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Creativity and Memory: Effects of an Episodic Specificity Induction on Divergent Thinking

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Abstract

After receiving an episodic specificity induction - brief training in recollecting details of a recent event - people produce more episodic details when imagining future events and solving means-end problems than after receiving a control induction not focused on episodic retrieval. Here we show for the first time that an episodic specificity induction also enhances divergent creative thinking. In Experiment 1, participants exhibited a selective boost on a divergent thinking task that involves generating unusual uses of common objects after a specificity induction compared with a control induction; by contrast, performance was similar on an object association task thought to involve little divergent thinking. In Experiment 2, we replicated the specificity induction effect on divergent thinking using a different control induction, and also found that participants performed similarly on a convergent thinking task following both inductions. These experiments provide novel evidence that episodic memory is involved in divergent creative thinking.

Keywords

episodic specificity induction; episodic memory; creativity; divergent thinking; convergent thinking; imagination

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Episodic memory is typically thought of as a neurocognitive system that supports the ability to recollect specific personal experiences that happened in a particular time and place (Tulving, 1983, 2002). However, it has become clear that episodic memory also plays an important role in a variety of tasks and functions that do not require recollection of specific past personal experiences. For example, Tulving (2002) argued that episodic memory supports "mental time travel" into the future as well as the past, and indeed numerous recent studies have provided evidence that episodic memory contributes importantly to imagining or simulating possible future experiences (for recent reviews, see Schacter, Addis, Hassabis, Martin, Spreng, & Szpunar, 2012; Szpunar, 2010). In a related vein, recent studies indicate that episodic memory contributes to solving open-ended or means-end problems that involve

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Author Contributions

All three authors developed the study concept and contributed to the study design. K.P. Madore performed data collection and statistical analyses under supervision of D.R. Addis and D.L. Schacter. K.P. Madore and D.L. Schacter drafted the manuscript, and D.R. Addis provided critical revisions. All three authors approved the final version of the manuscript for submission.

hypothetical social situations: more effective solutions to means-end problems are characterized by more episodic detail (Madore & Schacter, 2014; Sheldon, McAndrews, & Moscovitch, 2011).

The starting point for the present investigation comes from evidence suggesting that episodic memory may also contribute to aspects of creative thinking. For example, Duff, Kurzcek, Rubin, Cohen, and Tranel (2013) report that amnesic patients suffering from bilateral hippocampal damage, who exhibit severe impairments of episodic memory, also exhibit impairments on a widely used battery of creativity tasks, the Torrance Tests of Creative Thinking. Consistent with these findings, recent fMRI evidence (Ellamil, Dobson, Beeman, & Christoff, 2012) has revealed that brain regions typically associated with episodic memory, including the hippocampus, show increased activity when participants generate creative ideas while designing book cover illustrations. Benedek et al. (2014) obtained similar results when participants performed a task that requires generating alternative uses for common objects (the Alternate Uses Task or AUT; Guilford, 1967), which is thought to tap a key component of creativity known as *divergent thinking* – the capacity to generate creative ideas by combining diverse types of information in novel ways. Along these lines, Gilhooly, Fioratou, Anthony, and Wynn (2007) reported that participants sometimes draw on specific past experiences when performing the AUT, and Addis, Pan, Musicaro, and Schacter (2014) found that performance on the AUT is positively correlated with the amount of episodic detail that young and older adults generate when they imagine scenarios that might occur in their personal futures.

While the foregoing studies all suggest a link between episodic memory and creativity, the evidence is subject to various caveats and qualifications. Amnesic patients with hippocampal damage typically exhibit deficits in forming both new episodic and new semantic memories (i.e., impaired declarative memory; Eichenbaum & Cohen, 2001; Squire, Stark, & Clark, 2004), so it is unclear whether creativity deficits in such patients specifically implicate episodic memory. Evidence for activation in the hippocampus and related structures during creative idea generation and divergent thinking (Benedek et al., 2014; Ellamil et al., 2012) is consistent with a role for episodic memory, but does not provide conclusive evidence for it. In Gilhooly et al.’s (2007) study, retrieval of particular episodic memories on the AUT occurred infrequently (i.e., under 10% of the time). And although Addis et al. (2014) observed a link between divergent thinking and the amount of episodic detail in imagined future scenarios, no such link was observed between divergent thinking and the amount of episodic detail in imagined or recalled past events.

