Remembering the past and imagining the future: Selective effects of an episodic specificity induction on detail generation

Kevin P. Madore and **Daniel L. Schacter**

Harvard University, Department of Psychology

Abstract

According to the constructive episodic simulation hypothesis, remembering past experiences and imagining future experiences both rely heavily on episodic memory. However, recent research indicates that non-episodic processes such as descriptive ability also influence memory and imagination. We recently found that an episodic specificity induction – brief training in recollecting details of past experiences – enhanced detail generation on memory and imagination tasks but not a picture description task, and thereby concluded that the induction can dissociate episodic processes involved in remembering the past and imagining the future from those non-episodic processes involved in description. To evaluate the generality of our previous findings and to examine the role of generative search in producing those findings, we modified our paradigm so that word cues replaced picture cues, and a word comparison task that requires generation of sentences and word definitions replaced picture description. Young adult participants received either a specificity induction or one of two control inductions before completing the memory, imagination, and word comparison tasks. Replicating and extending our previous work, we found that the specificity induction increased detail generation in memory and imagination without having an effect on word comparison. The induction's selective effect on memory and imagination stemmed from an increase in internal (i.e., on-topic and episodic) details and had no effect on external (e.g., off-topic or semantic) details. The results point to the efficacy of the specificity induction for isolating episodic processes involved in remembering the past and imagining the future even when a non-episodic task requires generative search.

Keywords

Research examining the relationship between remembering past experiences and imagining or simulating future experiences has grown dramatically during recent years (for reviews, see Klein, 2013; Schacter, Addis, & Buckner, 2008; Schacter, Addis, Hassabis, Martin, Spreng, & Szpunar, 2012; Szpunar, 2010). According to the constructive episodic simulation hypothesis (Schacter & Addis, 2007), many of the striking similarities that have been documented between remembering the past and imagining the future reflect the influence of

Address correspondence to: Kevin P. Madore Harvard University, Department of Psychology 33 Kirkland Street, Cambridge, MA 02138 Phone: 617-495-3856, Fax: 617-495-3728 madore@fas.harvard.edu.

episodic memory (Tulving, 1983, 2002), which is thought to support the retrieval of details about past experiences and the flexible recombination of those details into simulations of possible future scenarios (i.e., episodic future thinking; Atance & O'Neill, 2001).

However, recent research concerning age-related changes in memory and future thinking has suggested an alternative interpretation of observed similarities between remembering the past and imagining the future that highlights the role of non-episodic influences. Several studies have reported that young adults recall more specific details from past experiences, and imagine more specific details about possible future experiences, than do older adults (e.g., Addis, Musicaro, Pan, & Schacter, 2010; Addis, Wong, & Schacter, 2008; Cole, Morrison, & Conway, 2013; Rendell, Bailey, Henry, Phillips, Gaskin, & Kliegel, 2012; for review, see Schacter, Gaesser, & Addis, 2013). According to the constructive episodic simulation hypothesis, such findings are attributable mainly to age-related declines in episodic memory that result in comparable age-related declines during episodic simulation/future thinking (Addis et al., 2010, 2008). Contrary to this interpretation, however, Gaesser, Sacchetti, Addis, and Schacter (2011) reported a similar pattern of results using a picture description task that does not require and should not involve episodic memory: older adults reported fewer specific details concerning the contents of presented pictures than did young adults. These findings suggest a role for non-episodic factors in driving the observed age effects, such as age-related changes in narrative style, communicative goals, or inhibitory control (cf., Adams, Smith, Nyquist, & Perlmutter, 1997; Arbuckle & Gold, 1993; Labouvie-Vief & Blanchard-Fields, 1982) that could similarly impact performance on tasks that tap remembering past experiences, imagining future experiences, and describing pictures (for discussion, see Gaesser et al., 2011; Schacter et al., 2013). More generally, these observations raise the possibility that many of the similarities documented between remembering the past and imagining the future in both young and older individuals could reflect the influence of such non-episodic factors rather than the influence of episodic memory (note, however, that this line of reasoning primarily applies to tasks requiring verbal descriptions and is probably less relevant to studies measuring phenomenological similarities in remembering and imagining with Likert scales [e.g., D'Argembeau & Van der Linden, 2004]).

In an attempt to distinguish episodic and non-episodic influences on remembering the past and imagining the future, Madore, Gaesser, and Schacter (2014) recently developed an experimental approach involving an *episodic specificity induction*: brief training in recollecting specific details of past experiences. After viewing a brief video of an everyday scene, participants received an episodic specificity induction based on the well-established Cognitive Interview (CI; Fisher & Geiselman, 1992; for recent review, see Memon, Meissner, & Fraser, 2010). The specificity induction guided participants to generate a mental picture of the scenes they had viewed in the video and report everything they remembered about the scenes in as much detail as possible, including what people looked like and did, how objects were arranged, and related episodic information. After receiving the specificity induction or control inductions (one requiring participants to describe their general impressions of the video, another requiring completion of math problems), participants performed memory, imagination, and picture description tasks like those used

