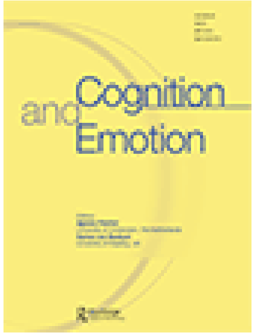

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How thinking about what could have been affects how we feel about what was

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How thinking about what could have been affects how we feel about what was

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ABSTRACT

Episodic counterfactual thoughts (CFT) and autobiographical memories (AM) involve the reactivation and recombination of episodic memory components into mental simulations. Upon reactivation, memories become labile and prone to modification. Thus, reactivating AM in the context of mentally generating CFT may provide an opportunity for editing processes to modify the content of the original memory. To examine this idea, this paper reports the results of two studies that investigated the effect of reactivating negative and positive AM in the context of either imagining a better (i.e. upward CFT) or a worse (i.e. downward CFT) alternative to an experienced event, as opposed to attentively retrieving the memory without mental modification (i.e. remembering) or no reactivation. Our results suggest that attentive remembering was the best strategy to both reduce the negative affect associated with negative AM, and to prevent the decay of positive affect associated with positive AM. In addition, reactivating positive, but not negative, AM with or without CFT modification reduces the perceived arousal of the original memory over time. Finally, reactivating negative AM in a downward CFT or an attentive remembering condition increases the perceived detail of the original memory over time.

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Counterfactual thinking; autobiographical memory; memory reactivation; emotion

Remembering specific autobiographical memories (AM) involves the reactivation and active reconstruction of episodic information into coherent mental simulations (Schacter & Addis, 2007). Usually, when we remember AM, we generate a mental simulation whose content more or less matches the way in which we originally experienced the event. However, given the dynamic nature of memory reconstruction, it is possible to mentally modify aspects of AM, both voluntarily and involuntarily, when mentally simulating them at retrieval. For instance, while most of the time we simulate AM from the same first-person perspective from which we originally experienced the remembered event, sometimes we mentally shift to an observer or third-person perspective when remembering certain AM, seeing ourselves in the memory rather than viewing it from our own eyes (Nigro & Neisser, 1983). The flexibility of these perspective shifts not only speaks to the dynamic nature of the memory retrieval (Schacter, 1996) but it also offers researchers strategies to experimentally manipulate the content and phenomenology of the retrieved AM in order to explore how AM may be modified (Butler, Rice, Wooldridge, & Rubin, 2016; St. Jacques, Szpunar, & Schacter, 2017).

Besides perspective shifts, another important way in which we mentally modify AM is when we imagine alternative ways in which the remembered events might have occurred instead—a common psychological experience known as *episodic counterfactual thinking* (CFT; De Brigard & Giovanello, 2012; Roese & Epstude, 2017). Extant evidence suggests

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that episodic CFT depends upon similar cognitive and neural mechanisms as those involved in the construction of episodic memories (De Brigard, Addis, Ford, Schacter, & Giovanello, 2013) and future thoughts (Van Hoeck et al., 2013). To account for these similarities, it has been suggested that, akin to the process of mentally simulating AM and future thoughts, mentally simulating episodic counterfactual thoughts also requires the reactivation and recombination of autobiographical episodic information (Schacter, Benoit, De Brigard, & Szpunar, 2015).

Importantly, evidence from numerous studies in CFT indicates that retrieving AM in the context of generating episodic CFT has affective consequences. According to Kahneman and Miller's (1986) influential proposal, counterfactual thoughts serve an emotional amplification role by heightening the emotions associated with the imagined alternative event. More precisely, if a certain outcome is mentally contrasted with an imagined better alternative in which a more desirable outcome could have occurred instead, the negative emotion associated with not having achieved that imagined outcome is heightened. As such, these *upward* counterfactuals—i.e. CFT in which the imagined alternative event is better than the actual one—tend to heighten negative emotions such as regret and disappointment. Conversely, if a certain outcome is mentally contrasted with an imagined worse alternative in which a less desirable outcome could have occurred instead, the positive emotion associated with having actually achieved a more desirable outcome than the imagined one is heightened. Thus, these *downward* counterfactuals—i.e. CFT in which the imagined alternative event is worse than the actual one—tend to heighten positive emotions, such as relief and content.