To assess more directly the possible contribution of episodic memory to specific forms of creativity, in the present experiments we take a novel approach involving the use of what we have called an *episodic specificity induction*: brief training in recollecting details of recent experiences (Madore, Gaesser, & Schacter, 2014; Madore & Schacter, 2014, 2015). The logic of our approach is straightforward: if a cognitive task relies on episodic memory, then performance on that task should be affected by an episodic specificity induction given prior to the task. By contrast, if performance on a cognitive task does not rely on episodic memory, then task performance should not be influenced by an episodic specificity induction given prior to the task. Adopting this logic, we have previously shown that compared with control inductions, an episodic specificity induction given prior to separate tasks that require remembering past experiences, imagining future experiences, or describing a pictorial scene selectively boosts the number of episodic details that participants generate when they remember the past and imagine the future, while having no effect on the number of semantic details generated and no effect at all on the number of details generated when describing a picture (Madore et al., 2014) or generating word definitions and comparisons (Madore & Schacter, 2015). We have also shown that an episodic specificity induction has beneficial effects on a means-end social problem-solving task (Platt & Spivack, 1975): after receiving the specificity induction, participants generated more relevant solution steps than they did following a control induction (Madore & Schacter, 2014). Based on this evidence, we have suggested that the induction could impact the process of *episodic retrieval orientation*: a flexible, goal-directed strategy for retrieving an episode in a more or less specific way when presented with a cue (Morcom & Rugg, 2012). In the series of experiments below, we test whether biasing a specific retrieval orientation affects divergent thinking.

More specifically, in Experiment 1, we test and provide evidence for the hypothesis that performance on a widely used test of divergent thinking, the AUT, will be enhanced after an episodic specificity induction compared with a control induction. We dissociate this effect from performance on a semantic object association task that also required generative responses but places less demand on divergent thinking than does the AUT (Abraham et al., 2012). Experiment 2 attempts to replicate this effect and examine whether the beneficial effects of the specificity induction extend to a task that taps a form of creativity known as *convergent thinking* – the ability to generate the best single solution to a specific problem (Guilford, 1967). In both experiments we also included an imagination task that we have previously shown to be affected by the specificity induction (Madore et al., 2014; Madore & Schacter, 2014, 2015) as a manipulation check to ensure that the specificity induction was operating as expected in the present study.

Experiment 1 Method

Participants

Twenty-four young adults (M_{age} = 22.50 years, SD_{age} = 3.72 yrs, 15 female) were recruited via advertisements at Boston University and Harvard University. All young adults had normal vision and no history of neurological impairment. They gave informed consent, were treated in accordance with guidelines approved by the ethics committee at Harvard University, and received pay for completing the study. We decided prior to the experiment on a sample size of 24 and stopped data collection after reaching this number because in our previous studies with the induction paradigm (e.g., Madore et al., 2014) this sample size has been adequate for detecting at least a medium-sized effect (i.e., d = .60) if it exists (power > .80, two-tailed for a within-subjects design). One participant was excluded due to a technical error; thus, our final sample consisted of 23 participants.

Overview

Participants came to the lab for two sessions, at least a week apart (*M* = 7.35 days, *SD* = 1.11). In each session, participants 1) watched one of two versions of a short video of a man and woman performing different activities in a house, 2) completed a short filler task and then were questioned about the video with the episodic specificity induction or control induction, and 3) completed the alternate uses, object association, and imagination tasks. In the second session, participants received whichever video and induction they had not received in the first session, and generated responses for the three tasks with new cues. The order of inductions and video-induction pairing was counterbalanced across participants.

Materials

Inductions

Episodic specificity induction: Half of the participants were randomly assigned to receive the episodic specificity induction in the first session (and control induction in the second session). During this induction, participants were asked questions about the specific contents of the video they had seen with different probes from the Cognitive Interview, a protocol that boosts the number of accurate details that eyewitnesses recall about an event (Fisher & Geiselman, 1992; Memon et al., 2010). The goal of the specificity induction is to help participants recall an experienced event in an episodically specific way. Participants were first told that they were the expert about the video, and were then guided through three mental imagery probes where they were asked to close their eyes and generate a picture in their mind about the setting, people, and actions they had seen. They were asked to verbalize everything they remembered and to be as specific as possible, and were probed for more detail with open-ended questions about elements they had mentioned.

