Research Report

Psychological Science
24(7) 1329–1334

DOI: 10.1177/0956797612468163
pss.sagepub.com

Coming to Grips With the Past: Effect of Repeated Simulation on the Perceived Plausibility of Episodic Counterfactual Thoughts

Felipe De Brigard, Karl K. Szpunar, and Daniel L. Schacter
Harvard University

Abstract
When people revisit previous experiences, they often engage in episodic counterfactual thinking: mental simulations of alternative ways in which personal past events could have occurred. The present study employed a novel experimental paradigm to examine the influence of repeated simulation on the perceived plausibility of upward, downward, and neutral episodic counterfactual thoughts. Participants were asked to remember negative, positive, and neutral autobiographical memories. One week later, they self-generated upward, downward, and neutral counterfactual alternatives to those memories. The following day, they resimulated each of those counterfactuals either once or four times. The results indicate that repeated simulation of upward, downward, and neutral episodic counterfactual events decreases their perceived plausibility while increasing ratings of the ease, detail, and valence of the simulations. This finding suggests a difference between episodic counterfactual thoughts and other kinds of self-referential simulations. Possible implications of this finding for pathological and nonpathological anxiety are discussed.

Keywords
autobiographical memory, episodic memory, memory, thinking

Received 4/10/12; Revision accepted 10/25/12

People frequently revisit their past experiences. Often, such revisions lead to episodic counterfactual thoughts: mental simulations about alternative ways in which specific personal past events might have occurred (De Brigard & Giovanello, 2012; Epstude & Roese, 2008; Kray et al., 2010). Considerable research has focused on the affective consequences of revisiting counterfactual simulations. It is well known, for instance, that ruminating about how bad things could have turned out better—upward counterfactuals—tends to elicit feelings of regret and disappointment (Landman, 1993). Conversely, thinking about how good things could have turned out worse—downward counterfactuals—tends to elicit feelings of relief and satisfaction (Mandel, Hilton, & Catellani, 2005; Markman, Gavanski, Sherman, & McMullen, 1993; Roese, 1994; Roese & Olson, 1995). Nonetheless, little is known about how repeated counterfactual simulation affects individuals' beliefs about such imagined alternative events. In particular, little is known as to whether or not revisiting episodic counterfactual thoughts may affect one's judgment of how plausible it is that the imagined event could have occurred.

On the one hand, it is possible that repeated simulation of episodic counterfactual events could lead to an increase in their perceived plausibility. A number of studies have demonstrated that repeated simulations of possible future events lead people to believe that those events are more likely to occur (Anderson, 1983; Carroll, 1978; Gregory, Cialdini, & Carpenter, 1982; Sherman, Cialdini, Schwartzman, & Reynolds, 1985; for a review, see Koehler, 1991), an effect that is more prevalent for

Corresponding Author:
Felipe De Brigard, Department of Psychology, William James Hall 860, Harvard University, 33 Kirkland St., Cambridge, MA 02138
E-mail: brigard@wjh.harvard.edu

emotional than nonemotional events (Szpunar & Schacter, 2013). Moreover, Szpunar and Schacter (2013) have shown that repetition enhances the level of detail and ease of simulation, and that such increases are associated with a higher degree of perceived plausibility for possible future events. As a result, it may be the case that repeated simulation of counterfactual thoughts, by way of enhancing their level of detail and ease of simulation, could produce a similar increment in perceived plausibility.

On the other hand, unlike simulation of possible future events, generating counterfactual thoughts involves a mental contrast between the event that actually occurred and the alternative imagined possibility (Johnson-Laird & Byrne, 2002). In that sense, counterfactual thinking is constrained by reality in a way that future thinking is not. Repeated simulation may then bring discrepancies between the actual and the possible events more sharply into focus, inviting people to reconsider the amount of modification that would have been required in order for the imagined event to have occurred. This, in turn, may affect people's assessment of the likelihood of the counterfactual event, leading to a decrease rather than an increase in the event's perceived plausibility. Indeed, it might be psychologically adaptive for rumination about episodic counterfactual events to lead to a decrease in their perceived plausibility, insofar as this would help people to come to grips with the way things were rather than invite them to focus on how things might have been.

