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Worrying about the Future: An Episodic Specificity Induction Impacts Problem Solving, Reappraisal, and Well-Being

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Abstract

Previous research has demonstrated that an episodic specificity induction – brief training in recollecting details of a recent experience – enhances performance on various subsequent tasks thought to draw upon episodic memory processes. Existing work has also shown that mental simulation can be beneficial for emotion regulation and coping with stressors. Here we focus on understanding how episodic detail can affect problem solving, reappraisal, and psychological well-being regarding worrisome future events. In Experiment 1, an episodic specificity induction significantly improved participants' performance on a subsequent means-end problem solving task (i.e., more relevant steps) and an episodic reappraisal task (i.e., more episodic details) involving personally worrisome future events compared with a control induction not focused on episodic specificity. Imagining constructive behaviors with increased episodic detail via the specificity induction was also related to significantly larger decreases in anxiety, perceived likelihood of a bad outcome, and perceived difficulty to cope with a bad outcome, as well as larger increases in perceived likelihood of a good outcome and indicated use of active coping behaviors compared with the control. In Experiment 2, we extended these findings using a more stringent control induction, and found preliminary evidence that the specificity induction was related to an increase in positive affect and decrease in negative affect compared with the control. Our findings support the idea that episodic memory processes are involved in means-end problem solving and episodic reappraisal, and that increasing the episodic specificity of imagining constructive behaviors regarding worrisome events may be related to improved psychological well-being.

Keywords

episodic future simulation; episodic specificity induction; worry; means-end problem-solving; reappraisal

Much recent research has focused on the nature of *prospection* or the human capacity to think about the future (Gilbert & Wilson, 2007; Seligman, Railton, Baumeister, & Spripada, 2013). Although the concept of prospection includes a variety of different phenomena and processes, four major forms of prospection have been identified: simulation, prediction, intention and planning (Szpunar, Spreng, & Schacter, 2014). Szpunar et al. (2014) further proposed that each of the major forms of prospection can be characterized on an episodic-

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semantic gradient, ranging from thoughts about specific events that might occur in the future (episodic) to thoughts about general future states of the world (semantic).

In this article we focus on a form of prospection that has been studied intensively during the past decade: *episodic simulation* or the construction of a detailed representation of a possible personal future experience (e.g., Schacter, Addis, & Buckner, 2008). Research on episodic simulation has been stimulated in part by the observation of striking cognitive and neural similarities between episodic memory and episodic simulation (for recent reviews, see Schacter et al., 2012; Szpunar, 2010). According to the *constructive episodic simulation hypothesis* (Schacter & Addis, 2007), having a constructive, flexible episodic memory plays a key role in supporting simulation of possible future experiences, allowing individuals to imagine or simulate future scenarios by drawing on past experiences. Several researchers have argued that episodic simulation can be highly adaptive because it allows people to construct simulations of different ways in which the future might play out without having to engage in actual behavior (cf., Ingvar, 1979; Schacter, 2012; Suddendorf & Corballis, 1997, 2007). Consistent with this observation, previous research has shown that the process of simulating a future event can be beneficial across a variety of contexts, including planning, prospective memory, decision-making, problem solving, and emotion regulation (for review, see Schacter, 2012).

While episodic simulation and prospection more generally serve adaptive functions, they can also take forms that are disruptive to psychological functioning and well-being, such as reduced capacity to imagine positive future experiences related to the self (e.g., MacLeod & Conway, 2007), greater anticipation of negative future experiences (e.g., MacLeod & Byrne, 1996), or excessive worry about the future (e.g., Borkovec, Ray, & Stöber, 1998). In this paper, we will focus on identifying and understanding the contribution of episodic memory and episodic simulation to problem solving, emotion regulation, and psychological well-being in the context of studying personally worrisome future experiences. Some previous evidence suggests that constructing a mental simulation of a worrisome future event can be beneficial. For example, Brown, MacLeod, Tata, and Goddard (2002) demonstrated that more detailed imaginings of a worrisome event (e.g., going into labor in a group of first-time pregnancy mothers) were correlated with reduced ratings of worry and increased subjective probability of a good outcome (e.g., successful delivery). Structured mental simulation of a controllable ongoing stressful event (e.g., preparing for an exam) has also been shown to increase ratings of positive affect and decrease negative emotions towards the event, as well as increase engagement in active coping strategies (e.g., facilitating studying behaviors, increasing planning) (Pham & Taylor, 1999; Rivkin & Taylor, 1999). Taylor, Pham, Rivkin and Armor (1998) have proposed a number of intrinsic characteristics of mental simulations that likely make them useful for self- and emotion-regulation, including that simulation increases the perceived plausibility of occurrence of an event, that simulations involve an organization of action that can yield a plan, and that simulations evoke emotional states and their potential control. While their hypotheses have largely been supported, there is little experimental evidence examining the specific processes that influence whether and how future event simulation may benefit psychological well-being.

Here we focus on how the *detail* with which one simulates a worrisome future event might impact subjective well-being, problem solving, and emotion regulation towards that event. Within a given event simulation, two major types of details that individuals produce can be distinguished: episodic or “internal” details (i.e., information about specific people, objects, and actions that constitute an event) and “external” or semantic details (i.e., factual information that is not specific to time and place, commentary, or references to other events; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). Existing research has reported that reduced specificity of autobiographical memory (i.e., fewer reported internal details) is commonly associated with normal aging (Addis, Wong, & Schacter, 2008), as well as with clinical populations characterized by such conditions as amnesia (Race, Keane, & Verfaellie, 2011), Alzheimer's disease (Addis, Sacchetti, Ally, Budson, & Schacter, 2009), and schizophrenia (D'Argembeau, Raffard, & Van der Linden, 2008). Critically, each of these studies has also shown that similar patterns of deficits are found when participants are asked to imagine future events, suggesting a common influence of episodic memory on both remembering and imagining and a disruption of this influence in each of the aforementioned populations.

More directly relevant to worrisome future events, there have also been reports of reduced specificity of episodic memory retrieval and future simulation in individuals with emotional disorders, such as depression (Williams et al., 1996) and anxiety disorders (Brown et al., 2014; McNally, Lasko, Macklin, & Pitman, 1995; McNally, Litz, Prassas, Shin, & Weathers, 1994). In a similar vein, there is evidence that worry in generalized anxiety disorder (GAD) involves predominately negative *verbal* and *conceptual* thought that lacks specific, concrete details typically contained in visual imagery and episodic simulations (for review, see Borkovec et al., 1998). Worry elicits less sympathetic arousal than visual imagery and suppresses somatic anxiety, and thus may serve a cognitive avoidance function to threat so that individuals can disengage and avoid arousing emotional processing towards the aversive or worrisome trigger (Borkovec et al., 1998; Williams, 2006). While reduced specificity and concreteness about an aversive, arousing event may serve as temporary relief, adopting such an orientation can have adverse long-term consequences, such as reducing the ability to cope with the problem at hand. It is thought that reduced specificity can magnify existing features of emotional disorders (e.g., hopelessness, avoidance) to make it more difficult for anxious and depressed individuals to imagine their future in a sufficiently concrete fashion to generate specific plans and goals, thus exacerbating their symptomology (Borkovec et al., 1998; Williams, 2006; Williams et al., 1996).

The results of several studies suggest that manipulations aimed at increasing specificity and detail of episodic retrieval can have beneficial consequences for subsequent performance of various kinds of tasks, including problem solving. For example, Madore and Schacter (2014) recently showed that increasing the level of detail with which participants recollect and elaborate upon recent experiences improves subsequent problem solving performance in healthy young and old adults. Level of detail was increased by using an *episodic specificity induction*, whereby participants were guided to recall specific episodic details from a short film compared with a control condition that did not require detailed episodic retrieval. The effect of the episodic specificity induction is also evident on other tasks administered subsequent to the induction that are thought to draw on episodic retrieval, including memory, imagination, and divergent thinking tasks (Madore, Gaesser, & Schacter, 2014; Madore, Addis, & Schacter, 2015; for review and discussion, see Schacter & Madore, in press). Although previous work has demonstrated that increased specificity of autobiographical memory can be linked to improvements in depressive symptoms (Neshat-Doost et al., 2012; Raes, Williams, & Hermans, 2009) and PTSD symptoms (Moradi et al., 2014) with respect to negative and distressing past events, there is little evidence that increased specificity can be beneficial for processing worrisome future events that have not yet been experienced, and the evidence that does exist is correlational (e.g., Brown et al., 2002). Given that reduced episodic specificity can limit the ability to imagine the future and to engage in effective problem solving towards potential future obstacles or achieving future goals, it is thus possible that increasing the specificity with which people imagine the future might serve as a useful intervention to foster more constructive problem-solving behaviors that can promote active coping and decrease overall maladaptive functioning.

In the current experiments we focus on two main avenues through which modulation of worrying about future events can be explored: (1) by taking steps to *prevent* a worrisome bad outcome and (2) by preparing to emotionally regulate or cope with a bad outcome *after* it occurs (Taylor & Schneider, 1989). The first avenue can be measured via the means-end problem solving paradigm (MEPS; Platt & Spivack, 1975), which involves a set of standardized problems which participants must generate steps (i.e., means) to solve. Patients with emotional disorders tend to show poorer performance on this task relative to healthy controls (Dickson & MacLeod, 2004; Goddard, Dritschel, & Burton, 1996; Raes et al., 2005; Sidley, Whitaker, Calam, & Wells, 1997; Sutherland & Bryant, 2008), perhaps because the MEPS task is known to be reliant on episodic memory processes (Sheldon, McAndrews, & Moscovitch, 2011; Sheldon et al., 2015; Vandermorris, Sheldon, Winocur, & Moscovitch, 2013) and reduced specificity of episodic memory has been documented in this population (McNally et al., 1994, 1995; Williams et al., 1996). As previously mentioned, Madore and Schacter (2014) demonstrated that increasing the level of detail with which participants recollect details of past experiences with an episodic specificity induction (Madore et al., 2014) positively impacted performance on the MEPS task by increasing the number of relevant steps and details generated for each problem. Given evidence from Pham and Taylor (1999) showing that constructive simulations can benefit emotion regulation in response to stressful events, we hypothesize that increasing the detail generated by using an episodic specificity induction before executing a MEPS task involving personally worrisome events would further improve subjective well-being concerning the problems used in the task.

The second avenue of examining modulation of worry about future events concerns emotion regulation after a negative outcome takes place. Existing studies have primarily focused on two emotion regulation strategies: cognitive reappraisal and expressive suppression, the former of which has been demonstrated to be more effective (for review, see Gross, 1998). Cognitive reappraisal is used to modulate responses to an affectively salient stimulus by reframing a negative response to that stimulus or situation, and is effective in down-regulating emotional experience and behavior (e.g., Goldin, Manber-Ball, Werner, Heimberg, & Gross, 2009; Goldin, McRae, Ramel, & Gross, 2008; Hofmann, Heering, Sawyer, & Asnaani, 2009). In the present studies we modified the traditional paradigm to involve reappraisal and reframing of a worrisome future episode, where participants are asked to simulate a specific event in which they actively engage in reappraisal regarding a negative outcome (for more details, see methods below). We will refer to this process as *episodic reappraisal*. Suggestive evidence related to the potential usefulness of episodic reappraisal comes from research on imaginal exposure treatment, during which PTSD patients are asked to recall details of a traumatic event while focusing their attention on their feelings, thoughts, and emotions (Arntz, Tiesema, & Kindt, 2007). This procedure has been found to reduce the severity of PTSD symptoms, such as a reduction in fear, avoidance, and feelings of helplessness (Arntz et al., 2007). While imaginal exposure treatment involves elaborating upon negative details of a past experience and confronting that event, we hypothesize that elaborating upon negative details of a future outcome and reframing such a scenario (i.e., episodic reappraisal) could also be effective for emotion regulation. Critically, we suggest that utilizing a specificity induction to increase the amount of episodic detail in this reappraisal task would lead to even larger gains in subsequent measures of emotion regulation and well-being, compared with engaging in a reappraisal task with less specificity.

