Get Real: Effects of Repeated Simulation and Emotion on the Perceived Plausibility of Future Experiences

Citation	Szpunar, Karl K., and Daniel L. Schacter. 2013. Get Real: Effects of Repeated Simulation and Emotion on the Perceived Plausibility of Future Experiences. Journal of Experimental Psychology: General 142, no. 2: 323-327.
Published Version	doi:10.1037/a0028877
Citable link	http://nrs.harvard.edu/urn-3:HUL.InstRepos:13415208
Terms of Use	This article was downloaded from Harvard University's DASH repository, and is made available under the terms and conditions applicable to Open Access Policy Articles, as set forth at http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#OAP

In Press
Journal of Experimental Psychology: General

Get real: Effects of repeated simulation and emotion on the perceived plausibility of future experiences

Karl K. Szpunar and Daniel L. Schacter

Harvard University

Department of Psychology

Address correspondence to:

Karl K. Szpunar

Department of Psychology

Harvard University

33 Kirkland Street, Cambridge, MA 02138

Phone: (617) 495-9031

Email: szpunar@wjh.harvard.edu

Abstract

People frequently imagine specific interpersonal experiences that might occur in their futures. The present study used a novel experimental paradigm to examine the influence of repeated simulation of future interpersonal experiences on subjective assessments of plausibility for positive, negative, and neutral events. The results demonstrate that repeated simulation increases estimates of plausibility for emotional, but not neutral, future interpersonal experiences. Additional correlational analyses reveal that increases in plausibility for emotional events are associated with concurrent increases in ease of simulation, event detail, and arousal. Implications for daily life and affective disorders such as depression and anxiety are noted.

In everyday life, people frequently imagine or simulate experiences that might occur in their personal futures, and these simulated experiences tend to revolve around anticipated interactions with others (D'Argembeau, Renaud, & Van Der Linden, 2011; for recent reviews, see Schacter, Addis, & Buckner, 2008; Szpunar, 2010). While simulating future interpersonal experiences can help people to prepare for and cope with upcoming situations (Taylor, 1991; Taylor, Pham, Rivkin, & Armor, 1998; Schacter, 2012), little is known about the associated cognitive consequences. We are specifically interested in whether the act of repeatedly simulating an upcoming interpersonal experience, such as a meeting, social gathering, job interview, or first date, influences beliefs about what will actually take place in one's personal future.

Although no study has addressed this specific question, prior research has demonstrated that simulating future outcomes of hypothetical events leads those outcomes to feel subjectively more likely, and that this relation can be strengthened via repetition. For instance, Carroll (1978) found that people who had imagined circumstances under which Jimmy Carter (or Gerald Ford) might win the 1976 Presidential election were more likely to predict that Carter (or Ford) would win the election. This initial demonstration was later extended to personal events. Various experiments showed that people who imagined committing a crime, winning a prize, or contracting a disease, later estimated that they were more likely to experience similar events in the future than people who had not imagined those events (Gregory, Cialdini, & Carpenter, 1982; Sherman, Cialdini, Schwartzman, & Reynolds, 1985). Further, Anderson (1983) demonstrated that the more often people imagined performing some action (e.g., donating blood), the more likely they were to believe that they would carry out that action in the future.

Nonetheless, the extent to which prior research informs our understanding of the relation between repeated simulation and beliefs about future interpersonal experiences is limited in a number of respects. Simulations of personal future experiences, including future interpersonal interactions, require individuals to generate specific episodes that revolve around their interactions with familiar people, places, and objects (Atance & O'Neill, 2001; Szpunar, 2010). Although a number of previous studies linking simulation to perceived likelihood focused on personal events, those studies either did not require participants to generate their own events (Gregory et al., 1982) or did not require participants to simulate specific episodes (Sherman et al., 1985). Moreover, although Anderson (1983) examined the effects of repeated simulation on perceived likelihood, participants in those experiments were explicitly instructed to avoid simulating the exact same event more than once (p. 296). Hence, no study has examined the effects of repeatedly simulating the same episode on subjective assessments of future occurrence.

The purposes of our study were threefold. First, we examined the effects of repeated simulation on estimates of perceived plausibility for future interpersonal experiences. To control for the influence of prior experience on beliefs related to future occurrence, we employed a recently developed paradigm that allowed us to ensure that participants simulated novel future events (Addis, Pan, Vu, Laiser, & Schacter, 2009; Martin, Schacter, Corballis, & Addis, 2011; Szpunar, Addis, & Schacter, 2012). Specifically, participants simulated personal future events that involved interacting with familiar people in the context of familiar places and objects. Each event was simulated either once or four times, and participants rated how plausible it was that each experience could take place in their futures. We asked participants to rate the plausibility, rather than likelihood, of occurrence in order to avoid potential floor effects that might arise from asking participants to simulate novel events (e.g., Gregory et al., 1982).