Control induction: The other half of participants were randomly assigned to receive a control induction in the first session (and specificity induction in the second session). During this induction, participants were also asked questions about the contents of the video they had seen. They were first asked to verbalize what their impressions and opinions of the video were, and then responded to general questions about its setting, people, and actions (e.g., adjectives to describe each) and other elements (e.g., equipment used to make the video). There were no mental imagery probes in this induction and participants were not asked to focus on or speak about specific details from the video. We used this as our control because we wanted participants in both inductions to reflect on and speak about the contents of the video they had seen so that an effect of the specificity induction could not be attributed to simply speaking about the video itself. The main difference in inductions was the degree to which participants recalled information in an episodically specific way. Inductions were approximately 5 minutes long (see Supplemental Materials for full scripts).

Main tasks—After completing the induction phase in each session, participants typed responses to object cues for the alternate uses, object association, and imagination tasks on a computer screen. The order of these tasks was blocked (e.g., uses-association-imagination) and randomized across participant, induction, and task (as was the order of object cues). Seventeen different object cues appeared in each session. The cues were everyday objects (e.g., newspaper, bed sheet, eye glasses) that are used in the official test booklet for the AUT (e.g., Guilford, Christensen, Merrifield, & Wilson, 1960) and other studies on divergent thinking. Before completing each task, participants responded to a practice cue to ensure that they understood the instructions and response interface. There were no experimenter questions or inputs during the main experimental trials. Participants had 3 minutes to complete each trial, during which a separate object cue appeared on the screen. Instructions before each main task also appeared on the screen in front of participants and focused on reporting everything in as much detail as possible so that report criteria would be equated following the induction manipulation.

Alternate Uses Task (AUT): Participants saw 5 different object cues (plus one practice) and typed as many unusual and creative uses as possible for each cue. They were told that while each object cue had a common use, they should generate as many other uses as they could in as much detail as they could (Guilford et al., 1960). The AUT is thought to tap divergent thinking in that participants are asked to flexibly recombine information in novel ways (Guilford, 1967).

Object Association Task (OAT): Participants saw 5 different object cues (plus one practice) and typed as many other objects typically associated with the cue as possible (Abraham et al., 2012), in as much detail as they could. The task was used as a complement to the AUT so that participants would generate information in response to object cues for the same amount of time in both conditions. The main difference is that object association is thought to involve divergent thinking or episodic imagery to a lesser degree than the AUT; generating typical semantic associates does not require the same level of flexible thinking as does generating unusual and creative uses for objects, and behavioral and neural dissociations have previously been found between these two tasks (Abraham et al., 2012).

Imagination: Participants saw 4 different object cues (plus one practice) and generated an event (on one day in one place) that could happen to them within the next few years that somehow incorporated the cue (Addis, Wong, & Schacter, 2008). Participants were told to imagine a novel event from a field perspective. They were asked to type everything they could imagine (e.g., people, actions) about the event in as much detail as possible. Given previous findings of a robust effect of the episodic specificity induction on the imagination task (Madore et al., 2014; Madore & Schacter, 2014, 2015), it was included to ensure that the specificity manipulation operated as expected.