From a theoretical perspective, it is important to note that the specificity induction used here, which draws on the Cognitive Interview (CI; Fisher & Geiselman, 1992; Memon, Meissner, & Fraser, 2010), a well-established procedure for increasing recall of episodic detail in eyewitnesses, impacts subsequent tasks in a highly selective manner. As noted earlier, effects of the specificity induction have been documented on subsequent tasks that are thought to draw on episodic retrieval, including memory, future imagining, means-end problem solving, and divergent thinking tasks (Madore et al., 2014, 2015; Madore & Schacter, 2014, 2015). Equally important, the specificity induction has had no detectable impact on the performance of subsequent tasks that are thought to rely on primarily semantic retrieval or non-episodic narrative processing, such as describing a picture (Madore et al., 2014), generating word definitions (Madore & Schacter, 2015), or generating object associations and semantic solution words (Madore et al., 2015). Schacter and Madore (in press) have suggested that the CI-based induction biases a subsequent episodic retrieval orientation toward a focus on specific event details, such that individuals construct more detailed mental scenes or events after a specificity induction than a control induction. These previous findings and ideas concerning the selective effects of the specificity induction on subsequent task performance should allow us to draw relatively specific theoretical conclusions concerning predicted effects of the induction on subsequent task performance.

In summary, we tested the hypothesis that manipulating the level of specificity with which individuals imagine worrisome future events would influence subsequent measures of emotion regulation and well-being based on problem-solving and episodic reappraisal tasks. While the MEPS task assesses primarily participants' ability to generate steps to prevent a bad outcome, the episodic reappraisal task targets their ability to cope with a negative outcome. In light of previous findings and theoretical ideas, we predicted that the episodic specificity induction, relative to a control induction, should (1) increase the number of relevant steps and internal details on the MEPS task (cf. Madore & Schacter, 2014), (2) increase the specificity with which participants perform the episodic reappraisal task, and (3) improve subjective measures of well-being and coping for a given problem.

Experiment 1

Method

Participants—A total of 35 healthy undergraduate students (ages 18 to 25, $M = 20.16$ years, 23 female) were recruited from Harvard College and Boston University. Participants were paid or received course credit for their participation. All participants had normal vision and no history of neurological or psychological impairment. A total of 10 participants were excluded due to experimenter error (2 participants), incompletion of the experiment (5 participants), or noncompliance (3 participants), leaving 25 participants in the final sample. Before the study was run we performed a power analysis to determine that a sample size of at least 24 useable participants was necessary to observe a medium-sized effect of the induction (power > .80, $\alpha = .05$, two-tailed, for a within-subjects design, $d = 0.60$), which has also been the case in prior induction studies (e.g., Madore et al., 2014, 2015). Given scheduling constraints with multiple sessions, data collection was stopped once it was determined that approximately enough useable participants had been run to reach this number.

Equipment—All experimental sessions were executed using Qualtrics on an Apple desktop computer. During the induction phases, participants viewed the induction videos using Quicktime media player. Participants' responses during the induction phases were recorded using an audio recorder.

Experimental Procedure—The experiment as a whole lasted approximately 6.5 hours across 3 separate sessions. The first session lasted 2.5 hours, during which participants provided 30 worrisome events. The second session took place 1 to 3 days after the first session ($M = 1.72$ days) and lasted 2 hours, and the third session took place 5 to 7 days after the second session ($M = 5.88$ days) and lasted 2 hours. In the second and third sessions, participants first completed an induction phase (specificity or control induction), and then completed two tasks (means-end problem solving and episodic reappraisal tasks) involving a subset of the worrisome events that they provided in the first session. See Figure 1 for a diagram of the experimental procedure.

<u>**Session 1:**</u> Participants provided 30 worrisome, anxiety-provoking problems or specific events that might take place in the near future (i.e., within the next 3-5 years). They were instructed to list specific, concrete, and highly familiar events or scenarios with tangible outcomes. Example categories of potential worries or problems included academics, health, career, relationships, and finances. Participants typically provided worries or problems from multiple categories, and were discouraged from listing events that involved the death of a loved one. Participants also generated a brief title and answered the following questions for each event they listed: (1) What exactly about this event worries you?; (2) What is the bad or negative outcome that you fear for this event?; and (3) What is the good or positive outcome

that you hope will happen for this event? Responses to these questions were used to tailor the main experimental tasks to each participant.

Participants also rated each event on a 1 to 9 scale on the following dimensions (modified from Brown et al., 2002): (1) How anxious or worried are you about this problem or event?; (2) How likely is it that you will experience a good outcome for this event?; (3) How likely is it that you will experience a bad outcome for this event?; and (4) How difficult do you think it would be to cope with a bad outcome for this event? Participants made these ratings in all three sessions, and changes in these ratings were used as subjective measures of well-being.

At the end of the first session, participants were asked to fill out the COPE Inventory (Carver, Scheier, & Weintraub, 1989), which can be divided into two separate composites for *engagement coping* (i.e., positive reinterpretation and growth, use of instrumental and emotional social support, active coping, planning) and *disengagement coping* (i.e., mental and behavioral disengagement, denial). We adapted the COPE Inventory to assess how participants judge that they *will respond* to the stressful events that they imagined in the experiment in the near future (i.e., the next week or month), instead of how they *typically respond* to stressors (e.g., Rivkin & Taylor, 1999). The COPE Inventory was administered after all three sessions to assess changes in indicated coping responses towards the worrisome events after the induction manipulation. Participants also completed the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970) at the end of the first session to examine whether trait anxiety might be associated with the quality of simulation or baseline levels of worry.

Sessions 2 and 3: The second and third experimental sessions consisted of multiple phases. First, participants completed an induction phase with either a specificity or control induction; only one induction was administered per session. Second, participants completed two tasks involving the worrisome events they provided in session 1: a means-end problem solving (MEPS) task and episodic reappraisal task.

Induction Phase: In the beginning of the second and third sessions, participants watched a short video of two adults performing routine activities in a kitchen; two different videos were used between induction conditions and the order of videos was counterbalanced across subjects. Following the videos, participants completed a math filler task (i.e., addition and subtraction questions) for 2 minutes. Afterwards, participants either received questions about the video in the form of an *episodic specificity induction* or a *control induction*; only one induction was administered per session and the order of inductions was counterbalanced across subjects. In the episodic specificity induction, participants were given mental imagery probes asking them to recall specific details about the people, setting, and actions in the video, with follow-up probes to encourage them to elaborate more on the details they had mentioned. In the control induction, participants worked on a packet of math questions for the same amount of time (i.e., no episodic retrieval and elaboration required). The episodic specificity and control inductions use the same procedures that have produced significant effects on memory, imagination, and problem solving tasks in previous work (Madore et al., 2014; Madore & Schacter, 2014). Contrasting performance on the subsequent tasks between the two induction conditions allowed us to assess the effect of episodic detail (i.e., more episodic detail with the specificity induction versus baseline detail with the math control) on self-report subjective well-being measures concerning the events involved in the tasks. See Supplemental Materials for the specificity induction script.

Experimental Tasks: After the induction phase, participants completed two experimental tasks: the means-end problem solving (MEPS) task and the episodic reappraisal task. The events from session 1 were randomized and adapted into an appropriate format for each task using answers to questions from session 1 (e.g., "What is the bad or negative outcome that you fear for this event?" and "What is the good or positive outcome that you hope will happen for this event?"). Participants completed one practice trial and subsequently viewed 6 events in each task. The order of tasks was counterbalanced across subjects.

Problem Solving: In the means-end problem-solving task (MEPS; adapted from Madore & Schacter, 2014; Platt & Spivack, 1975), participants viewed 6 different problem stories relating to the personal worrisome events they provided in session 1. Each story described the beginning of the problem (e.g., worrying about the problem) and an ending solution (e.g., achieving the positive outcome specified for the event in session 1). Participants were given 5 minutes to type out the steps they would execute to reach the final solution in each problem in as much detail as possible. They completed one practice trial with the experimenter before beginning the task to ensure that they understood all instructions. MEPS trials in sessions 2 and 3 were created from 14 randomly selected problems out of the 30 total problems that participants generated in session 1. See Supplemental Materials for task instructions and a sample story.

Episodic Reappraisal: The episodic reappraisal task was adapted from traditional cognitive reappraisal tasks that tap into primarily semantic knowledge of an emotional stimulus to aid in reframing a negative response to that stimulus. For example, an experiment examining distorted negative self-beliefs instructed participants to reinterpret the content of the belief; e.g., if the belief is "No one likes me," participants should tell themselves, "That is not always true, some people like me," or "This is only a thought, not a fact" (Goldin et al., 2009). These instructions are given in order to bring attention to objective, factual information that detracts from more subjective, emotional information about the stimulus or task. In the present study, we modified the typical paradigm so that participants are required to focus on *episodic* details of a scenario in which they are actively engaging in reappraisal of an imagined negative outcome, rather than focusing on more semantic information about the situation.

Participants were presented with 6 negative-outcome scenarios for problems or events they listed in session 1. For each event, participants were asked to (1) for 2 minutes, simulate a scenario in which a negative outcome to the event took place, (2) rate how anxious or worried they felt about the worrisome event, and (3) for 5 minutes, imagine themselves reinterpreting the situation so that it becomes less negative to them and describe their thoughts, feelings, and actions as they are doing so in as much detail as possible. We included the 2-minute simulation component so that participants would be able to experience negative emotion towards the worrisome event prior to reappraising the event.

Participants received one practice trial before the beginning of the task. Episodic reappraisal trials in sessions 2 and 3 were created from 14 randomly selected problems out of the 30 total problems that participants generated in session 1. See Supplemental Materials for task instructions and a sample scenario.

Participants received the same task instructions in sessions 2 and 3 regardless of induction condition, and focused on completing each task in as much detail as possible so that report criteria would be equated following the induction manipulation.

Ratings: After imagining each event during the MEPS and episodic reappraisal tasks, participants rated each event on a scale of 1 to 9 on the following: (1) How anxious or worried are you about this problem or event?; (2) How likely is it that you will experience a good outcome for this event?; (3) How likely is it that you will experience a bad outcome for this event?; and (4) How difficult do you think it would be to cope with a bad outcome for this event? We contrasted these ratings with the original ratings made in session 1 to examine changes in subjective measures of well-being and emotion regulation for the imagined events. For example, improved well-being could be marked by decreased ratings of anxiety, decreased plausibility for experiencing a bad outcome, increased plausibility for experiencing a good outcome, and decreased perceived difficulty in coping with a bad outcome.

Questionnaires: At the end of both sessions 2 and 3, participants once again completed the COPE Inventory questionnaire (Carver et al., 1989). Changes in responses to this questionnaire measure shifts in indicated coping responses towards the worrisome events after the induction manipulation.

Coding—Three raters were trained to score responses from the 5-minute simulation components to both the problem-solving and episodic reappraisal tasks. Responses for the MEPS task were scored as a “relevant step”, “irrelevant step”, or “no step” using the step categories defined by Platt and Spivack (1975); for the analyses, irrelevant and no steps were collapsed into one “other steps” category (cf. Madore & Schacter, 2014; Sheldon et al., 2015). A relevant step is a step or event that leads towards the designated solution state or goal, an irrelevant step is a step or event that leads towards a different solution state not designated in the prompt, and a no step is information that does not fit the step framework (e.g., commentary about the task, repetitive or off-topic information). As in previous work, participants’ responses were also scored with the internal and external detail categories of the Autobiographical Interview (AI; see Levine et al., 2002; Madore et al., 2014; Sheldon et al., 2011). Internal details were segmented as any bits of episodic information contained in the responses (e.g., people, places, actions, objects, thoughts, feelings, etc. of the central event), and external details were segmented as any bits of other information contained in the responses (e.g., semantic facts and commentary, off-topic and repetitive information, etc.). In the MEPS task, internal details corresponded to episodic information (usually contained in relevant steps), whereas external details corresponded to semantic information (usually contained in other steps). Importantly, the MEPS task was scored for both steps and details because the two variables do not necessarily have a one-to-one correspondence. For example, individuals could provide more relevant steps with the specificity induction without much impact on detail, or they could provide more relevant steps and more detail. Responses for the episodic reappraisal task were also scored with the internal and external detail categories.

All raters were blind to the condition of the narratives (control, specificity). The three raters separately scored 20 participant practice trial responses (10 MEPS, 10 episodic reappraisal) to assess inter-rater reliability, and high inter-rater reliability was obtained for details (standardized Cronbach's α = .977 for internal details and .982 for external details) and steps (standardized Cronbach's α = .973 for relevant steps and .926 for other steps). The remainder of responses was scored by one of the three raters separately. Rater 1 scored 40% of participant responses, rater 2 scored 32% of participant responses, and rater 3 scored 28% of participant responses.