by Gaesser et al. (2011) in which they had three minutes to remember a past experience related to a pictorial cue (a color picture of an everyday scene), imagine a plausible future experience related to the pictorial cue, or simply describe the picture. As in Gaesser et al. (2011) and earlier related studies (Addis et al., 2010, 2008), protocols were scored using an adapted version of the Autobiographical Interview (AI; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002), which distinguishes between two types of detail that comprise memories of personal experiences: "internal" details that are on-topic and episodic in nature, concerning what happened during an experience, who was there, and when and where the event occurred; and "external" details that are mainly semantic in nature, such as related facts, reflections on the meaning of what happened, or off-topic commentary and references to other events. Adapting this scoring procedure to memory, imagination, and picture description tasks using the methods of Gaesser et al. (2011), Madore et al. (2014) found that compared with control inductions, the episodic specificity induction selectively increased the number of internal details in remembered past experiences and imagined future experiences, while having no effect on the number of internal details reported during picture description, and no effect on the number of external details provided during any of the tasks.

The observed pattern of results suggests that the specificity induction selectively targets and enhances episodic retrieval on the memory and imagination tasks. We therefore argued that, consistent with the constructive episodic simulation hypothesis, these data provide evidence that remembering the past and imagining the future both depend heavily on episodic memory, whereas picture description relies on non-episodic processes that are unaffected by the specificity induction. However, the results of the Madore et al. (2014) study provide only limited support of these conclusions, for at least two reasons. First, it is unknown whether the key pattern of results that we reported (i.e., specificity induction selectively impacts memory and imagination tasks) is specific to the particular cues and tasks that we used, or whether the pattern applies more broadly. If the specificity induction indeed distinguishes episodic from non-episodic processes, then the results reported by Madore et al. (2014) should generalize to cues and tasks other than those used in our initial study.

A second, related issue concerns our prior use of picture description as the "non-episodic" task. We argued that in contrast to the memory and imagination tasks, picture description should not recruit episodic retrieval. However, the picture description task also differs from memory and imagination tasks in that the latter two tasks required participants to use pictures as a basis for engaging in a controlled, generative search (e.g., Addis, Knapp, Roberts, & Schacter, 2012; Conway & Pleydell-Pearce, 2000) to construct a remembered or imagined experience. By contrast, in the picture description task, responses are much more directly constrained by the properties of the picture itself and generative search is not required. In other words, compared with the memory and imagination tasks, picture description can be said to provide more environmental support (Craik, 1983; Lindenberger & Mayr, 2014) for target responses. It is thus important to determine whether the specificity induction that we used in Madore et al. (2014) can dissociate episodic from non-episodic processes under conditions in which the non-episodic task also requires generative search and retrieval.

To accomplish the foregoing objectives, we compared the effects of the specificity induction on episodic memory and imagination/future thinking tasks and a non-episodic task that uses word cues instead of the picture cues used by Madore et al. (2014). We call this latter task *word comparison,* and it is based on similar tasks developed in previous research (e.g., Addis, Pan, Vu, Laiser, & Schacter, 2009; Addis, Wong, & Schacter, 2007). The word comparison task requires participants to engage in generative search and retrieval by constructing a sentence containing words that refer to relatively larger and smaller objects than the object referred to by a cue word, and then to generate definitions of each word (see Method for more details), but does not require remembering or imagining personal episodes. We analyzed responses on the memory and imagination tasks using a version of the AI based on that used in our previous studies (Addis et al., 2010, 2008; Gaesser et al., 2011; Madore et al., 2014), and further adapted the AI scoring procedures to analyze the number of details provided in definitions that participants generated on the word comparison task (see Method). Internal and external details are comparable on the memory and imagination tasks, but because participants do not generate episodic details on the word comparison task, "internal" and "external" details on this task are not strictly comparable to internal and external details on the memory and imagination tasks (see Method). Thus, to compare performance across the three tasks, and to ensure that our conclusions regarding how the specificity induction impacts detail generation do not depend on the particular criteria used for distinguishing internal from external details, we collapsed across internal and external detail categories to generate a total detail score for each task. In addition, to assess whether results from the present paradigm replicate our previous findings concerning effects of the specificity induction on internal and external details in memory and imagination (Madore et al., 2014), we also analyzed the effects of the specificity induction on these tasks with respect to internal versus external details.

We compared AI responses on the three critical tasks following viewing of a video and a subsequent specificity induction, or two control inductions: one that required participants to describe their general impressions of the video and the other that required participants to complete math problems (the two control conditions yielded similar results in our previous work [Madore et al., 2014] but were included here to determine the generality of this outcome). If the specificity induction selectively affects performance on episodic but not non-episodic tasks, then performance should be enhanced on the memory and imagination tasks following the specificity induction compared with control inductions, but not on the word comparison task. By contrast, if the specificity induction affects generative retrieval regardless of whether the tasks tap episodic or non-episodic processes, then performance should be enhanced on all three tasks following the specificity induction compared with control inductions.

