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Constructing Autobiographical Events Within a Spatial or Temporal Context: A Comparison of Two Targeted Episodic Induction Techniques

Signy Sheldon[1], **Lauri Gurguryan**[1], **Kevin P. Madore**[2], **Daniel L. Schacter**[3]

[1]Department of Psychology, McGill University

[2]Department of Psychology, Stanford University

[3]Department of Psychology, Harvard University

Abstract

Recalling and imagining autobiographical experiences involves constructing event representations within spatiotemporal contexts. We tested whether generating autobiographical events within a primarily spatial (where the event occurred) or temporal (the sequence of actions that occurred) context affected how the associated mental representation was constructed. We leveraged the well-validated episodic specificity induction (ESI) technique, known to influence the use of episodic processes on subsequent tasks, to develop variants that selectively enhance spatial or temporal processing. We tested the effects of these inductions on the details used to describe past and future autobiographical events. We first replicated the standard ESI effect, showing that ESI enhances generating episodic details, particularly those that are perception-based, when describing autobiographical events (Experiment 1). We then directly compared the effects of the spatial and temporal inductions (Experiment 2 and 3). When describing autobiographical events, spatial induction enhanced generating episodic details, specifically perception-based details, compared to the control or temporal inductions. A greater proportion of the episodic details generated after the temporal induction were gist-based than after the spatial induction, but this proportion did not differ from a control induction. Thus, using a spatial or temporal framework for autobiographical event generation alters the associated details that are accessed.

Keywords

episodic memory; autobiographical memory; spatial context; temporal context; mental construction

Introduction

Constructing a mental representation of an autobiographical event, whether real or imagined, requires accessing information about the spatial (location) and temporal (chronology) context of the event, both of which rely on episodic memory (Tulving, 2002). Research has

Correspondence regarding this article should be addressed to: Signy Sheldon, signy.sheldon@mcgill.ca; Tel: 514-398-8696.

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documented a central role for contextual information in directing which other event details are accessed and how they are organized at retrieval (Robin, Buchsbaum, & Moscovitch, 2018; Staresina & Davachi, 2009; Tulving, 2002), suggesting that emphasizing the spatial or temporal aspects of an event's context can change how it is remembered (Eichenbaum, 2017; Howard, 2017). In this study, we tested whether activating spatial versus temporal contextual processing prior to autobiographical event generation would shift how the underlying event representation is formed relative to a control induction.

Our research question is based upon the constructive episodic simulation hypothesis that states that episodic memory processes bind together separately-stored details to construct a representation of an imagined or actual autobiographical event (e.g., Schacter & Addis, 2007; Schacter et al., 2012; also see Sheldon & Levine, 2016). Researchers have proposed that this construction tends to occur within the retrieved context of a memory and that providing cues about this context can change the particular details used to form the underlying representation (Moscovitch, 1992; for some related work see Robin & Moscovitch, 2014; Winocur, Kinsbourne, & Moscovitch, 1981). Autobiographical knowledge is theorized to be organized such that general details about experiences are stored at a higher-order level than associated episodic and specific details (activities, location, person) with suggestions that general details are more resistant to change than episodic details (Conway & Pleydell-Pearce, 2000; Rumelhart & Ortony, 1977). This formulation has found support from work showing that the episodic details of an event are more fragile and thus subject to change than general event details (Sekeres et al., 2016).

The above-reviewed theories lead to questions about whether framing an event primarily within a spatial or temporal context (defined here as where activities occurred vs the order in which activities occurred) will lead to differently detailed event representations (defined here as mental simulations of autobiographical experiences; Addis, 2018). Some work has proposed that framing an event within a spatial context will augment accessing perceptually-rich and vivid details (for a review, see Rubin & Umanath, 2015). This proposal is based on scene construction theory, which states that retrieving an event's spatial context will promote connections between the episodic memory processes that support constructing a detailed event representation and processes that support and store perceptual and imagery-based details of our experiences (Bird & Burgess, 2008; Hassabis & Maguire, 2007; Maguire & Mullally, 2013). An alternate but not orthogonal view is that spatial contextual information necessarily instills an envisioned experience and thus reinstates these details during generation (see Madore, Jing, & Schacter, 2019).

There is evidence that using a spatial context to mentally construct an autobiographical event will lead to an episodically and perceptually rich representation. One recent study in which participants reported on autobiographical event narratives found that these participants would spontaneously frame these narratives within a spatial context to construct a vivid imagination of the event (Robin, Wynn, & Moscovitch, 2016). Additional work has found that events recalled within a familiar spatial location tend to be recalled more vividly and with more detail than those recalled in an unfamiliar location (Arnold, McDermott, & Szpunar, 2011; Robin & Moscovitch, 2014) and events cued by spatial contextual cues are re-experienced more vividly than events cued by other types of information (Hebscher, Levine, & Gilboa, 2018; Sheldon & Chu, 2017). These behavioural findings are reinforced by neuroimaging results that have linked a spatial context enhancement effect during autobiographical event generation to activity in medial temporal lobe and posterior brain areas that support episodic memory and perceptually-based imagery, respectively (Robin et al., 2018).

When autobiographical events are framed within a temporal or chronological context, there are indications from laboratory experiments that this will result in episodic memory processes operating differently than when framed within a spatial context. One idea is that unlike spatial information that is directly experienced during autobiographical events, temporal information is more abstract and requires more evaluation of what happened (or will happen) during an experience. Some experiments have shown that recalling temporal contextual information (sequence memory) relies more strongly upon familiarity-based memory processes that are less perceptual and more gist-based than recollection-based memory processes promoted via spatial contextual information (Craver, Kwan, Steindam, & Rosenbaum, 2014; Rosenbaum et al., 2005). The Context Maintenance and Retrieval model of temporal memory (Polyn, Norman, & Kahana, 2009) provides an explanation for this effect, suggesting that sequentially-learned temporal representations are more likely to be integrated with a semantic (i.e., general) than episodic memory network. For example, when retrieving an item’s temporal context from a free recall task, people will often additionally recall semantic associates of that item. Extending to more complex event representations would suggest that framing an event within a temporal context will connect episodic memory processes to areas that process generalized event details when forming event representations, leading to more conceptualized (i.e., generalized) event representations. This idea aligns with theories that temporal or action-based information is useful for conceptualizing and evaluating the semantic meaning and sequence of events during an experience (Swallow, Zacks, & Abrams, 2009; Zacks & Swallow, 2007).