Results

We conducted a series of repeated-measures analyses of variance (ANOVAs) to test the hypotheses, which involved within-subjects factors of Induction (control vs. specificity), Task (MEPS vs. episodic reappraisal), Detail type (internal vs. external), Step type (relevant vs. other), and Time of Simulation (initial pre-simulation ratings during session 1 vs. post-simulation ratings during sessions 2 and 3). Both main effects and interactions were tested for each of the variables; we focus on the interactions to address the impact of induction on each of the variables. The counterbalanced order of induction and task did not have a significant effect on the analyses reported below.

Event exclusion—A total of 2.5% of event trials were excluded from the experiment (3.6% of reappraisal trials, 1.3% of MEPS trials) because the participant was unwilling or unable to perform the task, or because the participant actually experienced the event between session 1 and sessions 2 or 3.

Induction Effects on Steps and Details—We first examined how the specificity induction affected the steps generated in the MEPS task and details generated in both the MEPS and episodic reappraisal tasks (see Supplemental Table 1 for mean steps and details) when equating for induction length. The duration of the control induction (i.e., math control task) was 4 min, *SD* = 0 min, and the mean duration of participants' verbal responses during the specificity induction was 3.92 min, *SD* = .98 min.

For the MEPS task, we first conducted a 2 (Induction: control vs. specificity) × 2 (Step type: relevant vs. other) repeated-measures ANOVA. Critically, we found a significant interaction of Induction × Step Type, $F(1,24) = 71.63$, $p < .001$, $\eta_p^2 = .75$. Two-tailed post hoc t-tests showed that participants generated significantly more relevant steps, $t(24) = -8.90$, $p < .001$, 95% CI = [−5.23, −3.26], $d = 1.78$, and significantly fewer other steps, $t(24) = 4.16$, $p < .001$, 95% CI = [.74, 2.20], $d = 0.83$, in the specificity condition compared to the control condition (Relevant steps: $M_{difference} = 4.25$, $SE = .48$; Other steps: $M_{difference} = -1.47$, $SE = .35$). Next, we conducted another 2 (Induction: control vs. specificity) × 2 (Detail type: internal vs. external) repeated-measures ANOVA, where we found a significant interaction of Induction × Detail Type, $F(1,24) = 51.88$, $p < .001$, $\eta_p^2 = .68$. Participants generated significantly more internal details, $t(24) = -6.50$, $p < .001$, 95% CI = [−18.38, −9.52], $d =$

1.30, and significantly fewer external details, $t(24) = 4.32$, $p < .001$, 95% CI = [3.62, 10.25], $d = 0.86$, in the specificity condition compared to the control condition (Internal detail: $M_{difference} = 13.95$, $SE = 2.15$; External detail: $M_{difference} = -6.93$, $SE = 1.61$). Thus, the specificity induction effectively boosted the number of relevant steps (Figure 2A) and internal details (Figure 2B) that participants generated in the MEPS task. The number of relevant steps and internal details generated by participants were highly correlated, $r(23) = .94$, $p < .001$, 95% CI = [.87, .97].

In the episodic reappraisal task, we conducted another 2 (Induction: control vs. specificity) × 2 (Detail type: internal vs. external) repeated-measures ANOVA. Once again, we found a significant interaction of Induction × Detail Type, $F(1,24) = 38.54$, $p < .001$, $\eta_p^2 = .62$, where participants generated significantly more internal details, $t(24) = -4.78$, $p < .001$, 95% CI = [−13.88, −5.50], $d = 0.95$, and fewer external details, $t(24) = 3.72$, $p = .001$, 95% CI = [1.76, 6.13], $d = 0.74$, in the specificity condition relative to the control condition (Internal: $M_{difference} = 9.69$, $SE = 2.03$; External: $M_{difference} = -3.94$, $SE = 1.06$). Just as it did in the MEPS task, the specificity induction boosted the number of internal details that participants generated in the episodic reappraisal task (Figure 2C). Because the specificity induction boosted both the number of relevant steps and internal details in both tasks, we are able to relate this increase in specificity to changes in subjective well-being concerning the imagined worrisome events.

Induction Effects on Ratings of Subjective Well-being—Next, we contrasted pre-simulation (session 1) to post-simulation (sessions 2 and 3) changes in ratings of anxiety, perceived likelihood of a good or bad outcome, and perceived difficulty to cope with a bad outcome between the control and specificity conditions to assess effects of the induction on changes of subjective well-being towards the imagined events. Although most changes from pre- to post-simulation ratings were significant (see Supplemental Table 2 for mean ratings in MEPS task and Supplemental Table 3 for mean ratings in episodic reappraisal task), overall changes from session 1 to sessions 2 and 3 are of limited interest because they could reflect the influence of multiple factors. Accordingly, we focus on the *contrast* between rating changes in the control and specificity conditions through a series of 2 (Induction: control vs. specificity) × 2 (Time of Simulation: pre- vs. post-simulation) repeated-measures ANOVAs. In the following analyses we tested for both main effects and interactions, and focus on reporting the interactions to address the impact of induction on each of the variables. Correlations examining the relationship between the change in internal detail and the change in ratings between the specificity and control conditions are reported in Supplemental Table 4. Trait anxiety was not significantly related to any changes in ratings regarding the imagined events in the observed sample of participants (see Supplemental Table 5).

Change in Anxiety: For perceived anxiety concerning the imagined events, the Task (MEPS vs. reappraisal) × Induction × Time of Simulation interaction was not significant, $F(1,24) = .03$, $p = .87$, $\eta_p^2 = .001$. However, below we separate the analyses by task due to the difference in the nature of the tasks, but note that the results are the same when collapsed across tasks.

In the MEPS task, we found a significant interaction of Induction × Time of Simulation, $F(1,24) = 5.96$, $p < .05$, $\eta_p^2 = .20$. There was a significant decrease in ratings of anxiety for the imagined events from pre- to post-simulation in both the control and specificity conditions, but critically, there was a significantly larger decrease in anxiety ratings in the specificity condition than in the control condition, $t(24) = 2.44$, $p < .05$, 95% CI = [.08, .95], $d = 0.49$ (Figure 3A). In the episodic reappraisal task, we also found a significant interaction of Induction × Time of Simulation, $F(1,24) = 9.56$, $p < .01$, $\eta_p^2 = .29$. There was a significant decrease in ratings of anxiety for the imagined events from pre- to post-simulation in the control condition and specificity condition, but we observed a larger decrease in anxiety ratings in the specificity condition than in the control condition, $t(24) = 3.09$, $p < .01$, 95% CI = [.16, .79], $d = 0.62$ (Figure 4A). However, we note that there was a small but significant difference between initial anxiety ratings for trials in the control condition and specificity condition for both the MEPS task [$M_{difference} = .34$, $SE = .11$, $t(24) = -3.21$, $p < .01$, 95% CI = [−.55, −.12], $d = 0.64$] and episodic reappraisal task [$M_{difference} = .45$, $SE = .09$, $t(24) = -4.95$, $p < .001$, 95% CI = [−.64, −.26], $d = 0.98$].

Change in Perceived Likelihood of a Bad Outcome: For perceived likelihood of a bad outcome to the imagined events, the Task × Induction × Time of Simulation interaction was not significant, $F(1,24) = 1.02$, $p = .32$, $\eta_p^2 = .04$. Once again, we separate the following analyses by task due to the difference in the nature of the tasks.

In the MEPS task, we found a significant interaction of Induction × Time of Simulation, $F(1,24) = 4.96$, $p < .05$, $\eta_p^2 = .17$. There was a significant decrease in ratings of perceived likelihood of a bad outcome for the imagined events from pre- to post-simulation in both the control condition and specificity condition, but we observed a larger decrease in ratings of perceived likelihood of a bad outcome in the specificity condition than in the control condition, $t(24) = 2.23$, $p < .05$, 95% CI = [.03, .72], $d = 0.45$ (Figure 3B). In the episodic reappraisal task, we also found a significant interaction of Induction × Time of Simulation, $F(1,24) = 13.72$, $p = .001$, $\eta_p^2 = .36$. There was a significant decrease in ratings of perceived likelihood of a bad outcome from pre- to post-simulation only in the specificity condition, but there was a larger decrease in ratings of perceived likelihood of a bad outcome in the specificity condition than in the control condition, $t(24) = 3.70$, $p = .001$, 95% CI = [.27, .97], $d = 0.74$ (Figure 4B). We once again note that there was a small but significant difference between initial likelihood ratings for trials in the control condition and specificity condition in only the episodic reappraisal task [$M_{difference} = .46$, $SE = .18$, $t(24) = -2.53$, $p < .05$, 95% CI = [−.83, −.08], $d = 0.50$].

Change in Perceived Likelihood of a Good Outcome: For perceived likelihood of a good outcome to the imagined events, the Task × Induction × Time of Simulation interaction was not significant, $F(1,24) = .07$, $p = .79$, $\eta_p^2 < .01$. Below, we separate the analyses by task due to the difference in the nature of the tasks.

In the MEPS task, we found a significant interaction of Induction × Time of Simulation, $F(1,24) = 5.42$, $p < .05$, $\eta_p^2 = .18$. We observed a significant increase in ratings of perceived likelihood of a good outcome for the imagined events from pre- to post-simulation in both the specificity and control conditions, but there was a larger increase in ratings of perceived likelihood of a good outcome in the specificity condition than in the control condition, $t(24) = -2.33$, $p < .05$, 95% CI = [−.82, −.05], $d = 0.47$ (Figure 3C). We did not find a significant change in ratings of perceived likelihood of a good outcome in the episodic reappraisal task.

Change in Perceived Difficulty to Cope with a Bad Outcome: For perceived difficulty to cope with a bad outcome to the imagined events, there was a significant interaction of Task × Induction × Time of Simulation, $F(1,24) = 6.01$, $p < .05$, $\eta_p^2 = .20$.

In the episodic reappraisal task, we found a significant interaction of Induction × Time of Simulation, $F(1,24) = 26.61$, $p < .001$, $\eta_p^2 = .53$. There was a significant decrease in ratings of perceived difficulty to cope with a bad outcome for the imagined events from pre- to post-simulation in both the control condition and the specificity condition, but we observed a larger decrease in ratings of perceived difficulty to cope with a bad outcome in the specificity condition than in the control condition, $t(24) = 5.16$, $p < .001$, 95% CI = [.44, 1.02], $d = 1.03$ (Figure 4C). For the MEPS task, the Induction × Time of Simulation interaction was not significant, $F(1,24) = .31$, $p = .58$, $\eta_p^2 = .01$, although there was a significant decrease in ratings of perceived difficulty to cope with a bad outcome for the imagined events from pre- to post-simulation in both the control and specificity conditions.

Overall, these results suggest that greater detail of simulation via the specificity induction is related to 1) a larger reduction in anxiety towards the imagined events in both tasks, 2) a larger reduction in the perceived likelihood of a bad outcome for the imagined events for both tasks, 3) a larger increase in the perceived likelihood of a good outcome for the imagined events in the MEPS task, and 4) a larger reduction in the perceived difficulty to cope with a bad outcome for the imagined events in only the episodic reappraisal task, relative to the control induction (see Supplemental Table 4 for correlations).

COPE Inventory Questionnaire: The COPE Inventory was administered at the end of all three experimental sessions. Responses to the COPE Inventory were split into two composite scores for *engagement coping* (i.e., scale items related to positive reinterpretation and growth, use of social support, active coping, and planning) and *disengagement coping* (i.e., mental and behavioral disengagement, denial). There was a significant increase in indicated use of engagement coping behaviors from the initial session to both the control condition session [$M_{change} = 3.92$, $SE = 1.41$, $t(24) = -2.77$, $p < .05$, 95% CI = [−6.84, −1.00], $d = 0.56$], and the specificity condition session [$M_{change} = 5.20$, $SE = 1.24$, $t(24) = -4.20$, $p < .001$, 95% CI = [−7.76, −2.64], $d = 0.84$]. There was a slightly larger increase in indicated use of engagement coping in the specificity condition relative to the control condition, but the difference between the change scores from the initial session to the post-simulation sessions reached only trending significance, $t(24) = -1.93$, $p = .066$, 95% CI = [−2.65, .09], $d = 0.38$ (Figure 5). There was no significant difference in indicated use of disengagement coping behaviors from the initial session to the control [$M_{change} = -.52$, $SE = .91$, $t(24) = .57$, $p = .57$, 95% CI = [−1.35, 2.39], $d = 0.11$] or specificity sessions [$M_{change} = -1.04$, $SE = .87$, $t(24) = 1.20$, $p = .24$, 95% CI = [−.75, 2.83], $d = 0.24$].