Second, we examined whether the emotional tone associated with simulated future interpersonal experiences would influence the relation between repeated simulation and perceived plausibility. Simulations of personal future events are often characterized by emotional arousal (D'Argembeau et al., 2011), yet next to nothing is known about the effects of repeatedly simulating emotionally arousing events. Accordingly, participants in the present study simulated future interpersonal experiences that evoked positive emotions, negative emotions, or were emotionally neutral.

Third, the relation between repeated simulation and perceived likelihood has previously been attributed to the ease with which repeatedly simulated events come to mind (Anderson, 1983). However, no study has presented evidence for this assertion. Hence, it is not clear whether the relation between repeated simulation and perceived likelihood can be attributed to the subjective ease with which events come to mind (Tversky & Kahneman, 1973), the subjective details associated with those events (Lichtenstein, Slovic, Fishhoff, Layman, & Combs, 1978), a combination of these factors, or perhaps the influence of some other factors. In order to identify what features of simulated personal future events might be related to increases in plausibility, participants in the present study were required to provide a number of additional phenomenological ratings including, valence, ease, detail, and arousal.

Method

Participants

Thirty Boston University students were recruited via the Boston University Job Service. They provided informed written consent in a manner approved by Harvard’s institutional review board.

Materials and Procedure

Participants first visited the laboratory for approximately 2 hr to generate lists of 110 familiar people (first and last names; participants were allowed to login to their Facebook accounts and select names from their friend list), 110 familiar locations (specific locations that participants had previously visited, e.g., “Fenway Park” was an example of an acceptable location, whereas “Boston” was too general), and 110 familiar objects that participants could easily imagine having with them in a variety of locations (e.g., “cell phone” was an example of an acceptable object, whereas “couch” was too rigid). These lists were subsequently examined for quality based on the criteria noted above; we selected the 93 best examples of people, the 93 best examples of locations, and the 93 best examples of objects from each list, and randomly combined them to create 93 simulation cues (i.e., random combinations of person-location-object triads). One week later, participants returned for approximately 1 hr to simulate 30 positive, 30 negative, and 30 neutral future interpersonal experiences (in random order). On each of the 90 trials, participants were presented with one of three emotion tags (positive, negative, or neutral) that was accompanied by a unique simulation cue (i.e., a person-location-object triad) (cf. Szpunar et al., 2012). Participants were allotted 12.5 s to simulate a plausible future interpersonal experience that evoked the emotion indicated by the emotion tag and that involved the person, location, and object specified by the simulation cue (i.e., "imagine a future scenario that would evoke a positive/negative/neutral emotion from you in which you are interacting with the specified person, in the specified location, and that involves the specified object"). Participants were instructed that the simulated events should take place within the next 5 years. At the end of each trial, participants were prompted to type a one-sentence summary description of the future experience.

To ensure that participants understood all instructions, we conducted three practice trials in which participants simulated future interpersonal experiences, described the content of their simulations to the experimenter, and typed the corresponding summary descriptions. During experimental trials, participants were only required to simulate future interpersonal experiences and type the corresponding summary descriptions. After the experimental trials, all participants reported that their simulations were novel (i.e., the participants had not thought about or experienced the simulations prior to the experiment). Materials were presented with E-Prime software Version 1.0 (Psychology Software Tools, Pittsburgh, PA) on a Dell desktop computer, and participants used a keyboard to type their summary descriptions.

One day later, participants returned for 1.5 hr to re-simulate half (i.e., 15 positive, 15 negative, and 15 neutral) of the previously generated events three times each (in random order). Each of the 135 trials were performed according to the above parameters for experimental trials, except that participants' summary descriptions were now presented along with the emotion tags and person-location-object triads. Participants were instructed to simulate each event as they had the day before without generating additional details, and participants subsequently reported that the summary descriptions enabled them to follow this instruction.