Past and future autobiographical events

It is generally accepted that the episodic memory processes that support remembering details from past autobiographical events are also used to form simulations of future experiences (Schacter et al., 2012; Schacter & Addis, 2007; Sheldon & Levine, 2016; Szpunar, 2010; Szpunar, Spreng, & Schacter, 2014). Findings from a number of neuropsychological studies have reported that patients with deficits in episodic memory also have deficits in imagining future or novel scenarios (Hassabis, Kumaran, Vann, & Maguire, 2007; Klein, Loftus, & Kihlstrom, 2002; Race, Keane, & Verfaellie, 2011; Rosenbaum et al., 2005; but see also Dede, Wixted, Hopkins, & Squire, 2016) and neuroimaging studies have found overlap in the brain networks that support generating autobiographical events regardless of whether these events were from the past or imagined in the future (e.g., Addis, Wong, & Schacter, 2007; for a recent meta-analysis, see Benoit & Schacter, 2015). Even so, there is some evidence that events from these different temporal periods will place different requirements on episodic memory. One such distinction is that mentally constructing past events involves episodic memory processes reactivating (i.e., pattern completing) an event as it occurred, thus rendering these events more constrained in how the associated mental representation is formed (La Corte & Piolino, 2016). In contrast, future events that have yet to be experienced are generated from ‘scratch’ and thus depend more strongly on constructive episodic processes to formulate a representation, presumably making these events more susceptible to changes in how they are framed (Schacter et al., 2012; Schacter & Addis, 2007). It could also be for these future simulations, semantic memory processes are needed to provide a necessary generalized representation or schema for creating complex mental images (Binder and Desai, 2011), and thus semantic memory will interact with episodic memory when forming novel autobiographical representations (Irish et al., 2012). Thus, while it is likely that framing past and future autobiographical events within a spatial versus temporal context will be generated differently, it may be the case that future events are more susceptible to these framing effects, particularly those that relate to accessing generalized information (i.e., temporal).

Current Study

Summarizing above, we predict that emphasizing either the spatial or temporal context of a generated autobiographical event when accessing and organizing the associated details will lead to qualitatively different remembered past and imagined future events. Based on the reviewed literature, we hypothesize that emphasizing a spatial context during autobiographical event generation will enhance the retrieval of perceptual information whereas emphasizing a temporal context will enhance the retrieval of generalized event information. We tested this hypothesis by designing a novel experimental design that leverages the well-validated episodic specificity induction (ESI) paradigm (for a review, see Schacter & Madore, 2016). The ESI is a training protocol, based on the established Cognitive Interview (Fisher & Geiselman, 1992), in which participants are shown a video and are directed towards retrieving specific details from it (i.e., use a mental image to report about the setting, people, and actions). Several reports have shown that the ESI amplifies the episodic content of subsequent tasks ranging from autobiographical recall and future imagining (Madore, Gaesser, & Schacter, 2014) to problem solving (Jing, Madore, & Schacter, 2016; McFarland, Primosch, Maxson, & Stewart, 2017) and creativity (Madore, Addis, & Schacter, 2015; Madore, Jing, & Schacter, 2016), and we encourage the reader to explore these papers for further information regarding the ESI.

We modified the ESI to create versions that oriented participants towards spatial or temporal contextual information to investigate the impact of this manipulation on the way *subsequent* past and future autobiographical events were generated. As such, we scored these event descriptions with two methods. First, we used a standard protocol to score these descriptions for the number of episodic (internal) details using the Autobiographical Interview scoring protocol (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). Next, we created a scoring measure that assessed the effect of the induction techniques on the preference for generating perceptually-based episodic information to create a rich mental representation (e.g., what things looked like, where things were located) versus one for generating broad event-based episodic information that forms the concept of an event. With this new measure, we could directly test how emphasizing a spatial versus temporal context via the induction technique would shift the relative use of these detail types.

With these new techniques and scoring tools, we conducted three experiments. In Experiment 1, we replicated the established ESI effect on past and future event generation in two sessions with a different target event (i.e., video) than has been previously used and tested the new scoring systems described above in comparison to a control induction task. In Experiments 2 and 3, we focused on comparing the effects of the spatial and temporal inductions on autobiographical event generation. In Experiment 2, we contrasted the effects of these two forms of induction with a control induction task by testing participants in three experimental sessions. In Experiment 3, we directly compared the effects of spatial and temporal induction on event generation within one experimental session. By using these two methodologies, we could specify the significant effects attributable to induction manipulations that hold across experiments.

Experiment 1

Method and Materials

Participants.—24 young adults (age 18–23 years, mean =19.6, SD = 1.34, 14 female) were recruited from McGill University via online advertisements or through the University's participant pool. All participants were free from neurological or psychiatric illness, and they were fluent in English. Participants were compensated for their time.

Overview of the procedure.—Each participant completed two experimental sessions – one that included the ESI and one that included the control induction – that occurred approximately 4 days apart. The order of the sessions was randomized across participants and included unique stimuli (i.e., videos, cue-words). See the left panel of Figure 1 for a schematic of this experiment. Each session included the following three phases:

1. Video presentation: Participants watched a video of a complex scenario that followed a participant (Mr. Bean) completing common activities (e.g., drawing) in a familiar location (e.g., a hospital or a restaurant).
2. Induction phase: Participants answered questions about the video's content concerning either episodic-specific information (episodic specificity induction) or general information (control induction).
3. Recall phase: Participants recalled four past events (i.e., past few years) and imagined four future events (i.e., next few years) in response to different neutral cue-words.

Inductions.—During the specificity induction, participants were asked questions about the specific content of the video they had seen during the video presentation phase with the goal of promoting a specific episodic retrieval orientation. To do so, participants were told they were the expert on this video and were guided through imagery-based exercises to help them generate images about the setting, people, and actions from the video. Specific probes used were based on the Cognitive Interview (Fisher & Geiselman, 1992; Memon, Meissner, & Fraser, 2010). Participants stated out-loud everything they remembered from the video. During the control induction, participants were asked questions about their general impressions of the content of the video they viewed, such as what adjectives they would use to describe the setting, people, and actions, rather than questions that targeted episodic memory recall – i.e., they were not asked to focus on or speak about specific details from the video. Both induction conditions took the same length (range of 4 to 7 minutes), such that the only difference was the degree to which participants recalled episodically specific information. We note that previous behavioural (e.g., Madore et al., 2014) and neuroimaging (e.g., Madore, Szpunar, Addis, & Schacter, 2016) work have indicated that effects of ESI are attributed to a boost in performance following the manipulation rather than a decrease in performance following the general impressions induction because indistinguishable ESI effects are exhibited whether the general impressions induction or a math induction is used as the comparison. We thus used the impressions control in Experiment 1, as it is a more rigorous baseline than the math control.

Main task.—During this final recall phase, 16 cue words were presented randomly to the participants and were also randomly assigned to past and future event trials. These cues were nouns selected from the normative data provided by Clark and Paivio (2004). All cue words were four to ten letters in length and were high in frequency (Thorndike-Lorge frequency M = 1.85, SD = .15), imageability (M = 6.38, SE = .26), and concreteness (M = 6.85, SE = .13). These cues were randomly split into two lists, which were cycled through the two induction conditions in a randomized manner. For each cue, participants were given three minutes to generate and verbally describe in as much detail as possible a past or future event. After the participants finished their description, they were given one general probe for more information ('Can you tell me anything else about this event?'). This task format is derived from Madore et al. (2014) where induction-related effects were observed. Responses were audio-recorded and later transcribed for scoring. Each recall trial ended with participants providing the date of the event by classifying the event as happening within the week (1) to over a few years (6), classifying their visual perspective on a 3-point scale (1 – through my own eyes, 2 – from above, 3 – a mix) and then rating the event's vividness, emotional valence, importance, and how often they thought about the event (rehearsal) on five-point scales. These ratings are reported but are not used to test our hypotheses.