Experiment 1 Discussion

Overall, the results of Experiment 1 support the hypothesis that increasing episodic detail of simulation for constructive behaviors concerning worrisome events leads to improved subjective well-being towards those events. Using an episodic specificity induction increased the number of relevant steps and internal details that participants generated during a means-end problem-solving (MEPS) task and also increased the number of internal details generated during an episodic reappraisal task. Importantly, in the specificity condition relative to the control condition, we observed larger decreases in anxiety towards the worrisome events in both tasks, larger decreases in perceived likelihood of a bad outcome in both tasks, larger increases in perceived likelihood of a good outcome in the MEPS task (although the Task × Induction × Time of Simulation interaction was not significant), and larger decreases in perceived difficulty to cope with a bad outcome in only the episodic reappraisal task. There was also a trending increase in indicated use of engagement coping behaviors in the specificity condition relative to the control condition. These results suggest that episodic detail of simulation may be positively related to improved subjective well-being across a number of different measures.

As noted earlier, there were significant differences in the initial ratings of anxiety and perceived likelihood of a bad outcome between the control and specificity conditions, which limit our interpretation of the results. However, the direction of the difference (i.e., events in the specificity condition had higher initial anxiety and higher perceived likelihood of a bad outcome ratings) is opposite to the final pattern of anxiety ratings (i.e., events in the specificity condition had lower post-simulation anxiety and lower perceived likelihood of a bad outcome ratings), which makes it improbable that the difference in change between the specificity and control conditions is purely attributable to an initial difference in ratings. However, to account for this possibility, we aimed to more evenly match initial ratings for anxiety, perceived likelihood of a good or bad outcome, and perceived difficulty to cope with a bad outcome in Experiment 2.

Experiment 2

In Experiment 2, we aimed to extend the results of Experiment 1 after more evenly matching initial ratings of subjective well-being and using a different control induction than the math control used in Experiment 1. It is possible that the effects we attributed to specific episodic retrieval in Experiment 1 instead reflect other differences between the specificity induction and math control condition, such as the general requirement to think back to and talk about the video during the specificity induction. To address this issue, in Experiment 2 we used a more stringent *impressions control induction* that requires participants to reflect on general characteristics of the video, while not requiring them to retrieve specific episodic details. Thus, contrasting performance following the specificity and impressions control inductions will allow us to conclude with more certainty that effects of the specificity induction can be attributed to retrieving episodic details, rather than talking about the video more generally. Previous research has demonstrated similar effects of the episodic specificity induction on subsequent memory and imagination tasks compared with the math control and impressions control conditions (Madore et al., 2014), but it is critical for theoretical interpretation of our results to determine whether the same pattern holds for the key dependent measures in the present study. Overall, the methods used in Experiment 2 are very similar to those of Experiment 1, with differences highlighted below.

Method

Participants—A total of 32 healthy undergraduates were recruited from Harvard University and Boston University (ages 18 to 25, M = 20.84 years, 20 female). A total of 6 participants were excluded due to noncompliance (1 participant) or incompletion of the experiment (5 participants), leaving 26 participants in the final analysis. A power analysis based on the average effect sizes in Experiment 1 for changes in subjective well-being ratings in the specificity versus control condition revealed that a sample size of 22 would provide the ability to detect an overall effect with power of > .80 (two-tailed test, α = .05, d = 0.63). To keep the sample size in Experiment 2 comparable to that of Experiment 1, we stopped data collection after reaching the same approximate number of useable participants.

Questionnaires—In addition to the COPE Inventory and STAI questionnaires administered in Experiment 1, participants filled out the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) to measure changes in positive and negative affect before and after the simulation tasks. The PANAS was administered after all three sessions.

Experimental Procedure—On average, session 2 took place 1.46 days after session 1, and session 3 took place 5.74 days after session 2. See Figure 1 for a diagram of the experimental procedure.

Session 1: Session 1 remained the same in Experiment 2. In preparing event stimuli for sessions 2 and 3, we matched events more evenly on initial ratings of anxiety, perceived likelihood of a good or bad outcome, and perceived difficulty to cope with a bad outcome.

Sessions 2 and 3: Participants first completed the induction phase with either a specificity or control induction, and subsequently completed the problem solving and episodic reappraisal tasks. While the specificity induction procedures remained the same as in Experiment 1, we utilized a different control induction in Experiment 2, the *impressions control* induction. The order of inductions and tasks was counterbalanced across subjects.

Impressions Control Induction: After watching a short video and completing a math filler task, participants who received an impressions control induction were asked questions targeting general impressions, opinions, and thoughts about the video. The control induction did not require participants to retrieve specific episodic details about the video, while still allowing them to talk more generally about the video. See Supplemental Materials for the impressions control script.

Problem Solving: Participants viewed 6 problem stories related to their personal worrisome events and were asked to generate steps to reach a positive outcome. In contrast to Experiment 1, participants were also given 1 minute to imagine and describe a scenario in which they are worrying about the specified problem and to rate how anxious or worried they felt about the problem on a scale of 1 to 9, prior to generating steps to reach a positive outcome for 5 minutes. This format was adopted to match the time participants spent thinking about the worrisome event before the 5-minute simulation component in both the problem-solving and reappraisal tasks.

Episodic Reappraisal: The episodic reappraisal task consisted of 6 bad-outcome scenarios and was very similar to the version administered in Experiment 1. The only change from Experiment 1 was that participants were asked to first simulate a scenario in which a bad outcome to the problem took place for only 1 minute (whereas they did so for 2 minutes in Experiment 1).

Ratings and Questionnaires: All participants were asked to answer the same ratings (i.e., anxiety, likelihood of good or bad outcome, difficulty to cope with a bad outcome) and questionnaires (i.e., COPE Inventory) that were administered in Experiment 1, with the addition of the PANAS questionnaire after all three sessions. Changes in responses to these ratings and questionnaires between session 1 and sessions 2 and 3 indicated shifts in subjective well-being towards the worrisome events after the induction manipulation.

Coding—The same three raters from Experiment 1 scored participant responses for Experiment 2 (i.e., inter-rater reliability coefficients for steps and details were high and the same in both experiments, all Cronbach's $\alpha s \geq .926$). Rater 1 scored 38.5% of participant responses, rater 2 scored 23% of participant responses, and rater 3 scored 38.5% of participant responses.

Results

We tested our hypotheses by conducting a series of repeated-measures ANOVAs, which involved within-subjects factors of Induction (control vs. specificity), Task (MEPS vs. episodic reappraisal), Detail type (internal vs. external), Step type (relevant vs. other), and Time of Simulation (pre- vs. post-simulation). Below, we focus on the interactions to assess the effect of the inductions on each variable of interest. The counterbalanced order of induction and task did not have a significant effect on the following analyses.

Event exclusion—A total of 1.4% of event trials were excluded from the experiment (1.9% of reappraisal trials, 0.9% of MEPS trials) because the participant was unwilling or unable to perform the task, or because the participant actually experienced the event between session 1 and sessions 2 or 3.

Induction Effects on Steps and Details—Participants spent slightly longer discussing the video in the specificity induction (M = 4.16 min, SD = 1.26) than in the control induction (M = 3.50 min, SD = .81), $t(25) = -6.18$, $p < .001$, 95% CI = [−.89, −.44], d = 1.23. However, including the difference score for time as a covariate in the following repeated-measures ANOVAs did not significantly affect any results. See Supplemental Table 6 for mean steps and details.

In the MEPS task, we first conducted a 2 (Induction: control vs. specificity) × 2 (Step type: relevant vs. other) repeated-measures ANOVA. Critically, we found a significant interaction of Induction (control vs. specificity) × Step Type (relevant vs. other), $F(1,25) = 39.60$, $p < .001$, $\eta_p^2 = .61$. Post hoc t-tests showed that participants generated significantly more relevant steps, $t(25) = -6.02$, $p < .001$, 95% CI = [−4.83, −2.37], $d = 1.18$, and significantly fewer other steps, $t(25) = 4.25$, $p < .001$, 95% CI = [.53, 1.53], $d = 0.83$, in the specificity condition compared to the control condition (Relevant steps: $M_{difference} = 3.60$, $SE = .59$; Other steps: $M_{difference} = -1.03$, $SE = .24$). Next, we conducted another 2 (Induction: control vs. specificity) × 2 (Detail type: internal vs. external) repeated-measures ANOVA, where we also found a significant interaction of Induction × Detail Type (internal vs. external), $F(1,25) = 24.29$, $p < .001$, $\eta_p^2 = .49$. Participants generated significantly more internal details, $t(25) = -4.49$, $p < .001$, 95% CI = [−14.12, −5.24], $d = 0.88$, and significantly fewer external details, $t(25) = 2.87$, $p < .01$, 95% CI = [1.57, 9.53], $d = 0.56$, in the specificity condition compared to the control condition (Internal detail: $M_{difference} = 9.68$, $SE = 2.16$; External detail: $M_{difference} = -5.55$, $SE = 1.93$). The number of relevant steps and internal details generated by participants were highly correlated, $r(24) = .87$, $p < .001$, 95% CI = [.73, .94]. Thus, the specificity induction effectively boosted the number of relevant steps (Figure 6A) and the internal details (Figure 6B) that participants generated in the MEPS task, replicating and extending the effects of Experiment 1.

In the episodic reappraisal task, we conducted another 2 (Induction: control vs. specificity) × 2 (Detail type: internal vs. external) repeated-measures ANOVA. Once again, there was a significant interaction of Induction × Detail Type, $F(1,25) = 25.08$, $p < .001$, $\eta_p^2 = .50$. Participants generated significantly more internal details, $t(25) = -4.69$, $p < .001$, 95% CI = [−12.34, −4.81], $d = 0.92$, and fewer external details, $t(25) = 2.44$, $p < .05$, 95% CI = [.36, 4.22], $d = 0.48$, in the specificity condition relative to the control condition (Internal: $M_{difference} = 8.57$, $SE = 1.83$; External: $M_{difference} = -2.29$, $SE = .94$). As in Experiment 1, the specificity induction boosted the number of internal details that participants generated in the episodic reappraisal task (Figure 6C).

Induction Effects on Ratings of Subjective Well-being—Next, we contrasted pre-simulation and post-simulation ratings of anxiety, perceived likelihood of a good or bad outcome, and perceived difficulty to cope with a bad outcome between the control and specificity conditions to assess effects of the specificity induction on changes in subjective well-being towards the imagined events. Unlike Experiment 1, there were no significant differences in baseline ratings for any of the variables. Although most overall changes from pre- to post-simulation ratings were significant (see Supplemental Table 7 for mean ratings in MEPS task and Supplemental Table 8 for mean ratings in episodic reappraisal task), because it is not clear how to interpret these changes, as in Experiment 1 we focus on the *contrast* between rating changes in the control and specificity conditions through a series of 2 (Induction: control vs. specificity) × 2 (Time of Simulation: pre- vs. post-simulation) repeated-measures ANOVAs. In the following analyses we tested for both main effects and interactions, and focus on reporting the interactions to address the impact of induction on each of the variables. Correlations examining the relationship between the change in internal detail and the change in ratings between the specificity and control conditions are reported in Supplemental Table 9. Trait anxiety was not significantly related to any changes in ratings concerning the imagined events in the observed sample of participants (see Supplemental Table 10).

Change in Anxiety: For perceived anxiety concerning the imagined events, the Task (MEPS vs. reappraisal) × Induction × Time of Simulation interaction was not significant, $F(1,25) = .70$, $p = .41$, $\eta_p^2 = .03$. Below, we separate the analyses by task due to the difference in the nature of the tasks, but note that the results are the same when collapsed across tasks.