After a 10 min break, participants re-simulated all 90 of the originally generated events (30 positive, 30 negative, and 30 neutral; simulated in random order), so that future experiences were simulated for the first or fourth time that day. After each of these 90 trials, participants were first asked to specify whether or not the future experience had been simulated earlier that day (i.e., 10 min ago), and then completed five 5-point phenomenological ratings [valence (1 = very negative, 5 = very positive), ease (1 = very difficult, 5 = very easy), detail (1 = few details, 5 = many details), arousal (1 = very calming, 5 = very arousing), and most critically, *plausibility (1 = very implausible, 5 = very plausible)*; presented in a new random order for each participant]. Participants used a keyboard to make their memory judgments (yes/no recognition) and phenomenological ratings. Post-experiment interviews indicated that the memory test (Hits – FA = .99) and additional ratings successfully obscured the true purpose of the experiment (i.e., to examine the influence of repeated simulation on plausibility).

It is important to highlight that using distinct sets of items to examine the influence of repeated simulation on judgments of future occurrence introduced an important advantage and limitation to the present design. With regard to the advantage, asking participants to rate the plausibility (and other phenomenological characteristics) of each event only once (i.e., following the first simulation for some events and the fourth simulation for other events) helped to avoid potential biases that might have arisen had participants been asked to rate the same events across multiple simulations (e.g., under such circumstances previous ratings of individual events might influence subsequent ratings of those same events). However, this important feature of the design also placed limitations on our ability to elucidate how other characteristics of future event simulation might help to account for the influence of repeated simulation on ratings of plausibility. Specifically, because different events were simulated once or four times, changes in phenomenological characteristics as a function of repetition could not be calculated for individual events. Nonetheless, changes in phenomenological characteristics could be calculated for individual subjects, and we elaborate further on this point in the following section.

Lastly, it is important to note that although participants simulated distinct sets of events once or four times on the day that phenomenological ratings were collected, each event had been simulated once the day before, when brief descriptions of these events were originally generated. Hence, distinct sets of events were simulated twice or five times in total, but once or four times on the day of the critical manipulation.

Results

Table 1 presents the mean phenomenological ratings for positive, negative, and neutral simulations of future interpersonal experiences as a function of event repetition. Repeated measures analyses of variance[1] demonstrated a strong effect of repetition across each rating scale such that future interpersonal experiences simulated four times were rated as more plausible, positive, easy to generate, detailed, and arousing than future interpersonal experiences simulated once [smallest F (1,29) = 16.66, $p < .001$, $\eta_p^2 = .365$]. There was also a strong effect of emotion for ratings of valence [F (2,58) = 176.42, $p < .001$, $\eta_p^2 = .859$], detail [F (2,58) = 3.58, $p = .034$, $\eta_p^2 = .110$], and arousal [F (2,58) = 53.38, $p < .001$, $\eta_p^2 = .648$]. Specifically, positive and negative events were respectively rated as more positive [$t(29) = 7.03$, $p < .001$, $d = 1.31$] and negative [$t(29) = 14.55$, $p < .001$, $d = 2.71$] than neutral events. Moreover, positive and negative events were rated as more detailed than neutral events [$t(29) = 2.26$, $p = .032$, $d = 0.41$ and $t(29) = 2.24$, $p = .033$, $d = 0.41$, respectively], whereas positive and negative events did not differ in terms of detail ($t < 1$). Finally, negative events were rated as more arousing than positive [$t(29) = 5.00$, $p < .001$, $d = 0.94$] and neutral [$t(29) = 8.59$, $p < .001$, $d = 1.58$] events, and positive events were rated as more arousing than neutral events [$t(29) = 6.38$, $p < .001$, $d = 1.16$].

Notably, repetition interacted with emotion on each phenomenological scale [smallest $F(2,58) = 3.19$, $p = .048$, $\eta_p^2 = .099$]. With regard to plausibility, future interpersonal experiences simulated four times were rated as more plausible than future interpersonal experiences simulated once for positive [$t(29) = 3.94$, $p < .001$, $d = 0.72$] and negative [$t(29) = 4.89$, $p < .001$, $d = 0.89$] events, but not for neutral events [$t(29) = 1.09$, *ns*]. Similarly, ratings of ease, detail, and arousal demonstrated greater increases across repeated simulations for positive and negative events than for neutral events [smallest $F(1,29) = 4.16$, $p = .050$, $\eta_p^2 = .125$]. For ratings of valence [$F(2,58) = 16.22$, $p < .001$, $\eta_p^2 = .359$], positive events simulated four times were rated as more positive than positive events simulated once [$t(29) = 5.28$, $p < .001$, $d = 1.00$], whereas no change in valence was observed for negative and neutral events (*t*s < 1).

Finally, we examined the extent to which increases in plausibility for emotional (i.e., positive and negative) simulations of future interpersonal experiences were associated with concurrent increases in the four remaining phenomenological scales. As we alluded to in the previous section, the experimental design did not allow changes in phenomenological characteristics as a function of repetition to be calculated for individual events (i.e., different subsets of events had been simulated once or four times).