Scoring.—As done in prior studies, participants' responses were coded for the number of internal and external details (Levine et al., 2002) by two trained scorers who achieved inter-rater reliability scores that were > .80 for internal and external details (scores were correlational values based on scores on 12 events randomly selected from different participants). Internal details represent episodic content and are defined as segments of information contained in descriptions that are tied to the specific context of the event being described. External details are details that are non-episodic in nature and include semantic facts and commentary as well as content from the episodes that are tangential to the main event being described. The average number of internal and external details was computed for each participant for past and future events (we also calculated a proportion measure for internal details, reported in Appendix C).

New to this study, we calculated a *perception-based detail ratio score* to measure the preference for generating perception-based internal details over generating internal details based on an event's central meaning or gist (Conway & Pleydell-Pearce, 2000; for a similar scoring distinction, see Sekeres et al., 2016). To generate this ratio score, we took the following steps. First, we referred to the established internal detail subcategories from the original scoring protocol (Levine et al., 2002) to broadly classify all internal details as either perception-based or event-based. We defined perception details as those that can rely on perceptual processing to be recalled, which includes descriptions about sensory features of objects (e.g., colors or sizes of recalled objects), the spatial contextual elements of the event as well as event duration and body position information (perception and time/place detail subcategories from the original scoring protocol). Any internal detail that was not classified as perception-based was classified as event-based, which includes details that represent broad gist-like information of an experience. This includes details that provide information about the central story being described, the sequence of what happened, or interpretations of the events as they unfolded (event and thought details from the original scoring protocol). Table 1 provides a description of event information that was captured by this classification system. For this study, we used this system to compute the perception-based detail ratio score with the formula (# perception details / # perception+event internal details) for each generated response and averaged these proportions separately for past and future events. It is worth noting that the calculated perception-based ratio score is the inverse of an event-based detail ratio score and in the below results we test the perception-based detail ratio where appropriate in our ANOVA models. Thus, any induction-related results that boost the perception-based metric thus decrease the event-based metric, and vice versa.

Results

Subjective ratings.—We explored any potential differences in ratings with a series of repeated measures ANOVAs that included induction (control vs specificity) and temporal direction (past vs future) as within-subject factors. These analyses did not show any main effects on the ratings across induction condition (vividness, ($F(1, 23) = .25$, $p = .62$, $\eta_p^2 = .01$; importance, $F(1, 23) = .10$, $p = .61$, $\eta_p^2 = .01$; rehearsal, $F(1, 23) = 1.77$, $p = .20$, $\eta_p^2 = .07$; emotion, $F(1, 23) = .96$, $p = .34$, $\eta_p^2 = .04$), suggesting that any induction-related effects on detail generation will not be due to event experience differences. There were, however, significant effects of temporal direction (past vs future) for vividness ($F(1, 23) = 26.66$, $p < .001$, $\eta_p^2 = .54$), importance ($F(1, 23) = 4.67$, $p = .04$, $\eta_p^2 = .17$), and rehearsal ($F(1, 23) = 8.59$, $p = .008$, $\eta_p^2 = .27$), but not emotion $F(1, 23) = .86$, $p = .36$, $\eta_p^2 = .04$, nor perspective, $F(1, 23) = 3.27$, $p = .09$, $\eta_p^2 = .13$. As documented in Table B1 (Appendix B), events generated to future event cues were rated as more rehearsed (i.e., events that were thought about more often during the day) and more important than those generated to past event cues. Past events were rated as experienced more vividly than future events.

Detail count.—A repeated measures ANOVA with induction (control vs specificity), temporal direction (past vs future), and detail type (internal vs external) as within-subjects factors revealed a significant interaction effect between induction and detail type, $F(1, 23) = 10.35$, $p = .004$, $\eta_p^2 = .31$, in addition to the significant main effects of temporal direction, $F(1, 23) = 27.78$, $p < .005$, $\eta_p^2 = .55$, detail type, $F(1, 23) = 35.24$, $p < .005$, $\eta_p^2 = .61$, and an interaction between temporal direction and detail type, $F(1, 23) = 42.95$, $p < .005$, $\eta_p^2 = .65$. Focusing on the interaction between induction and detail type, post-hoc pairwise comparisons were run on internal and external details. Irrespective of temporal direction, participants generated significantly more internal details after the specificity induction (M = 16.70 SE =1.70) than the control condition (M = 14.10, SE = 1.50; $t = 2.87$, $p = .009$, $d = .33$) and more external details after the control (M = 6.70, SE = .70) than the specificity induction condition (M = 5.60, SE = .60, $t = 2.21$, $p = .03$, $d = .34$).

Perception-based and event-based detail ratio score.—A repeated measures ANOVA on the ratio of internal details that were perceptual with induction (control vs specificity) and temporal direction (past vs future) as within-subject factors revealed no effect of temporal direction ($F(1, 23) = .05$, $p = .83$, $\eta_p^2 = .002$) but one of induction ($F(1, 23) = 8.97$, $p = 0.006$, $\eta_p^2 = .28$). The perception-based ratio was higher after the specific compared to control induction. Since the inverse proportion of this score is an event-based ratio score, this result indicates a greater reliance on event details after the control compared to specificity induction. There was also an interaction effect ($F(1, 23) = 10.04$, $p = .004$, $\eta_p^2 = .31$). Post-hoc comparisons revealed that the perception-based ratio was significantly higher after the specific compared to control induction for future events ($t = 4.27$, $p < .001$, $d = .71$; Figure 2) but this did not reach significance for past events ($t = .78$, $p = .44$, $d = .22$).

Experiment 1 summary.—Replicating prior results, we found a significant interaction between induction and detail type, such that more internal and fewer external details were generated after the ESI than control induction condition for past and future events. Extending published reports, we found that the increase in internal details after the ESI was focused on perception-based details, particularly for future events. Thus, these results provide new information on how episodic retrieval processes are targeted by the ESI, which we consider at length in the discussion section. Having established the validity of our experimental tools in Experiment 1, we examined in Experiments 2 and 3 how orienting to a spatial or temporal context affects subsequent detail generation for past and future events.

Experiment 2

Method and Materials

Participants.—37 young adults were recruited from McGill University; however, three participants were removed because of a later disclosed medical condition, problems understanding the task, not being fluent in English, or because they were identified as outliers (i.e., detail generation was +/− 2.50 standard deviations away from the mean). Thus, the analyzed sample was 32 participants (mean age =20 years, SD = 1.22, 30 female).