In the MEPS task, we found a significant interaction of Induction × Time of Simulation (Pre vs. Post), $F(1,25) = 6.36$, $p < .05$, $\eta_p^2 = .20$. There was a significant decrease in ratings of anxiety for the imagined events from pre- to post-simulation in both the control and specificity conditions, but importantly, we observed a larger decrease in anxiety ratings in the specificity condition than in the control condition, $t(25) = 2.52$, $p < .05$, 95% CI = [.07, .72], $d = 0.49$ (Figure 7A). In the episodic reappraisal task, there also was a significant interaction of Induction × Time of Simulation, $F(1,25) = 9.50$, $p < .01$, $\eta_p^2 = .28$. There was a significant decrease in anxiety ratings for the imagined events in both the control and specificity conditions, but we observed a larger decrease in anxiety ratings in the specificity condition than in the control condition, $t(25) = 3.08$, $p < .01$, 95% CI = [.21, 1.06], $d = 0.60$ (Figure 8A).

Change in Perceived Likelihood of a Bad Outcome: For perceived likelihood of a bad outcome to the imagined events, the Task × Induction × Time of Simulation interaction was not significant, $F(1,25) = 2.50$, $p = .13$, $\eta_p^2 = .09$. Once again, we separate the following analyses by task due to the difference in the nature of the tasks.

In the MEPS task, we found a trending interaction of Induction × Time of Simulation, $F(1,25) = 3.91$, $p = .059$, $\eta_p^2 = .14$. There was a significant decrease in ratings of perceived likelihood of a bad outcome for the imagined events in both the control condition and the specificity conditions, but there was a larger decrease in ratings of perceived likelihood of a bad outcome in the specificity condition than in the control condition that showed only trending significance, $t(25) = 1.98$, $p = .059$, 95% CI = [−.01, .69], $d = 0.39$ (Figure 7B). In the episodic reappraisal task, we found a significant interaction of Induction × Time of Simulation, $F(1,25) = 17.68$, $p < .001$, $\eta_p^2 = .41$. There was also a significant decrease in ratings of perceived likelihood of a bad outcome for the imagined events in both the control and the specificity conditions, but once again there was a larger decrease in ratings of perceived likelihood of a bad outcome in the specificity condition than in the control condition, $t(25) = 4.21$, $p < .001$, 95% CI = [.33, .98], $d = 0.82$ (Figure 8B).

Change in Perceived Likelihood of a Good Outcome: For perceived likelihood of a good outcome to the imagined events, there was a significant interaction of Task × Induction × Time of Simulation interaction, $F(1,25) = 8.52$, $p < .01$, $\eta_p^2 = .25$.

In the MEPS task, we found a significant interaction of Induction × Time of Simulation, $F(1,25) = 7.53$, $p < .05$, $\eta_p^2 = .23$. There was a significant increase in ratings of perceived likelihood of a good outcome for the imagined events in both the control and specificity conditions, but there was a larger increase in ratings of perceived likelihood of a good outcome in the specificity condition than in the control condition, $t(25) = -2.75$, $p < .05$, 95% CI = [−.60, −.09], $d = 0.54$ (Figure 7C). There were not significant changes in ratings of perceived likelihood of a good outcome in the episodic reappraisal task.

Change in Perceived Difficulty to Cope with Bad Outcome: For perceived difficulty to cope with a bad outcome to the imagined events, we found a significant interaction of Task × Induction × Time of Simulation, $F(1,25) = 15.46$, $p = .001$, $\eta_p^2 = .38$.

In the episodic reappraisal task, there was a significant interaction of Induction × Time of Simulation, $F(1,25) = 20.97$, $p < .001$, $\eta_p^2 = .46$. We observed a significant decrease in ratings of perceived difficulty to cope with a bad outcome for the imagined events in both the control and specificity conditions, but there was a larger decrease in ratings of perceived difficulty to cope with a bad outcome in the specificity condition than in the control condition, $t(25) = 4.58$, $p < .001$, 95% CI = [.32, .85], $d = 0.90$ (Figure 8C). For the MEPS task, the Induction × Time of Simulation interaction was not significant, $F(1,25) = 1.85$, $p = .19$, $\eta_p^2 = .07$.

Consistent with the results of Experiment 1, these results suggest that greater detail of simulation via the specificity induction is related to 1) a larger reduction in anxiety towards the imagined events in both tasks, 2) a larger reduction in the perceived likelihood of a bad outcome for the imagined events for both tasks, 3) a larger increase in the perceived likelihood of a good outcome for the imagined events in only the MEPS task, and 4) a larger reduction in the perceived difficulty to cope with a bad outcome for the imagined events in only the episodic reappraisal task, relative to the control induction (see Supplemental Table 9 for correlations).

PANAS and COPE Inventory Questionnaires: The PANAS and COPE Inventory questionnaires were administered at the end of all three sessions.

In examining the composite score for positive affect from the PANAS questionnaire, we found a significant increase in positive affect from the initial session to the specificity condition session [$M_{change} = 4.23$, $SE = 1.65$, $t(25) = -2.56$, $p < .05$, 95% CI = [−7.64, −.82], $d = 0.50$], but not in the control condition session [$M_{change} = 1.19$, $SE = 1.54$, $t(25) = -.78$, $p = .45$, 95% CI = [−4.35, 1.97], $d = 0.15$]. While there was a slightly larger increase in positive affect in the specificity condition than in the control condition, the change scores from the initial session to the control and specificity conditions showed only trending significance, $t(25) = -1.89$, $p = .071$, 95% = [−6.36, .28], $d = 0.37$ (Figure 9A).

There was a significant decrease in the composite score for negative affect from the initial session to both the control condition session [$M_{change} = -2.73$, $SE = 1.05$, $t(25) = 2.60$, $p < .05$, 95% CI = [.57, 4.89], $d = 0.51$] and specificity condition session [$M_{change} = -5.46$, $SE = .95$, $t(25) = 5.77$, $p < .001$, 95% CI = [3.51, 7.41], $d = 1.13$]. Overall, there was a larger decrease in negative affect in the specificity condition than in the control condition, $t(25) = 2.55$, $p < .05$, 95% CI = [.52, 4.94], $d = 0.50$ (Figure 9B).

For the engagement coping composite score from the COPE Inventory, there was a significant increase in the indicated use of engagement coping behaviors from the initial session to the specificity condition session [M_{change} = 3.08, SE = 1.09, $t(25) = -2.83$, $p < .01$, 95% CI = [−5.32, −.84], d = 0.55], but not in the control condition session [M_{change} = .04, SE = 1.11, $t(25) = -.04$, p = .97, 95% CI = [−2.32, 2.24], $d < 0.01$]. There was a significantly larger increase in the indicated use of engagement coping behaviors in the specificity condition compared to the control condition, $t(25) = -2.71$, $p < .05$, 95% CI = [−5.35, −.73], d = 0.53 (Figure 10). There was no significant difference in indicated use of disengagement coping behaviors from the initial session to the control [M_{change} = .23, SE = .66, $t(25) = -.35$, p = .73, 95% CI = [−1.59, 1.13], d = 0.07] or specificity sessions [M_{change} = −.58, SE = .72, $t(25)$ = .8, p = .43, 95% CI = [−.91, 2.06], d = 0.16].

Experiment 2 Discussion

The results of Experiment 2 extend the results of Experiment 1 using a tighter control condition (i.e., impressions control induction) and matching initial subjective well-being ratings. The episodic specificity induction increased the number of relevant steps and internal details that participants generated during the MEPS task and also increased the number of internal details generated during an episodic reappraisal task. Critically, in the specificity condition relative to the control condition, we observed larger decreases in anxiety towards the worrisome events in both tasks, larger decreases in the perceived likelihood of a bad outcome in both tasks, larger increases in the perceived likelihood of a good outcome in only the MEPS task, and larger decreases in the perceived difficulty to cope with a bad outcome in only the reappraisal task. There was also a trending increase in overall positive affect, a larger decrease in negative affect, and a larger increase in indicated post-experimental use of engagement coping behaviors concerning the imagined events in the specificity condition relative to the control condition. These results confirm that the observed changes in ratings between the control and specificity conditions are not merely consequences of baseline differences in ratings. Similar to the results in Experiment 1, these data suggest that episodic detail of simulation may be positively related to improved subjective well-being across a number of different measures.

General Discussion

Overall, the data from both experiments support the hypothesis that increasing the level of episodic detail when imagining constructive behaviors regarding worrisome events is related to improved psychological well-being towards those events. We note three key findings to emerge from the two experiments reported here. First, using an episodic specificity induction that selectively targets episodic processes increased both the number of relevant steps and internal details that participants generated during a means-end problem-solving (MEPS) task involving real, personalized problems, thus replicating and extending previous results by Madore and Schacter (2014). Second, we demonstrated for the first time that the specificity induction boosts the internal details generated in an episodic reappraisal task. Traditional cognitive reappraisal tasks are used to down-regulate negative emotional responses to an affective stimulus, and task instructions are primarily semantic in nature, in the sense that they draw attention to factual information about the stimulus that detracts from the more arousing emotional information (e.g., Goldin et al., 2008, 2009). In the present study, we created a paradigm that required participants to imagine a specific, concrete event where they are actively engaging in reappraisal of a negative future outcome, presumably making the task more episodic in nature (episodic reappraisal). Given that the specificity induction selectively boosted internal details in this episodic reappraisal task, this finding suggests that the modified paradigm indeed engages episodic memory processes.

Third, we provide novel evidence that increasing the specificity of simulated constructive behaviors for worrisome future events via the specificity induction can be positively related to psychological well-being towards those events. Although previous experiments have demonstrated that increasing the specificity of autobiographical memory can be linked to improvements in depressive and PTSD symptoms for distressing past events (Moradi et al., 2014; Neshat-Doost et al., 2012; Raes et al., 2009), existing literature on the impact of future simulation on subjective well-being has thus far relied on correlational evidence. For example, Brown et al. (2002) demonstrated that quality of future event simulation (e.g., temporal ordering, logic of sequential steps generated) is correlated with improved well-being; however, the authors did not document or even investigate the importance of episodic detail. Other studies have explicitly manipulated the level of specificity of future event simulation (Williams et al., 1996), but have not directly linked changes in specificity to measures of psychological well-being. In the present studies, we directly manipulated episodic detail by using the specificity induction and subsequently assessed changes in subjective well-being based on this selective increase in episodic detail. Notably, we found that an increase in relevant steps and internal details produced by the specificity induction is related to larger decreases in anxiety towards the worrisome events in both tasks, larger decreases in the perceived likelihood of a bad outcome in both tasks, larger increases in the perceived likelihood of a good outcome in only the MEPS task, and larger decreases in the perceived difficulty to cope with a bad outcome in only the episodic reappraisal task. We also report a trending increase in overall positive affect and a significant reduction in negative affect, as well as an increase in the indicated use of engagement coping behaviors concerning the imagined events at a later time point in the specificity condition relative to the control condition. Thus, experimentally increasing episodic specificity of imagining constructive behaviors regarding worrisome future events may be related to improved subjective well-being towards the imagined events on a number of different measures.

How might an increase in episodic detail produced by the specificity induction relate to improvements in subjective well-being towards imagined worrisome future events? First, the specificity induction prompts individuals to retrieve episodic details related to people, objects, places, and actions, which leads them to focus on describing similar types of details when they later create mental events during the MEPS and episodic reappraisal tasks. We have argued previously (Schacter & Madore, in press) that creating coherent mental events in part involves the construction of internal scenes (Hassabis & Maguire, 2007), and that the specificity induction increases the details associated with elements of a scene such as the people, setting, and objects, as well as the relation of these elements to one another within a mental scene (see Schacter & Madore, in press, for further theoretical elaboration). Worry, as it is manifest in disorders such as GAD, is thought to be a primarily verbal and abstract process that reduces the concreteness of the visual imagery associated with simulations of a worrisome event and can minimize physiological response to a stressful trigger (Borkovec et al., 1998). By this logic, worry likely results in reduced concreteness of a mentally constructed event or scene. If the verbal, conceptual nature of worry serves to avoid the arousing emotional processing that comes with detailed visual imagery of an aversive event at the expense of generating concrete steps to resolve the worry (Borkovec et al., 1998), increasing the specificity of constructive mental simulations regarding these worrisome events might counter this effect by making the event more concrete and tangible.

