us to exclude any stories that participants were already familiar with before they started writing.

Story prompts were selected from the stimulus set used by Tamir, Bricker, Dodell-Feder, and Mitchell (2015). In their experiment, Tamir et al. presented participants with literary passages. Each of these passages was characterized as social or nonsocial and vivid or abstract. For our experiment, we chose passages categorized by Tamir et al. as both social and highly vivid to promote participant engagement. We wanted to avoid story prompts that participants would recognize, as they

might then complete the writing task by reciting the works of literature that the prompts came from. As a result, when we tested the task instructions for clarity in a separate online pilot sample, we additionally asked these pilot participants whether they recognized any prompts in an open-response question at the end of the study. We excluded story prompts that any pilot participant recognized. Ten stories from the remaining selection were then chosen for use in these experiments (see Appendix for story prompts). Stories were presented in a random order in Experiment 1 and assigned to lists that were then counterbalanced in Experiment 2.

Scoring

Scoring: internal and external details

To quantify the effect of the inductions on creative writing, the stories were scored for the number of episodic, or internal, details and the number of non-episodic, or external, details they contained. To do this, we used scoring procedures from the ESI studies of Madore et al. (2014) and Jing et al. (2016), which were adapted from the Autobiographical Interview (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). Internal details consisted of event details, including people, actions, objects, thoughts, emotions, locations and other similar details. External details consisted of factual, or semantic, details that do not contribute to a specific event. To illustrate internal and external detail scoring, we have included two annotated examples in the Appendix. For more information about these detail categories, see Levine et al. (2002). In this study, external details consisted largely of backstory or non-perceptual descriptions of the situations or characters. While previous internal/external scoring procedures often require that all internal details belong to a single event (e.g. Levine et al., 2002), many stories in our sample included multiple events and scenes. To avoid labeling episodic details as external, our scoring procedure only required that internal details belong to an event, rather than to the central event.

In Experiment 1, three raters obtained high interrater reliability for internal details (Cronbach's alpha = .91, assessed on 10 practice items) and external details (Cronbach's alpha = .87, assessed on 10 practice items). Items for assessing interrater reliability were taken from participants who were excluded from Experiment 1 for failing to attend the second study session (as such, their data were not included in the ESI analysis presented below). To ensure that scorers did not deviate from their training over the course of scoring, a randomly selected subset of stories were scored by two raters. Reliability remained high for internal details (Cronbach's alpha = .95, assessed on 10 stories from Experiment 1) and external details (Cronbach's alpha = .98, assessed on 10 stories from Experiment 1). All three raters were blind to the experimental condition (ESI vs. Control).

Scoring: originality

Responses to each prompt were sorted into three equally large categories of low, medium, and high originality with high reliability (Cohen's Kappa with equal weights = .60, assessed on 62 practice items) by two raters who were blind to the experimental condition (ESI vs. Control). The stories used to determine interrater reliability between the two raters were taken from an online pilot. This pilot was conducted to ensure that participants understood task instructions and did not recognize the prompts. This pilot contained no induction procedures.

Guidelines for scoring originality of these stories were derived from existing subjective scoring guidelines for judging creativity of responses to the alternative uses task (Silvia & Benedek, 2019). These guidelines suggest that the creativity of a response can be assessed along three dimensions: how common the response is, how remote a response is (or how different it is from the everyday), and how clever the response is (cf., Silvia et al., 2008).

Accordingly, stories that reiterate the writing prompt or continue the story as would be expected based on the prompt (i.e. responses that were not remote from the story prompt) and responses that were similar to many other responses (i.e. common) were assigned to the lowest originality group. Stories that stood out as highly original were then assigned to the highest originality group. These stories were often identified by being appropriate but quite different from other responses in the sample (i.e. uncommon). Stories that did not simply continue the writing as would be expected based on the prompt (i.e. remote) were also more likely to be assigned to this group. Stories that were clever, regardless of whether the topic was remote or common, were often also assigned to this group.

Remaining stories that were not as easily placed into the low or high originality bins were then ordered according to ascending subjective originality. These stories where then split among the low, medium, and high originality groups such that each group had an equal number of stories. An example story of each level of originality is presented in the Appendix.