Overview of the procedure.—Each participant completed three experimental sessions – one that included the spatial induction, one that included the temporal induction, and one that included the control induction – that occurred approximately 4 days apart. The order of these sessions was randomized across participants and the stimuli (videos, cue-words) were unique for each session. Similar to Experiment 1, participants completed the following three phases for each session: 1. Video presentation 2. Induction phase (spatial, temporal, control), 3. Recall phase. See the middle panel of Figure 1 for a schematic of the experiment.

Inductions.—During the *spatial induction*, participants were asked questions about the specific spatial details of the video that they had watched with the goal of promoting the retrieval of spatial contextual information. To do so, participants were told they were the expert on this video and were guided via mental imagery to recall all the details related to the scene, including the spatial layout, the room, and where things were in the environment. They were specifically instructed to describe only concrete details about the room and how things were arranged and not to recall what happened or the order of actions that occurred. If they did start to describe these details, they were told to re-focus on the spatial elements of the video. During the *temporal induction*, participants were asked questions about the specific temporal order of the actions that occurred in the video as a means of promoting the retrieval of temporal contextual information. Again, participants were told they were the expert on the video and were guided to recall the order that things happened in the video, from start to finish. They were told to focus on the sequence of actions that occurred, as if it were a script. They were specifically instructed to describe only details regarding the timing of actions as they occurred and not details about the surrounding environment. If they did start to describe these details, they were told to re-focus on the temporal elements of the video. The control induction was as described in Experiment 1. All inductions took the same length (range of 4 to 7 minutes), so the only difference was the type and degree to which participants recalled episodically-specific information (see Appendix A for the spatial and temporal induction scripts used in the experiments).

Main task.—During this final phase, participants recalled past events and imagined future events in response to 10 different neutral cue words (5 past event cues and 5 future event cues per induction per session) as described in Experiment 1. Each trial was followed with the subjective ratings described in Experiment 1.

Scoring.—The descriptions were scored as described in Experiment 1.

Results

Subjective ratings.—Similar to Experiment 1, ratings did not differ across induction condition (importance, $F(2, 62) = .93$, $p = .53$, $\eta_p^2 = .02$; rehearsal, $F(2, 62) = .79$, $p = .46$, $\eta_p^2 = .03$; vividness, $F(2, 62) = .47$, $p = .63$, $\eta_p^2 = .02$; perspective, $F(2, 62) = 1.23$, $p = .30$, $\eta_p^2 = .04$; emotion, $F(2, 62) = 1.15$, $p = .32$, $\eta_p^2 = .04$) but there were differences across temporal direction for ratings of importance ($F(1, 31) = 30.20$, $p <.001$, $\eta_p^2 = .493$), rehearsal ($F(1, 31) = 21.37$, $p <.001$, $\eta_p^2 = .41$), vividness ($F(1, 31) = 22.26$, $p <.001$, $\eta_p^2 = .49$), and emotion ($F(1, 31) = 15.41$, $p <.001$, $\eta_p^2 = .33$) but not perspective, $F(1, 31 = 1.32$, $p = .26$, $\eta_p^2 = .04$. Future events were rated as more rehearsed and important than past events, but past events were rated as experienced more vividly and more positive than future events. See Table B2 (Appendix B) for the average rating scores.

Detail count.—We ran a repeated measures ANOVA with induction (control vs spatial vs temporal), temporal direction (past vs future), and detail type (internal vs external) as within-subject factors (Table 2). Focusing on the induction effects, there was no significant main effect of induction ($F(2, 62) = 2.29$, $p = .11$, $\eta_p^2 = .07$) but there was a significant interaction between induction and temporal direction ($F(2, 62) = 7.62$, $p <.001$, $\eta_p^2 = .20$) and a three-way interaction between induction, temporal direction, and detail type ($F(2, 62) = 3.65$, $p = .03$, $\eta_p^2 = .11$). To understand the three-way interaction, the effects of induction and detail type were analyzed independently for each temporal direction. For past events, a 3*2 ANOVA with induction and detail type as within-subject factors revealed no main effect of induction ($F(2, 62) = .76$, $p = .48$, $\eta_p^2 = .02$) but a significant interaction between induction and detail type ($F(2, 62) = 5.12$ $p = .009$, $\eta_p^2 = .15$). Post-hoc comparisons revealed that more internal details were generated after the spatial induction compared to both the control ($t = 2.50$, $p = .02$, $d = .44$) and temporal induction conditions ($t = 2.00$, $p = .05$, $d = .35$). None of the other effects of internal details were significant. None of the pairwise comparisons between the induction conditions for external details were significant. For future events, the 3*2 ANOVA with induction (control vs spatial vs temporal) and detail type (internal vs external) as within-subject factors resulted in a significant main effect of induction ($F(2, 62) = 7.02$, $p = .002$, $\eta_p^2 = .19$), but no interaction of induction with detail type ($F(2, 62) = .83$, $p = .44$, $\eta_p^2 = .03$). Post-hoc comparisons showed that the effect of induction was attributable to more details overall generated in the temporal compared to the control ($t = 2.20$; $p = .04$ $d = .37$), but not after the spatial induction ($t = .17$; $p = .86$, $d = .03$).

Perception-based and event-based detail ratio scores.—A repeated measures ANOVA with induction (control vs spatial vs temporal) and temporal direction (past vs future) as within-subjects factors revealed a main effect of induction on perception-based detail ratio scores ($F(2, 62) = 8.01$, $p < .003$, $\eta_p^2 = .13$), but no interaction with temporal direction ($F(2, 62) = .11$, $p = .90$, $\eta_p^2 = .003$). Post-hoc tests indicated this score decreased in a step-wise fashion from highest scores in the spatial than the temporal ($t = 3.41$, $p = .001$, $d = .58$) and then the control induction conditions ($t = 3.55$, $p < .001$, $d = .55$: Figure 2). The temporal and control inductions did not differ from one another ($t = .14$, $p = .89$, $d = .03$; Figure 3*)*. Inherent in this metric, temporal and control inductions led to a higher event-based ratio relative to spatial induction but did not differ from each other.

Experiment 2 summary.—The spatial and temporal inductions differentially affected generating past and future events. For past events, there were more internal details generated after the spatial induction compared to the other two induction conditions and there was no difference between the induction conditions for external detail generation. For future events, temporal induction selectively increased the ability to generate details, irrespective of detail type, compared to the control condition. While these patterns indicate that spatial induction has a specific effect on past event generation and temporal induction on future events, we found that spatial induction led to a preference in generating perceptual details for all generated events. The temporal and control inductions led to a preference in generating event-based details relative to the spatial induction. Given that the relative effect sizes of the reported results were small, we sought to conceptually replicate Experiment 2 in a follow-up that tested for these effects by directly comparing the temporal and spatial induction conditions within one experimental setting.

