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Influence of outcome valence in the subjective experience of episodic past, future, and counterfactual thinking

Felipe De Brigard [a,b,*], Kelly S. Giovanello [b,c]

[a] Department of Psychology, Harvard University, United States
[b] Department of Psychology, UNC, Chapel Hill, United States
[c] Biological Research Imaging Center, UNC, Chapel Hill, United States

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ABSTRACT

Recent findings suggest that our capacity to imagine the future depends on our capacity to remember the past. However, the extent to which episodic memory is involved in our capacity to think about what could have happened in our past, yet did not occur (i.e., episodic counterfactual thinking), remains largely unexplored. The current experiments investigate the phenomenological characteristics and the influence of outcome valence on the experience of past, future and counterfactual thoughts. Participants were asked to mentally simulate past, future, and counterfactual events with positive or negative outcomes. Features of their subjective experiences during each type of simulation were measured using questionnaires and autobiographical interviews. The results suggest that clarity and vividness were higher for past than future and counterfactual simulations. Additionally, emotional intensity was lower for counterfactual simulations than past and future simulations. Finally, outcome valence influenced participants' judgment of probability for future and counterfactual simulations.

1. Introduction

Memory and imagination are commonly considered different cognitive faculties. This assumption is held in folk psychology and largely shared by philosophers and psychologists (e.g., Russell, 1921; Stout, 1915). Despite arguments from empiricists philosophers such as Thomas Hobbes (1651) and Hume (1739) that memory and imagination are a single faculty—or at a minimum two integrated faculties sharing many operations—the succeeding philosophical tradition remained largely unmoved by their proposals (e.g., Locke, 1971). Recent scientific evidence, however, is starting to lend credence to Hobbes and Hume's views, inviting us to question our assumptions about the correct way of individuating the faculties of memory and imagination.

Of particular interest is the substantial amount of evidence gathered during the past three decades suggesting that our capacity to imagine our future may depend on our capacity to remember past events—both processes that constitute what is often referred to as "mental time travel" (Tulving, 1985). Neuropsychological studies have shown that people who have deficits in mentally re-experiencing events that happened in their pasts, also exhibit impairments when mentally pre-experiencing events that may happen in their future, a cognitive process that has come to be known as *episodic*

* Corresponding author. Address: Department of Psychology, Harvard University, 884 William James Hall, 33 Kirkland St., Cambridge, MA 02139, United States.
E-mail address: brigard@wjh.harvard.edu (F. De Brigard).

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future thinking (Atance & O'Neill, 2001; Szpunar, 2010). Evidence to this effect comes from research on amnesic subjects (Hassabis, Kumaran, Vann, & Maguire, 2007; Klein, Loftus, & Kihlstrom, 2002; Tulving, 1983), patients with severe depression (Dickson & Bates, 2005; Williams, 1996), individuals with a diagnosis of schizophrenia (D'Argembeau et al., 2008), young children (Busby & Suddendorf, 2005; Perner, Kloo, & Rohwer, 2010; Suddendorf & Busby, 2005), older adults (Addis, Wong, & Schacter, 2008), individuals with amnestic mild cognitive impairment (Gamboz et al., 2010), and patients with Alzheimer's disease (Addis, Sacchetti, Ally, Budson, & Schacter, 2009; Addis, Musicaro, Pan, & Schacter, 2010). Additionally, research on healthy individuals using neuroimaging techniques has revealed a significant overlap in the brain regions engaged during episodic recollection and episodic future thinking, suggesting that both processes may be mediated by similar cognitive mechanisms (Addis & Schacter, 2008; Addis, Wong, & Schacter, 2007; Hassabis et al., 2007; Okuda et al., 2003; Schacter, Addis, & Buckner, 2007; Szpunar, Watson, & McDermott, 2007). Finally, to further examine the connection between these two processes, researchers have explored the phenomenological features of episodic future thinking in relation to the phenomenology of episodic memory (D'Argembeau and Van der Linden, 2004, 2006; Szpunar & McDermott, 2008; Winfield & Kamboj, 2010). These studies have revealed striking parallels between the subjective experience of both cognitive processes, further suggesting the involvement of similar cognitive mechanisms Schacter and Addis (2007).

In an exciting new development in the search for the cognitive mechanisms of mental time travel, Addis and collaborators (2009) showed that a common "core brain network" engaged during episodic memory and future thinking (Buckner & Carroll, 2007) is also involved in the mental construction of imaginary past events. Further research has shown that the involvement of such brain network is greater during mental simulations of alternative past events we think are more plausible to having occurred relative to simulations of imaginary alternatives we consider implausible (De Brigard et al., submitted for publication). Related studies are starting to provide convergent evidence suggesting that the core brain network engaged when thinking about what may happen in our future is also recruited when we consider what could have happen in our past yet did not occur (Addis, Pan, Vu, Laiser & Schacter, 2009; Kurczek et al., 2010; Van Hoeck, Ma, Van Overwalle, & Vandekerckhove, 2010, in press)—a cognitive process we call *episodic counterfactual thinking* (De Brigard et al., submitted for publication). The idea behind this line of research is that the common mechanisms that allow episodic memory to reconstruct our personal past and to construct thoughts about possible events that *could happen* in our future, also enable us to construct thoughts about possible events that, although they did not happen, *could have* happened in our past.

However, the phenomenology of our thoughts about alternative ways in which our past could have occurred remains largely unexplored. The main purpose of the current experiments was to investigate the nature of the subjective experience of episodic counterfactual thinking, and to contrast it with the phenomenology of episodic recollection and episodic future thinking. We conjectured that this direct contrast could yield one of two results. One possibility was that the phenomenological ratings for episodic autobiographical recollections would be higher than episodic counterfactual thoughts, which in turn would be higher than episodic future thoughts since, presumably, counterfactual thoughts may involve less recombination of memory components than future thoughts. A second possibility, however, was that changing the temporal dimension of the mental simulation from past to future would require less mental manipulation than counterfactual thinking, in which case we would expect to see higher phenomenological ratings for future than for counterfactual thoughts, with episodic autobiographical recollections receiving higher ratings overall. By directly contrasting these three kinds of mental simulation the current studies seek to investigate these possibilities.