Researchers have proposed that mental simulations possess a number of intrinsic properties that benefit emotion regulation (Taylor et al., 1998; Taylor & Schneider, 1989), and we argue that increasing episodic detail of simulation may augment multiple, and possibly all, steps in this process. First, mental simulation can make events "seem real or true" (Taylor & Schneider, 1989). That is, simulating a hypothetical event can make the scenario seem more realistic and concrete by providing more information about how the event might take place, and thus can enhance the subjective likelihood that the event will actually occur (Anderson, 1983; Carroll, 1978; Gregory, Cialdini, & Carpenter, 1982; Szpunar & Schacter, 2013). Increasing episodic detail of simulation via a specificity induction, relative to baseline levels of detail, can thus provide even more information about how the event might unfold, further contributing to an increase in plausibility that the event will take place. In support of this idea, we show that in the MEPS task, simulating more relevant steps (and internal, episodic details associated with those steps) to reach a positive outcome increased the perceived likelihood that the positive outcome would take place. Furthermore, increased episodic detail while simulating positive, constructive tasks (i.e., generating steps to solve a problem and reappraising a bad outcome into something less negative) decreased the perceived likelihood that a bad outcome would take place. Thus, manipulating the plausibility of an event may be one avenue through which episodic detail might affect subjective well-being.

Second, enhancing the likelihood of an event might pave the road for taking action. Taylor et al. (1998) proposed that simulations consist of a sequence of actions that tend to be causally linked, and this organization of action can help to yield a concrete plan. The concreteness of simulation can provide important information about the event that contributes to a more realistic representation of the constraints and requirements of the event or task (Hayes-Roth & Hayes-Roth, 1979; for review, see Taylor et al., 1998). In the present studies, generating more episodic detail while trying to reach a good outcome or reframing a bad outcome may have led participants to formulate more detailed sequences of action that produced a more concrete plan. It is also likely that individuals were able to gain access to relevant, more realistic features of an imagined scenario or plan that may not have been as negative as initially thought. Related to this point, our data showed that participants reported a larger decrease in the perceived difficulty to cope with a bad outcome after imagining themselves coping with a bad outcome in more episodic detail. The reported decrease in the perceived likelihood of a bad outcome may also speak to this point, such that participants might have accessed critical details about why a bad outcome was unlikely to occur after generating a more detailed plan to reach a positive outcome or after reframing a negative outcome. Thus, increasing the organization of action and the access to realistic details about constructive behaviors concerning a worrisome event may be another way in which episodic detail can improve subjective well-being.

Given that simulations can increase the subjective likelihood that an event might take place, that they contain an implicit organizational structure that can yield a plan, and that they facilitate access to more realistic representations of the event, mental simulations may thus provide links between thought and action, making it more likely for individuals to execute the plan at hand (Taylor et al., 1998; Taylor & Schneider, 1989). Indeed, we report suggestive evidence that there was a larger increase in the indicated post-experimental use of engagement coping strategies in the COPE Inventory questionnaire (e.g., positive reinterpretation and growth, use of instrumental and emotional social support, active coping, planning; Carver et al., 1989) towards the imagined events in the specificity condition relative to the control condition. While these data only speak to an increase in the *intention* of action and not the execution of action directly, we believe that the demonstrated effects of episodic detail on self-reported psychological well-being take us a step closer to linking simulation and action. Overall, using an episodic specificity induction to increase episodic detail of mental simulation might serve as an upstream intervention that can augment all of these links, thus leading to positive downstream consequences such as a reduction in anxiety concerning a worrisome event and improving psychological well-being as a whole.

This research may have implications for clinical populations, and particularly for patients with anxiety disorders. It has often been shown that clinically anxious individuals report inflated subjective probabilities and greater anticipation that negative events will occur (Barlow, 2000; Butler & Mathews, 1983; MacLeod & Byrne, 1996; MacLeod, Tata, Kentish, Carroll, & Hunter, 1997), as well as increased vividness for negative events (Morina, Deeprose, Pusowski, Schmid, & Holmes, 2011; Stöber, 2000). These findings have been interpreted in the context of the simulation heuristic (Kahneman & Tversky, 1982), in that anxious individuals tend to have increased access to reasons for why negative events might occur, and reduced access to reasons for why they might not occur (Byrne & MacLeod, 1997; MacLeod, Williams, & Bekerian, 1991). However, Raune, MacLeod, and Holmes (2005) reported that simulating reasons against why a negative event might happen lowered subjective probability estimates of the likelihood that a given negative event would take place. Along with our findings that the specificity induction results in simulating constructive behaviors in more episodic detail and increased likelihood estimates of a good outcome and decreased likelihood estimates that a bad outcome will take place, these results highlight the importance of positive and constructive mental future simulations for emotion regulation and psychological well-being.

It is also important to note that subjective well-being towards worrisome events may be modulated by other important aspects of the events. For example, in generating concrete plans and goals, qualitative features of implementation (e.g., ease, perceived likelihood of success) may also modulate subjective well-being (for review, see Eccles & Wigfield, 2002). That is, generating steps that are more easily achievable and attainable may contribute more to subjective well-being than generating steps that are more difficult to achieve. Furthermore, personal significance and importance of a goal or worrisome event might also influence how beneficial simulation might be for a given event (Eccles & Wigfield, 2002; Emmons, 1986), such that a richer mental simulation of a worrisome event that holds more importance and weight might lead to larger gains in subjective-well being than simulation of a worrisome event of less importance. Thus, it is not only the quantity of rich, concrete details that individuals generate in mental simulations of constructive behaviors regarding worrisome future events that is important for psychological well-being; there are also other facets of worrisome events that can influence an individual's subjective well-being towards the event. Although the present data cannot speak to this issue, we believe that further research is necessary to clarify how these different factors might influence psychological well-being and emotion regulation in relation to worrisome future events.

In summary, the results of our experiments extend the range of tasks on which a specificity induction selectively boosts episodic detail to means-end problem solving and episodic reappraisal of personally worrisome future events, and demonstrate that increased episodic detail of simulation can be positively related to improved subjective well-being across a number of different measures. While further research is needed to explore the exact mechanism behind how episodic detail might influence downstream factors such as plausibility, motivation, and taking action, this line of work could have important implications for understanding the regulation of future-oriented emotion in both healthy and clinical populations.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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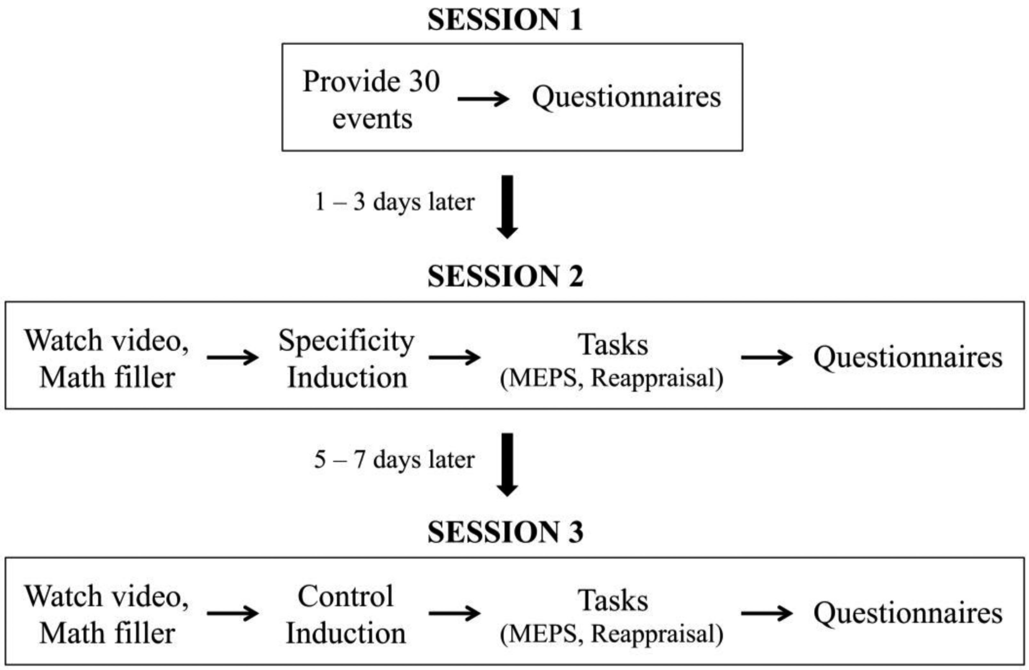

Figure 1.

Schema of experimental design. The order of tasks (MEPS, episodic reappraisal) and inductions (specificity, control) was counterbalanced across participants.

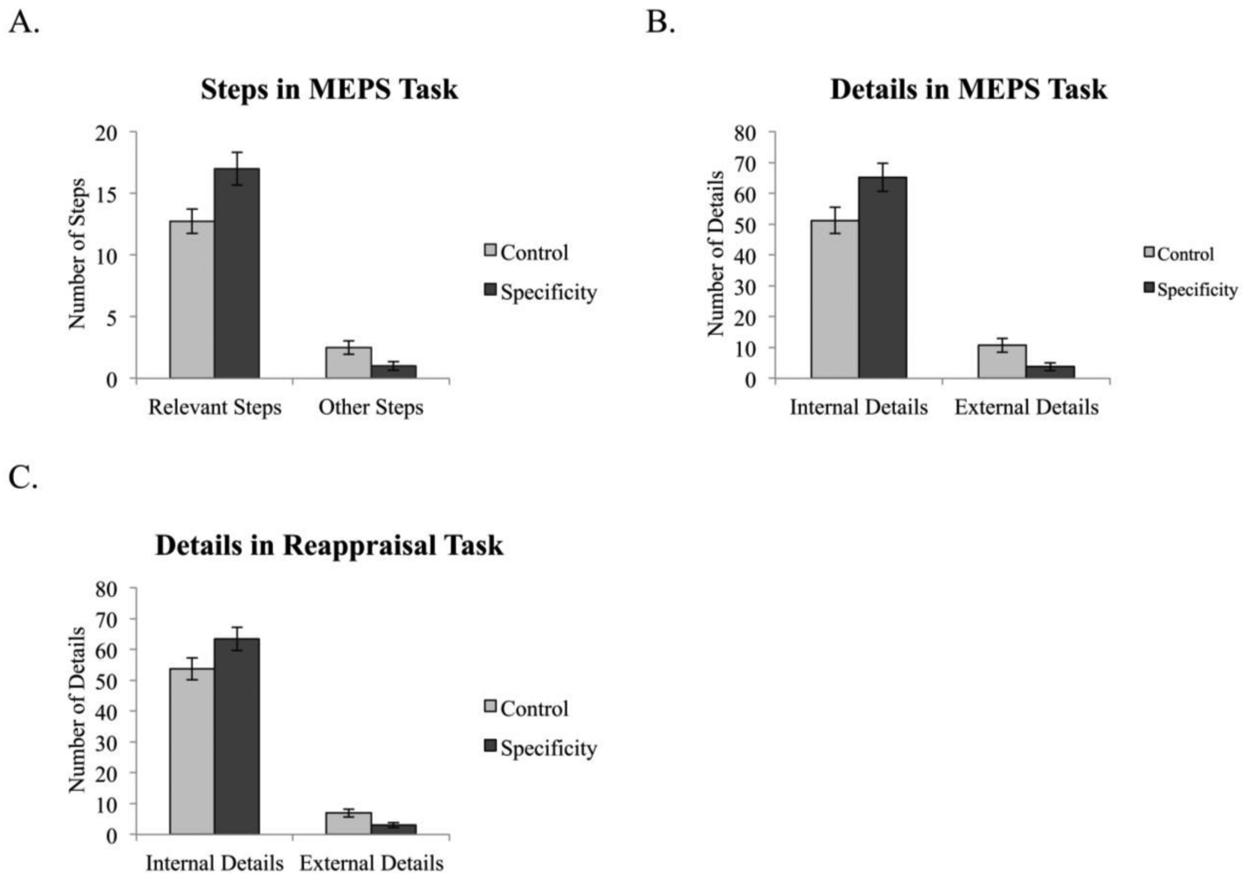

Figure 2.

Experiment 1 mean induction effects on steps and details in control and specificity conditions: (A) Relevant and other steps in means-end problem solving (MEPS) task; (B) Internal and external details in MEPS task; and (C) Internal and external details in episodic reappraisal task. The y-axis represents the mean number of steps or details per trial, and error bars represent one standard error of the mean.