This approach to scoring originality differs from typical methods used to assess creativity in AUT responses. We rated originality on a categorical 3-point scale, while

AUT responses are commonly rated on a continuous 5-point scale (e.g. Silvia et al., 2008). Preliminary attempts by two raters to use a standard 5-point scale yielded low levels of agreement between raters – which is often the case with subjective creativity scoring (Forthmann et al., 2017) – resulting in our decision to use the categorical 3-point scale described above (i.e., low, medium, high originality), which can reduce ambiguity and improve rater agreement (Benedek, Mühlmann, Jauk, & Neubauer, 2013), as was the case in our study.

Statistical analyses

If episodic retrieval contributes to the generation of event details during creative writing, we would expect a significant effect of ESI on internal details when compared to a control induction. By contrast, we would expect no effect of ESI on external details.

We evaluated this hypothesis by testing whether the number of details in the stories differed based on an interaction between detail type (internal/external) and induction type (control/ESI). In addition to these fixed effects, random effects were included to account for possible individual differences in writing ability and style and differences in story prompts. Specifically, we added random intercepts for the interaction of participant number and detail type as well as random intercepts for the interaction of story prompt and detail type. The first random effect captures both variation in the amount that participants write as well as differences in their baseline use of internal and external details. The second random effect similarly accounts for differences in the lengths of stories and the number of internal and external details that particular story prompts elicit. This multi-level mixed model was implemented using the function *lmer* from the R package *lmerTest* (Kuznetsova, Brockhoff, & Christensen, 2017).

After testing for an interaction of induction type and detail type, follow-up tests evaluated the effect of ESI (versus control) on internal details, and the effect of ESI (versus control) on external details. These regression models additionally contained random intercepts for participant identities and story prompts.

In addition to testing for the effect of ESI on internal and external details, we also tested for the effect of ESI on originality ratings. We used an ordinal regression that included participant ID as a random effect and word count as a covariate. The ordinal regression was implemented using the function *clmm* with flexible thresholds from the R package *ordinal* (Christensen, 2015). The random effect for participant ID was included to account for differences in participants' abilities to generate creative stories. Since originality ratings were not independent from story word count, we wanted to ensure that any effect of the ESI on ratings could not be explained by a simple increase in story length. For this reason, we included word count as a covariate in our model. No random effect of story prompt is necessary because each story prompt has an equal number of low, medium, and high originality ratings as a result of the scoring procedure. Therefore, no variability in ratings can be attributed to prompt number.

Results and discussion: experiment 1

We found a significant interaction between detail type and induction type as hypothesized (b = 6.53, t(395.80) = 2.06, p = .040). Follow-up tests indicate that stories included more internal details after the ESI than after the control induction (b = 5.88, t(197.99) = 2.66, p = .009), but no significant difference was found for external details (b = −0.37, t(200.04) = −0.16,p = .87). The number of internal and external details (averaged across prompts and participants) are displayed as a function of induction type in Figure 2. The mean number of internal details in stories following ESI was 29.29 (SD = 20.76), whereas the mean number of internal details in stories following the control induction was 22.96 (SD = 18.15). The mean number of external details in stories following ESI was 19.23 (SD = 18.11), whereas the mean number of external details in stories following the control induction was 19.54 (SD = 18.10).

We found no significant effect of ESI (relative to control) on the originality of responses (proportional odds ratio = 0.91, p = .74), using the ordinal regression model described in *Statistical Analyses*. The number of words in each story was a significant predictor of originality ratings (proportional odds ratio: 1.02, p < .001), consistent with past work reporting positive associations between word count/elaboration and creativity ratings (Beaty & Johnson, 2021; Forthmann, Oyebade, Ojo, Günther, & Holling, 2019).

To summarize, in Experiment 1, we found that ESI selectively increased the number of internal details in creative writing, relative to an impressions control induction. These results provide preliminary evidence that episodic retrieval contributes to the amount of content individuals generate during creative writing.