In addition, previous studies on the phenomenological characteristics of episodic autobiographical memories (D'Argembeau et al., 2003; Schaefer & Philippot, 2005) and future thinking (D'Argembeau and Van der Linden, 2004) have shown that valence influences the quality of the experience, with events yielding positive outcomes normally receiving higher qualitative ratings than events with negative outcomes. However, in such studies, the valence of the outcomes of the simulated events remained fixed, so that memories that yielded an outcome with a certain valence were simulated as future events with the same outcome valence. Since episodic counterfactual thinking allows one to flip the valence of the outcome of an event, it constitutes a suitable way to investigate the influence of outcome valence on the subjective experience of mental simulations about episodic past, future, and counterfactual events. Thus, if the quality of the experience during the simulation of a counterfactual event differs from the quality of the experience when the same event is either remembered or simulated as a future possibility, then it would suggest that the emotional valence of the outcome of an event, and not only the event itself, can affect the phenomenological quality of the mental simulation. Moreover, this manipulation affords the opportunity to investigate whether the reported higher ratings for positive past and future simulations (D'Argembeau and Van der Linden, 2004; D'Argembeau et al., 2003) are dependent upon the valence of the outcome of the event, or rather whether they depend on the quality of the simulated event regardless of its outcome.

To investigate these issues, in the current experiments participants were asked to remember episodic autobiographical events, think of possible future events, and construct alternative ways in which past experienced events could have turned out. Half of the mental simulations they engaged in had positive outcomes, whereas the other half had negative outcomes. The features of their subjective experiences during these three kinds of mental simulations were measured using adapted forms of the phenomenological characteristic questionnaire (Johnson, Foley, Suengas, & Raye, 1988) and the autobiographical memory interview (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002).

2. Study 1

2.1. Method

2.1.1. Participants

Thirty undergraduates (Mean age = 20.4; SD = 5.4; 18 female) from the university of North Carolina at Chapel Hill participated in the experiment. Participants received partial class credit for their participation. Participants gave written informed consent in accord with the requirements of the Institutional Review Board at UNC-CH.

2.1.2. Materials and procedure

The experimental session consisted of two parts. Each part took approximately 30 min. In the first part of the experiment, participants were presented with emotionally neutral words (e.g., bowl, cotton, meat) adapted from Clark and Paivio (2004) and asked to report autobiographical memories according to the Galton–Crovitz word-cuing technique (Crovitz & Schiffman, 1974; Galton, 1880). One experimenter (F.D.B.) and one research assistant, who was blind to the purpose of the study, conducted this interview. Importantly, participants were asked to report only specific memories (i.e. vividly detailed recollections of single experienced events; Conway & Pleydell-Pearce, 2000) rather than general memories. Examples of both specific and general autobiographical memories were given to ensure adherence to the instructions. Additionally, participants were asked to report memories containing an action or an event that had happened to them, as well as an outcome that was brought about as a result of the action or event. Finally, they were asked to report specific memories that were emotionally salient. Thus, when presented with a cue word (e.g., "horse"), participants reported a personally experienced event that had occurred at a certain place and time (e.g., "Last summer I went horseback riding in Virginia") with a specific immediate outcome (e.g., "I fell off my horse"). All reported events happened within the past 10 years. Participants were asked to rate the emotional valence of each memory based on its outcome from 1 (Negative) to 5 (Positive). Each participant reported ten memories during the first part of the experimental session. From these memories, a total of four memories were selected according to three criteria. The first criterion was *outcome valence*: Two of the selected four memories received a rating of 1 ("Negative memories"), while the other two received a rating of 5 ("Positive memories"). The second criterion was *concreteness*: The interviewer and the research assistant deemed all four chosen memories to be detailed and concrete. Finally, the third criterion was *outcome substitutability*: Each selected memory had an outcome for which it was feasible to substitute an alternative outcome in order to create an episodic counterfactual event. If more than four memories met all three criteria, two positive and two negative memories were randomly selected.

In the second part of the experiment, participants were given written questionnaires to rate each of the chosen four memories reported. The questions were selected from the Memory Characteristics Questionnaire (MCQ) developed by Johnson and collaborators (Johnson et al., 1988; see appendix). Participant's memories were rated for 18 dimensions: Clarity (1 = dim; 7 = clear), color (1 = black and white; 7 = full color), visual detail (1 = none; 7 = a lot), sound (1 = none; 7 = a lot), smell (1 = none; 7 = a lot), touch (1 = none; 7 = a lot), taste (1 = none; 7 = a lot), vividness (1 = vague; 7 = very vivid), composition (1 = sketchy; 7 = very detailed), clarity of location (1 = vague; 7 = clear), clarity of spatial arrangement of objects (1 = vague; 7 = clear), clarity of spatial arrangement of people (1 = vague; 7 = clear), clarity of time of day (1 = vague; 7 = clear), emotion felt during the event (1 = not at all; 7 = definitively), emotion during the recollection of the event (1 = negative; 7 = positive), intensity of emotion during the event (1 = not intense; 7 = very intense), emotion during the recollection of the event (1 = negative; 7 = positive), intensity of the emotion during recollection (1 = not intense; 7 = very intense), and overall feeling of remembrance (1 = hardly; 7 = very well). Additionally, participants were asked to rate whether the memory was recalled from a field or from an observer's perspective (Nigro & Neisser, 1983).

Once participants completed the MCQ for the two positive and two negative memories, they were told that, in addition to thoughts about what happened in their past, we were also interested in their thoughts of what may happen in their future (i.e., episodic future thinking), as well as their thoughts about what could have happened in their past but did not occur (i.e., episodic counterfactual thinking). For the episodic future thinking task, participants were asked to think about an event, similar to that which they reported, but occurring in the future. For example, if after being presented with the word "horse" a participant reported a memory involving riding and falling off of a horse, then s/he was asked to imagine a similar event occurring *in the future*, in which she would be horseback riding and, again, fall off the horse. Thus, in the *Future* condition the action and the outcome of the event remained fixed, but the temporal context was changed from past to future. That is, a negative memory would inspire a negative episodic future thought (i.e., a future thought with a negative outcome), and a positive memory would inspire a positive episodic future thought (i.e., a future thought with a positive outcome). Each participant produced two negative and two positive episodic future thoughts.