Method

Participants

Thirty-two young adults (age 18-27 years, $M = 20.69$, $SD = 1.91$, 21 female) participated in the study for pay or for course credit. They had attained an average of 14.06 years of education (12-18 years of education, $SD = 1.63$) at the time of study and were recruited via

postings at Harvard University and Boston University. All participants had normal or corrected-to-normal vision and no history of neurological impairment. Participants provided written informed consent before the study commenced and were treated in accordance with guidelines supported by the Committee on the Use of Human Subjects Research at Harvard University.

Materials, Design, and Procedure

Overview—Participants completed the study in one session comprised of two different segments separated by a 5-minute break during which they performed an odd-even number judgment task. In each of the two segments, participants 1) watched different versions of a short video involving two people carrying out routine actions in a kitchen and then completed a filler task, 2) after completing these tasks, received the episodic specificity induction or one of two control inductions, and 3) following each of the inductions, completed memory, imagination, and word comparison tasks in response to a total of 48 word cues, where they recalled a past experience, imagined a future experience, or generated a size sentence and word definitions for each trial.

Inductions—The key manipulation occurred in the induction phase of each segment after participants had watched the video and done the filler task. All participants were randomly assigned to receive the episodic specificity induction in one of the two segments. They were also randomly assigned to receive the *impressions control induction* or the *math control induction* in the other segment. The induction manipulation itself (i.e., control vs. specificity) was a within-subjects factor while the control induction received was a between-subjects factor (i.e., impressions vs. math). The order of inductions presented was counterbalanced across participants, as was the induction-video pairing. The entire study took approximately 2.5 to 3 hours to complete.

Participants received the *episodic specificity induction* during either the first or second segment of the study. As in our previous work (Madore et al., 2014; Madore & Schacter, 2014), the induction was a modified CI (Fisher & Geiselman, 1992). Participants were first told that they were the chief expert about the video they had seen and were then asked to verbally report about episodic details they remembered related to the setting, people, and actions in the video. For each category of information, participants were instructed to report everything they remembered in as much detail as possible using mental imagery probing (e.g., "Please close your eyes and get a picture in your mind about the people in the video you saw... Once you have a really good picture I want you to tell me everything you remember about the people. Try to be as specific and detailed as you can."). The setting probe asked participants to focus on the environment, the objects in it, and how they were arranged; the people probe asked participants to focus on what they looked like and what they were wearing; and the actions probe asked participants to focus on what they were and how the people did them, starting with the first one and ending with the last one. Participants were also asked to expand on different aspects of the video they had mentioned with follow-up probes that were typically presented in an open-ended, "tell me more" manner (e.g., "You said the man first brought in flowers. Tell me more about the flowers."). For each

category, participants were generally asked one follow-up probe. See Madore et al. (2014) for the specificity induction script.

Participants received one of two versions of the control induction during whichever segment of the study they did not receive the specificity induction, as in our previous work (e.g., Madore et al., 2014). Participants who received the *impressions control induction* were first asked to verbalize their general opinions, impressions, and thoughts about the video they had seen. They were then asked to provide their opinions of the setting, actions, and people in the video specifically, and adjectives they would use to describe each. Participants also responded to a number of questions from a question bank. These included items such as when they thought the video was made and if it reminded them of anything from their own lives. After going through the question bank, participants were asked if they wanted to say anything else about the video or about their impressions or opinions of it. This control induction required participants to reflect on and speak about the contents of the video they had seen, as in the specificity induction; the main difference was that the control induction elicited general impressions from participants while the specificity induction elicited episodic details from participants. See Madore et al. (2014) for the impressions control induction script.

Participants who did not receive the impressions induction for the control instead received the *math control induction*. Here participants did not speak about the contents of the video they had seen; they simply filled out a packet of addition and subtraction math problems after watching the video and doing the filler task. We included two control inductions to ensure that any differences in performance from baseline on the main tasks could be attributed to a boost from the specificity induction and not to a reduction from the impressions control induction (for detailed discussion of this issue, see Madore et al., 2014). Participants did not significantly differ at the $p < .05$ level in terms of age, education level, or gender as a function of control induction.

On average, participants also spent similar amounts of time in the control induction ($M = 3$ minutes, 26 seconds, $SD = 1$ minute, 22 seconds) and the specificity induction ($M = 3$ minutes, 48 seconds, $SD = 1$ minute, 7 seconds), $F(1, 31) = 2.13$, $MSE = 3802.26$, $p = .16$, $\eta_p^2 = .06$.