Overview: experiment 2

To further investigate the role of episodic retrieval in creative writing, we modified our experimental design in two ways for Experiment 2. First, we replaced our

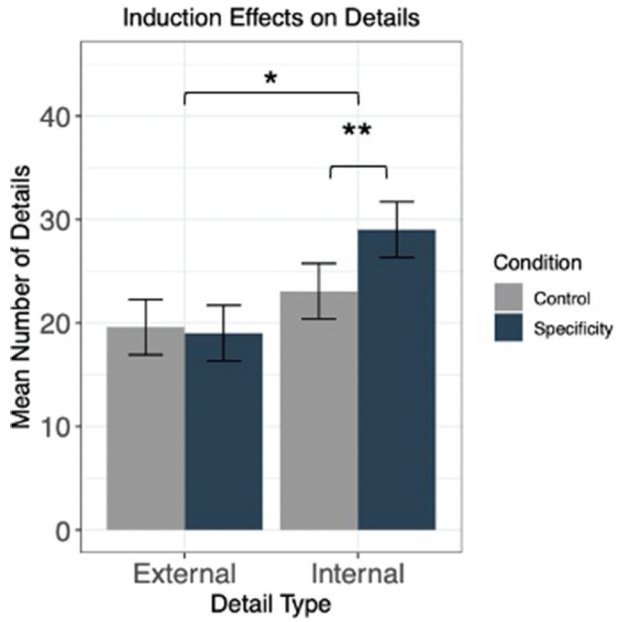

Figure 2. Experiment 1: Effects of an episodic specificity induction and impressions control induction on the mean number of details that participants include in stories. The displayed number of details result from averaging across prompts and participants. Error bars represent 1 SE. The largest grouping line indicates that there is a significant interaction effect: the difference in number of details following ESI versus control is greater for internal details than for external details. The smaller grouping line suggests that there is a significant effect of ESI on internal details, relative to the control induction. * $p < .05$, ** $p < .01$, *** $p < .001$.

impressions control induction with a different control task. Second, we increased our target sample size from 24 to 32 participant to increase power. We chose this sample size to be consistent with previous ESI studies, which typically use either 24 or 32 participants (e.g. Madore & Schacter, 2016; Madore, Szpunar, Addis, & Schacter, 2016; Madore et al., 2019).

We replaced the impressions control induction with a math control task to exclude an alternative explanation for the results in Experiment 1. The results in Experiment 1 are based on the contrast of ESI to the impressions control induction. A positive result, then, could be driven by a boost in internal details caused by ESI. Alternatively, a positive result could arise from a decrease in internal details as a result of the impression induction. The former helps us understand the link between episodic memory and creative writing, as it suggests that episodic retrieval contributes to our task; the latter does not provide evidence for this link. To exclude this latter possibility, we test whether the effect of ESI persists with a different control task. Based on previous research, which has not found a difference between the impressions and math control inductions (e.g., Madore et al., 2014, 2015; Madore & Schacter, 2016), we likewise expected no differences between control conditions, as both likely require little episodic retrieval.

Materials and methods: experiment 2

Procedure

Each participant attended a single session that lasted approximately 2 hours. Participants received either the math control or the ESI first, counterbalanced across participants. In the math control task, participants were given a series of addition and subtraction problems and were not asked questions about the video. The math control task was approximately matched in time to the ESI.

After the first induction, participants were given six minutes per story to write five stories. As in experiment one, participants were then asked to complete a filler task for ten minutes to prevent carry-over effects of the induction. After the filler task, participants completed the second induction (whichever one they had not completed in the first segment) before writing the remaining five stories. This procedure is depicted in Figure 1.

Participants

Thirty-two participants were recruited for this experiment with the same guidelines used for recruiting in Experiment 1. Three participants were then excluded for failure to write all of the stories. To meet our target sample size of 32 participants, three additional participants were recruited. Participants in this sample were 18–30 years old (M = 24.03 years, SD = 3.51; 21 female, 11 male).

Scoring

Internal and external details were scored with the same procedure as in Experiment 1. As before, raters were blind to the experimental condition of the stories. Two raters who had previously scored responses in Experiment 1 also scored responses for Experiment 2. These two raters obtained excellent interrater reliability for the internal (Cronbach's alpha = .94, assessed on 10 practice items) and external details (Cronbach's alpha = .92, assessed on 10 practice items). Interrater reliability was calculated from the same items used to establish reliability in Experiment 1. After scoring was completed, we checked whether scorers deviated from their training while scoring. On a random sample of ten

stories from this experiment, reliability for internal (Cronbach's alpha = .93) and external details (Cronbach's alpha = .90) remained high.