Scoring

Participants' responses were scored by one of two raters who were blind to which induction had been received and to all experimental hypotheses. For the AUT, we focused on the number of *categories of appropriate uses* since appropriateness is the most stringent definition of a use (modified from Addis et al., 2014; Guilford, 1967; Guilford et al., 1960). *Appropriate*, or feasible and possible uses, are clustered into distinct *categories* (e.g., using a safety pin for earrings and for a bracelet charm are both appropriate uses that fall under one category of jewelry; using a shoe to hold an adult and to hold a big-screen television are both inappropriate uses and would not be scored); the number of categories of appropriate uses was summed across cues for each participant. Before scoring the experimental trials, raters separately scored responses from 10 cues along these dimensions with high inter-rater reliability (Cronbach's α = .92). Other standard dimensions of AUT use generation were also scored (see Supplemental Materials). For the OAT, raters identified *objects* and excluded other words (e.g., for sock, an object could be washing machine; non-object responses such as dirty were excluded) to ensure consistency with previous work and task instructions (Abraham et al., 2012); the number of objects was summed across cues for each participant. Before scoring the experimental trials, raters separately scored responses from 10 cues for objects with high inter-rater reliability (Cronbach's α = .98). For imagination, we focused on *internal* and *external details* (Levine et al., 2002). Internal details – or episodic details – are any bits of information (e.g., people, setting, actions, feelings, objects, etc.) that are tied to the central event. External details – or primarily semantic details – are typically any bits of information (e.g., facts, commentary, etc.) that are non-episodic. The average number of internal and external details across events was computed for each participant. Before scoring the experimental trials, raters separately scored responses from 12 cues along these dimensions with high inter-rater reliability (Cronbach's αs ≥ .92).

Experiment 1 Results

To assess whether the specificity induction had the same effects as in previous research, we examined performance on the imagination task with a 2 (Induction: control vs. specificity) x 2 (Detail type: internal vs. external) repeated-measures ANOVA. Five responses were excluded (2.71% of total) for not falling in the *next few years* (results were the same when the trials were included). We found no main effect of Induction, $F(1, 22) = 0.95$, $p > .250$, $\eta_p^2 = .04$, a main effect of Detail type, $F(1, 22) = 53.46$, $p < .001$, $\eta_p^2 = .71$, and most critically, an interaction between Induction and Detail type, $F(1, 22) = 9.30$, $p = .006$, $\eta_p^2 = .30$. Participants generated more *internal details* ($M_{control} = 26.12$, $SE = 2.87$; $M_{specificity} = 30.30$, $SE = 2.79$), and fewer *external details* ($M_{control} = 5.81$, $SE = 1.43$; $M_{specificity} = 3.44$, $SE = 1.01$) after the specificity induction than the control, smallest $t(22) = -2.23$, $p = .036$, mean difference = −2.37, 95% CI = [−4.58, −0.16], $d = 0.46$. These results closely replicate our previous findings (e.g., Madore & Schacter, 2014) and thus indicate that the specificity induction operated as expected.

To address our main hypothesis – that the episodic specificity induction would enhance performance on the AUT to a greater extent than on the OAT – we conducted another 2 (Induction: control vs. specificity) x 2 (Task: OAT vs. AUT) repeated-measures ANOVA. There was no main effect of Induction, $F(1, 22) = 0.51$, $p > .250$, $\eta_p^2 = .02$), a main effect of Task, $F(1, 22) = 37.77$, $p < .001$, $\eta_p^2 = .63$, and most critically, an interaction between Induction and Task, $F(1, 22) = 7.18$, $p = .014$, $\eta_p^2 = .25$. Participants generated more *categories of appropriate uses* when they received the specificity induction ($M = 34.48$, $SE = 3.55$) compared with the control induction ($M = 28.57$, $SE = 2.72$), $t(22) = 2.49$, $p = .021$, mean difference = 5.91, 95% CI = [0.98, 10.85], $d = 0.52$. By contrast, participants generated a similar number of *objects* following both inductions ($M_{control} = 52.83$, $SE = 4.49$; $M_{specificity} = 49.83$, $SE = 5.19$), $t(22) = -1.05$, $p > .250$, mean difference = −3.00, 95% CI = [−8.93, 2.93], $d = 0.22$. Figure 1 depicts the mean difference score for each task. We found the same selective boost from the specificity induction when we examined other standard dimensions of AUT use generation: total uses, appropriate uses alone, and categories of all uses (see Supplemental Materials). Figure 1.