The main purpose of the present study was to try to adjudicate between these two alternative hypotheses by examining the effect of repeated simulation on the perceived plausibility of novel episodic counterfactual thoughts. In addition, we examined whether or not the emotional direction of counterfactual simulation influenced the relation between repeated simulation and perceived plausibility of the event. Finally, we also examined whether or not the perceived plausibility of counterfactual simulations is related to their level of detail and ease of simulation, an effect that has been proposed in the case of episodic future thinking (Anderson, 1983).

Method

Thirty-seven undergraduates participated in this study. The number of observations was insufficient for 7 participants (see the Results section), so data from 30 participants were analyzed (mean age = 20.57 years, *SD* = 2.08; 15 females, 15 males).

The study consisted of three sessions. In Session 1, participants generated 35 negative, 35 positive, and 35 neutral autobiographical memories. For each memory, participants typed a short description and a title, as well as the name of a person (other than themselves) who was involved, the location where the event took place, and an object featured in the memory.

One week later, participants returned to the lab for an episodic-counterfactual-simulation session. They were told that they would be engaging in three kinds of counterfactual simulations—upward, downward and neutral—and that each simulation would be prompted by a display on a computer monitor. When the heading on the screen was "Upward," they would be presented with the person, place, object, and title from one of the negative memories they had reported in Session 1, and they were to imagine an alternative, better way in which the cued negative memory could have occurred. Conversely, when the heading was "Downward," they would be presented with the person, place, object, and title from a positive memory, and they were to imagine an alternative, worse way in which the cued positive memory could have occurred. Finally, when the heading was "Neutral," participants would be presented with the person, place, object, and title from a neutral memory, and they were simply to imagine an alternative way in which the same event could have occurred, without the emotional value of the actual event having been altered at all. Participants were allotted 12.5 s to simulate each episodic counterfactual event. After each simulation, they were prompted to write a short new title for the counterfactual event. They were told that this new title would help them remember the event they had just imagined. Participants simulated 30 upward, 30 downward, and 30 neutral episodic counterfactuals, in random order, for 30 negative, 30 positive, and 30 neutral autobiographical memories (respectively) randomly selected from the memories reported in Session 1. For each kind of memory, 1 of the remaining 5 memories was selected at random for an initial practice session, conducted to ensure that participants would adhere to the instructions (Fig. 1).

The third session took place 1 day later. This session consisted of two parts. In the first part, participants were asked to resimulate 15 upward, 15 downward, and 15 neutral counterfactuals in random order, and three times each. These counterfactuals were randomly selected from the counterfactuals participants had simulated the day before. The stimulus displays followed the parameters in Session 2: For each counterfactual, participants were presented with the heading indicating the counterfactual's direction (i.e., "Upward," "Downward," or "Neutral"); the person, place, and object for that memory; and the new title they had written the day before. They were given 12.5 s to resimulate each event. Participants were explicitly asked to resimulate the very same counterfactuals they had generated the day before.

Next, participants had a 10-min break, during which they engaged in a distraction task (Sudoku or word