Stories in Experiment 2 were additionally scored for originality by two raters with the same procedure as in Experiment 1. Both raters were blind to the experimental condition (ESI or Control) of each story. One of these raters also scored responses for originality in Experiment 1. Responses to each cue were sorted into groups of low, medium, or high originality. Interrater reliability was high, and was assessed prior to scoring on the same 62 practice items as in Experiment 1 (Cohen's Kappa with equal weights = .617).

Results

In Experiment 2, we adopted the same mixed-model approach and observed the same general trends for an effect of ESI on the key detail measures, but the trends failed to reach standard levels of statistical significance. Thus the interaction between detail type and induction type approached but did not attain statistical significance (b = 6.6, $t(550.7)$ = 1.80, p = .072). Similarly, follow-up tests indicate that stories did not include significantly more internal details after the ESI than after the control induction (b = 4.37, $t(275.36)$ = 1.69, p = .092), though the trend was in the same direction as Experiment 1. No significant difference as a function of induction was found for external details (b = −2.21, $t(275.35)$ = −0.85, p = .394), in line with Experiment 1. Results are displayed in Figure 3. The mean number of internal details in stories following ESI was 33.29 (SD = 29.17), whereas the mean number of internal details in stories following the control induction was 28.52 (SD = 28.63). The mean number of external details in stories following ESI was 30.34 (SD = 28.91), whereas the mean number of external details in stories following control induction was 32.79 (SD = 28.83).

In addition, we found no significant effect of ESI on originality ratings (proportional odds ratio: 1.41, p = .12) when modeled with an ordinal regression that included participant ID as a random effect and word count as a covariate. Word count was a significant predictor of originality ratings in this model (proportional odds ratio: 1.01, p = .009), as it was in Experiment 1.

Finally, in an exploratory analysis, we combined data from Experiments 1 and 2 to test for the effect of ESI on creative writing relative to the two control conditions. The model for this analysis was specified in the same way as above, with the addition of a fixed effect of experiment number. We found a significant interaction between detail type and induction type (b = 6.51, $t(957.7)$ = 2.57, p = .011). Follow-up tests indicated that

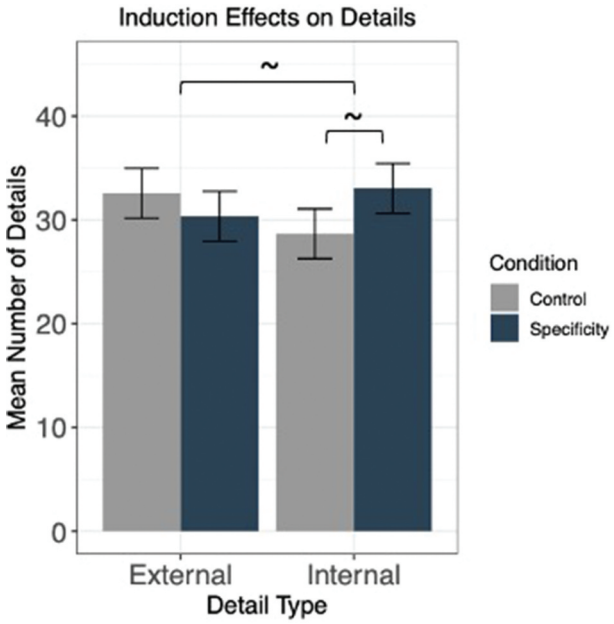

Figure 3. Experiment 2: Effects of an episodic specificity induction and math control on the mean number of details that participants include in stories. The displayed number of details result from averaging across prompts and participants. Error bars represent 1 SE. The largest grouping line indicates that there is a marginally significant interaction effect: the difference in number of details following ESI versus control is numerically greater for internal details than for external details. The smaller grouping line shows that there is a marginally significant effect of ESI on internal details, relative to the control induction. ~ p < .1, * p < .05, ** p < .01, *** p < .001.

stories included more internal details after the ESI than after the control induction (b = 4.94, $t(478.50)$ = .75, p = .006), but no significant difference was found for external details (b = −1.57, $t(479.30)$ = −0.87,p = .384). The mean number of internal details for the stories was 31.67 (SD = 26.11) following the ESI, and 26.19 (SD = 24.90) after the control induction. The mean number of external details was 25.82 (SD = 25.59) after the ESI, and 27.22 (SD = 25.75) after the control induction. Figure 4 displays induction effects on internal and external details with data combined across Experiments 1 and 2.