Subsequent results have supported this view for episodic CFT that are based on AM. Evidence that upward episodic CFT evokes negative emotions has been reported numerous times. In a pioneering study, Roese (1994) asked participants to remember unpleasant AM. He then asked them to imagine either better (upward CFT) or worse (downward CFT) alternatives to the actual experienced event. Participants induced to generate upward episodic counterfactual thoughts reported higher negative affect and greater feelings of regret relative to participants induced to generate downward episodic CFT (see also Allen, Greenlees, & Jones, 2014; Gilovich & Medvec, 1995; Landman, 1993; Roese, 1997, 1999; Stanley, Parikh, Stewart, & De Brigard, 2017). Complementary results have shown that generating downward episodic CFT about specific AM tend to evoke positive emotions. For example, McMullen and Markman (2000) showed that when participants are asked to imagine how a bad experience could have become more tragic, people experience more positive emotions about the actual outcome as compared to those who did not retrieve the autobiographical memory in the context of a downward episodic CFT (Rim & Summerville, 2014; White & Lehman, 2005).

Nevertheless, given that most research on affective consequences of episodic CFT has focused on immediate effects that follow from the simulation of a counterfactual thought, it is unclear whether there may be long-term effects on AM when they are retrieved in the context of episodic CFT (for initial relevant evidence, see De Brigard, Szpunar, & Schacter, 2013; Gerlach, Dornblaser, & Schacter, 2014). Following recent evidence documenting reactivation-related modifications in AM (e.g. Finn & Roediger, 2011; Forcato, Rodriguez, Pedreira, & Maldonado, 2010; Hupbach, Gomez, Hardt, & Nadel, 2007; Schwabe & Wolf, 2010; St. Jacques & Schacter, 2013; St. Jacques, Montgomery, & Schacter, 2015), the current three-session study investigates whether retrieving both positive and negative AM in the context of either upward or downward episodic CFT modifies their phenomenological characteristics relative to reactivating them but without counterfactual modification, or not reactivating them at all. In session 1, participants provided positive and negative episodic AM, which they rated along five dimensions: valence, arousal, detail, ease and reliving. A week later, in session 2, participants were asked to reactivate a subset of their reported positive and negative memories, and to do so in the context of generating upward counterfactual simulations, downward counterfactual simulations, or simply to attentively reactivate them without counterfactual modification. Finally, a day after the reactivation manipulation, participants returned for a third and final session in which all AM were presented again (including baseline AM not reactivated during session 2), while being asked to rate them along the same dimensions used in the first session.

The current study allows us to explore whether reactivating emotional memories in the context of either an upward or a downward counterfactual simulation differentially modifies their phenomenological characteristics relative to attentively reactivating the memories in non-imaginative contexts, or not reactivating them at all. Specifically, we explore possible reactivation-related changes in five phenomenological dimensions—valence, arousal, detail, ease and reliving—based upon two lines of evidence. On the one hand, several studies on both episodic future and CFT show reactivation-related effects on valence, arousal, and detail—although these effects are measured on the CFT per se, not the AM they are derived from (De Brigard, Szpunar, et al., 2013; Stanley, Parikh, et al., 2017; Stanley, Stewart, & De Brigard, 2017; Szpunar & Schacter, 2013). On the other hand, recent studies have shown effects on intensity (Sekiguchi & Nonaka, 2014), reliving (St. Jacques et al., 2017) and vividness (Akhtar, Justice, Loveday, & Conway, 2017) in AM after perspective-shifts during reactivation. Within this context, the current study explores five specific hypotheses. First, given similarities between CFT and perspective-shift in AM (St. Jacques, Carpenter, Szpunar, & Schacter, 2018) as well as reactivation-related effects of perspective-shifts in AM (e.g. Butler et al., 2016; Sekiguchi & Nonaka, 2014; St. Jacques et al., 2017), we expected changes from the first to the last session for valence, arousal and detail in AM reactivated in the CFT conditions relative to those reactivated in the attentive remembering and baseline conditions. Second, based upon previous results showing increases in ease and reliving as a function of repetition for both CFT and AM (De Brigard, Szpunar, et al., 2013; Stanley, Stewart, et al., 2017), we expected ease and reliving to equally increase after reactivation for the attentive remembering and CFT conditions relative to baseline.