Instead, average changes in each phenomenological characteristic as a function of repetition were calculated for each subject (i.e., average for events simulated four times relative to average for events simulated once). These average change scores were then used to correlate the magnitude of change in plausibility ratings with the magnitudes of change in valence, ease, detail, and arousal. Although the results of these analyses should be interpreted with some caution, increases in plausibility were found to be significantly correlated with concurrent increases in ease (r = .42, N = 30, p = .022), detail (r = .38, N = 30, p = .039), and arousal (r = .59, N = 30, p = .001), but not with changes in valence.[2] Moreover, the strength of these correlations did not differ as a function of valence (i.e., between positive and negative simulations; see Raghunathan, Rosenthal, & Rubin, 1996 for discussion of comparing correlations).

General Discussion

We examined the relation between repeated simulation of future interpersonal experiences and judgments of plausibility. Our findings are notable in three respects: (1) repeated simulation increased the perceived plausibility of future interpersonal experiences, (2) this effect was only evident for emotional events, and (3) increases in plausibility for emotional events were associated with concurrent increases in ease of simulation, event detail, and arousal.

The finding that future interpersonal experiences simulated four times were perceived as more plausible than future interpersonal experiences simulated once fits well with prior research demonstrating similar effects for nonpersonal or general personal events (Anderson, 1983; Carroll, 1978; Gregory et al., 1982; Sherman et al., 1985). Moreover, the influence of repeated simulation on the perceived plausibility of future interpersonal experiences was only evident for emotional events. After one simulation, participants rated positive [$t(29) = 2.06$, $p = .048$, $d = 0.38$] and, to a greater extent, negative [$t(29) = 3.24$, $p = .003$, $d = 0.59$] events as less plausible than neutral events. Interestingly, this pattern of data similarly emerged when, upon completing the experiment, a subset of the participants (N = 15) were asked to estimate what proportion of their daily future experiences over the next five years would be characterized by positive (38%), negative (18%), and neutral (44%) events. However, after four simulations, plausibility ratings for future positive, negative, and neutral interpersonal experiences were indistinguishable from one another.

Why do emotional future interpersonal experiences feel more plausible following repeated simulation? Although it has previously been suggested that repeated simulations feel more plausible because they come to mind more easily (Anderson, 1983), our results suggest that the answer to this question might be more complex. Specifically, we demonstrated that increases in plausibility for emotional events were further associated with concurrent increases in subjective detail (cf. Lichtenstein et al., 1978) and arousal. The association between detail and plausibility fits particularly well with the results of a recent study showing that, following brief delays, details of emotionally arousing simulations were better remembered than details of emotionally neutral simulations (Szpunar et al., 2012). Accordingly, participants in the present study may have better retained the details that accumulated across repeated simulations of emotionally arousing simulations, which in turn influenced their judgments of plausibility.

It is noteworthy that increases in subjective detail were observed across repeated simulations despite the fact that participants had been explicitly instructed to avoid adding new details. Future research will need to delineate whether, and under what circumstances, the increases in subjective detail that accompany repeated simulations are related to the addition of new details, the bringing into focus of details associated with the original simulation, a combination of these factors, or perhaps some other factors.

Of course, the data on which our preliminary conclusions are based are correlational and future research will need to examine the relation of repeated simulation to estimates of perceived plausibility in a manner that directly manipulates various features of future event simulation before any causal conclusions can be drawn. To this end, experimental designs that examine changes in ratings of plausibility, and other phenomenological characteristics, at the level of individual events will be of considerable value in developing a more complete understanding of the influence that repeated simulation has on beliefs related to future occurrence. Additionally, because the relation between repetition and plausibility was specifically associated with emotional simulations, it will also be important for future research to examine the extent to which variables related to emotionality (e.g., self-relevance) might also help to account for the present set of results.[3]

Finally, our results have possibly important implications for understanding emotional disorders such as depression and anxiety, where negative expectations for the future (MacLeod & Byrne, 1996) could be especially heightened by repeated simulations of negative events. This process may be particularly acute in patients with anxiety disorders, who generate more vivid imagery for negative future scenarios than either healthy controls or patients with major depressive disorder (Morina, Deeprose, Pusowski, Schmid, & Holmes, 2011). Because our procedure generates many more observations than standard paradigms (cf. Anderson, 1983; Gregory et al., 1982; Sherman et al., 1985), we believe that variations of it will be useful for both clinical and experimental studies of the effects of repeated simulation on the plausibility of future interpersonal experiences.