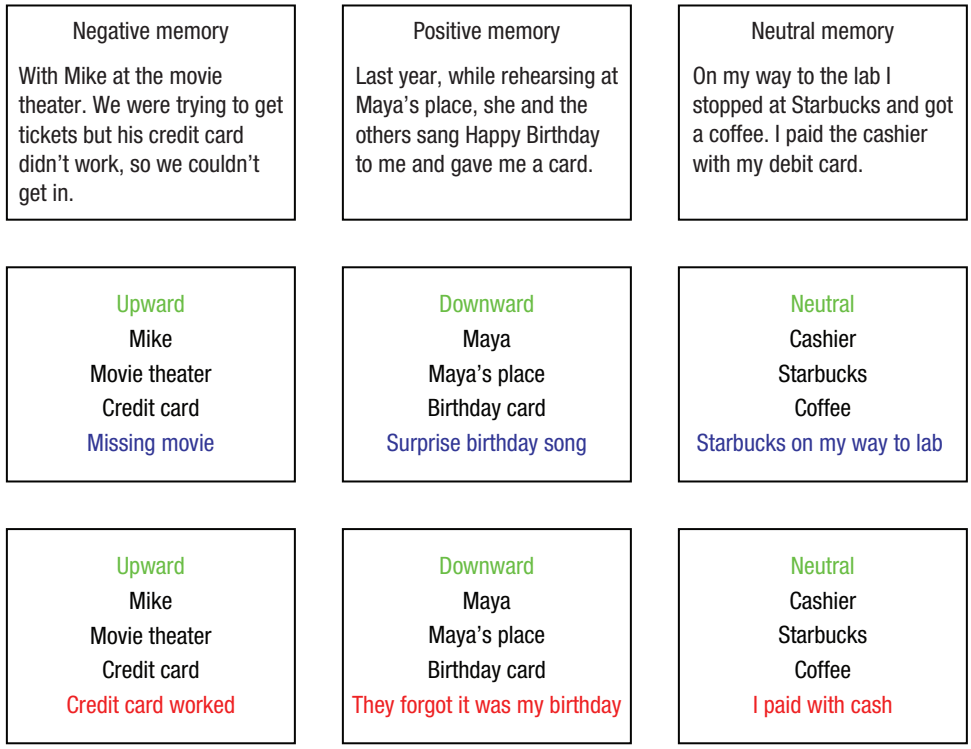

Fig. 1. Examples of autobiographical memories reported in Session 1 and the corresponding stimulus displays and counterfactual generations from Session 2. The top row shows examples of negative, positive, and neutral memories. The second row shows the stimulus displays used to prompt upward, downward, and neutral counterfactual simulations for these events. For each memory, participants saw the person, place, object, and title (shown in blue) that they had reported in Session 1. The heading on the screen (shown in green) indicated the direction of the counterfactual: upward for negative memories, downward for positive memories, and neutral for neutral memories. The third row illustrates examples of counterfactuals generated by participants; in each case, the new title given to the counterfactual is shown in red.

puzzle) aimed at preventing them from reentertaining recently rehearsed simulations. Then, in the second part of the session, participants resimulated all 30 upward, 30 downward, and 30 neutral counterfactuals. In all, then, half of the counterfactuals were resimulated just one time, whereas the other half were resimulated a total of four times. This last portion of the experiment was introduced as a recognition test. Participants were told that the main task was to indicate whether or not they had simulated each particular counterfactual event earlier that day (i.e., 10 min earlier). In addition, they rated the phenomenology of the simulations according to their detail (1 = *few details*, 5 = *many details*), ease (1 = *very difficult to imagine*, 5 = *very easy to imagine*), valence (1 = *very negative*, 5 = *very positive*), plausibility (1 = *very implausible*, 5 = *very plausible*), and novelty (1 = *absolutely sure not novel*, 2 = *pretty sure not novel*, 3 = *not sure*, 4 = *pretty sure novel*, 5 = *absolutely sure novel*). (The order of the ratings was random.) Postexperimental interviews indicated that the recognition test (hit rate = .98) and additional ratings successfully masked the real purpose of the study (i.e., examining the effect of repeated simulation on the subjective plausibility of novel episodic counterfactual thoughts).

Results

Given that the purpose of the study was to examine the effect of repeated simulation of *novel* episodic counterfactual thoughts, only counterfactuals that participants had not entertained prior to the experiment (i.e., novelty rating of 3, 4, or 5) were analyzed. Participants who did not have at least four novel counterfactuals for each kind of counterfactual simulation (upward, downward, neutral) per repetition condition (one repetition, four repetitions) were excluded,[1] so data from a total of 30 participants are reported. For simulations repeated four times, participants contributed on average 9.97 (*SD* = 3.03) downward, 7.67 (*SD* = 2.71) upward, and 10.77 (*SD* = 3.47) neutral novel counterfactuals. For simulations repeated only once, participants contributed on average 10.20 (*SD* = 2.62) downward, 8.60 (*SD* = 2.74) upward,

and 11.03 (*SD* = 2.89) neutral novel counterfactuals. Although participants produced on average fewer upward than both downward and neutral counterfactuals, $F(2, 28) = 7.934$, $p < .01$, $\eta^2 = .362$, the total number of counterfactuals generated did not differ between the one-repetition and four-repetitions conditions ($p > .05$).