For the episodic counterfactual thinking task, participants were asked to imagine what would have happened if the event they reported had an outcome with the opposite valence. That is, if the reported events had a negative outcome (i.e., a negative memory), participants were asked to imagine an alternative *positive* outcome (e.g., not falling off of the horse). Conversely, if the reported event had a positive outcome (i.e., positive memory), participants were asked to imagine an alternative *negative* outcome to that event. In this *Counterfactual* condition, the outcome valence was reversed relative to the reported memory, but the temporal context and the action remained fixed. Thus, a negative memory (i.e., a memory with a negative outcome) would give rise to a positive episodic counterfactual thought (i.e., an episodic counterfactual thought

with a possible positive outcome that could have happened instead of the actual negative outcome), whereas a positive memory would give rise to a negative episodic counterfactual thought (i.e., an episodic counterfactual thought with a possible negative outcome that could have happened instead of the actual positive outcome). The interviewers agreed upon the alternative outcomes that created the counterfactual scenarios. If there was disagreement (i.e., if an interviewer suggested an alternative outcome the research assistant deemed implausible or vice versa), a second alternative outcome was suggested. If the disagreement persisted, the memory was discarded (but this never occurred). Each participant produced two positive and two negative episodic counterfactual thoughts. Following each episodic future thought (one positive and one negative) and each episodic counterfactual thought (one positive and one negative), participants completed either a Future Characteristic Questionnaire (FCQ) or an Autobiographical Counterfactual Characteristic Questionnaire (ACCQ). Both FCQ and ACCQ consisted of the same ratings as the MCQ, except for one additional question in which participants were asked to rate the probability of the imagined event happening (1 = not probable; 7 = highly probable) [See appendix for all three questionnaires]. To avoid task habituation, episodic future thoughts and episodic counterfactual thoughts were produced by participants randomly.

2.2. Results

Consistent with previous studies using phenomenological characteristics questionnaires for past (Schaefer & Philippot, 2005; Suengas & Johnson, 1988) and future (D'Argembeau & Van der Linden, 2004) thinking, ratings of clarity, color, visual, sound, smell, touch, taste, and vividness were averaged into a single *sensory* phenomenological factor (Cronbach's $\alpha = .82$). Likewise, ratings of composition, location, objects, people, and clarity of day were averaged into a single *composition* factor ($\alpha = .84$). Ratings of intensity during the event, intensity as the event is simulated, and overall sense of simulation were averaged into a singe *intensity* factor ($\alpha = .73$). Since the ratings for emotion attributed to the simulated event and for emotion during simulation (questions 15 and 17, respectively) did not yield an acceptable reliability level ($\alpha = .57$), each score was analyzed separately as a single phenomenological factor: *emotion then* and *emotion now* (Table 1).

A 3 (Condition: remember, future, counterfactual) × 2 (Outcome Valence: positive, negative) × 5 (Phenomenological Factor: sensory, composition, intensity, emotion then, emotion now) ANOVA on these ratings revealed main effects of Condition, $F(2,58) = 14.747$, $p < .001$, $\eta^2 = .337$, Outcome Valence, $F(1,59) = 287.457$, $p < .001$, $\eta^2 = .830$, and Phenomenological Factor, $F(4,56) = 83.978$, $p < .001$, $\eta^2 = .857$, with significant Condition × Phenomenological Factor, $F(8,52) = 7.213$, $p < .001$, $\eta^2 = .526$, Outcome Valence × Phenomenological Factor, $F(4,56) = 138.268$, $p < .001$, $\eta^2 = .908$, and Condition × Outcome Valence × Phenomenological Factor interactions, $F(8,52) = 2.986$, $p < .01$, $\eta^2 = .315$.

To further elucidate these effects, 3 (Condition: Remember, Future, Counterfactual) × 2 (Outcome Valence: Positive, Negative) ANOVAs for each phenomenological factor were conducted. For the *sensory* factor, there were no significant effects. For the *composition* factor, this analysis revealed a main effect of Condition, $F(2,58) = 14.420$, $p < .001$, $\eta^2 = .332$, with no interactions. Direct contrasts showed that the composition of items in episodic memories was perceived more clearly than both future, $t(119) = 5.935$, $p < .001$, and counterfactual simulations, $t(119) = 3.507$, $p < .001$, which in turn were perceived more clearly than future simulations, $t(119) = 2.352$, $p < .05$. For the *intensity* factor, the analysis revealed main effects of Condition, $F(2,58) = 8.937$, $p < .001$, $\eta^2 = .236$, with a significant Condition × Outcome Valence interaction, $F(2,58) = 3.332$, $p < .05$, $\eta^2 = .103$, driven by a difference in intensity between negative and positive future simulations, $t(59) = 3.396$, $p < .001$, suggesting that future simulations with possible negative outcomes were felt more intensely than future simulations with possible positive outcomes. A direct contrast confirmed that memories were felt more intensely than counterfactual simulations, $t(119) = 3.507$, $p < .001$.

For the *emotion then* factor, the analysis revealed main effects of Condition, $F(1,59) = 3.512$, $p < .05$, $\eta^2 = .108$, and Outcome Valence, $F(1,59) = 709.274$, $p < .001$, $\eta^2 = .923$, with no interactions. Direct contrasts showed that memories with

Table 1
Ratings from Study 1.

	Remember		Future		Counterfactual	
	Negative	Positive	Negative	Positive	Negative	Positive
Ratings[a]						
Sensory	4.20 (1.11)	4.41 (1.03)	4.17 (1.17)	4.14 (1.23)	3.99 (1.11)	4.00 (1.17)
Composition	5.75 (0.96)	5.68 (0.99)	4.84 (1.61)	4.72 (1.57)	5.05 (1.24)	5.31 (1.37)
Intensity	5.43 (1.11)	5.44 (0.83)	5.33 (1.21)	4.74 (1.17)	4.88 (1.14)	4.98 (1.29)
Emotion then	1.90 (1.05)	6.03 (1.33)	1.58 (1.01)	5.62 (1.52)	1.93 (1.07)	5.43 (1.64)
Emotion now	3.08 (1.59)	5.90 (1.34)	2.10 (1.23)	5.32 (1.51)	2.48 (1.37)	5.38 (1.57)
Probability	N/A	N/A	3.85 (1.72)	4.28 (2.12)	4.33 (2.16)	4.20 (1.85)
Perspective[b]						
Field	39 (65%)	37 (61.7%)	37 (61.7%)	25 (41.7%)	32 (53.3)	36 (60%)
Observer	20 (33.3%)	21 (35%)	23 (38.3%)	33 (55%)	27 (45%)	23 (38.3%)
Neither	1 (1.7%)	2 (3.3%)	0 (0%)	2 (3.3%)	1 (1.7%)	1 (1.7%)

[a] Mean ratings for phenomenological factors and probabilities. Standard deviations are in parenthesis.
[b] Number of responses for perspective from a total of 60. Percentages of responses are in parenthesis.

negative outcomes received higher ratings for *emotion then* than did future simulations with negative outcomes, $t(59) = 2.496$, $p < .05$, whereas memories with positive outcomes received higher ratings than counterfactual simulations with positive outcomes, $t(59) = 2.155$, $p < .05$. There were no further differences between these conditions. Finally, for the *emotion now* factor, the analysis revealed main effects of Condition, $F(2,58) = 11.020$, $p < .001$, $\eta^2 = .275$, and Outcome Valence, $F(1,59) = 253.667$, $p < .001$, $\eta^2 = .811$, with no interactions. Direct contrasts indicated that memories were simulated less negatively than did future, $t(59) = 4.402$, $p < .001$, and counterfactual thoughts with negative outcomes, $t(59) = 2.658$, $p < .01$. Conversely, memories were simulated more positively than did future, $t(59) = 2.134$, $p < .05$, and counterfactual thoughts with positive outcomes, $t(59) = 1.925$, $p < .05$. Lastly, future thoughts with negative outcomes were simulated more negatively than did counterfactual thoughts with negative outcomes, $t(59) = 2.305$, $p < .05$, but there was no difference between future and counterfactual thoughts with positive outcomes ($p > .5$).