Adapted Autobiographical Interview—After the induction phase, participants transitioned to an adapted AI task that involved *construction* and *elaboration* phases (e.g., Addis, Cheng, Roberts, & Schacter, 2011; Addis et al., 2009, 2007). In each of the two segments, participants saw 48 different word cues and were asked to remember an event from the past few years related to the cue, imagine an event that could occur in the next few years related to the cue, or complete a word comparison task. For the memory and imagination trials, participants were instructed to think of a single event lasting a few minutes to a few hours that spanned no longer than a day. They were instructed to think about the event through their own eyes and to think of everything they could in as much detail as possible, including the people involved in the event, their actions, and emotions. For the word comparison task, participants were instructed to use the cue in a size sentence with two related words and to then think of a definition for each word. They were also

instructed to think of everything they could in as much detail as possible. For example, if the word cue were "Apple", then participants could come up with the size sentence "Tree is larger than Pie is larger than Apple" and then define each of the three words. Participants were instructed to use the X > Y > Z format for their size sentence specifically (i.e., larger than rather than smaller than) as in previous work (e.g., Addis et al., 2011). While all three tasks involve building on, integrating, and generating details that are related to the cue at hand, only for the memory and imagination tasks are these details primarily episodic in nature (see Addis et al., 2009, 2007).

After the presentation of each cue, participants had 26 seconds to mentally (i.e., silently) produce a memory, imagination, or word comparison before they verbalized the content generated during this time period. We used this procedure because the present study also served as a behavioral pilot for a functional MRI study that would require silent thought during scanning, and our 26-second trial length is based on the trial length used previously in relevant neuroimaging studies (e.g., Addis et al., 2011, 2009, 2007). During the 26-second silent period, participants hit the space bar when they had initially *constructed* their memory, imagination, or size sentence. They then mentally *elaborated* on the details of their memory or imagination, or the definitions of the words contained in their size sentence, for the remainder of the 26-second silent period. After the silent period ended, participants verbalized what they had thought about during the silent period. This latter phase was self-paced, and participants spoke without any input or probing from the experimenter. After participants had finished speaking, they hit the space bar to move on to the next trial.

The 96 word cues for the AI task were nouns used by Addis et al. (2011). The nouns were high in imageability, concreteness, and Thorndike-Lorge frequency according to Clark and Paivio's (2004) extended norms. The word cues were divided into different lists of 16, and the lists did not differ significantly in these characteristics (Fs 1.18, MSEs 0.02, ps > .28, η_p^2s .07). There were 6 memory trials, 6 imagination trials, and 4 word comparison trials per list. In each segment, participants viewed 3 lists for a total of 18 memory trials, 18 imagination trials, and 12 word comparison trials per segment (i.e., 48 trials per segment). The order of the trials within each list was randomized across participants, and the word cues contained in each list were randomly paired with the different task types.

Coding

Participants' responses for the memory, imagination, and word comparison trials were audio-recorded during the study and later transcribed and scored. Scoring focused on segmenting the bits of information contained in participants' responses into meaningful units, as is typically done in studies using the AI (see Levine et al., 2002) and in our previous work with the induction (Madore et al., 2014; Madore & Schacter, 2014). Internal details for memory and imagination were episodic and on-topic in nature (e.g., time, setting, people, objects, actions, feelings, and/or thoughts about the one central event). External details for memory and imagination were semantic or off-topic in nature (e.g., facts, commentary, repetitive information, and/or disconnected from the one central event). Internal details for the word comparison task were details contained in the definitions of the three words that were on-topic and meaningful (e.g., for the "Apple" cue an internal detail

could be describing an apple as a fruit, or an apple as red). External details for word comparison were bits that were off-topic, repetitive, disconnected from the definitions, or not meaningful (e.g., for the "Apple" cue an external detail could be describing the task as hard, or repeating that an apple is a fruit). As noted earlier, because the criteria for internal and external details were necessarily slightly different when applied to the memory and imagination tasks on the one hand and the word comparison task on the other, we calculated a total detail count on each of the three tasks based on scoring done for internal and external details. Scoring was completed by one of three raters blind to experimental hypotheses and to which induction had been received. Before viewing the main experimental responses, these raters completed training and scored a practice set of 20 separate responses from young adults. Inter-rater reliability was high, with a Cronbach's α of .95 for total details, .95 for internal details, and .91 for external details.

Results

Preliminary Analyses

Reaction time—We first examined whether participants varied in how long it took them to mentally construct a memory, imagination, or word comparison during the AI as a function of the within-subjects factors of Induction (Control vs. Specificity) and Task (Memory vs. Imagination vs. Word Comparison) and the between-subjects factor of Control Condition (Impressions vs. Math). Previous work (e.g., Addis et al., 2011, 2009) has found that remembered and imagined events typically take similar amounts of time to construct, while word comparison slightly differs. Using a mixed-factorial ANOVA and follow-up tests in the form of repeated measures ANOVAs, we found a similar pattern. There was a significant main effect of Task on reaction time during construction, $F(1.64, 49.27) = 34.08$, $MSE = 3.84$, $p < .001$, $\eta_p^2 = .53$ (the Huynh-Feldt correction was used to correct for violations of sphericity assumptions for the Task variable). Collapsed across induction and control condition, participants took significantly longer to construct a word comparison than they did to construct a memory, $F(1, 31) = 41.42$, $MSE = 2.28$, $p < .001$, $\eta_p^2 = .57$, or imagination, $F(1, 31) = 40.34$, $MSE = 1.58$, $p < .001$, $\eta_p^2 = .57$. The word comparison took approximately 2.5 seconds longer to construct compared with memory and approximately 2 seconds longer compared with imagination. Importantly, participants did not differ significantly in how long it took them to construct in memory or imagination, though there was a trend towards significance, $F(1, 31) = 41.42$, $MSE = 0.77$, $p = .06$, $\eta_p^2 = .11$. This pattern of results – with no significant differences in reaction times for construction in memory and imagination, and slightly different reaction times for construction in the semantic word task – indicates that participants were completing the study as has been done previously (e.g., Addis et al., 2009).[1]