References

Addis, D.R., Pan, L., Vu, M.A., Laiser, N., & Schacter, D.L. (2009). Constructive episodic simulation of the future and the past: Distinct subsystems of a core brain network mediate imagining and remembering. *Neuropsychologia*, *47*, 2222-2238.

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.

Atance, C.M., & O'Neill, D.K. (2001). Episodic future thinking. *Trends in Cognitive Sciences, 5,* 533-539.

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.

D'Argembeau, A.D., Renaud, O., & Van der Linden, M. (2011). Frequency, characteristics, and functions of future-oriented thoughts in daily life. *Applied Cognitive Psychology*, *25*, 96-103.

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.

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

MacLeod, A.K. & Byrne, A. (1996). Anxiety, depression, and the anticipation of future positive and negative experiences. *Journal of Abnormal Psychology, 105*, 286-289.

Martin, V.C., Schacter, D.L., Corballis, M., & Addis, D.R. (2011). A role for the hippocampus in encoding simulations of future events. *Proceedings of the National Academy of Sciences, USA*, *108*, 13858-13863.

Morina, N., Deeprose, C., Pusowski, C., Schmid, M., & Holmes, E.A. (2011). Prospective mental imagery in patients with major depressive disorder or anxiety disorders. *Journal of Anxiety Disorders, 25*, 1032-1037.

Raghunathan, T.E., Rosenthal, R., & Rubin, D.B. (1996). Comparing correlated but nonoverlapping correlations. *Psychological Methods*, *1*, 178-183.

Schacter, D.L. (2012), Adaptive constructive processes and the future of memory (*manuscript submitted for publication*).

Schacter, D. L., Addis, D. R., & Buckner, R. L. (2008). Episodic simulation of future events: Concepts, data, and applications. *Annals of the New York Academy of Sciences, 1124*, 39-60.

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. (2010). Episodic future thought: An emerging concept. *Perspectives on Psychological Science*, *5*, 142-162.

Szpunar, K.K., Addis, D.R., & Schacter, D.L. (2012). Memory for emotional simulations: Remembering a rosy future. *Psychological Science*, *23*, 24-29.

Taylor, S.E. (1991). Asymmetrical effects of positive and negative events: The mobilization-minimization hypothesis. *Psychological Bulletin*, *110*, 67-85.

Taylor, S.E., Pham, L.B., Rivkin, I.D., & Armor, D.A. (1998). Harnessing the imagination: Mental simulation, self-regulation, and coping. *American Psychologist, 53*, 429-439.

Tversky, A., & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, *5*, 207-232.

Author Note

This research was supported by a grant from the National Institute of Mental Health (5R01MH60941-11) awarded to Daniel L. Schacter.

Footnotes

1. Non-parametric analyses, to the extent that appropriate tests were available, were also carried out on the present data set, and produced a similar pattern of results.
2. We also conducted additional analyses for which: (1) either the change in plausibility ratings across repeated simulations or the ratings of plausibility following four simulations were treated as the dependent variable, and (2) ratings of plausibility following one simulation were treated as a covariate. These analyses demonstrated a similar pattern of results (i.e., ratings of plausibility were reliably predicted by ratings of ease, detail, and arousal).
3. Notably, many previous experiments relating simulation to plausibility also made use of emotionally arousing scenarios [e.g., imagining helping another person (Anderson, 1983); imagining the results of an upcoming election (Carroll, 1978); imagining committing a crime or winning a trip to Hawaii (Gregory et al., 1982); or imagining contracting a specific disease (Sherman et al., 1985)].

Table 1. Mean phenomenological ratings for positive, negative, and neutral simulations of future interpersonal experiences as a function of event repetition. Standard deviations are presented in parentheses.

	Positive	**Negative**	**Neutral**
PLAUSIBILITY			
Fourth	2.81 (.66)	2.77 (.74)	2.79 (.76)
First	2.47 (.62)	2.27 (.71)	2.66 (.68)
EASE			
Fourth	4.02 (.69)	3.98 (.73)	3.77 (.80)
First	3.04 (.71)	3.04 (.73)	3.04 (.77)
DETAIL			
Fourth	3.49 (.68)	3.52 (.78)	3.18 (.72)
First	2.72 (.65)	2.75 (.58)	2.70 (.63)
AROUSAL			
Fourth	2.44 (.51)	2.85 (.64)	1.59 (.49)
First	2.12 (.51)	2.53 (.57)	1.55 (.50)
VALENCE			
Fourth	4.04 (.37)	1.95 (.47)	3.33 (.28)
First	3.61 (.51)	1.99 (.41)	3.28 (.36)