Finally, judgments of subjective probability for the *Future* and the *Counterfactual* conditions were analyzed with a 2 (Condition: Future, Counterfactual) × 2 (Outcome Valence: Negative, Positive) ANOVA. This analysis yielded no significant effects ($p > .05$). Finally, a comparison of ratings for Field, Observer, and Neither/Unclear perspective revealed no significant differences among them ($p > .05$; Table 1). In sum, the results of Study 1 suggest that memories were perceived more clearly and more intensely than episodic future and counterfactual simulations. Additionally, future simulations with negative outcomes were experienced more negatively than memories and counterfactual simulations with negative outcomes. Conversely, positive memories were experienced more positively than both future and counterfactual simulations with positive outcomes.

3. Study 2

In Study 1, we investigated the influence of outcome valence in episodic past, future, and counterfactual thinking by asking participants to rate episodic memories, future simulations, and counterfactual thoughts with either positive or negative outcomes along several phenomenological dimensions. However, there are two important limitations to the design of Study 1. First, participants always provided MCQ ratings for their memories prior to rating their future simulations and counterfactual thoughts. Since only the last two of the three experimental conditions were randomized across subjects, it is possible that the FCQ and the ACCQ ratings were biased by the initial MCQ ratings. To avoid this potential problem, in Study 2 all ratings were randomized across participants. Second, the nature of the questionnaires used in Study 1 capture only the subject's self assessment of the mental simulations they reported. A concurrent objective measure of their reports could provide an additional assessment that might warrant a clearer interpretation of the results. As such, in Study 2 we incorporated an adapted version of the Autobiographical Interview (AI), previously used in some studies of episodic future thinking (e.g., Addis et al., 2008; Gaesser, Sacchetti, Addis, & Schacter, 2011; Race, Keane, & Verfaellie, 2011), in addition to the questionnaires.

3.1. Method

3.1.1. Participants

Twenty-four undergraduates (Mean age = 23.54, SD = 8.87; 13 female) from the university of North Carolina at Chapel Hill received partial class credit for their participation. Participants gave written informed consent in accord with the requirements of the Institutional Review Board at UNC-CH.

3.1.2. Procedure

The experimental session consisted of two parts. In the first part, a stimulus collection interview was conducted. Following the Galton–Crovitz word-cuing technique (Crovitz & Schiffman, 1974; Galton, 1880), participants were asked to report 16 autobiographical memories prompted by a list of emotionally neutral nouns adapted from Clark and Paivio (2004). Following the methodology in Study 1, participants were instructed to report only recent (i.e., less that 10 years old) specific autobiographical memories with immediate outcomes. As in Study 1, participants rated the emotional valence of each memory based on its outcome from 1 (Negative) to 5 (Positive).

From these memories, a total of six memories were selected according to the three criteria employed in Study 1: Outcome valence, concreteness, and substitutability. Three of selected six memories received a rating of 1 (''Negative memories''), while the other three selected memories received a rating of 5 (''Positive memories''). The interviewer (F.D.B.) and the research assistant deemed all six memories as detailed and concrete. Finally, each selected memory had an outcome for which it was feasible to substitute an alternative outcome in order to create an episodic counterfactual event. If more than six memories met all three criteria, three positive memories and three negative memories were selected randomly. To create each experimental stimulus, three components were extracted from each of these six memories. The *context* component was the place and time of the reported situation (e.g., ''last summer, Virginia''). The *action* component was the particular action or event the participant reported (e.g., ''horseback riding''). The *outcome* component was the immediate effect of the reported action (e.g., ''fell off horse'').

The second part of the study took place one week after the stimulus collection interview. In this session, participants completed three experimental tasks: *Remember, Future,* and *Counterfactual.* All tasks had the same structure. Participants were presented with a sheet of paper headed with the name of the task (i.e., ''Remember'', ''Future'' or ''What if'', for the counterfactual condition) and three memory components: Context, action and outcome. In the *Remember* task, participants saw the

title "Remember" and the three components that belonged to one of the chosen memories. The participants were instructed to retrieve the memory with as much detail as possible. Additionally, they were instructed to do so out loud while being recorded. Finally, participants were told not to leave out any details that came to mind, and were invited to speak for up to 3 min. There were two trials to the *Remember* task: One trial with a negative outcome and one trial with a positive outcome. In the *Future* task, participants were also presented with three components, except that only the action and the outcome components belonged to the same memory. The context component differed from the reported one in that it indicated a future context. The temporal distance of the suggested future event reflected the temporal distance of the reported memory. For example, if the event from which the future trial was extracted occurred 1 year ago, the context in the future trial would have read "one year from now". Participants were asked to think of a possible future event, in the temporal context suggested by the prompt, that involved the same action and the same outcome as the one reported. Participants were asked to imagine a new event, rather than merely recasting the memory from which the components were extracted. As with the *Remember* task, participants were asked to construct this future simulation in their minds and to describe it out loud, with as much detail as possible, for up to 3 min while being recorded. There were two trials to the Future task: One with a negative outcome and one with a positive outcome. Finally, in the *Counterfactual* condition, participants were presented with context and action components that belonged to the same reported memory, but the outcome component was changed either to a positive alternative outcome (for the negative memory) or a negative alternative outcome (for the positive memory). Each alternative outcome was suggested by the interviewer and agreed upon by the research assistant. If there was disagreement (that is, if an interviewer suggested an alternative outcome the research assistant deemed implausible), a second alternative outcome was suggested. If the disagreement persisted, the memory was discarded (although this never happened). Participants were asked to imagine what would have happened had the outcome been as suggested, and they were asked to describe their mental simulation out loud, with as much detail as possible, for up to 3 min while being recorded. Each participant completed all six trials randomly. After each trial, participants received the phenomenological characteristics questionnaires employed in Study 1. The MCQ was used only for the *Remember* trials. For the Future Characteristic Questionnaire (FCQ) was used for *Future* trials, whereas the Autobiographical Counterfactual Characteristics Questionnaire (ACCQ) was employed for *Counterfactual* trials (see appendix).