Experiment 1 Discussion

The results of Experiment 1 show clearly that an episodic specificity induction significantly boosted performance on a task that involves divergent thinking, the AUT, while having little effect on an object association task that is thought to involve little divergent thinking (Abraham et al., 2012). The specificity induction also produced very similar effects as observed in our previous studies (Madore et al., 2014; Madore & Schacter, 2014, 2015) on an imagination task, boosting the number of episodic but not semantic details that participants generated when they imagined possible future events. The parallel effects of the specificity induction on divergent thinking and imagination provide novel support for the idea that both draw importantly on episodic retrieval, consistent with previous findings and ideas about creative cognition (Addis et al., 2014; Benedek et al., 2014; Ellamil et al., 2012; Finke, Ward, & Smith, 1992; Gilhooly et al., 2007; Smith, 1995; Smith & Ward, 2012), and to our knowledge the first evidence that an experimental manipulation that specifically increases episodic retrieval also increases a measure of creative thinking (for an example of related evidence, see Storm & Patel, 2014).

In Experiment 2, we addressed three issues raised by Experiment 1. First, we attempted to determine whether we could replicate the effects of the specificity induction on the AUT. Second, we examined whether the effect of the specificity induction versus the control induction on the AUT reflects an *increase* relative to baseline produced by the specificity induction or a *decrease* relative to baseline produced by the control induction. The latter induction emphasizes general impressions and thoughts, which conceivably could have suppressed divergent thinking below the levels that would have been attained following a more neutral baseline (see Koutstaal & Cavendish, 2006; Rudoy, Weintraub, & Paller, 2009, for related evidence of retrieval orientation manipulations). To address the issue, we replaced the impressions control with a task that involved completing math problems. We have previously found similar effects of the specificity induction on memory and imagination compared with the impressions control and math problems control (Madore et al., 2014; Madore & Schacter, 2015), and expected to observe the same effect on the AUT. Third, we asked whether the effects of the specificity induction are selective to divergent thinking, or whether they also extend to the component of creativity known as *convergent thinking*, which as noted earlier is the ability to generate the best single solution to a specific problem (Guilford, 1967). To address this issue, we used the Remote Associates Test (RAT; Bowden & Jung-Beeman, 1998; Mednick, 1962), which is a standard measure of convergent thinking.

Experiment 2 Method

Participants

Twenty-four young adults (M_{age} = 20.75 years, SD_{age} = 2.69 yrs, 14 female) were run in the study with the same recruitment and data collection parameters as in Experiment 1.

Participants received pay or course credit for the study. One participant was excluded due to task noncompliance; thus, our final sample consisted of 23 participants.

Overview and Materials

Participants again came to the lab for two sessions, at least a week apart (M = 7.30 days, SD = 1.46). The design parameters and stimuli were exactly the same in Experiment 2 as in Experiment 1 with two exceptions. First, the impressions control induction was replaced with a math packet control induction (as in Madore et al., 2014; Madore & Schacter, 2015). In this condition, after watching the video and completing the filler task, participants worked on math problems rather than speak about the video's contents. This control condition does not explicitly call for episodic retrieval of any kind and should be a more neutral baseline than the impressions control. Inductions were approximately 5 minutes long.

Second, the OAT was replaced with the RAT, a standard measure of convergent thinking. Participants saw 30 different triads (plus one practice), with each triad consisting of three main words, and were asked to generate a solution word that formed a common word/phrase with each of the three main parts of the triad (e.g., for "Eight/Skate/Stick" the solution word would be "Figure"). Participants had 30 seconds to generate the solution word for each triad, so that equal time would be spent completing the experimental trials for this task and the AUT. Participants viewed 30 different triads in the second session (plus one practice). Triads were randomized across participant and induction. We chose 62 triads from Bowden and Jung-Beeman's (2003) normative list that between 0–46% of individuals could solve in 30 seconds to avoid floor or ceiling effects (based on these normative data, success percentages were approximately 27% in both inductions).

Scoring

Participants' responses were again scored by one of two raters blind to induction and to all experimental hypotheses. For the AUT, we focused again on *categories of appropriate uses* (Cronbach's α = .95) and for imagination, *internal* and *external details* (Cronbach's αs $\geq$ .92). Inter-rater reliability was not calculated for RAT solution words since we simply summed the number of correct responses across all trials for a participant. Scoring and results for other dimensions of AUT use generation appear in Supplemental Materials; we replicated these induction effects from Experiment 1.