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[1]It should be noted that in Addis et al. (2009) participants took less time to construct a word comparison than to construct a remembered or imagined event, whereas here we found that participants took more time to construct a word comparison. We do not think this difference is important because participants overall did not significantly differ in times to construct for the episodic event tasks. Moreover, recent evidence from Hach, Tippett, and Addis (2014) with young adults shows the same pattern we found in the current study, with time to construct longer for word comparison than for the episodic event tasks (which do not differ from each other).

The main effect of Task on reaction time was the only significant finding in this model. The Induction and Control Condition main effects were non-significant, and these variables did not interact significantly with each other or with the Task variable (Fs 2.67, MSEs 1.64, ps .11, η_p^2s .08). Of critical importance, this pattern indicates that participants spent similar amounts of time mentally constructing memories, imaginations, and word comparisons after they received the control and specificity inductions, regardless of the type of control induction used as the comparison. That is, participants spent similar amounts of time mentally elaborating on their memories, imaginations, and the definitions of the words in their comparisons with both the control induction and the specificity induction, and when both types of control inductions were used as the comparison (because each 26-second trial window was divided into self-paced construction and elaboration times). This finding is important because it suggests that any significant effects of the induction are attributable to factors other than the length of time spent mentally constructing and mentally elaborating after the control and the specificity inductions.[2] Table 1 displays the construction times collapsed across induction and split by induction.

Carryover—We also conducted a preliminary analysis to determine whether the total number of details that participants generated on the memory, imagination, or word comparison tasks differed as a function of whether they received the specificity induction in the first segment or in the second segment. Although we have not found carryover effects from either the specificity or control inductions in previous studies using counterbalanced designs (e.g., Madore et al., 2014; Madore & Schacter, 2014), this study differed from our prior studies in that participants received the second induction almost immediately after the first; in our previous studies, participants received the second induction approximately one week after the first induction. We conducted a series of mixed-factorial ANOVAs on details generated for the memory, imagination, and word comparison tasks similar to the analysis described above for reaction times that included Induction Order (i.e., carryover) as an independent variable. We found no significant main effects or interactions associated with Induction Order on total details, internal details, or external details (Fs 2.31, MSEs 2.33, ps .11, η_p^2s .08). These results indicate that participants performed similarly in the study irrespective of whether they received the specificity induction in the first segment or second segment, and that any significant findings or lack thereof are not attributable to carryover effects.

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[2]We also examined how long participants spent generating a description in response to each cue, as well as word count. We found that participants spent significantly longer describing, $F(1, 31) = 4.96$, $MSE = 6.99$, $p = .033$, $\eta_p^2 = .14$, and used more words on memory trials, $F(1, 31) = 6.65$, $MSE = 39.76$, $p = .015$, $\eta_p^2 = .18$, when they had received the specificity induction compared with the control induction. We did not find significant differences in timing or word count on the imagination trials or word comparison trials as a function of induction (Fs 2.03, MSEs 5.17, ps .17, η_p^2s .06). Thus, it seems unlikely that the differences in timing and word count on memory trials are critical to the specificity induction effect because we observed the same detail boost from the specificity induction on the imagination task, where timing and word count did not differ. Moreover, it is not unreasonable to expect that the specificity induction could help participants generate richer and more detailed events on a later task than they otherwise would, which could be reflected in timing and/or word count differences. We have also observed the same specificity induction benefit on memory and imagination tasks when time is held constant across conditions (i.e., Madore et al., 2014; Madore & Schacter, 2014) rather than self-paced.

Main Analysis

Induction and details—To address our main hypotheses we first examined whether the episodic specificity induction impacted performance on the different components of the AI task in terms of total details generated, and whether any effects found depended on the control condition used as the comparison. To do this we performed a mixed-factorial ANOVA with the within-subjects factors of Induction (Control vs. Specificity) and Task (Memory vs. Imagination vs. Word Comparison) and the between-subjects factor of Control Condition (Impressions vs. Math). We computed the main effects and interactions for the different factors, and focus here on the interactions found because they a) trumped the main effects and b) address our hypotheses most directly. Follow-up tests were repeated-measures ANOVAs to ensure that the same effect size measure was used throughout the analyses. To anticipate our main findings, as shown in Figure 1 and Table 2, which display the results collapsed across control inductions and also split by control induction, these findings extend our previous work (Madore et al., 2014): compared with the control inductions, the episodic specificity induction significantly increased total details on memory and imagination tasks but had no effect on the word comparison task.