3.1.3. Autobiographical interview scoring

The transcription of each participant's recording was scored following the conventional Autobiographical Interview (AI) protocol (Levine et al., 2002). Consistent with previous studies employing the AI to assess memory and simulation (Addis et al., 2008; Gaesser et al., 2011; Race et al., 2011), an adapted scoring system was used. First, for each participant's transcription, a main event was identified. If more than one event was identified, the main event was the event with the most extensive discussion. The transcription was then divided into distinct details or independent chunks of information, such as unique occurrences or thoughts. Only details concerning the main event were rated as *internal*. Details concerning events other than the main event were considered as *external*. External details also involved non-episodic information, such as semantic details, repetitions, and editorial comments. Finally, external episodic details (i.e., episodic information relative to episodes other than the main event) were divided into two categories: *Related* and *unrelated* external episodic details. Any episodic detail that did not belong to the main event, but that nonetheless was causally and temporally connected to the main event, was rated as related external episodic detail. Episodic details that did not belong to the main event, nor were causally and temporally detached from the main event, were rated as unrelated external episodic details. For each trial, the number of internal and external details was tallied. Inter-rater reliability of scoring between coders was established on the basis of an interclass correlation analysis for all the tallied scores (two-way mixed model; standardized Cronbach's $\alpha = .87$ for internal scores, and .90 for external scores).

3.2. Results

3.2.1. Phenomenological characteristics

As in Study 1, and consistent with previous reports using phenomenological characteristics questionnaires for past (Suengas & Johnson, 1988; Schaefer & Philippot, 2005) and future thinking (D'Argembeau & Van der Linden, 2004), ratings of clarity, color, visual, sound, smell, touch, taste and vividness were averaged into a single *sensory* phenomenological factor ($\alpha = .89$). Similarly, ratings of composition, location, objects, people and clarity of day were averaged into a single *composition* factor ($\alpha = .87$). Ratings of intensity during the event, intensity as the event is simulated, and overall sense of simulation were averaged into a singe *intensity* factor ($\alpha = .86$). Finally, ratings of emotion during the event and emotion during simulation were averaged into a single *emotion* factor, since in Study 2—unlike Study 1—they did yield an acceptable reliability level ($\alpha = .81$; Table 2).

A 3 (Condition: remember, future, counterfactual) × 2 (Outcome Valence: positive, negative) × 3 (Phenomenological Factor: sensory, composition, intensity, emotion) ANOVA on these ratings revealed main effects of Condition, $F(1,22) = 9.888$, $p < .001$, $\eta^2 = .473$, Outcome Valence, $F(1,23) = 7.351$, $p < .05$, $\eta^2 = .242$, and Phenomenological Factor, $F(3,21) = 28.205$, $p < .001$, $\eta^2 = .801$, with a significant Outcome × Phenomenological Factor interaction, $F(3,21) = 39.044$, $p < .001$, $\eta^2 = .848$.

To further elucidate these effects, 3 (Condition: remember, future, counterfactual) × 2 (Outcome Valence: positive, negative) ANOVAs for each phenomenological factor were conducted. This analysis revealed a main effect of Condition for the *sensory* factor, $F(2,22) = 6.215$, $p < .01$, $\eta^2 = .361$, with no interactions. Direct contrasts showed that memories were perceived

Table 2
Ratings from Study 2.

	Remember		Future		Counterfactual	
	Negative	Positive	Negative	Positive	Negative	Positive
Ratings[a]						
Sensory	4.68 (1.20)	4.46 (1.13)	4.36 (1.30)	3.86 (1.19)	4.32 (1.16)	3.91 (1.04)
Composition	5.94 (0.87)	5.05 (1.09)	5.29 (.87)	4.42 (1.50)	5.34 (1.04)	4.79 (1.15)
Intensity	4.68 (1.35)	4.95 (0.98)	4.36 (1.05)	4.82 (0.97)	3.99 (1.28)	4.54 (1.59)
Emotion	3.21 (1.31)	5.42 (1.17)	3.17 (1.09)	5.46 (1.03)	2.98 (1.34)	4.69 (1.62)
Probability	N/A	N/A	4.25 (1.67)	5.38 (1.61)	4.08 (1.74)	3.67 (1.86)
Perspective[b]						
Field	17 (70.8%)	16 (66.6%)	11 (45.8%)	12 (50%)	10 (41.7%)	15 (62.5%)
Observer	5 (20.8%)	6 (25%)	11(45.8%)	12 (50%)	14 (58.3%)	9 (37.5)
Neither	2 (8.4%)	2 (8.4%)	2 (8.4%)	0 (0%)	0 (0%)	0 (0%)

[a] Mean ratings for phenomenological factors and probabilities. Standard deviations are in parenthesis.
[b] Number of responses for perspective from a total of 24. Percentages of responses are in parenthesis.

as having more sensory components than both episodic future, $t(23) = 2.607$, $p < .05$, and counterfactual thoughts, $t(23) = 3.406$, $p < .005$. For the *composition* factor, there were main effects of Condition, $F(2,22) = 6.021$, $p < .01$, $\eta^2 = .354$, and Outcome Valence, $F(1,23) = 13.648$, $p < .001$, $\eta^2 = .372$, with no interactions, indicating that the composition of items in simulations with negative outcomes were perceived more clearly than positive outcomes. Moreover, direct contrasts showed that the composition of items in episodic memories was perceived more clearly than both future, $t(23) = 3.477$, $p < .005$, and counterfactual thoughts, $t(23) = 2.565$, $p < .05$.

For the *intensity* factor, there was a main effect of Outcome Valence, $F(1,23) = 6.086$, $p < .05$, $\eta^2 = .209$, with no interactions, indicating that mental simulations with positive outcomes were experienced more intensely than mental simulations with negative outcomes. Finally, for the *emotion* factor, there were main effects of Condition, $F(2, 22) = 4.295$, $p < .05$, $\eta^2 = .281$, and Outcome Valence, $F(1,23) = 126.298$, $p < .001$, $\eta^2 = .846$, with no interactions. Direct contrasts showed that episodic counterfactual thoughts received lower emotion ratings than both memories, $t(23) = 2.367$, $p < .05$, and future thoughts, $t(23) = 2.997$, $p < .01$.