Experiment 3

Material and Methods

Participants.—32 participants, collected from a sample of 39 McGill University (age = 21 years SE = 1.3) were included in the analyzed sample. Seven of the participants were removed due to failure to follow instructions (2), because the participant was not fluent in English (3), or because they were identified as outliers (2). Removing these outliers did not change the direction of our effects.

Overview of the procedure.—Participants completed spatial and temporal induction conditions in one experimental session with distinct stimuli sets (videos, cue-words) and a randomized task order across participants. As described in the previous experiments, each session contained three phases: 1. the Video presentation, 2. the Induction (spatial or temporal), and 3. the Recall phase. See the right panel of Figure 1 for a schematic of the experiment.

Inductions.—The spatial and temporal inductions were used as described in Experiment 2.

Main task.—During this Recall phase, participants retrieved and described 4 past events and 4 imagined future events in response to 8 different neutral cue words. Each trial was followed with the subjective ratings described in Experiment 1.

Scoring.—The descriptions were scored as described in Experiment 1.

Results

Subjective ratings.—Ratings did not differ across induction condition (importance, $F(1, 31) = 1.92$, $p = .18$, $\eta_p^2 = .06$; rehearsal, $F(1, 31) = .15$, $p = 71$, $\eta_p^2 = .005$; vividness, (1,31) = .11, $p = .75$, $\eta_p^2 = .003$; perspective, $F(1, 31) = .60$, $p = .45$, $\eta_p^2 = .02$; emotion, $F(1, 31) = 3.14$, $p = .09$, $\eta_p^2 = .09$). There were differences across temporal direction for importance ($F(1,31) = 8.57$, $p = .006$, $\eta_p^2 = .22$), rehearsal, $F(1, 31) = 12.03$, $p = .002$, $\eta_p^2 = .28$), vividness, ($F(1, 31) = 14.91$, $p < .001$, $\eta_p^2 = .33$), and perspective, $F(1, 31) = 10.70$, $p = .003$, $\eta_p^2 = .26$, but not emotion, $F(1, 31) = 1.47$, $p = 2.32$, $\eta_p^2 = .04$. As with Experiment 2, future events were rated as more rehearsed and more important than past events, but past events were rated as more vivid than future events and more likely to be imagined from a first-person perspective. See Table B3 (Appendix B) for the average rating scores.

Detail count.—A repeated measures ANOVA with induction (temporal vs spatial), detail type (internal vs external), and temporal direction (past vs future) as within-subjects factors resulted in a main effect of induction ($F(1, 31) = 7.14$, $p = .01$ $\eta_p^2 = .19$) and an induction interaction effect with detail type ($F(1, 31) = 7.20$, $p = .01$, $\eta_p^2 = .19$; Table 2). Collapsed across temporal direction, there were more internal details generated after the spatial induction compared to the temporal induction ($t = 3.78$, $p < .001$, $d = .55$) and no difference between the inductions for external details ($t = .15$, $p = .84$, $d = .05$). A lack of a three-way interaction indicates that this effect is similar across temporal direction.

Perception-based and event-based detail ratio scores.—The repeated measures ANOVA with induction (spatial vs temporal) and temporal direction (past vs future) as within-subjects factors showed a main effect of induction on perception-based detail ratio scores ($F(1, 31) = 16.21$, $p < .001$, $\eta_p^2 = .35$) and a just significant interaction effect between temporal direction and induction ($F(1, 31)$ 4.76, $p = .04$, $\eta_p^2 = .14$). This score was higher for spatial compared to the temporal induction ($t = 4.03$, $p = .001$; d = .72) and to a greater degree for future events (Figure 4). Inherent in this metric, the event-based detail ratio score was higher for temporal relative to spatial induction and to a greater degree for future events.

Experiment 3 summary.—Like Experiment 2, only the spatial induction led to an increase in the number of internal details used to describe past events, but now this effect extended to future events. Critically, we replicated the selective effects of spatial induction on increasing the perception-based detail ratio score. Because a lower perception-based detail ratio score also reflects a greater reliance on event-based details when generating autobiographical events, our results provide indirect evidence that the temporal induction led to a stronger reliance on event-based details than the spatial induction. We note though that temporal and control inductions did not differ on event-based detail production in Experiment 2.

Discussion

An autobiographical event's spatiotemporal context serves as the critical framework for how that event can be constructed in mind (see Schacter et al., 2012, for review). In this study, we attempted to disentangle the contributions of emphasizing an event's spatial and temporal (actions unfolding) context on the details used to generate past and future autobiographical events. To this end, we leveraged a well-studied episodic specificity induction (ESI) technique that amplifies the use of episodic memory processes on subsequent event generation (Madore et al., 2014) to design two induction techniques that activated spatial or temporal (action-based) contextual episodic memory processes prior to generating mental representations of past and future events. With this new technique, we found evidence that emphasizing spatial relative to temporal contextual information prior to event generation promoted the use of episodic processes to access perceptual details of that event. Notably, there were no induction effects on ratings of event vividness, autobiographical re/pre-experiencing, suggestive that the reported results are not a consequence of participants generating different, less vivid memories, but rather accessing different details to form the memories (for related evidence, see Madore, Szpunar, et al., 2016; Madore et al., 2019).

Prior to comparing the effects of the temporal and spatial induction techniques on autobiographical event generation, our first experiment replicated the typically reported ESI effect with the novel stimuli we used in this study. In line with prior work, we found that the standard ESI increased the ability to generate episodically-specific (i.e., internal) but not the ability to generate extraneous (i.e., semantic or external) details when describing subsequent past and future events (Madore et al., 2014) relative to a control. In addition, this experiment validated our new scoring measure that assessed the ratio of perception-based versus event-based episodic details used to describe events. The perception-based detail ratio revealed that the ESI targets the recruitment of perception-based details during past and future event generation, particularly for future events. Methodologically, this finding fits well with the structure of the ESI technique. The ESI technique is based on the Cognitive Interview (Fisher & Geiselman, 1992; Memon et al., 2010) and involves visual imagery-guided methods (i.e., *close your eyes and imagine this event)* to improve episodic memory retrieval. Imagery-guided forms of event generation have been linked to retrieving vivid, perceptually-rich mental representations that rely on perception-based processes (Brewer & Pani, 1996; Greenberg & Rubin, 2003; Sheldon & El-Asmar, 2018).

The focus of the ESI on perception-based details also lines up with the idea that general thematic details (the activities that occur and the order in which they unfolded) from an experience, those captured by the event-based details, are naturally accessed when the experience is remembered or imagined. Perceptual details that can be considered peripheral to the meaning of an autobiographical experience will only be accessed if specifically prompted with an appropriate cue (Brainerd & Reyna, 2002). For example, a recent study found that peripheral (perceptual) details associated with an experience have a steeper forgetting curve than the central event-based details, yet these perceptual details could be reinstated when an appropriate retrieval cue was present (Sekeres et al., 2016). It is likely that although perceptual details of an autobiographical experience – whether real or imagined – may appear to be ‘lost’ during retrieval, these elements of an event can be actively brought to mind if promoted under the correct circumstances, like those provided by the ESI. This idea fits well with a prominent hierarchical model for autobiographical event knowledge storage that envisages separate methods for accessing event-based and perception-based details (Conway & Pleydell-Pearce, 2000; Loveday & Conway, 2011). At the top of the hierarchy are general event details (thematic knowledge) that represent an event’s meaning that are combined with other similar events in this organizational structure. At the bottom of the hierarchy are perceptual details of one event that are accessed once general event details have been accessed and a particular event related to these details has been selected, likely requiring more selective retrieval cues, such as those induced by the ESI.