Third, consistent with the emotional amplification view of CFT, we also hypothesise that the direction of this effect would differ between negative and positive memories depending on whether the original memory is reactivated in the context of an upward or a downward CFT. For instance, we predict that if episodic CFT affects the original AM in the direction of the simulation, then negative AM would be reappraised as less negative if they have been reactivated in downward CFT (which are usually associated with feeling of relief), whereas positive AM would be reappraised as less positive if they have been reactivated in upward CFT (which are usually associated with feeling of regret). Fourth, we anticipate lasting down-regulation of both negative and positive AM in the attentive reactivation condition without counterfactual modification, thus providing a reappraisal baseline against which to compare the effects of the episodic CFT manipulation. We base this hypothesis on recent research concerning affect-biased attention and emotional reappraisal of AM, according to which selectively attending to salient aspects of emotional experiences tends to modulate our affective responses toward them relative to not attending to such features, or selectively attending to irrelevant aspects of emotional experiences (Ochsner & Gross, 2005; Todd, Cunningham, Anderson, & Thomson, 2012). Finally, we expect minimal to no changes between the first and third sessions in the AM that are not reactivated in session 2, thus providing an appropriate baseline of potential changes in AM due to time alone against which to compare effects of reactivation.

Experiment 1

Methods

Participants

26 community members from the Durham, NC area, and 5 from the Boston area, participated in the study. Data from 6 participants were excluded because of failure to understand the instructions (4 participants) or computer error (2 participants). As such, data from 25 participants were analyzed (*M* age = 21.36, SD = 2.94; 17 women). For sample size estimation, a power analysis using G*Power 3.1 was conducted based on a previous between-subjects study (Sekiguchi & Nonaka, 2014) that reported a large effect size of session ($\eta^2 = .39$) on emotional intensity. Assuming an alpha level of .05 and a suggested power = .80, the projected sample size needed for the current study was $N = 22$, making our sample size adequate to detect an effect of at least partial $\eta^2 = .39$. Participants received monetary compensation for their collaboration, and gave consent following the requirements of the Institutional Review Boards at Harvard and Duke Universities.

Procedure

The study consisted of three sessions. In session 1, participants generated 42 negative and 42 positive autobiographical memories about specific decisions made in the past 5 years (e.g. "deciding to express a political view in public"; "deciding to skip a meeting"). To help retrieve these memories, participants were provided with a list of 100 possible common decisions. This list was previously normed with a large sample from the same population as the participants, and it has been previously employed in other studies (e.g. De

Brigard, Parikh, Stewart, Szpunar, & Schacter, 2017; De Brigard, Spreng, Mitchell, & Schacter, 2015). For each memory, participants typed a short description of the event and a title. Additionally, participants rated each memory on Valence (1 = negative, 9 = positive), Arousal (1 = calm, 9 = excited), Detail (1 = vague, 9 = clear), Ease (1 = difficult, 9 = easy), and Reliving (1 = low, 9 = high).

Approximately one week later (between 6 and 9 days), participants returned to the lab for session 2. Participants were asked to engage in counterfactual simulation or to remember the memories they had generated in the previous session, as indicated by screen headings. There were two CFT conditions: *Upward* and *Downward*. In the upward condition, participants saw the header "Better" and were asked to imagine an alternative *better* way in which a memory—cued by the title provided in session 1—could have occurred. Then were asked to type a brief summary of that counterfactual simulation. For example, suppose that a participant reported a negative memory about skipping a meeting that turned out to be important. When cued to imagine a better alternative for this memory, the participant would describe an alternative, better way in which the event could have occurred, e.g. having the meeting postponed at the last minute. In the downward condition, participants saw the header "Worse" and were asked to imagine, and type, an alternative *worse* way in which the cued memory could have occurred. For example, suppose that a participant reported the positive memory of being asked an easy question in a final exam. In the downward condition, the participant would imagine and describe an alternative, worse way in which the event could have happened, i.e. being asked a very difficult question. In the *Remember* condition, participants saw the heading "Remember", were asked to retrieve the event exactly as it happened, and were asked to attend and record a specific yet salient detail of the memory. For example, if a person reported having closely missed the subway, they were asked to focus on a salient detail of the subway station (e.g. the smell or a poster on the wall). The task was self-paced and there were no time limits. Participants simulated 10 better and 10 worse counterfactuals for positive and negative AMs, and 10 positive and 10 negative memories were reactivated; additionally, 10 positive and 10 negative remembered events were not cued during the second session. All memories were randomly selected in equal numbers from positive and negative memories (i.e. 40 from the set of negative, and 40 from the set of positive AM), and the title-cues were presented randomly as well. The remaining four memories were used for an initial, practice trial.