Experiment 2 Results

As in Experiment 1, we also replicated our effect for imagination as a manipulation check with a 2 (Induction: control vs. specificity) x 2 (Detail type: internal vs. external) repeated-measures ANOVA. Two responses (1.09% of total) were excluded for not falling in the *next few years* (results were the same when these trials were included). There was no main effect of Induction, $F(1, 22) = 1.41$, $p = .247$, $\eta_p^2 = .06$, a main effect of Detail type, $F(1, 22) = 75.24$, $p < .001$, $\eta_p^2 = .77$, and an interaction between Induction and Detail type, $F(1, 22) = 12.01$, $p = .002$, $\eta_p^2 = .35$. Participants generated more *internal details* ($M_{control}$ = 26.84, SE = 2.55; $M_{specificity}$ = 32.86, SE = 3.04), and fewer *external details* ($M_{control}$ = 9.21, SE =

1.43; $M_{specificity}$ = 5.09, *SE* = 1.65), after the specificity induction than the control, smallest $t(22) = 2.95$, $p = .007$, mean difference = 6.02, 95% CI = [1.79, 10.25], $d = 0.62$.

For our main analysis, we conducted another 2 (Induction: control vs. specificity) x 2 (Task: RAT vs. AUT) repeated-measures ANOVA to examine whether 1) the specificity induction effect on use generation from Experiment 1 replicates, and 2) whether this effect extends to the RAT. As in Experiment 1, we found a selective boost on the AUT from the specificity induction.

There were main effects of Induction, $F(1, 22) = 12.42$, $p = .002$, $\eta_p^2 = .36$, and Task, $F(1, 22) = 80.54$, $p < .001$, $\eta_p^2 = .79$, and a marginal interaction between Induction and Task, $F(1, 22) = 4.26$, $p = .051$, $\eta_p^2 = .16$. Participants generated more *categories of appropriate uses* when they received the specificity induction (*M* = 26.57, *SE* = 1.96) compared with the control (*M* = 23.09, *SE* = 2.05), $t(22) = 3.67$, $p = .001$, mean difference = 3.48, 95% CI = [1.51, 5.45], $d = 0.77$. Participants generated non-significantly more *correct solution words* on the RAT following the specificity than control induction ($M_{control}$ = 6.91, *SE* = 0.77; $M_{specificity}$ = 7.83, *SE* = 0.76), $t(22) = 1.13$, $p > .250$, mean difference = 0.91, 95% CI = [−0.76, 2.58], $d = 0.24$. Figure 2 depicts the mean difference score for each task.

General Discussion

The two experiments reported here provide clear and consistent evidence that an episodic specificity induction that increases the number of episodic details on a future imagining task also boosts performance on the AUT, a classic test of divergent thinking. In both experiments, the most stringent output measure on the divergent thinking task – categories of appropriate uses – showed a significant increase following the specificity induction compared with the control induction. We observed similar effects of the specificity induction compared with the impressions control induction in Experiment 1 and math problems control in Experiment 2, consistent with the idea that our findings reflect an increase above baseline produced by the specificity induction, rather than a decrease produced by a focus on general impressions and thoughts in the impressions induction, which as we noted earlier could conceivably have suppressed divergent thinking below the levels that would have been attained following a more neutral baseline.

Experiment 1 showed that the effects of the specificity induction are selective to the divergent thinking task, with no comparable effects observed on an object association task thought to elicit little divergent thinking (Abraham et al., 2012). Experiment 2 suggests that the observed effects do not extend to convergent thinking: we failed to observe reliable effects of the specificity induction on RAT performance. However, some interpretive caution is required on this point, because the Induction x Task interaction was marginal.

Why does the episodic specificity induction boost performance on the AUT? We have previously argued (e.g., Madore et al., 2014) that because the specificity induction increases episodic details reported on both memory and imagination tasks, it affects a process tapped by both remembering and imagining. As mentioned in the Introduction, one process common to both is *episodic retrieval orientation*, a flexible, goal-directed strategy invoked when presented with a retrieval cue (Morcom & Rugg, 2012). Biasing a specific retrieval orientation – that is, retrieval cue processing that focuses on episodic details related to places, people, or actions – may impact subsequent memory, imagination, and divergent thinking because these tasks all involve creating mental scenarios that contain details like those emphasized during the specificity induction. By contrast, the OAT and RAT tasks focus more on generating semantic information, and hence show little effect of the specificity induction.