We found a significant two-way interaction of Induction $\times$ Task, $F(2, 60) = 3.56$, $MSE = 4.73$, $p = .035$, $\eta_p^2 = .11$; the three-way interaction of Induction $\times$ Task $\times$ Control Condition was non-significant, $F(2, 60) = 0.37$, $MSE = 4.73$, $p = .70$, $\eta_p^2 = .01$. The Control Condition variable did not interact significantly with Induction or Task separately (Fs 0.23, MSEs 11.55, ps .64, η_p^2s .01). Collapsed across control conditions, participants generated a significantly greater number of total details on the memory task, $F(1, 31) = 8.18$, $MSE = 11.69$, $p = .008$, $\eta_p^2 = .21$, and the imagination task, $F(1, 31) = 13.47$, $MSE = 2.43$, $p = .001$, $\eta_p^2 = .30$, when they received the specificity induction compared with the control inductions; critically, total details on the word comparison task did not differ significantly as a function of induction, $F(1, 31) = 0.39$, $MSE = 6.41$, $p = .54$, $\eta_p^2 = .01$.

Given that the specificity induction boosted total details generated in memory and imagination without affecting word comparison, we conducted a second analysis to examine whether there were differences in the type of detail the induction affected. We focused on memory and imagination because these were the two tasks that the induction impacted, and we divided the total details into internal and external details as in our previous work (e.g., Madore et al., 2014). We used another mixed-factorial ANOVA with the within-subjects factors of Induction (Control vs. Specificity), Task (Memory vs. Imagination), and Detail (Internal vs. External) and the between-subjects factor of Control Condition (Impressions vs. Math). We focused on the interactions found and follow-up tests were repeated-measures ANOVAs.

We found a significant two-way interaction of Induction $\times$ Detail, $F(1, 30) = 13.73$, $MSE = 5.58$, $p = .001$, $\eta_p^2 = .31$; the Task and Control Condition variables were non-significant when added to this interaction separately or together (Fs 0.97, MSEs 3.29, ps .33, η_p^2s .03). The two-way interactions of Induction $\times$ Task and Induction $\times$ Control Condition were also non-significant (Fs 1.35, MSEs 3.06, ps .26, η_p^2s .04). Collapsed across task and control condition, the specificity induction significantly increased internal details

generated on memory and imagination compared with the control induction, $F(1, 31) =$ 14.74, $MSE = 4.62$, $p = .001$, $\eta_p^2 = .32$, and had no effect on external details, $F(1, 31) = 2.14$, $MSE = 0.12$, $p = .15$, $\eta_p^2 = .06$. We also found the same pattern of results when the memory and imagination tasks were analyzed separately. As displayed in Figures 2-3 and Table 2, the dissociable effect of the induction on memory and imagination internal details – but not external details – replicates and extends our previous work (e.g., Madore et al., 2014).

It should also be noted that while the main analysis indicated the specificity induction had no effect on total detail generation in word comparison, we also ran a secondary analysis including this task in the model and examined the follow-up tests for word comparison internal and external details, as defined in the Method: as in total detail, the specificity induction had no effect on the internal, $F(1, 31) = 0.17$, $MSE = 6.63$, $p = .68$, $\eta_p^2 = .01$, or external details, $F(1, 31) = 1.99$, $MSE = 0.13$, $p = .17$, $\eta_p^2 = .06$, generated in word comparison (see Table 2).

Discussion

The results of the present study extend our previous findings concerning the effects of a specificity induction on episodic and non-episodic processes (Madore et al., 2014) in two important ways. First, our finding that the specificity induction, compared with control inductions, produced a significant increase in internal but not external details when participants remembered the past and imagined the future in response to word cues indicates that our previous report of the same pattern with picture cues is not restricted to those cues and generalizes across cue types. Second, our finding that the specificity induction selectively affected details generated in the memory and imagination tasks, while having no effect on details generated in the word comparison task, indicates that the specificity induction can dissociate episodic from non-episodic processes under conditions in which the non-episodic task requires generative search and retrieval (Addis et al., 2012; Conway & Pleydell-Pearce, 2000), in contrast to the picture description task used in our previous study (Madore et al., 2014). As discussed in the Introduction, the picture description task provides more environmental support (Craik, 1983; Lindenberger & Mayr, 2014) for responding than do the memory and imagination tasks: responses on the picture description task are highly constrained by physical properties of the picture, such that generative search is not required, whereas memory and imagination tasks require generative search. The word comparison task used here also requires generative search to come up with details of word definitions, yet no effects of the specficity induction were observed on generation of definition details.