Session 3 took place one day later. Participants were presented with the titles of all 80 memories generated in session 1, and were asked to determine if each memory had been associated with a counterfactual alternative on the previous day (i.e. presented under "Better" or "Worse" headings) or not (i.e. presented under "Remember" heading or not at all). They were then asked to rate their confidence in their recognition response on a 9-point scale (1 = low, 9 = high). Finally, participants rated each memory on the same dimensions they had encountered in the first session: Valence, Arousal, Detail, Ease and Reliving. As in session 1, scales also ranged from 1 to 9, and were identically anchored.

Results

Average ratings and standard deviations for all trials are displayed in Table 1. Data from positive and negative memories were modeled independently as five separate 4 (Condition: Upward, Downward, Remember, Baseline) by 2 (Session: First, Last) ANOVAs for each rating. Post-hoc tests were Bonferroni corrected.

Valence

For negative memories, there was a main effect of Session, $F(1, 24) = 49.07$, $p < .001$, partial $\eta^2 = .67$, indicating that valence ratings increased (i.e. became more positive) from the first ($M = 2.46$, $SEM = .10$) to the last session ($M = 3.27$, $SEM = .12$) in all conditions. There was also a main effect of Condition, $F(3, 22) = 4.92$, $p = .004$, partial $\eta^2 = .17$, but no interaction ($p = .28$). Post-hoc tests indicated overall lower valence ratings (i.e. more negative) for the upward and downward conditions relative to the baseline condition ($p = .048$ and $p = .047$, respectively). For positive memories there was also a main effect of Session, $F(1, 24) = 13.42$, $p = .001$, partial $\eta^2 = .36$, qualified by a significant interaction with Condition, $F(3, 22) = 3.25$, $p = .027$, partial $\eta^2 = .119$. To clarify this interaction we conducted pairwise comparisons between sessions for each condition. Valence ratings decreased (i.e. became more negative) from the first to the last session in the upward ($p = .002$), downward ($p = .017$), and baseline ($p < .001$) conditions, but not in the remember condition ($p = .385$).

Table 1. Average ratings for all trials in Experiment 1.

	Negative			Positive		
	Session			Session		
	First	Last	Cohen's *d*	First	Last	Cohen's *d*
Valence						
Upward	2.38 (0.58)	3.06 (0.82)	1.05 ***	7.76 (0.58)	7.19 (0.76)	0.70 **
Downward	2.30 (0.62)	3.05 (0.90)	1.02 ***	7.65 (0.57)	7.35 (0.65)	0.51 *
Remember	2.61 (0.50)	3.42 (0.71)	1.17 ***	7.53 (0.60)	7.41 (0.72)	0.18 $^{n.s.}$
Baseline	2.56 (0.75)	3.57 (0.86)	1.03 ***	7.57 (0.68)	7.11 (0.73)	0.85 ***
Arousal						
Upward	5.39 (1.21)	5.35 (1.11)	0.03 $^{n.s.}$	6.71 (1.02)	6.27 (0.83)	0.38 *
Downward	5.03 (1.60)	5.57 (0.99)	0.36 $^{n.s.}$	6.96 (0.96)	6.24 (0.85)	0.69 **
Remember	5.16 (1.50)	5.26 (0.94)	0.09 $^{n.s.}$	6.49 (0.85)	6.28 (1.07)	0.18 $^{n.s.}$
Baseline	4.86 (1.38)	5.12 (1.10)	0.24 $^{n.s.}$	6.42 (1.35)	5.97 (1.33)	0.38 *
Detail						
Upward	6.43 (1.06)	6.74 (1.03)	0.34 $^{n.s.}$	6.90 (.98)	7.04 (.89)	0.19 $^{n.s.}$
Downward	6.06 (1.09)	6.96 (.76)	0.85 ***	6.78 (.87)	6.99 (.86)	0.21 $^{n.s.}$
Remember	6.05 (1.21)	6.69 (.83)	0.48 *	6.61 (1.08)	6.95 (.79)	0.45 $^{n.s.}$
Baseline	6.36 (1.13)	6.57 (.98)	0.19 $^{n.s.}$	7.04 (.92)	6.88 (.98)	0.18 $^{n.s.}$
Ease						
Upward	6.25 (1.13)	6.08 (1.32)	0.13 $^{n.s.}$	6.85 (0.89)	6.55 (1.17)	0.26 $^{n.s.}$
Downward	5.82 (1.39)	6.25 (1.06)	0.27 $^{n.s.}$	6.51 (1.05)	6.58 (1.03)	0.06 $^{n.s.}$
Remember	5.79 (1.20)	6.06 (0.96)	0.19 $^{n.s.}$	6.55 (1.05)	6.59 (1.14)	0.05 $^{n.s.}$
Baseline	5.92 (1.21)	5.62 (1.18)	0.25 $^{n.s.}$	6.69 (0.95)	6.38 (1.17)	0.26 $^{n.s.}$
Reliving						
Upward	5.57 (1.53)	5.37 (1.76)	0.19 $^{n.s.}$	6.62 (1.26)	6.23 (1.22)	0.29 $^{n.s.}$
Downward	5.60 (1.53)	5.46 (1.67)	0.09 $^{n.s.}$	6.79 (1.09)	6.32 (0.95)	0.43 $^{n.s.}$
Remember	5.35 (1.68)	5.30 (1.32)	0.04 $^{n.s.}$	6.44 (1.28)	6.07 (1.14)	0.33 $^{n.s.}$
Baseline	5.85 (1.75)	5.15 (1.75)	0.56 $^{n.s.}$	6.71 (1.34)	6.07 (1.32)	0.48 $^{n.s.}$