Since participants only produced judgments of subjective probability for the *Future* and the *Counterfactual* conditions, a 2 (Condition: Future, Counterfactual) × 2 (Outcome Valence: Negative, Positive) ANOVA was conducted. This analysis revealed a main effect of condition, $F(1, 23) = 12.88$, $p < .005$, $\eta^2 = .359$, suggesting that possible future episodes were perceived as more likely to occur than counterfactuals events with alternative outcomes. This analysis also revealed a Condition × Outcome Valence interaction that closely approached significance, $F(1,23) = 3.882$, $p = .052$, $\eta^2 = .144$. For that reason, a post hoc *t*-test analysis was conducted, confirming that possible positive future episodes are perceived as more likely to occur than possible negative future episodes, $t(23) = 12.433$, $p < .05$, and possible positive counterfactual events, $t(23) = 16.354$, $p < .005$. Finally, a comparison of ratings for perspective (Field, Observer, Neither/Unclear) revealed no significant differences (all $p > .05$. Table 2).

3.2.2. Autobiographical interview scores

To analyze significant differences in the number of internal versus external details across conditions for negative and positive outcomes, a 3 (Condition: Remember, Future, Counterfactual) × 2 (Outcome Valence: Negative, Positive) × 2 (Detail: Internal, External) ANOVA was conducted.[1] This analysis revealed a main effect of Detail, $F(1,22) = 51.608$, $p < .001$, $\eta^2 = .701$, qualified by a marginally significant Condition × Detail, $F(2,21) = 3.256$, $p = .057$, $\eta^2 = .237$, interaction. For that reason, subsequent 3 × 2 ANOVAs for both Internal and External details were conducted, revealing a main effect of Condition, $F(2,21) = 5.575$, $p < .01$, $\eta^2 = .347$ for internal, but not for external details ($F < 1$). Direct contrasts showed that memories contained more internal details than both future, $t(22) = 3.061$, $p < .01$, and counterfactual, $t(22) = 2.439$, $p < .05$, thoughts (Fig. 1A).

To analyze differences within the general category of internal details, the five subcategories (i.e., event details, details of place, details of time, perceptual details, and emotions or thoughts) were compared. A 3 (Condition: Remember, Future, Counterfactual) × 2 (Outcome Valence: Negative, Positive) × 5 (Internal Detail: Event, Place, Time, Perceptual, Emotion/Thought) ANOVA revealed main effects of Condition, $F(2,21) = 5.575$, $p < .05$, $\eta^2 = .347$, and Detail, $F(4, 19) = 19.4$, $p < .001$, $\eta^2 = .803$, with a Condition × Outcome Valence × Detail interaction, $F(8,15) = 2.67$, $p < .05$, $\eta^2 = .587$. To further analyze the Condition × Outcome Valence × Detail interaction, five 3 (Condition) × 2 (Outcome Valence) ANOVAs were conducted, one for each separate internal detail. For details of place, there was a main effect of condition, $F(2,21) = 5.519$, $p < .05$, $\eta^2 = .345$, which direct contrasts showed to be significant only for *Remember* versus the *Counterfactual*, $t(22) = 2.335$, $p < .05$. For details of time, there was a main effect of condition, $F(2,21) = 7.168$, $p < .005$, $\eta^2 = .406$, with no interactions. Direct contrasts showed that participants included more time references in their episodic recollections relative to their future simulations, $t(22) = 2.313$, $p < .05$, and in turn, more time references in their future simulations than in their counterfactual

[1] Results from 23 participants are reported here, as data from one participant was irretrievably lost due to a problem with the recording device employed.