Table 1 presents the mean phenomenological ratings for upward, downward, and neutral episodic counterfactual simulations in each repetition condition. For the plausibility rating, a 3 (direction: downward, upward, neutral) × 2 (repetition: four times, one time) analysis of variance (ANOVA) revealed main effects of direction, $F(2, 28) = 41.895$, $p < .001$, $\eta^2 = .750$, and repetition, $F(1, 29) = 17.023$, $p < .001$, $\eta^2 = .370$, with no interaction ($p = .379$). With regard to direction, post hoc contrasts revealed that neutral episodic counterfactuals were rated as more plausible than both upward and downward episodic counterfactuals, $t(29) = 9.137$, $p < .001$, $d = 1.91$, and $t(29) = 7.489$, $p < .001$, $d = 1.77$, respectively, and that downward episodic counterfactuals were rated as more plausible than upward episodic counterfactuals, $t(29) = 1.959$, $p < .05$, $d = 0.29$. Critically, episodic counterfactual thoughts simulated four times were judged as less plausible than those simulated only once.

Additional 3 (direction) × 2 (repetition) ANOVAs were conducted for the other phenomenological ratings. The detail, ease, and valence ratings all showed main effects of direction, smallest $F(2, 28) = 4.264$, $p < .05$, $\eta^2 = .233$, and repetition, smallest $F(1, 29) = 4.410$, $p < .05$, $\eta^2 = .132$, with no interactions (largest $p = .398$). Upward counterfactuals, $t(29) = 2.485$, $p < .05$, $d = 0.43$, and downward counterfactuals, $t(29) = 4.510$, $p < .001$, $d = 0.69$, were more detailed than neutral counterfactuals, and there was no difference in rated detail between downward and upward counterfactuals ($p = .169$). Downward counterfactuals came to mind more easily than neutral counterfactuals, $t(29) = 2.969$, $p < .01$, $d = 0.23$. Downward counterfactuals were more negative than both upward counterfactuals, $t(29) = 2.201$, $p < .01$, $d = 0.74$, and neutral counterfactuals, $t(29) = 2.893$, $p < .01$, $d = 0.71$, and there was no difference in valence between upward and neutral counterfactuals ($p = .274$). Upward, downward, and neutral episodic counterfactuals were all rated as more detailed, more easily simulated, and more positive after four repetitions than after just one repetition. Finally, for the ratings of novelty, there were no effects of direction or repetition.

Discussion

The main purpose of this study was to examine the effect of repeated simulation of novel episodic counterfactual thoughts on their perceived plausibility. We found that episodic counterfactual thoughts that were simulated repeatedly were judged as less plausible than those that were simulated only once. These results contrast with extant evidence on future thinking, which suggests that the perceived plausibility of imagined possible future events increases as a function of repeated simulations (Anderson, 1983; Carroll, 1978; Gregory et al., 1982; Sherman et al., 1985; Szpunar & Schacter, 2013).

In addition, we examined whether or not the direction of the counterfactual mutation (i.e., upward or downward) influences the effect of repeated simulation on the

Table 1. Mean Phenomenological Ratings for Downward, Upward, and Neutral Episodic Counterfactual Simulations in the Two Repetition Conditions

	Type of counterfactual		
Rating and number of repetitions	Downward	Upward	Neutral
Plausibility			
Four repetitions	2.86 (0.70)	2.59 (0.86)	3.86 (0.49)
One repetition	3.02 (0.66)	2.89 (0.84)	3.93 (0.45)
Detail			
Four repetitions	3.69 (0.63)	3.62 (0.71)	3.21 (0.79)
One repetition	3.29 (0.65)	3.11 (0.78)	2.97 (0.67)
Ease			
Four repetitions	4.08 (0.69)	3.96 (0.78)	3.85 (0.80)
One repetition	3.68 (0.67)	3.52 (0.89)	3.29 (0.73)
Valence			
Four repetitions	2.59 (0.96)	3.23 (0.93)	3.08 (0.22)
One repetition	2.48 (1.02)	3.16 (0.75)	2.99 (0.24)
Novelty			
Four repetitions	4.17 (0.41)	4.07 (0.46)	4.09 (0.62)
One repetition	4.24 (0.44)	3.98 (0.51)	4.06 (0.65)