Note: Standard deviations in parenthesis. Effect sizes for the pairwise comparisons for the effect of session for each condition were calculated using Cohen's *d* statistic. * = $p < .05$; ** = $p < .005$, *** = $p < .001$. $^{n.s.}$ = not significant.

Arousal

For negative memories, there were no effects. For positive memories, there was only a main effect of Session, $F(1, 24) = 6.64$, $p = .017$, partial $\eta^2 = .22$, indicating that arousal ratings decreased from the first ($M = 6.64$, $SEM = .16$) to the last session ($M = 6.19$, $SEM = .17$), although follow-up comparisons indicated that this effect was not significant for the remember condition ($p = .377$).

Detail

For negative memories, there was a main effect of Session, $F(1, 24) = 8.60$, $p = .007$, partial $\eta^2 = .26$, qualified by a significant interaction with Condition, $F(3, 22) = 3.90$, $p = .012$, partial $\eta^2 = .14$). To clarify this interaction, we conducted pairwise comparisons between sessions for each condition. Detail ratings increased from the first to the last session only in the downward ($p < .001$) and the remember ($p = .024$) conditions. For positive memories, there were no effects. Finally, there were no effects or interactions for *Ease* or *Relieving* ratings.[1]

Discussion

Experiment 1 investigated the effects of retrieving a memory in the context of either an upward or a downward counterfactual simulation versus attentive reactivation in the absence of imaginative modification (i.e. remember), or no reactivation (i.e. baseline). The results revealed that negative memories became more positive from the first to the last session, regardless of condition. In contrast, positive memories became more negative from the first to the last session for all except the remember condition. Additionally, positive, but not negative, memories decreased in arousal from the first to the last session in all except the remember condition. The effect sizes, however, were either small or medium (Table 1). Interestingly, our results also showed that negative memories in the downward and remember conditions received higher ratings of detail in the last relative to the first session. This increase was not apparent in the upward CFT or the baseline conditions.

The experimental paradigm employed in Experiment 1 included a surprise memory test in the third session, which allowed us to evaluate whether the previous effects depended upon correctly remembering initial AM. Although the results from the analysis of correctly remembered trials did not significantly differ relative to the results from all trials (see Supplementary Information), including this recognition component in the last session introduced a potential confound in our experimental design. Given that the re-rating of AM in session 3 occurred only after participants were asked to recall them, in the context of the memory test, it is unclear whether the difference in the ratings found here is attributable to the retrieval manipulation in the session 2, memory reactivation during the last session, or both. To control for this potential confound, and to further elucidate the effects found in Experiment 1, we conducted a second experiment that did not include a memory component in session 3. Additionally, we included a stronger manipulation in session 2, whereby AM were reactivated three times—as opposed to only once as in Experiment 1—both in the CFT and the remember conditions.