Discussion

Despite clear evidence that episodic retrieval contributes to laboratory measures of divergent creative thinking, the role of episodic retrieval in naturalistic creative tasks like creative writing is less clear. Experiment 1 suggests a role of episodic retrieval in creative writing. Participants in this experiment included significantly more internal details in their stories following the ESI than following the control, while no change in external

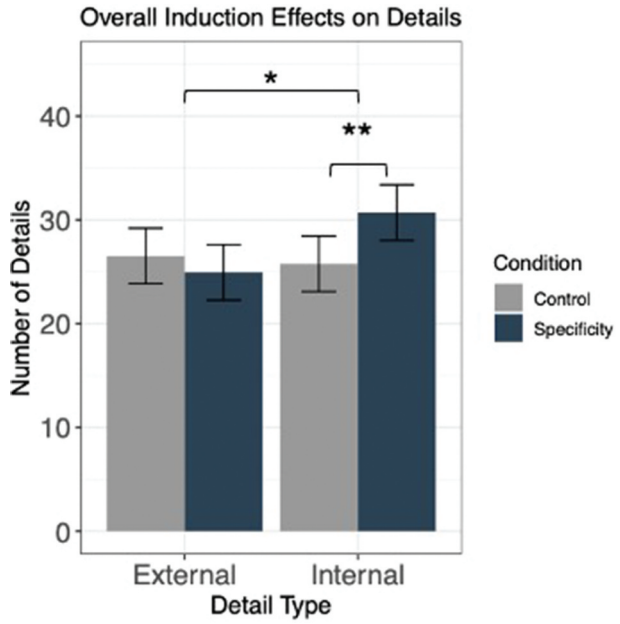

Figure 4. Experiment 1 & 2: Effects of an episodic specificity induction and control inductions on the mean number of details that participants include in stories. The displayed number of details result from averaging across prompts, participants, and Experiment 1 and 2. Error bars represent 1 SE. The largest grouping line indicates that there is a significant interaction effect: the difference in number of details following ESI versus control is greater for internal details than for external details. The smaller grouping line indicates that there is a significant effect of ESI on internal details, relative to the control induction. * $p < .05$, ** $p < .01$, *** $p < .001$.

details was observed, as hypothesized. These findings, if considered in isolation, would suggest that episodic retrieval plays a role in the generation of event details for creative stories. These results would also suggest that episodic retrieval does not play a significant role in generating non-internal details, such as factual background of the characters, during creative writing. However, Experiment 2 does not strongly support these conclusions. While the effect of ESI on detail generation followed the same trend as in Experiment 1, the effect was not statistically significant. Nonetheless, the combined analysis of Experiments 1 and 2 did reveal a significant effect of ESI on internal details in creative writing. To summarize, the two experiments discussed here provide suggestive, but not conclusive evidence that episodic retrieval contributes to generating event and scene details of creative stories.

In addition, these results do not provide evidence that episodic retrieval impacts the originality of written stories. We found no significant effect of ESI on originality ratings in either Experiment 1 or Experiment 2. These results are consistent with similar findings in divergent creative thinking studies, which show an increase in quantity, rather than originality, of creative content following ESI. Previous studies show that ESI has no effect on originality ratings in the AUT, despite increasing the number of original items produced on this task (Madore et al., 2015, Madore, Jing, et al., 2016, Madore, Thakral, et al., 2019).

The mixed findings that we report here may result from low statistical power due to large variability in the number of external and internal details across stories. Some responses consisted entirely of factual background and other external details, whereas other stories contained only episodic details. This large variability could have made it difficult to detect an effect of ESI in these experiments.

To test whether low power is a possible explanation of our null result, we conducted a power analysis based on resampling data from the first experiment. We drew random samples of different sizes with replacement from the data and calculated the proportion of times that the interaction effect included in the model was significant for each sample size. This bootstrapping procedure suggested that that our second study's power was .55, and we should have included 72 participants to have an 80% chance of finding an effect if it exists. The second experiment, then, was underpowered to find an effect.