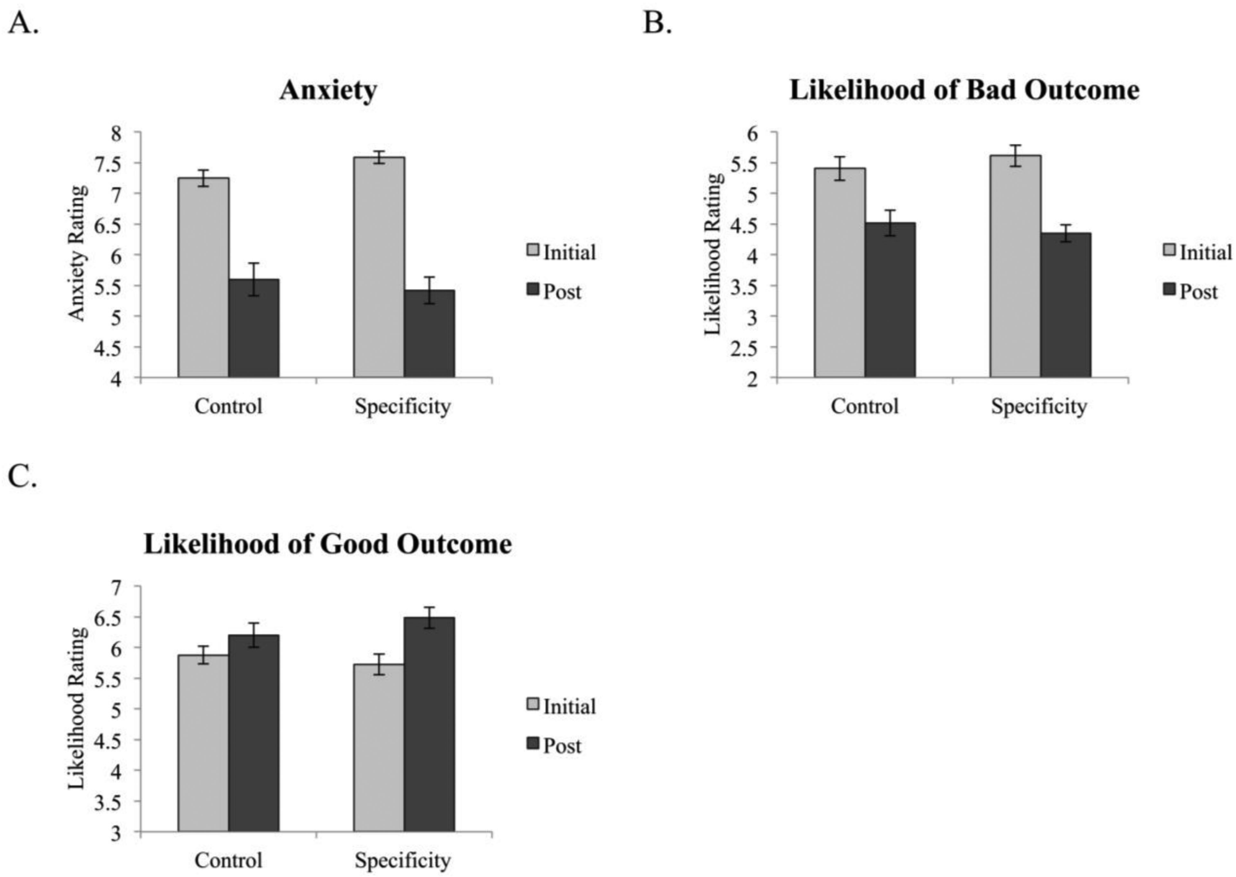

Figure 3.
Experiment 1 mean initial and post-simulation ratings in the control and specificity conditions in the MEPS task of: (A) Anxiety; (B) Perceived likelihood of a bad outcome; and (C) Perceived likelihood of a good outcome. All ratings were made on a 1 to 9 scale. The y-axis represents the mean rating per trial, and error bars represent one standard error of the mean.

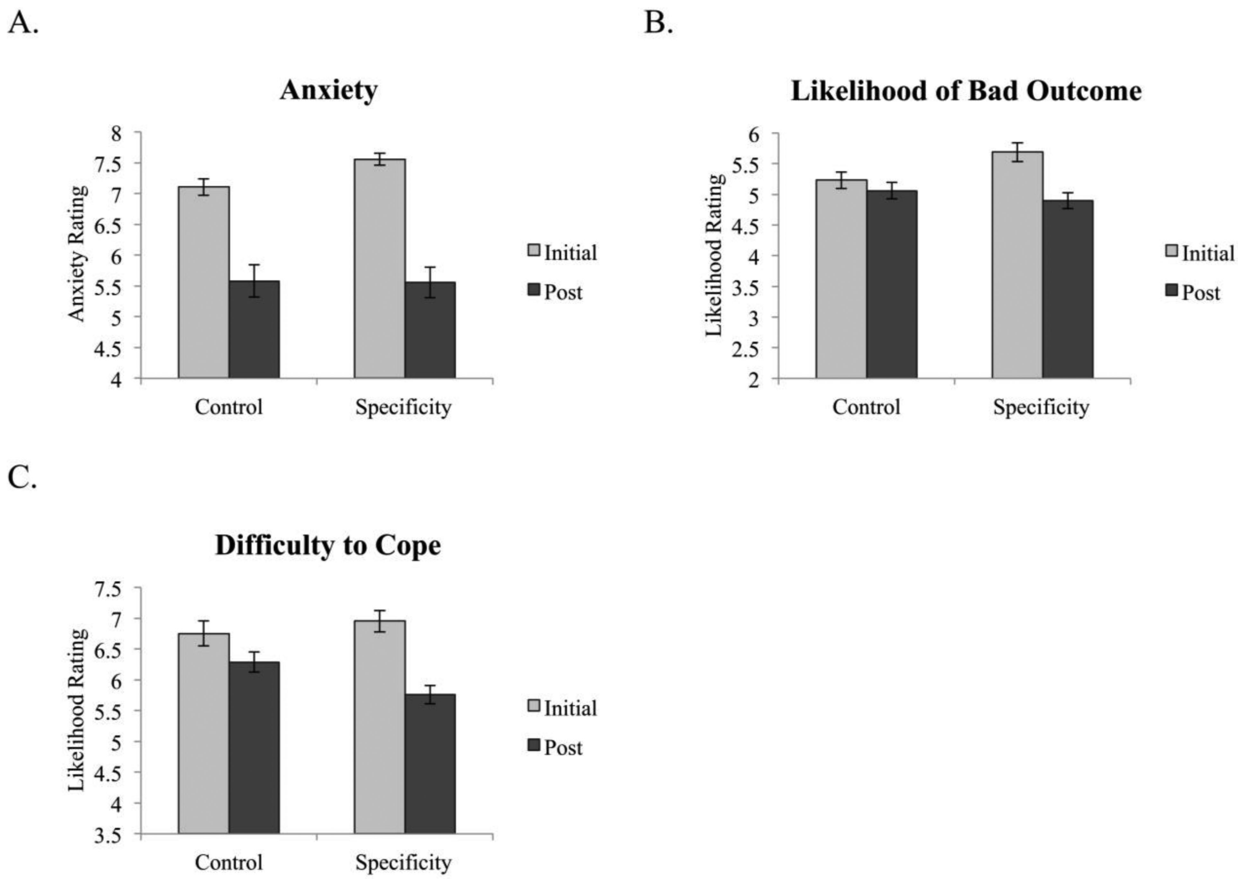

Figure 4.

Experiment 1 mean initial and post-simulation ratings in the control and specificity conditions in the episodic reappraisal task of: (A) Anxiety; (B) Perceived likelihood of a bad outcome; and (C) Perceived difficulty to cope with a bad outcome. All ratings were made on a 1 to 9 scale. The y-axis represents the mean rating per trial, and error bars represent one standard error of the mean.

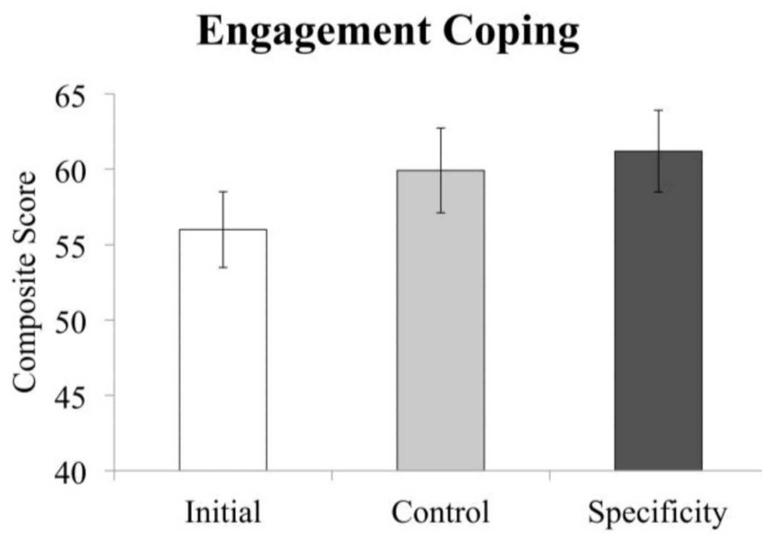

Figure 5.

Experiment 1 mean engagement coping composite score from COPE Inventory scale items in the initial session (session 1), control and specificity sessions (sessions 2 and 3). The minimum composite score is 20 and the maximum composite score is 80. The y-axis represents the mean total score across questions, and error bars represent one standard error of the mean.

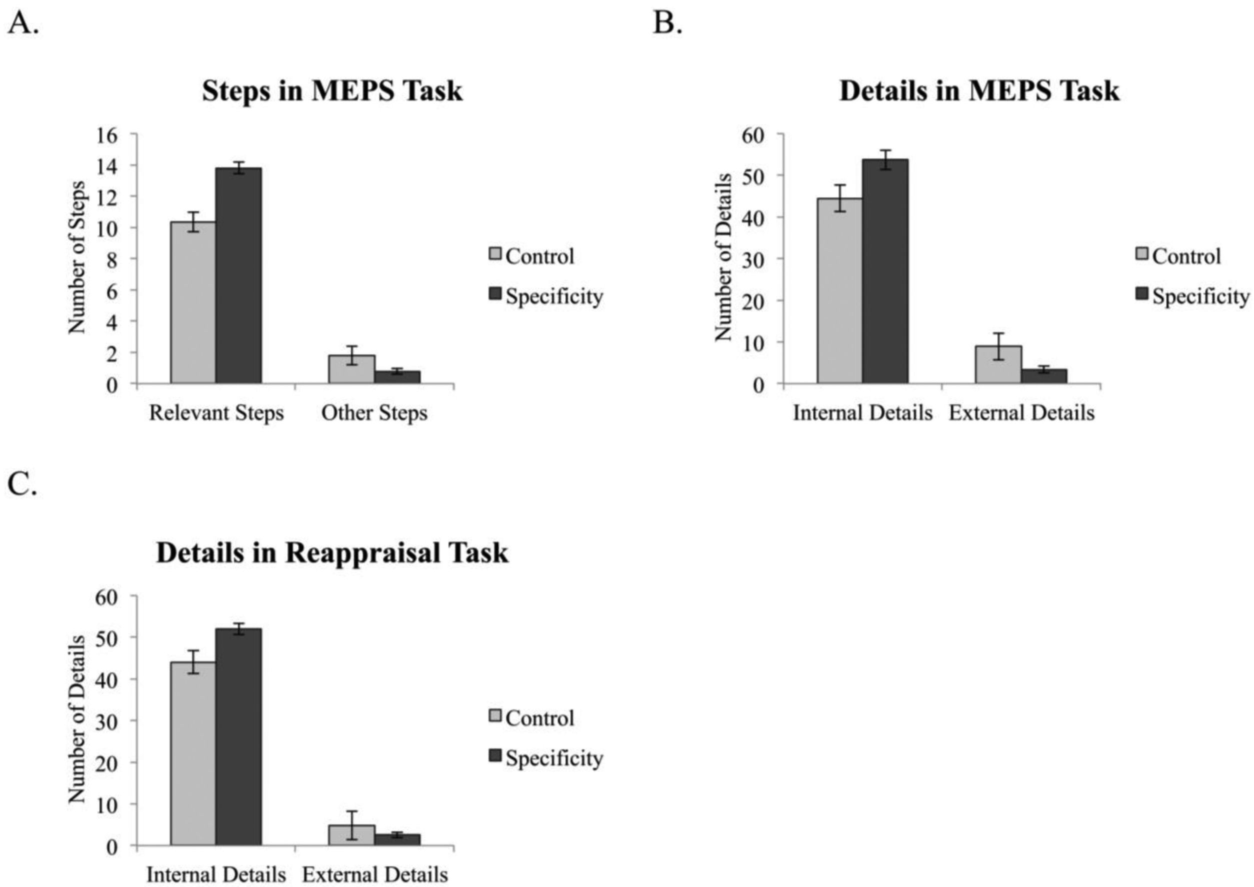

Figure 6.