The main aim of the reported study was to use the ESI technique to compare how focusing participants towards temporal (action-based) or spatial context information impacted the details used to build subsequent autobiographical event representations. To meet this aim, Experiment 2 and 3 used the newly developed spatial and temporal induction techniques in different experimental designs. In Experiment 2, the effects of these inductions on event generation were compared to a control (general impressions) condition using an across-experimental session design. In Experiment 3, the effects of the spatial and temporal induction conditions were compared within one session. Over and above these methodological differences, the results of these experiments showed that inducing spatial but not temporal contextual processing improved the ability to generate subsequent internal details of events, particularly when generating for past events. Inducing spatial processing increased the proportion of internal details that were perception-based for both past and future events, established from an increase to the perception-based detail ratio score after the spatial as compared to the temporal induction condition. Because an inverse of this ratio score is an increase in the use of event-based details, this finding further suggests that inducing temporal processing relative to spatial processing leads to a stronger reliance on details that are event-based to generate autobiographical experiences.

According to the constructive episodic simulation hypothesis (Schacter & Addis, 2007), episodic retrieval flexibly binds together disparate details of an event to form a coherent representation and, according to other theoretical views, an event's context is a key determinant for how these details are accessed or organized when this representation is formed (Stark, Reagh, Yassa, & Stark, 2017). Our findings that constructing a representation of an experienced event within a spatial context led to a representation that was rich in specific perceptual episodic information fits with recent work that has found that instating the spatial context of an encoded event will promote episodic-based recollective processes compared to when a spatial context is not reinstated (Ameen-Ali, Norman, Eacott, & Easton, 2017). Also aligning with our report, studies have found that spatial information compared to other types of information (e.g., information about the event) improves the ability to recall specific episodic details from the past (Maguire & Mullally, 2013; Robin et al., 2018; Sheldon & Chu, 2017). Thus, we speculate that using a spatial context as a framework for event generation serves to foster a link between episodic memory and perceptual processes to help reactivate the vivid mental experience of an autobiographical event. Another possibility is that the spatial induction enhanced scene construction processing such that a coherent spatial framework - a defining feature of episodic memory - was more strongly formed to guide the generation of autobiographical events (Maguire & Mullally, 2013; Robin, 2018). Although we cannot disentangle whether this induction induced perceptual processing directly or indirectly via scene construction, it is worth noting that with either explanation, it was details rooted in experience and perception that were emphasized by inducing an individual to think about spatial context (for additional evidence on this point, see Madore, Jing, & Schacter, 2019).

The perception-based detail ratio score differences between the experimental inductions further suggest that temporal induction – but also the control induction - led to a preference in accessing event-based details to construct an autobiographical experience. We are cautious to interpret this finding as indication that a temporal induction infused more event-based details into a memory given the similarity in this ratio score to the control condition. This is because emphasizing an event's temporal context essentially activates centralized details regarding what happened, which tend to be stored as generalized knowledge of events and are likely more difficult to shift with an induction (Eichenbaum, 2017; Howard, 2017; Tulving, 2002). That is, the general details of an event represented within a temporal context may be the conceptual or semanticized elements of an experiment that allow one to help understand the meaning of an event (Zacks & Swallow, 2007). In this respect, focusing on temporal aspects - the unfolding of events - may enhance the interplay between semantic and episodic processes when creating event representations, particularly for future, not-yet-experienced events (Irish et al., 2012). This speculation is also in line with accounts of memory processing that suggest that temporal or action-based information has an interactive relationship with semantic memory (Polyn et al., 2009).

So far, we have highlighted the common results from the two experiments that tested the spatial and temporal induction techniques, however, it is important to note the distinctions that emerged across these two experiments. In Experiment 2, the inductions were administered in three separate experimental sessions that also included a control (general impressions) induction condition. Here, we found the temporal induction condition led to more details overall when participants were describing future events, which could be due to imagined events benefiting more from the semantic processes activated during this condition to create a platform (i.e., schema) to construct novel autobiographical representations. However, this effect was not found in Experiment 3 when participants completed only the spatial and temporal inductions in one session. A possibility for this discrepancy could be because we removed the control condition or that the significant effect of temporal induction on overall detail generation of Experiment 2 emerged from within-person variability across multiple sessions (Salthouse & Berish, 2005; Salthouse, Nesselroade, & Berish, 2006). Despite the reason for these experimental differences, the spatial induction more firmly altered the proportion of perception-based details that were generated for autobiographical events, with the effects of the temporal inductions being more questionable. Following some updated views on episodic simulation that suggest that perceptual details are used to refine broader structural details of a generated event (Addis, 2018), this pattern suggests that temporal induction may underlie broader structural aspects of a memory and spatial context helps refine those aspects with experiential-like details. This could mean that spatially-induced details are more peripheral to a generated autobiographical event, potentially less evaluative in nature, and thus are more subject to changes in mental reconstruction.