This problem could be addressed in future experiments by including larger sample sizes. Researchers could also alter the prompts and instructions used in these experiments to reduce variability in story responses. Our preliminary results indicate that episodic retrieval may aid an author in generating event-specific contextual details in a story, so instructions that focus on writing specific events may make an effect of ESI easier to detect. In other words, researchers could revise instructions so that participants are asked to write a creative story focused on a specific event. This, or similar changes, could reduce response variability and increase researchers' ability to detect contributions of episodic retrieval to creative writing. In addition, future researchers can ensure that instructions do not discourage detail generation. To do so, the instructions that were used in these two experiments, which encouraged participants to be as creative as possible, could be modified. Instructing participants to "be creative" decreases the amount of content generated in the AUT, relative to instructions that emphasize the quantity of output ("be fluent"; Nusbaum, Silvia, & Beaty, 2014), so similar instructions in this paradigm might likewise have decreased output. Instead, participants could be told to generate a creative story with as much detail as possible. Such instructions would require creative

responses but would emphasize the quantity of output (for similar instructions emphasizing both quantity and creativity, see e.g. Madore, Jing, et al., 2016).

To summarize, when researchers seek to investigate the role of episodic retrieval in domain-specific creativity, our results suggest that creative writing remains a promising target of study. Creative writing also remains a promising target of study because previous work suggests that episodic retrieval plays a central role in imagining specific events (e.g. Schacter & Addis, 2007), which is critical to writing new stories. According to the constructive episodic simulation hypothesis, we imagine specific scenes and events by recombining details from episodic memories (e.g. Schacter & Addis, 2007, 2020; Schacter et al., 2012). Episodic retrieval, then, may allow an author to generate relevant event and scene details as they write their story.

Other literature suggests that an interplay between episodic and semantic memory allows us to imagine future events (the semantic scaffolding hypothesis; e.g. Irish, Addis, Hodges, & Piguet, 2012; Irish & Piguet, 2013). Specifically, semantic memory retrieval may be used to build a scaffold of general knowledge and schematic information that can then be filled in by episodic details. For example, to imagine a day at the beach, we may use general semantic information to frame the event (e.g. "I usually go with a group of four friends, so I'll probably go with them for this trip as well") and then retrieve specific episodic details to develop the event (e.g. "I can see an ice cream truck parked on the boardwalk"). These processes used to imagine future events may be involved in imagining new events for creative purposes, such as creative writing, as well. As a result, episodic retrieval may be involved in generating much of the content of creative writing stories, while semantic retrieval or other processes may be used to generate the creative idea or story arc that is expressed in the narrative.

Our experiments represent a first attempt to explore the contribution of episodic retrieval to creative writing, but future research could focus on additional forms of domain-specific creativity, such as the design of scenes in theater and film, that seem to benefit from the imagination of specific events. Episodic memory contributes to many tasks that are not traditionally thought of as memory tasks, and several forms of domain-specific creativity might benefit from its contributions.

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Appendix

Story prompts (modified from Tamir et al., 2015)

(1) Under the trees several pheasants lay about, their rich plumage dabbled with blood; some were dead, some feebly twitching a wing, some staring up at the sky, some pulsating quickly, some contorted, some stretched out – all of them writhing in agony except the fortunate ones whose tortures had ended during the night. Tess's first thought was to put the still living birds out of their torture, and to this end with her own hands she broke the necks of as many as she could find, leaving them to lie where she had found them.

Thomas Hardy, *Tess of the D'Ubervilles* (1891)

(1) He dreamed that the priest whom they had shot that morning was back in the house dressed in the clothes his father had lent him and laid out stiffly for burial. The boy sat beside the bed and his mother read out of a very long book: there was a fish basket at her feet, and the fish were bleeding, wrapped in her handkerchief. He was very bored and very tired and somebody was hammering nails into a coffin in the passage. Suddenly the dead priest winked at him – an unmistakable flicker of the eyelid, just like that.