An interesting question concerns whether adopting a specific retrieval orientation enables participants to retrieve more past episodes that involve alternate uses of objects, more readily retrieve and recombine episodic details that support constructing entirely new uses of objects, or both. Using a procedure in which participants label uses on the AUT as "old" or "new" ideas, other researchers (Benedek et al., 2014; Gilhooly et al., 2007) have argued that new ideas arise from recombining semantic information and imagery. We collected preliminary data suggesting that the specificity induction may boost both "old" and "new" ideas (see Supplemental Materials), but the issue requires more systematic investigation.

More broadly, the impact of episodic specificity on tasks that tap imaginative functions extends beyond divergent thinking. In addition to effects of the episodic specificity induction on imagining future experiences, we recently found that it also increases the number of relevant steps that individuals generate when solving means-end problems concerning hypothetical social scenarios (Madore & Schacter, 2014). Future work should use the specificity induction as a tool to identify the contribution of episodic processes to other cognitive tasks that are not usually thought of as "episodic memory tasks", yet nonetheless rely on constructive uses of episodic retrieval.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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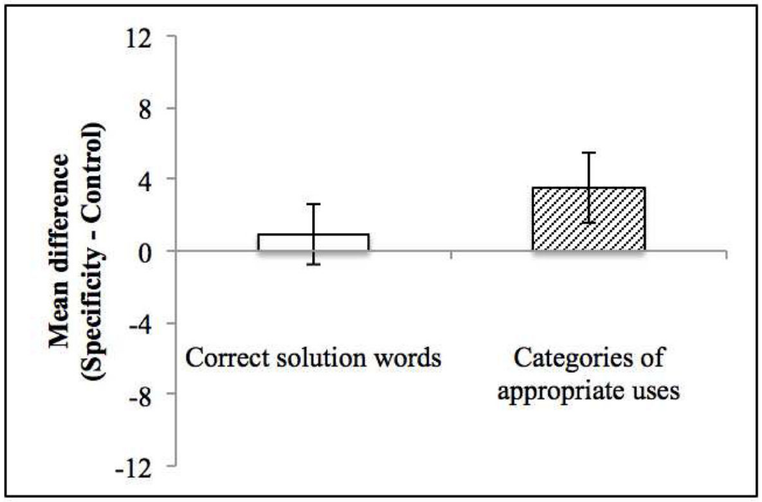

Fig. 1.
Mean difference for each output variable as a function of induction. Error bars represent 95% confidence interval on each mean difference. A greater positive difference reflects a boost with the specificity induction.

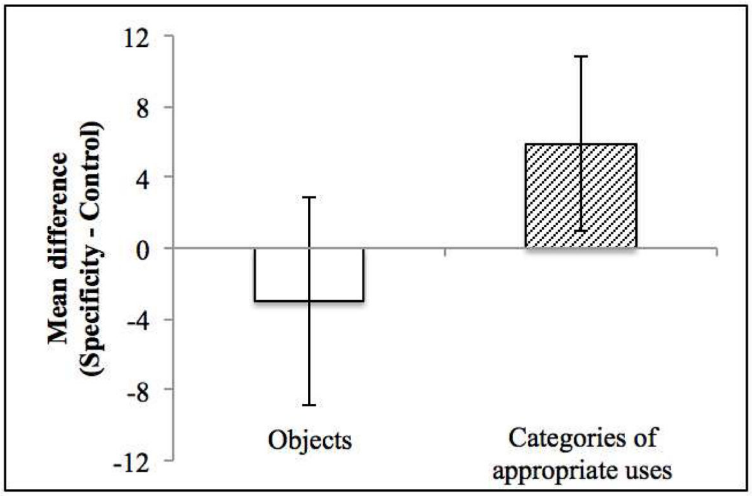

Fig. 2.

Mean difference for each output variable as a function of induction. Error bars represent 95% confidence interval on each mean difference. A greater positive difference reflects a boost with the specificity induction.