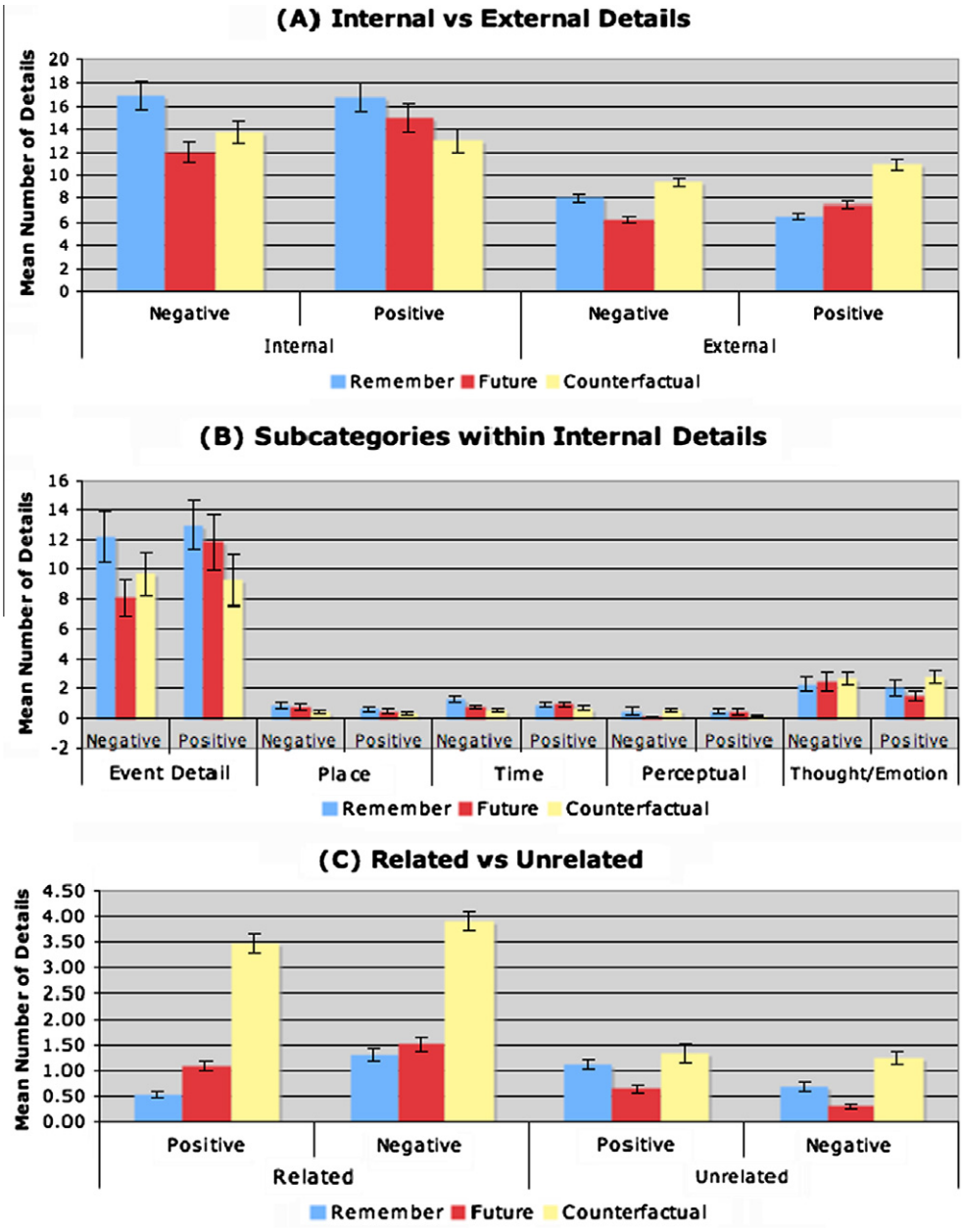

Fig. 1. Proportion of details from the autobiographical memory interview. (A) Mean number of internal and external details. (B) Mean number of details for all subcategories within internal details. (C) Mean number of details for related versus unrelated external details.

thoughts, $t(22) = 2.336$, $p < .05$. However, given the near floor effects observed in these internal categories, these results should be interpreted with caution. No other effects of condition were found for other internal details (Fig. 1B).

Finally, as described in Section 3.1.3), external episodic details were divided into two categories—related and unrelated—depending on whether or not the details were temporally and/or causally connected to the main event. To analyze significant differences between related and unrelated external episodic details across conditions for negative and positive outcomes, a 3 (Condition: Remember, Future, Counterfactual) × 2 (Outcome Valence: Negative, Positive) × 2 (Relatedness: Related, Unrelated) ANOVA was conducted. This analysis revealed a main effect of Relatedness, $F(1, 22) = 14.917$, $p < .001$, $\eta^2 = .404$, modulated by a Condition × Relatedness interaction, $F(2,21) = 3.871$, $p < .05$, $\eta^2 = .269$. As such, subsequent 3 × 2 ANOVAs were conducted for both related and unrelated external episodic details. This analysis revealed a main effect of Condition, $F(2,21) = 5.374$, $p < .013$, $n2 = .339$, for related external, but not for unrelated external, details. Direct contrasts showed that episodic counterfactual thoughts elicited more related external details than both episodic memories, $t(22) = 3.784$, $p < .01$, and future thoughts, $t(22) = 2.426$, $p < .05$ (Fig. 1C).

4. Discussion

The aim of the present studies was to investigate participants' subjective experiences during episodic counterfactual thinking in relation to episodic autobiographical memory and episodic future thinking. In addition, both studies examined the effect that outcome valence had on such experiences. Taken together, the results of the present studies indicate that episodic autobiographical memories were experienced as having more sensory details (Study 2) and clearer spatial and item composition (Studies 1 and 2) than both episodic future and counterfactual thinking. Somewhat surprisingly, Study 1, but not Study 2, showed that memories were felt more intensely than counterfactual simulations. This apparent incongruent result may be due to having fewer observations in Study 2. However, a more probable explanation comes from the fact that Study 2, as opposed to Study 1, showed that mental simulations with positive outcomes were felt more intensely than mental simulations with negative outcomes. This finding suggests that possible differences in intensity ratings in Study 1 may have been missed due to participants biasing their responses in the future and counterfactual questionnaires to adjust for their answers in the MCQ. The same explanation may apply to differences in the emotion ratings between Studies 1 and 2. Specifically, Study 2 revealed that episodic counterfactual thoughts received lower emotion ratings than both episodic memories and future thoughts, not only for negative, but also for positive outcomes. Although this observation is consistent with recent studies suggesting that people misestimate their emotional reaction when considering paths not taken (Andrade & Van Boven, 2010), further research is required to clarify the factors that influence such reactions during the construction of episodic counterfactual thoughts.

The results from the adapted AI employed in Study 2 revealed a greater number of details for episodic autobiographical memories relative to both episodic future and counterfactual thinking. Also, the analysis of the internal details' subcategories revealed a grater number of spatial and temporal details for episodic autobiographical memories, relative to episodic future thinking and counterfactual thinking. This result is consistent with episodic memories receiving significantly higher ratings for the *Composition* factor (Studies 1 and 2), which averaged over details of location, spatial arrangement of objects, people and time of the day. Moreover, this result is consistent with previous studies comparing episodic memories and future thinking, where contextual details consistently receive higher ratings during retrieval tasks relative to prospection (D'Argembeau & Van der Linden, 2004; Szpunar, 2010). These results also agree with those of previous studies showing that memories of real events receive higher ratings for sensorial and contextual details relative to memories of imagined events (Johnson et al., 1988; McGinnis & Roberts, 1996).

The findings of Study 2 also showed a striking result in participants' judgments of subjective probability. Overall, participants thought that it was more likely that a past event could occur in the future, and bring about the same outcome it did in the past, than it was for past events to have a different outcome from the one that actually occurred. This effect was more pronounced for episodic future thoughts with positive outcomes relative to episodic counterfactual thoughts with alternative negative outcomes. In other words, participants were more likely to think that it is more plausible that a past event with a positive outcome could reoccur in the future, than to think that a past event with a positive outcome could have occurred with a negative outcome. This direct comparison of judgments of subjective probability between episodic future and counterfactual simulations is consistent with extant data from previous studies in both prospection and counterfactual thinking. For example, studies of future thinking have shown that people tend to overestimate the likelihood of positive events happening in the future relative to negative events (Sharot, Riccardi, Raio, & Phelps, 2007; Weinstein, 1980). Underestimating the probability of a negative outcome having occurred instead of an actual positive outcome may also reflect this optimism bias, but in a more intricate way. Previous research has shown that upward counterfactuals (i.e., thinking of outcomes that are evaluated better than actual ones) are generated more frequently, effortlessly, and tend to produce greater emotional impact than downward counterfactuals (i.e., thinking of outcomes that are evaluated as having been worse than the actual ones; Heath, Larrick, & Wu, 1999; Roese & Olson, 1997). It has been suggested that upward counterfactuals serve a preparatory function, insofar as they allow us to think of possible, yet non-actualized, better alternatives for future action. On the other hand, downward counterfactuals appear to play an affective function: Contemplating possible yet non-actualized worse alternatives to what actually happened can make us feel better about what actually occurred (Markman & McMullen, 2003). Although speculative, it may be possible that underestimating the probabilities of something worse happening instead of the positive outcome that actually occurred, could be another side of the positivity bias observed for future thinking. Specifically, it could be that contemplating possible, yet non-actualized, negative alternatives as being more unlikely than positive ones could motivate us to think that they are also less likely to reoccur in the future. However, there is another possible explanation. A series of recent studies suggest that people sometimes engage in counterfactual thinking in order to find "meaning" in life (Galinsky, Ku, & Wang, 2005; Kray et al., 2010). Specifically, when people think of alternative ways in which experienced events could have occurred, they tend to increase their sense that such events had to happen in their life—as though they were meant to be. Perhaps underestimating the probability of a negative outcome occurring, instead of the actual positive one, is another way of highlighting the importance of that particular event in one's own life. At any rate, more research on the effects of valence on subjective judgments of probability in episodic counterfactual thinking is needed to clarify this interesting issue.