Experiment 2

Methods

Participants

26 community members from the Durham, NC area participated in the study. Data from 1 participant were excluded due to computer error. As such, data from 25 participants were analyzed (*M* age = 23.24, SD = 3.18; 13 women). Participants received monetary compensation for their collaboration, and gave consent following the requirements of the Institutional Review Board at Duke University.

Procedure

The procedure was the same as Experiment 1 with three exceptions. First, during session 1, participants were asked to come up with 36 rather than 42 negative and positive AM and, thus, there were 8 rather than 10 AM assigned to each condition; the remaining ones, as in Experiment 1, were used for the practice trial. Second, in session 2, participants simulated each memory, upward and downward episodic CFT three times—as opposed to just one time—in random order. Participants were asked to simulate exactly the same CFT each time, rather than three different CFTs. Finally, as in Experiment 1, in session 3 participants were presented with the titles of all 64 memories generated in session 1, but they did not receive a recognition test, that is, they were not asked to determine whether or not they had created a counterfactual alternative the previous day. Instead, they were simply asked to re-rate each memory on the same dimensions they had encountered in session 1.

Results

Average ratings for all trials are displayed in Table 2. Data from positive and negative memories were modeled independently as five separate 4 (Condition: Upward, Downward, Remember, Baseline) × 2 (Session: First, Last) ANOVAs for each rating.

Valence

For negative memories, there were main effects of Condition, $F(3, 22) = 2.94$, $p = .039$, $\eta^2 = .11$, and Session, $F(1, 24) = 14.14$, partial $\eta^2 = .37$, qualified by a Condition by Session interaction, $F(3, 22) = 4.48$, $p = .012$, partial $\eta^2 = .16$. To clarify this interaction, we conducted pairwise comparisons between sessions for each condition. Valence ratings increased from the first to the last session only for the downward ($p = .02$,) and the remember ($p < .001$) conditions, but not for the upward or baseline conditions (all *p*s > .05). For positive memories, there was only an effect of Condition, $F(3, 22) = 3.84$, $p = .013$, partial $\eta^2 = .14$, with no interaction. Post-hoc tests indicated that valence ratings were higher for the upward (*M* = 7.71, *SEM* = .115) relative to the remember (*M* = 7.49, *SEM* = .11) condition, but not the downward or baseline conditions (all *p*s > .05).

Arousal

For negative memories, there were no effects. For positive memories, there was only a main effect of Session, $F(1, 24) = 14.49$, $p = .001$, partial $\eta^2 = .38$, indicating that arousal ratings decreased from the first (*M* = 5.95, *SEM* = .33) to the last (*M* = 5.34, *SEM* = .29) session.

Detail

For negative memories, there was a main effect of Session, $F(1, 24) = 10.74$, $p = 003$, partial $\eta^2 = .31$, qualified by a significant interaction with Condition, $F(3, 22) = 3.21$, $p = .028$, partial $\eta^2 = .12$. To clarify this interaction, we conducted pairwise comparisons between

Table 2. Average ratings for all trials in Experiment 2.