Conclusions and future directions

The main conclusion from the three experiments reported here is that biasing an individual towards different contextual information provokes alternate strategies for how informational details are accessed and organized when mentally constructing past and future autobiographical experiences. Viewing context as a form of framework to guide how episodic processes associate details to form a coherent experiential representation, our main result is that evoking a spatial context to guide these processes significantly increased the perceptual content of a mental construction. Evoking a temporal context – activating action-based information – led to mental constructions formed with more broad generalized details in a similar fashion to a control condition that did not tap into episodic processes. We close by considering some implications and related avenues of research. First, a broader interpretation of our data is that perceptual details are more flexibly integrated into a mental construction and activated by spatial information. This flexibility may be reflecting episodic processes – those that are supported by the hippocampus – and promoting access to fine-grained details that are inherently perceptual during autobiographical event generation compared to coarse-grained details that are more thematic in nature. This distinction in detail is reminiscent of findings from the neuroimaging literature that suggest that emphasizing memory processes at these different detail hierarchies relies on different neural hippocampal substrates [(fine-grained detailed memories relying upon the posterior hippocampus and coarse-grained detailed memories relying on the anterior hippocampus (Collin, Milivojevic, & Doeller, 2017; Poppenk, Evensmoen, Moscovitch, & Nadel, 2013; Sheldon & Levine, 2016)]. Thus, a possible avenue of research would be to investigate hippocampal alteration from the spatial induction as compared to the temporal induction condition. Also moving forward, it would be of interest to directly compare the standard ESI and the spatial induction on autobiographical event generation, as both seem to increase the proportion of perceptual details. Determining whether there are different detail patterns from the ESI versus the spatial induction would be important to establish the extent of overlap between episodic and spatial processing (for related evidence, see Madore et al., 2019). Finally, our findings also call into question the reasons why we may have multiple methods of mental construction and, particularly, why perception-based details are more susceptible to activation by spatial information. There is a growing body of work showcasing the role of episodic processes that support forming event representations in a number of tasks, such as problem solving (Jing et al., 2016; Madore & Schacter, 2014; Sheldon, McAndrews, & Moscovitch, 2011), creativity (Addis, Pan, Musicaro, & Schacter, 2016; Madore, Jing, et al., 2016), and navigation (Sheldon & Ruel, 2018). Thus, it would be worthwhile to examine whether the targeted induction techniques developed can tease apart the importance of temporal and spatial contextual processes to these tasks.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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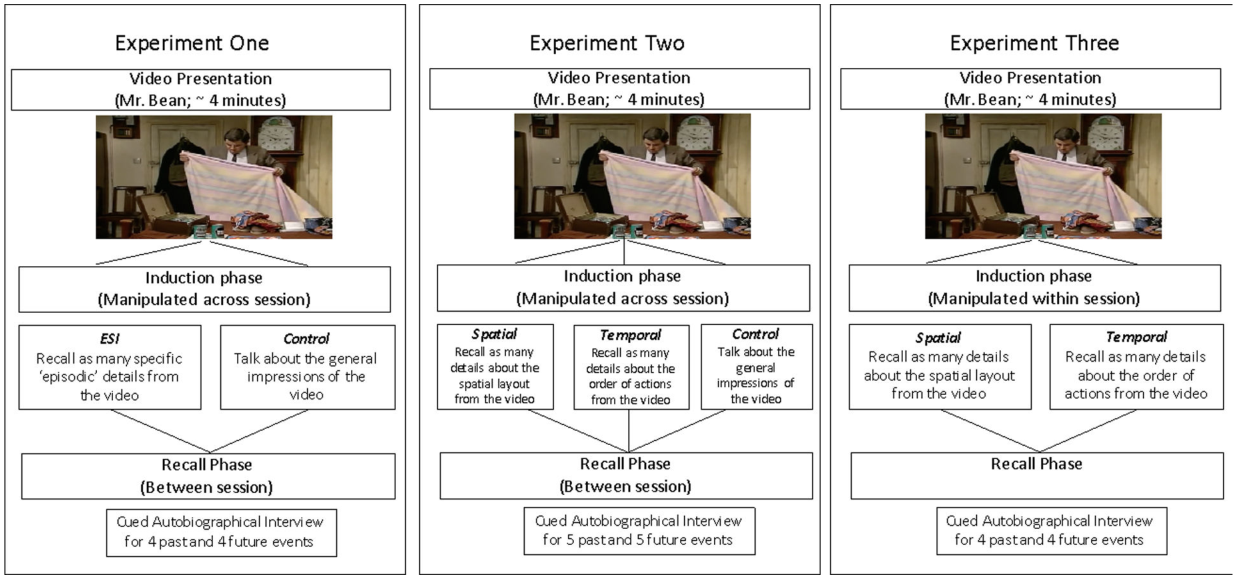

Figure 1.

A schematic of the design used in all three experiments.

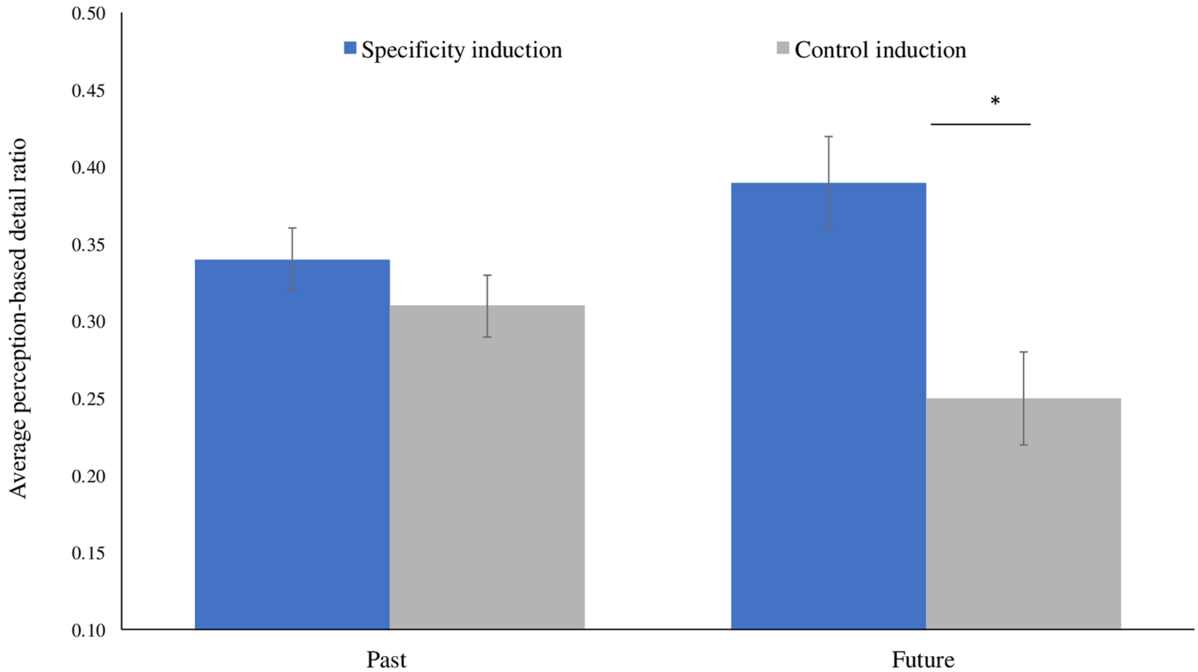

Figure 2.
An illustration of the effect of the specificity and control inductions on the average perception-based detail ratio scores for Experiment 1. Error bars indicate +/− 1 standard error of the mean and significant results are denoted by an asterisk ($p < 0.05$).