Note: Standard deviations are given in parentheses.

perceived plausibility of novel episodic counterfactual thoughts. Our results did not reveal any interaction between the direction of the counterfactual mutation and the number of repetitions. Thus, the evidence gathered here suggests that repeated simulation reduces the perceived plausibility of novel episodic counterfactual thoughts independently of the direction of the mutation. Nonetheless, it is important to note that repeated simulation did have an effect on the valence with which the counterfactuals were experienced (i.e., counterfactuals repeated four times were rated as more positive than those repeated just once), and future research should examine whether or not valence and repetition might have an interactive effect on plausibility under certain conditions.

Our study also examined whether or not the perceived plausibility of counterfactual simulations is related to their amount of detail and ease of simulation. The results indicate that although the perceived plausibility of counterfactual thoughts decreased as a function of repeated simulation, ratings of both detail and ease increased. Thus, our results for detail and ease, but not for plausibility, replicated previous results for future thinking (Lichtenstein, Slovic, Fischhoff, Layman, & Combs, 1978). This suggests that an increase in perceived plausibility of possible events is not an inevitable consequence of an increase in the detail and ease of their simulation.

What accounts for the divergence between future thinking and counterfactual thinking in how repetition affects perceived plausibility? A possible explanation derives from the mental-models view on counterfactual generation (Byrne, 1997, 2002; Johnson-Laird & Byrne, 2002). According to this view, when people generate counterfactual thoughts, they contrast a mental representation of what is true, what is known, or what is perceived as normal with another mental representation that minimally deviates from the first one. The less this counterfactual alternative deviates from the true, known, or normal representation, the more likely it is perceived to be. In the case of episodic counterfactual thoughts, the initially generated counterfactual diverges minimally from the actual memory, and the perceived plausibility of the counterfactual is high. But when more attention can be allocated to further details of the counterfactual, as a result of repetition, the divergence from the actual memory increases, which renders the counterfactual less plausible. In contrast, in the case of future thinking, there is no true, known, or normal representation against which to contrast the mental simulation, so there is no divergence that could affect the perceived plausibility of the imagined event. The same line of reasoning can be applied to results obtained when participants repeatedly imagine past events that never occurred; such repetition increases the subjective likelihood that the events did occur (imagination inflation; see Garry, Manning, Loftus, & Sherman, 1996), because there is no true event available for contrast.

It may actually be healthy for the perceived plausibility of what could have happened to decrease as a function of repeated pondering about such what-ifs. Research has shown that increased counterfactual thinking is associated with anxiety and excessive nervousness (Nolen-Hoeksema, 2000; Rachman, Gruter-Andrew, & Shafran, 2000; Roese, Park, Smallman, & Gibson, 2008). In nonpathological cases, perhaps rumination helps bring into focus increasingly divergent details of the counterfactual events so that, when they are contrasted with what actually occurred, their perceived plausibility decreases, along with the need for further pondering. Conversely, in pathological cases, there may be no such decrease in perceived plausibility, which may contribute to excessive rumination. Whether or not this is the case remains an open question, and one that merits further research.

Acknowledgments

We thank Daniel Elledge for help collecting data and two anonymous reviewers for insightful comments.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Funding

This research was supported by grants from the National Institute of Mental Health (R01MH60941) and the National Institute on Aging (RO1 AG008441) to D. L. S.

Note

1. We had participants judge the novelty of the counterfactual thoughts after the repetition manipulation in order to avoid biasing participants away from generating realistic counterfactuals. However, it is possible that participants rated fewer counterfactuals as novel in the four-repetitions condition than in the one-repetition condition because the repeated repetitions increased the familiarity of the counterfactuals; in turn, this could have reduced the number of observations we were able to include in our analysis, given our cutoff of a novelty score of 3. Nonetheless, we conservatively excluded participants whose number of generated counterfactuals was more than 2 standard deviations below the mean, as including them could have artificially skewed the variance of the weighted average from all participants' ratings

References

Anderson, C. A. (1983). Imagination and expectation: The effect of imagining behavioral scripts on personal intentions. *Journal of Personality and Social Psychology*, *45*, 293–305.