	Negative			Positive		
	Session			Session		
	First	Last	Cohen's *d*	First	Last	Cohen's *d*
Valence						
Upward	2.66 (0.64)	2.91 (0.61)	0.33 *n.s.*	7.85 (0.74)	7.57 (0.60)	0.40 *n.s.*
Downward	2.69 (0.64)	2.92 (0.50)	0.49 *	7.53 (0.64)	7.36 (0.61)	0.29 *n.s.*
Remember	2.64 (0.57)	3.35 (0.53)	1.02 ***	7.46 (0.64)	7.52 (0.59)	0.11 *n.s.*
Baseline	2.85 (0.75)	3.15 (0.77)	0.37 *n.s.*	7.44 (0.67)	7.29 (0.74)	0.23 *n.s.*
Arousal						
Upward	4.95 (1.67)	4.98 (1.30)	0.02 *n.s.*	6.05 (1.98)	5.53 (1.73)	0.46 *
Downward	4.61 (1.50)	4.83 (1.39)	0.18 *n.s.*	5.92 (1.65)	5.21 (1.63)	0.69 **
Remember	4.83 (1.69)	4.64 (1.30)	0.13 *n.s.*	5.93 (1.77)	5.29 (1.48)	0.67 **
Baseline	4.35 (1.55)	4.47 (1.15)	0.08 *n.s.*	5.88 (1.73)	5.33 (1.49)	0.49 *
Detail						
Upward	6.24 (1.40)	6.45 (1.37)	0.19 *n.s.*	6.84 (1.26)	6.69 (1.13)	0.19 *n.s.*
Downward	5.74 (1.25)	6.54 (1.37)	0.82 ***	6.21 (1.12)	6.41 (1.18)	0.21 *n.s.*
Remember	5.58 (1.34)	6.26 (0.97)	0.58 **	6.43 (1.13)	6.67 (0.99)	0.27 *n.s.*
Baseline	5.62 (1.46)	5.79 (1.22)	0.18 *n.s.*	6.34 (1.36)	6.31 (1.25)	0.02 *n.s.*
Ease						
Upward	6.51 (1.61)	6.34 (1.41)	0.10 *n.s.*	6.94 (1.34)	6.66 (1.25)	0.22 *n.s.*
Downward	5.69 (1.45)	6.30 (1.31)	0.41 *n.s.*	6.58 (1.27)	6.57 (1.01)	0.01 *n.s.*
Remember	5.56 (1.64)	6.30 (1.15)	0.41 *n.s.*	6.31 (1.39)	6.56 (1.25)	0.21 *n.s.*
Baseline	5.35 (1.64)	5.69 (1.36)	0.19 *n.s.*	6.15 (1.65)	6.43 (1.27)	0.19 *n.s.*
Reliving						
Upward	5.33 (2.21)	5.42 (1.73)	0.06 *n.s.*	5.89 (1.85)	5.73 (1.74)	0.14 *n.s.*
Downward	5.44 (1.83)	5.13 (1.75)	0.25 *n.s.*	6.82 (2.08)	5.63 (1.60)	0.19 *n.s.*
Remember	5.12 (1.96)	5.06 (1.40)	0.04 *n.s.*	5.59 (2.01)	5.64 (1.52)	0.05 *n.s.*
Baseline	5.16 (1.96)	4.77 (1.49)	0.25 *n.s.*	5.53 (2.28)	5.33 (1.73)	0.16 *n.s.*

Note: Standard deviations in parenthesis. Effect sizes for the pairwise comparisons for the effect of session for each condition were calculated using Cohen's *d* statistic. * = $p < .05$; ** = $p < .005$, *** = $p < .001$. *n.s.* = not significant.

sessions for each condition. Detail ratings increased from the first to the last session only in the downward ($p < .001$) and the remember ($p = .008$) conditions. For positive memories, there was only a main effect of Condition, $F(3, 22) = 4.02$, $p = .011$, partial $\eta^2 = .14$, with no interaction. Post-hoc tests indicated higher detail ratings in the upward ($M = 6.77$, $SEM = .23$) relative to the downward ($M = 6.31$, $SEM = .21$) and baseline ($M = 6.33$, $SEM = .24$) conditions ($p = .047$ and $p = .032$, respectively).

Ease

For negative memories, there was a main effect of Condition, $F(3, 22) = 8.57$, $p < .001$, partial $\eta^2 = .26$, qualified by significant interaction with Session, $F(3, 22) = 4.73$, $p = .005$, partial $\eta^2 = .17$. To clarify this interaction, post-hoc comparisons were conducted. This analysis revealed that ratings of ease were higher in the upward relative to all other conditions in the first but not in the last session (largest $p = .008$). For positive memories, there was only a main effect of Condition, $F(3, 22) = 4.66$, $p = .005$, partial $\eta^2 = .16$, with no interaction. Pairwise comparisons indicated that ratings of ease where only higher for upward ($M = 6.80$, $SEM = .23$) relative to the baseline ($M = 6.29$, $SEM = .26$) condition. Finally, there were no effects on reliving ratings.

Discussion

Consistent with the findings from Experiment 1, in Experiment 2 we found an increase in positive valence for negative memories that were reactivated in the downward and remember conditions. However, this effect was not evident in the upward or baseline conditions, suggesting that these changes may have been due to either the reactivation of memories in the recognition test or the repetitive simulation during session 2. Additionally, in Experiment 2—unlike Experiment 1—the effect size in the remember condition was large, whereas the effect in the downward condition was small (Table 2). On the other hand, in contrast to Experiment 1, in Experiment 2 we found no effect of session on valence ratings for positive memories. The effects of arousal in Experiment 2 replicated those in Experiment 1, as reflected by a decrease in ratings from the first to the third session in positive, but not negative, memories. However, unlike Experiment 1, in Experiment 2 this effect was also significant for the remember condition. Finally, Experiment 2 also replicated the increase in detail ratings from the first to the last session in negative memories in the remember and downward conditions only.