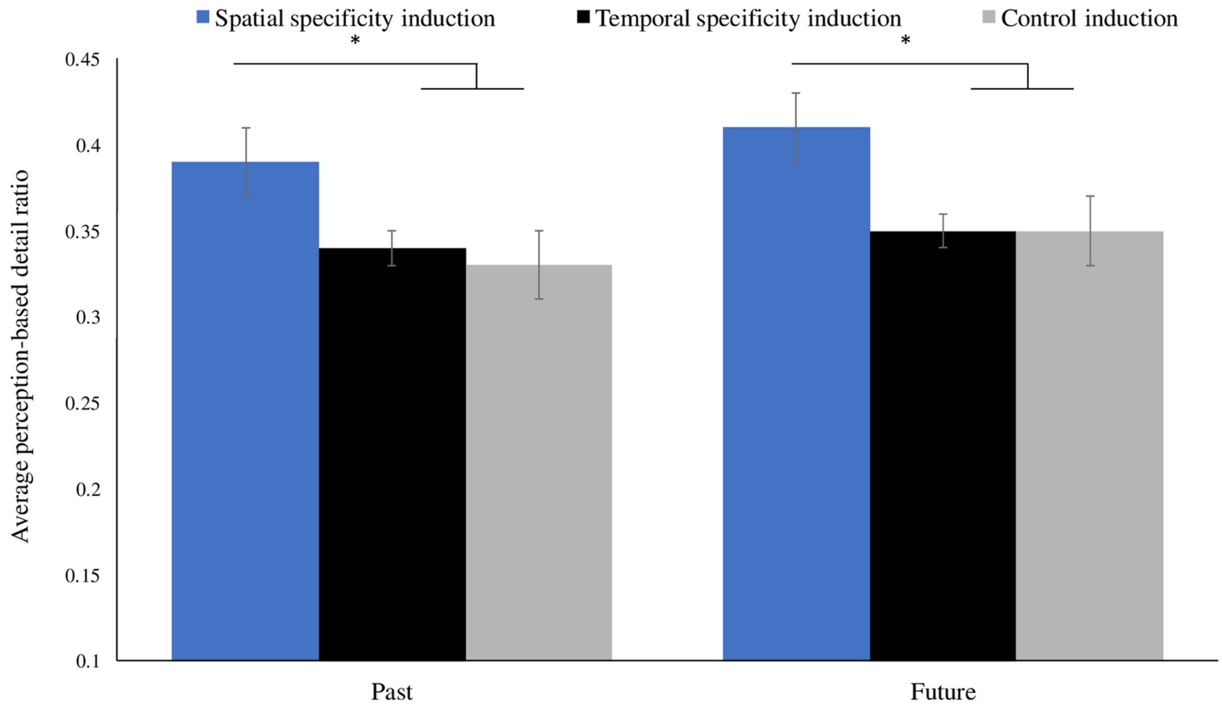

Figure 3.

An illustration of the effect of the spatial, temporal, and control inductions on the average perception-based detail ratio scores for the tested temporal directions (past and future events) for Experiment 2. Error bars indicate +/− 1 standard error of the mean and significant results are denoted by an asterisk ($p < 0.05$).

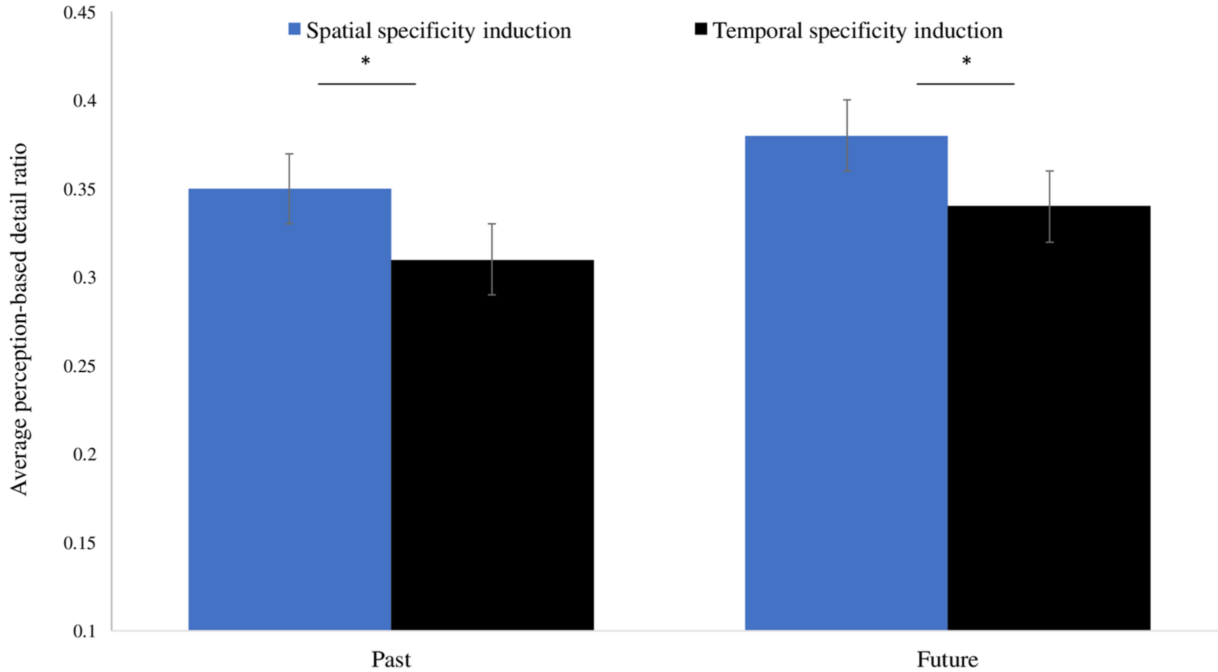

Figure 4.
An illustration of the effect of the spatial and temporal inductions on the average perception-based detail ratio scores for the tested temporal directions (past and future events) for Experiment 3. Error bars indicate +/− 1 standard error of the mean and significant results are denoted by an asterisk ($p < 0.05$).

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Table 1.

A description of episodic informational elements that were classified as perception- vs event-based details that were used to calculate the perception-based vs. event-based detail ratio scores.

Detail	Example	Original subcategory*
Perception-based details		
Descriptors of auditory, olfactory, tactile, taste, visual elements	*The candles were bright red*	Perceptual
Descriptors of objects that are part of the perceptual landscape	*There were lit candles everywhere*	Perceptual
Descriptors about allocentric-egocentric space, body position, and duration	*I was to the right of Phife; The dinner dragged on for over an hour*	Perceptual
Descriptors about the perception of an event's spatiotemporal context	*It was late at night; We were in a fancy restaurant*	Time/Place
Event-based details		
Information about the central event	*We went out for dinner*	Event
Information about sequences of events that occurred	*We ate dinner then ordered dessert*	Event
Information about one's mental state at the time of the event	*I thought he was angry with me*	Thought/Emotion

*The original internal detail subcategories from Levine et al., 2002

Table 2.

The average internal and external details generated for the tested induction conditions across temporal direction (past and future). Standard errors are shown in parentheses.

	Past		Future	
	Internal	**External**	**Internal**	**External**
Experiment 2				
Control	19.0(1.2)	7.9(.6)	14.0(1.1)	6.7(.5)
Spatial	21.0(1.0)	6.7(.6)	15.0(1.3)	6.5(.5)
Temporal	19.5(1.0)	7.5(.6)	16.0(1.1)	7.4(.6)
Experiment 3				
Spatial	28.0(1.4)	14.0(1.4)	23.0(1.2)	10.6(1.3)
Temporal	25.0(1.6)	13.0(1.0)	21.0(1.3)	10.4(1.0)