- Graham Greene, *The Power and the Glory* (1940)

(1) Lloyd shoves off the bedcovers and hurries to the front door in white underwear and black socks. He steadies himself on the knob and shuts his eyes. Chill air rushes under the door; he curls his toes. But the hallway is silent. Only high-heeled clicks from the floor above. A shutter squeaking on the other side of the courtyard. His own breath, whistling in his nostrils, whistling out. Faintly, a woman's voice drifts in. He clenches his eyelids tighter, as if to drive up the volume, but makes out only murmurs, a breakfast exchange between the woman and the man in the apartment across the hall.

- Tom Rachman, *The Imperfectionists* (2010).

(1) My brother was already in school by the time I was born, and my earliest memory is of Jimmy going to school every day, leaving me to think of the future when I could go to big school myself. In the afternoons I would press my nose against the picture window in the den, watching for the big yellow school bus and listening for the screech of air brakes as the bus stopped at the top of the hill to deliver Jimmy home.

- Cindi Rigsbee, *Finding Mrs. Warnecke* (2010).

(1) Meru is a hydra-headed massif, with multiple summits; our goal was to climb the most dramatic of these, a blade of pale, steep granite aptly named the Shark's Fin. But on this afternoon the weather had turned nasty, and we were afforded little rest. Hammered by high winds, our entire world bucked wildly against the cams and pitons holding us to the wall. The ice we'd climbed to reach this point wasn't particularly solid, a bad sign for what lay ahead.

- Conrad Anker, "Why Am I Here Again?" *Outside* (April 2009)

(1) He dropped his oars and felt the weight of the small tuna's shivering pull as he held the line firm and commenced to haul it in. The shivering increased as he pulled in and he could see the blue back of the fish in the water and the gold of his sides before he swung him over the side and into the boat. He lay in the stern in the sun, compact and bullet shaped, his big, unintelligent eyes staring. The old man hit him on the head for kindness and kicked him, his body still shuddering, under the shade of the stern.

- Ernest Hemingway, *The Old Man and the Sea* (1952)

(1) Entering through a window, I gathered up all the household chemicals, and, believe me, he had a lot, more than I did, more than he needed, thinner, paint, lye, gas, solvents, etc. I got it all in like nine Hefty bags and was just starting up the stairs with the first bag when here comes the whole damn family, falling upon me, even his kids, whipping me with coat hangers and hitting me with sharp-edged books and spraying hair spray in my eyes, the dog also nipping at me, and rolling down the stairs of the basement I thought, They are trying to kill me.

- George Saunders, "Adams," *In Persuasion Nation* (2006)

(1) Lily, the caretaker's daughter, was literally run off her feet. Hardly had she brought one gentleman into the little pantry behind the office on the ground floor and helped him off with his overcoat than the wheezy hall-door bell clanged again and she had to scamper along the bare hallway to let in another guest. Miss Kate and Miss Julia were there, gossiping and laughing and fussing, walking after each other to the head of the stairs, peering down over the banisters and calling down to Lily to ask her who had come.

- James Joyce, "The Dead," *The Dubliners* (1914)

(1) John Reed was a schoolboy of fourteen years old: large and stout for his age, with a dingy and unwholesome skin; thick lineaments in a spacious visage, heavy limbs and large extremities. He gorged himself habitually at table, which made him bilious, and gave him a dim and bleared eye and flabby cheeks. He ought now to have been at school; but his mama had taken him home for a month or two, on account of his delicate health.

- Charlotte Brontë, *Jane Eyre* (1847)

(1) Roger gathered a handful of stones and began to throw them. Yet there was a space round Henry, perhaps six yards in diameter, into which he dare not throw. Here, invisible yet strong, was the taboo of the old life. Round the squatting child was the protection of parents and school and policemen and the law.

- William Golding, *Lord of the Flies* (1954)

Example Responses with Originality Ratings

Story Prompt

My brother was already in school by the time I was born, and my earliest memory is of Jimmy going to school every day, leaving me to think of the future when I could go to big school myself. In the afternoons I would press my nose against the picture window in the den, watching for the big yellow school bus and listening for the screech of air brakes as the bus stopped at the top of the hill to deliver Jimmy home.