Byrne, R. M. J. (1997). Cognitive processes in counterfactual thinking about what might have been. In D. L. Medin (Ed.),

The psychology of learning and motivation: Advances in research and theory (Vol. 37, pp. 105–154). San Diego, CA: Academic Press.

Byrne, R. M. J. (2002). Mental models and counterfactual thoughts about what might have been. *Trends in Cognitive Sciences*, *6*, 426–431.

Carroll, J. S. (1978). The effect of imagining an event on expectations for the event: An interpretation in terms of the availability heuristic. *Journal of Experimental Social Psychology*, *14*, 88–96.

De Brigard, F., & Giovanello, K. S. (2012). Influence of outcome valence in the subjective experience of episodic past, future and counterfactual thinking. *Consciousness and Cognition*, *21*, 1085–1096.

Epstude, K., & Roese, N. (2008). The functional theory of counterfactual thinking. *Personality and Social Psychology Review*, *12*, 168–192.

Garry, M., Manning, C. G., Loftus, E. F., & Sherman, S. J. (1996). Imagination inflation: Imagining a childhood event inflates confidence that it occurred. *Psychonomic Bulletin & Review*, *3*, 208–214.

Gregory, W. L., Cialdini, R. B., & Carpenter, K. M. (1982). Self-relevant scenarios as mediators of likelihood estimates and compliance: Does imagining make it so? *Journal of Personality and Social Psychology*, *43*, 89–99.

Johnson-Laird, P. N., & Byrne, R. M. J. (2002). Conditionals: A theory of meaning, pragmatics, and inference. *Psychological Review*, *109*, 646–678.

Koehler, D. J. (1991). Explanation, imagination, and confidence in judgment. *Psychological Bulletin*, *110*, 499–519.

Kray, L. J., George, L. H., Liljenquist, K. A., Galinsky, A. D., Tetlock, P., & Roese, N. (2010). From what might have been to what must have been: Counterfactual thinking creates meaning. *Journal of Personality and Social Psychology*, *98*, 106–118.

Landman, J. (1993). *Regret: The persistence of the possible*. New York, NY: Oxford University Press.

Lichtenstein, S., Slovic, P., Fischhoff, B., Layman, M., & Combs, B. (1978). Judged frequency of lethal events. *Journal of Experimental Psychology: Human Learning and Memory*, *17*, 551–578.

Mandel, D. R., Hilton, D. J., & Catellani, P. (2005). *The psychology of counterfactual thinking*. New York, NY: Routledge.

Markman, K. D., Gavanski, I., Sherman, S. J., & McMullen, M. N. (1993). The mental simulation of better and worse possible worlds. *Journal of Experimental Social Psychology*, *29*, 87–109.

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology*, *109*, 504–511.

Rachman, S., Gruter-Andrew, M., & Shafran, R. (2000). Post-event processing in social anxiety. *Behaviour Research and Therapy*, *38*, 611–617.

Roese, N. J. (1994). The functional basis of counterfactual thinking. *Journal of Personality and Social Psychology*, *66*, 805–818.

Roese, N. J., & Olson, J. M. (1995). *What might have been: The social psychology of counterfactual thinking*. Mahwah, NJ: Erlbaum.

Roese, N. J., Park, S., Smallman, R., & Gibson, C. (2008). Schizophrenia involves impairment in the activation of intentions by counterfactual thinking. *Schizophrenia Research*, *103*, 343–344.

Sherman, S. J., Cialdini, R. B., Schwartzman, D. F., & Reynolds, K. D. (1985). Imagining can heighten or lower the perceived likelihood of contracting a disease: The mediating effect of ease of imagery. *Personality and Social Psychology Bulletin*, *11*, 118–127.

Szpunar, K. K., & Schacter, D. L. (2013). Get real: Effects of repeated simulation and emotion on the perceived plausibility of future experiences. *Journal of Experimental Psychology: General*. Advance online publication. doi: 10.1037/a0028877