Experiment 2 mean induction effects on steps and details in control and specificity conditions: (A) Relevant and other steps in means-end problem solving (MEPS) task; (B) Internal and external details in MEPS task; and (C) Internal and external details in episodic reappraisal task. The y-axis represents the mean number of steps or details per trial, and error bars represent one standard error of the mean.

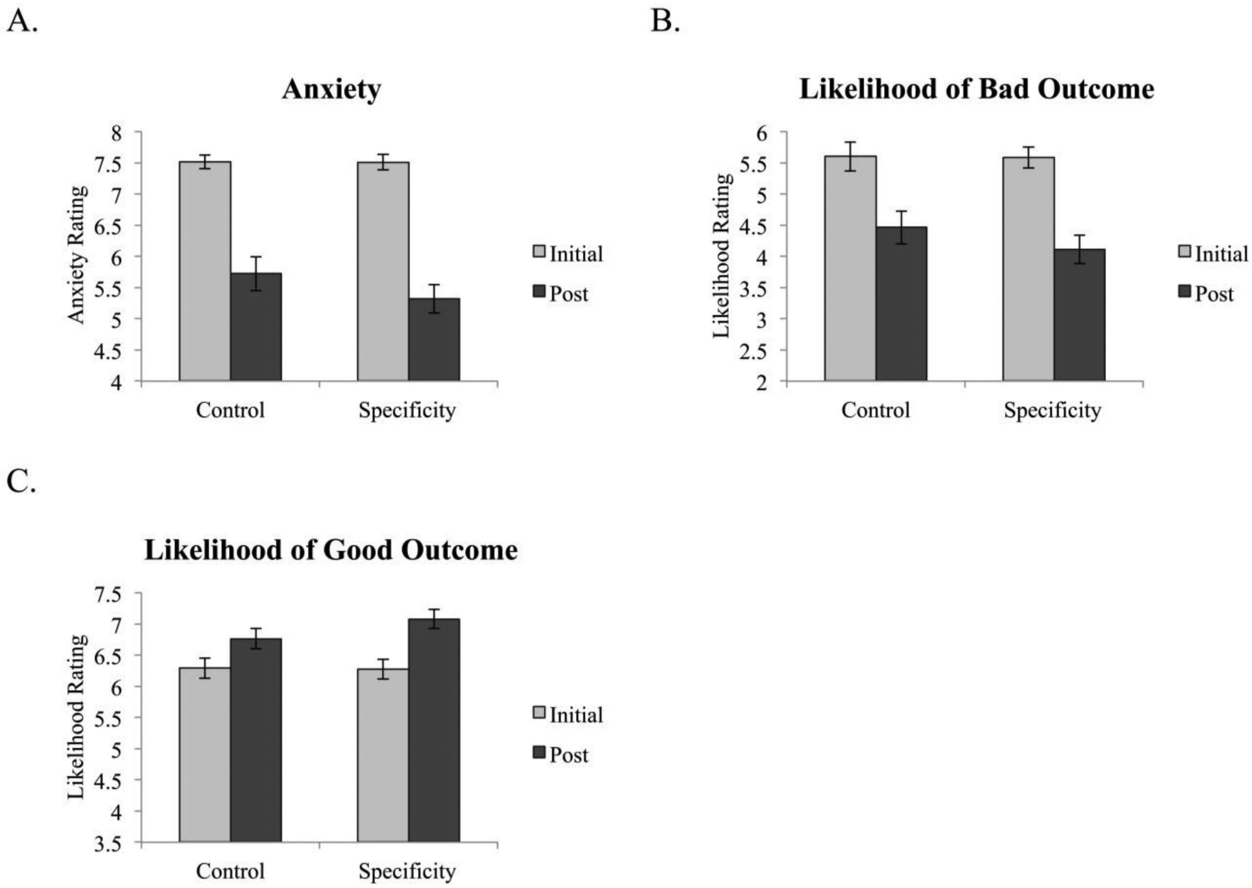

Figure 7.

Experiment 2 mean initial and post-simulation ratings in the control and specificity conditions in the MEPS task of: (A) Anxiety; (B) Perceived likelihood of a bad outcome; and (C) Perceived likelihood of a good outcome. The y-axis represents the mean rating per trial, and error bars represent one standard error of the mean.

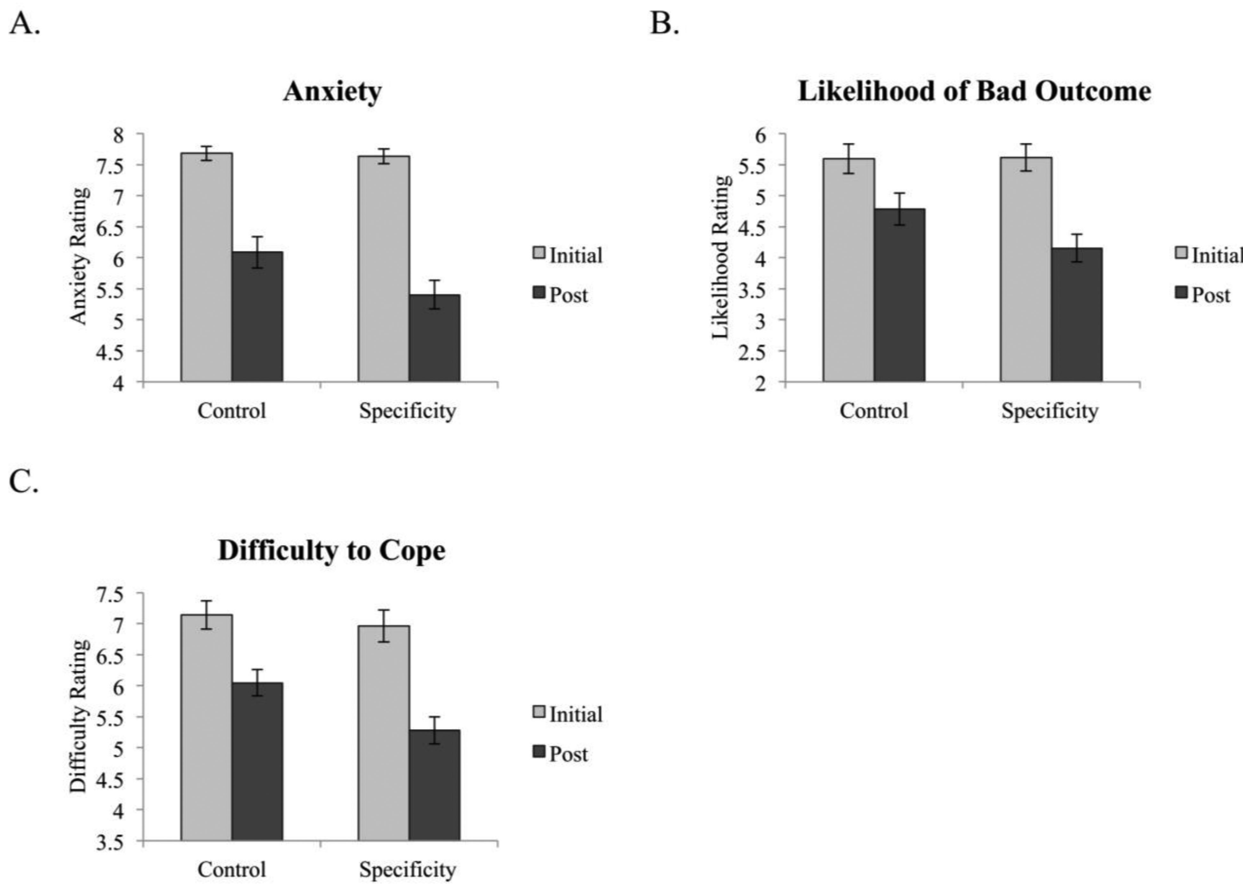

Figure 8.

Experiment 2 mean initial and post-simulation ratings in the control and specificity conditions in the episodic reappraisal task of: (A) Anxiety; (B) Perceived likelihood of a bad outcome; and (C) Perceived difficulty to cope with a bad outcome. The y-axis represents the mean rating per trial, and error bars represent one standard error of the mean.

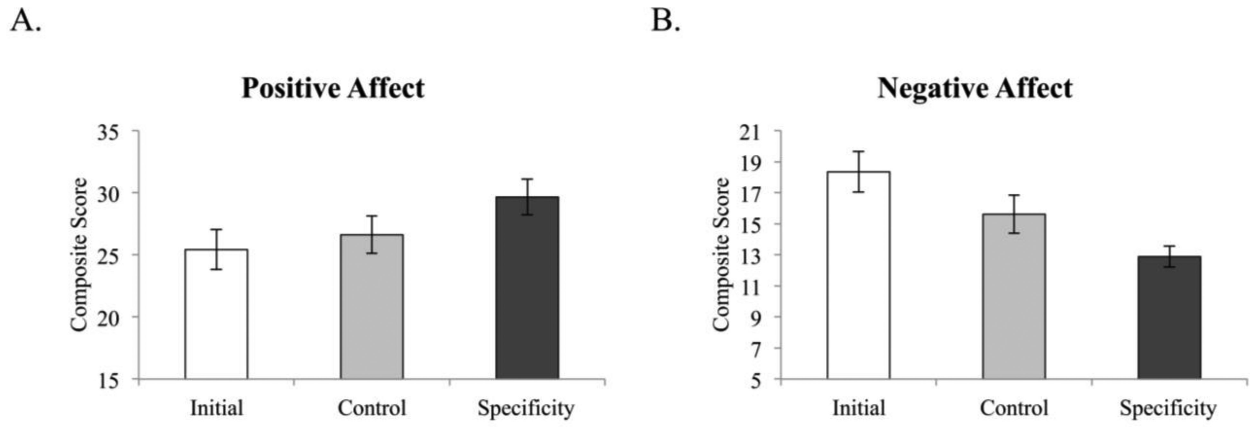

Figure 9.

Experiment 2 mean PANAS composite scores for (A) positive affect and (B) negative affect in the initial session (session 1), control and specificity sessions (sessions 2 and 3). The minimum composite score is 10 and the maximum composite score is 50 for both positive and negative affect. The y-axis represents the mean total score across scale items, and error bars represent one standard error of the mean.

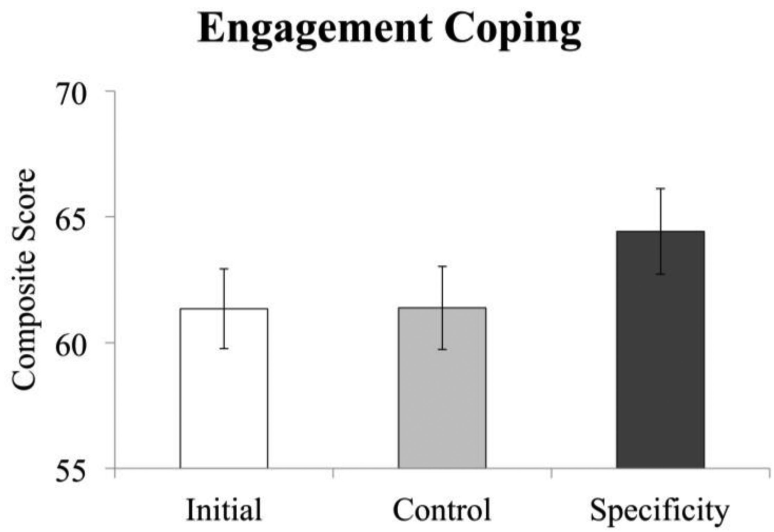

Figure 10.

Experiment 2 mean engagement coping composite score from COPE Inventory scale items in the initial session (session 1), control and specificity sessions (sessions 2 and 3). The minimum composite score is 20 and the maximum composite score is 80. The y-axis represents the mean total score across questions, and error bars represent one standard error of the mean.