These results are consistent with the idea that the effects of the specificity induction are selective to tasks that draw on episodic retrieval, including tasks that involve imagining future personal experiences. More specifically, we hypothesized previously (Madore et al., 2014) that the induction affects a specific subcomponent of retrieval known as *episodic retrieval orientation* (Morcom & Rugg, 2012): retrieval cue processing that involves a focus on the specific episodic details (e.g., details of places, people, and actions) that comprise an episode. During the specificity induction, asking participants to generate a picture in their minds about the environment, people, and actions in the video should have led them to adopt a more specific retrieval orientation on subsequent tasks that benefit from focus on episodic

details compared with the control inductions. We believe that this specific retrieval orientation impacts subsequent memory and imagination tasks because these tasks involve creating mental scenarios containing details similar to those focused on during the specificity induction, whereas the word comparison task emphasizes generating semantic details, which are not targeted by the specificity induction.

As noted in the Method, to score detail generation on the word comparison task, we adapted the criteria used for "internal" details on the memory and imagination tasks, such that "internal" details on the word comparison task were details contained in the definitions of the three words that were on-topic and meaningful, in contrast to the episodic details that count as internal details on memory and imagination tasks. External details for word comparison were largely comparable to external details as scored on the memory and imagination tasks. Importantly, however, the observed pattern of results on the word comparison task did not depend critically on the criteria used for distinguishing internal from external details: there was no effect of the specificity induction on total detail generation in word comparison in contrast to the significant effects on total detail generation in memory and imagination. Further, when we split the AI responses into internal and external details we observed the same lack of a specificity induction effect on word comparison. This pattern contrasts with the reliable effects of the specificity induction on internal but not external details in the memory and imagination tasks. In light of the present results, we also examined total detail generation in Madore et al. (2014) for memory, imagination, and picture description as a function of induction, and obtained the same results as reported here: the specificity induction significantly and selectively enhanced total detail generation for memory and imagination without affecting picture description. As reported by Madore et al. (2014), dividing total details into internal and external ones revealed the same pattern, whereby the induction significantly and selectively boosted internal details in memory and imagination with no effect on external details, and no effect on either type of detail in picture description. Taken together, these findings indicate that the specificity induction targets episodic processes involved in memory and imagination that are distinct from those processes involved in word comparison or other tasks that measure non-episodic processes (e.g., picture description), and thereby supports the constructive episodic simulation hypothesis (Schacter & Addis, 2007).

Another aspect of our findings that merits discussion concerns the amount of time and effort spent during the specificity induction. Although the data reported here replicate and extend our previous finding that the specificity induction reliably affects memory and imagination tasks, our observation that the induction enhanced performance whether it preceded the control induction or came directly after it suggests that the effect does not last very long. That is, there was no effect of induction order (i.e., carryover) on detail generation, indicating that whatever benefits are derived from the specificity induction are not evident only a few minutes later when participants perform memory and imagination tasks after receiving control inductions. One reason for this short-term impact could be the relatively brief amount of time spent in the specificity induction. Studies that have used specificity manipulations similar to the one reported here in attempts to increase the specificity of autobiographical memory retrieval in psychopathological populations often include multiple sessions spread out over several weeks, where participants complete homework assignments

and meet individually and in groups to train on and discuss specificity (e.g., Neshat-Doost, Dalgleish, Yule, Kalantari, Ahmadi, Dyregrov, & Jobson, 2013). This procedure culminates in hours of training compared with our approximately 4-minute induction. Future work should examine more systematically the impact of extended specificity induction sessions on memory and imagination.

In a related vein, we have recently (Madore & Schacter, 2014) established that the specificity induction improves performance on a means-ends problem-solving task (Platt & Spivack, 1975) where participants are provided with beginning problems and ending solutions and are asked to fill in the steps they would take to solve each problem and reach the identified end state. Compared with the control induction, the specificity induction increased the number of relevant steps that participants generated in problem solving without increasing the number of irrelevant or off-topic steps. When the steps were scored for internal and external details, it was found that the specificity induction also increased the number of internal details generated in step solutions without increasing external details. This pattern of findings suggests that the specificity induction can improve performance on a cognitive task that taps everyday problem solving skills, and where retrieving and recombining episodic details is important (Sheldon, McAndrews, & Moscovitch, 2011). It also indicates the potential usefulness of the specificity induction as a tool for isolating episodic contributions on a range of cognitive tasks that involve memory and imagination. Further research using a specificity induction to target a broader range of tasks that tap functionally useful cognitive processes and rely on episodic retrieval would be highly desirable. The present results are important for such research because they help to establish more securely the critical point that the specificity induction selectively boosts episodic retrieval across a range of situations.

Acknowledgements

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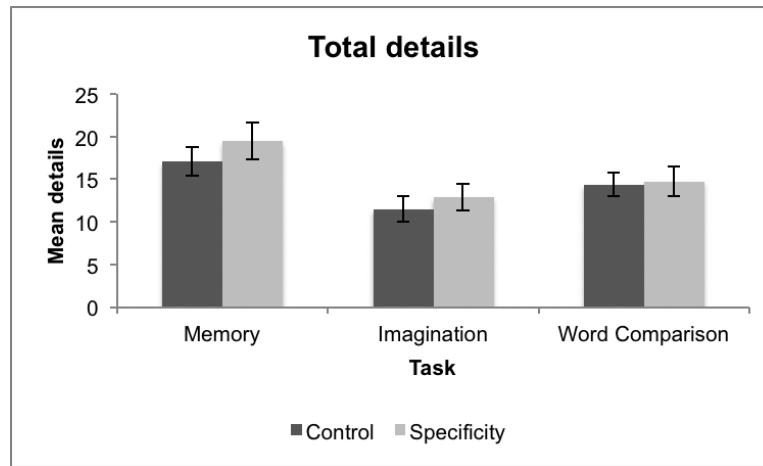
Figure 1.
Mean total details reported by participants as a function of induction and task collapsed across control condition used as the comparison. Error bars represent one standard error.