Example Response with Low Originality Rating Response

I was so excited for Jimmy to get home. I would ask him questions about what he learned, how his teachers and friends are like, what he eats for lunch, and so on. He wasn't too excited to talk to school when he got back which was disappointing but I understand now after going to school myself. I have to wake up early at 7am to get on the school bus and I love sleeping in. When I get to school, there's assembly and we have five classes everyday - Math, English, Science, Social Studies, and Spanish. Math is hard and my teacher is not so nice. She gives us so much homework everyday and I am struggling. Thankfully I have my big brother Jimmy to help me with my homework when I get stuck. The only part of school that I enjoy is lunch break. We have a cafeteria in school and the menu changes daily. Some of my friends don't like the food and would rather bring their own lunch but I'm not a picky eater and I think the food at the cafeteria isn't bad. After lunch, me and my friends usually play soccer or dodge ball. I wish lunch break was longer. After lunch, we have more classes and it's sometimes hard for me to focus because I get sleepy after eating food. On Monday, Wednesday, and Friday, I have volleyball practice. Volleyball is fun but it can be stressful and tiring sometimes. My arms get bruised and it's hard for me to

Example Response with Medium Originality Rating

I wanted to be just like Jimmy when I was younger. I wanted to follow him around, go to school and meet his friends. When he was in middle school, I would mimic his mannerisms and habits so that he would think I was cool enough to hang out with his friends. When he was in high school, and I was in seventh grade, I would try to tell him about my "girlfriends" to show him that I was really mature for my age. My image of Jimmy was that he was perfect. He was well-liked by his friends and teachers, a successful football player and did well in every class. However, I did not realize until later that this was all just an image he created for us to see to please us.

Only in the past couple of years has Jimmy really opened up to me. He told me about how he struggled with his self-esteem and while outwardly he seemed content, he was often not. Depression, he told me, is like a cut so deep that you feel like you are always bleeding even if no one can actually see it. He feels like his emotions were always seeping out of him and that it made

Example Response with High Originality Rating

Even then, he walked like he does now: slow, loping; you'd think of panthers, or the hunters that hang their heads on walls. He was never made for Kansas, I think. The squareness of the state extends to the people, men built like refrigerators . . . all-muscle oxen squared off next to barns and silos that barely last the winter. Jimmy was softer on the edges. You'd almost say graceful.

When he talked about California for the first time, we were eight and fourteen, and crowded around the woodstove waiting for our parents to get home. Of course I'd studied the state

in passing, heard about its voting habits now as new election cycles rolled around, but to me it seemed far-off and mystical. I'd heard, vaguely, of New Age, so I imagined that they'd come up with a different

Example Responses with Detail Scoring

The following condensed examples contain both internal and external details. Internal details are event and scene details, which includes the objects, actions, locations, thoughts of people in the scene, and other similar details. External details are details that are not specific to an event and are mostly made up of factual information. In some cases, they are used to provide context to the story. In other cases, they are the main focus of the story. In the examples below, details are separated with a forward slash, and the external details are surrounded in square brackets. For more information on how pieces of text are separated into details, see Levine et al. (2002).

Example 1:

[I was 4/ when it happened./The day/ started like every other one/.] Momma /yelled /at Jimmy/ for 20 minutes/ to get out of bed,/ or else he's be late /for the bus./ [It always went like this /- Jimmy/ didn't wake up/ particularly well/.] Momma /sent me/ into his room /to wake him/ so, I jumped /on top of him,/ screaming /in his ear / "Momma /says /up/! Time to get up/!" Groaning, /he playfully /pushed me off/. "Tell /mom/ I'm on my way down./" Ten minutes later /he ran down/, slinging/ his bag /over his shoulder,/ and grabbed/ a granola bar /from the tin/ on his way out/ and onto the bus /that took him / to school/.

[Momma /would receive a call/ at about 20 past 4./ We never saw it coming/]

Example 2:

Why was the priest/winking at him/?, he thought./ Dead people/ don't blink!/Maybe he wasn't really dead?/

[So, why did they shoot/ the priest?/ It's because he was really a bad man/. Priests /can be bad men too/. They found that out/ the hard way/. They started out/ trusting/ a man of the cloth/, because they are usually good men/. Some of the best/. But this was a bad man/. He had swindled people/ out of money/]