Another possibility for future research would be examining the effects of temporal distance in judgments of subjective probability in episodic counterfactual thinking. Previous studies comparing memory and future thinking for recent and remote events have shown differential effects of temporal distance in mental simulation, such as number of details, vividness,

and contextual coherence (Trope and Liberman (2003); D'Argembeau & Van der Linden, 2004; Spreng & Levine, 2006; Szpunar & McDermott, 2008). Relatedly, evidence offered by studies on counterfactual thinking shows that people's judgments of subjective probabilities are affected by several factors, such as availability and recency (Mandel, Hilton, & Catellani, 2009). Studying the influence of both factors on *episodic* counterfactual thinking could further illuminate the role that episodic memory plays in our capacity to think of alternative ways in which our life could have occurred. Finally, further studies should also explore whether there are temporal differences in field/observer judgments as a function of temporal distance. Although our study did not find significant differences in perspective across conditions, there seems to be a trend toward imagining negative episodic counterfactual thoughts from an observer perspective, rather than from a field perspective. Further studies may be able to clarify whether temporal factors influence the perspective from which we mentally see ourselves when we think of alternative ways in which our past could have happened.

The idea that memory and imagination are two different cognitive faculties is well entrenched in our folk psychology. Over three centuries ago, empiricist philosopher Thomas Hobbes challenged that view, and surmised that "imagination and memory are but one thing" (Hobbes, 1651, I:2). Almost a century later David Hume followed suit and suggested that our occasional inability to distinguish memories from imagination may be due to similarities in their operations (Hume, 1739, Book I, Part III, Section V). The study of the relationship between episodic memory and episodic future thinking constituted an important step in our path to understanding such similarities. The study of the relationship between episodic memory and episodic counterfactual thinking may help illuminate another part of the road.

Appendix A

Memory characteristics questionnaire

1. Clarity (1 = dim; 7 = clear).
2. Color (1 = black and white; 7 = full color).
3. Visual detail (1 = none; 7 = a lot).
4. Sound (1 = none; 7 = a lot).
5. Smell (1 = none; 7 = a lot).
6. Touch (1 = none; 7 = a lot).
7. Taste (1 = none; 7 = a lot).
8. Vividness (1 = vague; 7 = very vivid).
9. Composition (1 = sketchy; 7 = very detailed).
10. Clarity of location (1 = vague; 7 = clear).
11. Clarity of spatial arrangement of objects (1 = vague; 7 = clear).
12. Clarity of spatial arrangement of people (1 = vague; 7 = clear).
13. Clarity of time of day (1 = vague; 7 = clear).
14. Do you remember how you felt during the event? (1 = not at all; 7 = definitively).
15. Emotion during the event (1 = negative; 7 = positive).
16. Intensity of emotion during the event (1 = not intense; 7 = very intense).
17. Emotion as you are remembering now (1 = negative; 7 = positive).
18. Intensity of the emotion as you are remembering now (1 = not intense; 7 = very intense).
19. Overall, how do you remember this event? (1 = hardly; 7 = very well).
20. Field/observer/none?

Autobiographical counterfactual characteristics questionnaire

1. Clarity (1 = dim; 7 = clear).
2. Color (1 = black and white; 7 = full color).
3. Visual detail (1 = none; 7 = a lot).
4. Sound (1 = none; 7 = a lot).
5. Smell (1 = none; 7 = a lot).
6. Touch (1 = none; 7 = a lot).
7. Taste (1 = none; 7 = a lot).
8. Vividness (1 = vague; 7 = very vivid).
9. Composition (1 = sketchy; 7 = very detailed).
10. Clarity of location (1 = vague; 7 = clear).
11. Clarity of spatial arrangement of objects (1 = vague; 7 = clear).
12. Clarity of spatial arrangement of people (1 = vague; 7 = clear).
13. Clarity of time of day (1 = vague; 7 = clear).
14. Can you imagine how would you've felt during the event? (1 = not at all; 7 = definitively).
15. What would have been your emotion? (1 = negative; 7 = positive).

16. What would have been the intensity of your emotion? (1 = not intense; 7 = very intense).
17. Emotion as you are thinking now (1 = negative; 7 = positive).
18. Intensity of the emotion as you are thinking now (1 = not intense; 7 = very intense).
19. Overall, how do you imagine this event? (1 = hardly; 7 = very well).
20. What's the probability that this event would have occurred as suggested? (1 = not probable; 7 = highly probable).
21. Field/observer/none?

Future characteristics questionnaire

1. Clarity (1 = dim; 7 = clear).
2. Color (1 = black and white; 7 = full color).
3. Visual detail (1 = none; 7 = a lot).
4. Sound (1 = none; 7 = a lot).
5. Smell (1 = none; 7 = a lot).
6. Touch (1 = none; 7 = a lot).
7. Taste (1 = none; 7 = a lot).
8. Vividness (1 = vague; 7 = very vivid).
9. Composition (1 = sketchy; 7 = very detailed).
10. Clarity of location (1 = vague; 7 = clear).
11. Clarity of spatial arrangement of objects (1 = vague; 7 = clear).
12. Clarity of spatial arrangement of people (1 = vague; 7 = clear).
13. Clarity of time of day (1 = vague; 7 = clear).
14. Can you imagine how you will feel during the event? (1 = not at all; 7 = definitively).
15. Emotion during the event (1 = negative; 7 = positive).
16. Intensity of emotion during the event (1 = not intense; 7 = very intense).
17. Emotion as you are imagining now (1 = negative; 7 = positive).
18. Intensity of the emotion as you are imagining now (1 = not intense; 7 = very intense).
19. Overall, how do you imagine this event? (1 = hardly; 7 = very well).
20. What's the probability that this event will happen? (1 = not probable; 7 = highly probable).
21. Field/observer/none?

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