Internal details

Figure 2.
Mean internal details reported by participants as a function of induction and task collapsed across control condition used as the comparison. Error bars represent one standard error.
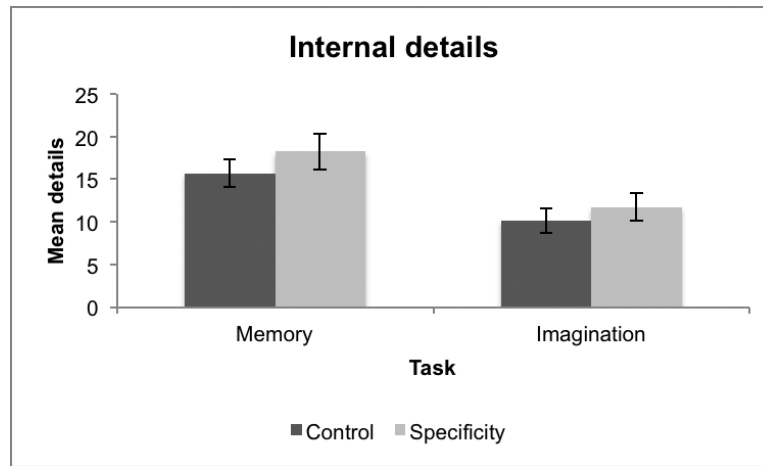
Figure 3.
Mean external details reported by participants as a function of induction and task collapsed across control condition used as the comparison. Error bars represent one standard error.
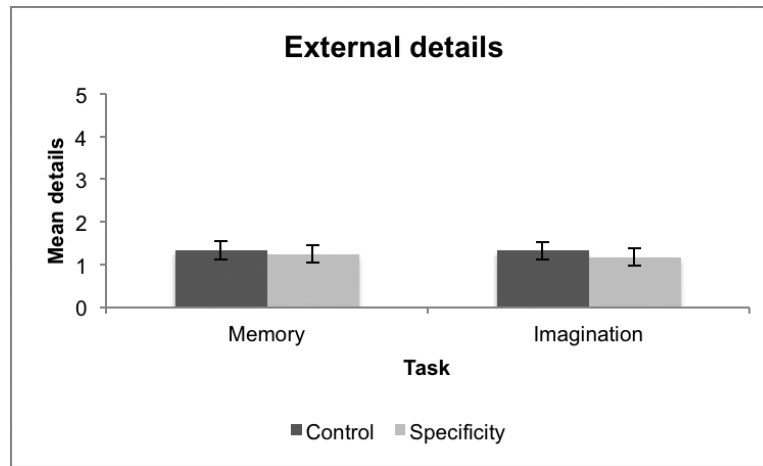
Table 1

Mean reaction times for construction in seconds. Standard error in parentheses.

	Control induction	**Specificity induction**	**Collapsed**
Memory	7.41 (0.63)	7.88 (0.67)	7.65 (0.63)
Imagination	8.06 (0.73)	8.10 (0.65)	8.08 (0.67)
Word Comparison	9.90 (0.70)	10.26 (0.84)	10.08 (0.75)

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Table 2

Mean details generated split by control condition and task. Standard error in parentheses.

	Impressions Control	Specificity[1]	Math Control	Specificity[1]
Memory total details	17.36 (2.57)	20.11 (3.22)	16.72 (2.31)	18.86 (2.99)
Memory internal details	16.17 (2.50)	19.03 (3.13)	15.25 (2.10)	17.47 (2.81)
Memory external details	1.19 (0.31)	1.09 (0.26)	1.47 (0.30)	1.39 (0.32)
Imagination total details	11.66 (2.07)	12.96 (2.33)	11.30 (2.17)	12.86 (2.27)
Imagination internal details	10.53 (2.14)	11.88 (2.42)	9.79 (2.06)	11.61 (2.16)
Imagination external details	1.13 (0.31)	1.09 (0.33)	1.51 (0.29)	1.25 (0.26)
Word comparison total details	14.63 (2.15)	15.54 (2.71)	14.09 (1.88)	13.96 (2.16)
Word comparison internal details	14.33 (2.12)	15.19 (2.60)	13.80 (1.88)	13.48 (2.21)
Word comparison external details	0.29 (0.09)	0.35 (0.21)	0.29 (0.10)	0.48 (0.17)

[1]Results for the Specificity Induction are reported separately for the 16 participants who received the Impressions Control and the 16 participants who received the Math Control.