Common effects across Experiments 1 and 2

Experiments 1 and 2 were designed to explore the role of reactivating AM in the context of upward or downward CFT relative to reactivating AM without counterfactual modification or not reactivating AM at all. Many of the findings from Experiment 1 were replicated in Experiment 2, despite minimal differences between the two. Thus, to better understand the impact of each reactivation condition on AM from the first to the last session and obtain a clearer idea of common effects of session across both experiments, we conducted additional repeated measures 4 (Condition) × 2 (Session) ANOVAs for the ratings of valence, arousal, and detail on the combined effects across Experiments 1 and 2, with Experiment as between-subjects factor.

Valence

For negative memories, there was no main effect of Experiment, $F(1, 48) = 0.054$, $p = 0.82$, partial $\eta^2 = 0.001$. There were, however, main effects of Condition, $F(3, 47) = 7.84$, $p < .001$, partial $\eta^2 = 0.138$, and Session, $F(1, 49) = 52.46$, $p < .001$, partial $\eta^2 = .517$, qualified by a Session by Condition interaction, $F(3, 47) = 2.88$, $p = 0.038$, partial $\eta^2 = .06$. To clarify this interaction, Bonferroni-corrected pairwise comparisons were conducted. This analysis revealed that while there was no difference between ratings of valence for negative memories during the first session, the ratings of valence during the second session were higher for the remember and baseline conditions relative to both CFT conditions (all *p*s < .005; Figure 1(A)). This finding suggests that while in all conditions the ratings of valence for negative AM increased (i.e. became more positive) from the first to the third session, the increment was greater for the remember and baseline conditions relative to both upward and downward CFT conditions.

For positive memories, there was no main effect of Experiment, $F(1, 48) = 0.176$, $p = 0.68$, partial $\eta^2 = 0.004$. There were, however, main effects of Condition, $F(3, 47) = 3.68$, $p = 0.014$, partial $\eta^2 = 0.7$, and Session, $F(1, 49) = 12.53$, $p < .001$, partial $\eta^2 = 0.204$, qualified by a Condition by Session interaction, $F(3, 47) = 5.64$, $p = 0.001$, partial $\eta^2 = 0.103$. To clarify this interaction, Bonferroni-corrected pairwise comparisons were conducted. This analysis confirmed that while ratings of valence for positive AM decreased (i.e. became less positive) from the first to the last session in the upward, downward and baseline conditions (largest $p = 0.006$), they remained unchanged in the remember condition ($p = 0.708$; Figure 1(B)).

Arousal

For negative memories, there was no main effect of Experiment, $F(1, 48) = 2.90$, $p = 0.095$, partial $\eta^2 = 0.057$, and only a main effect of condition, $F(3, 47) = 4.779$, $p = 0.003$, partial $\eta^2 = 0.091$. Bonferroni-corrected pairwise comparisons revealed that arousal ratings in the upward CFT were higher than in the baseline condition ($p = 0.002$). Within-subject effects were not modeled jointly for positive memories because there was a main effect of Experiment, $F(1, 48) = 5.48$, $p = 0.023$, partial $\eta^2 = 0.103$.

Detail

For negative memories, there was no effect of Experiment, $F(1, 48) = 3.51$, $p = 0.067$, partial $\eta^2 = 0.068$. There were, however, main effects of Condition, $F(3, 47) = 3.389$, $p = 0.020$, partial $\eta^2 = 0.066$, and Session, $F(1, 49) = 18.952$, $p < .001$, partial $\eta^2 = 0.283$, qualified by a Condition by Session interaction, $F(3, 47) = 7.086$, $p < .001$, partial $\eta^2 = 0.129$. Follow-up Bonferroni-corrected pairwise comparisons indicated that ratings of detail in the upward CFT were greater than the baseline condition, ($p = 0.029$. Additionally, this analysis revealed an increase in ratings of detail from the first to the third session for the downward ($p < .001$), and remember, ($p < .001$), but not for the upward or baseline conditions (both *p*s > .05; Figure 1(C)). There were no effects for positive memories.[2]

General discussion

The current study compared how engaging in upward and downward episodic CFT for positive and negative AM modified phenomenological ratings of valence, arousal, detail, ease and reliving relative to attentively reactivating AM in non-imaginative contexts, or not

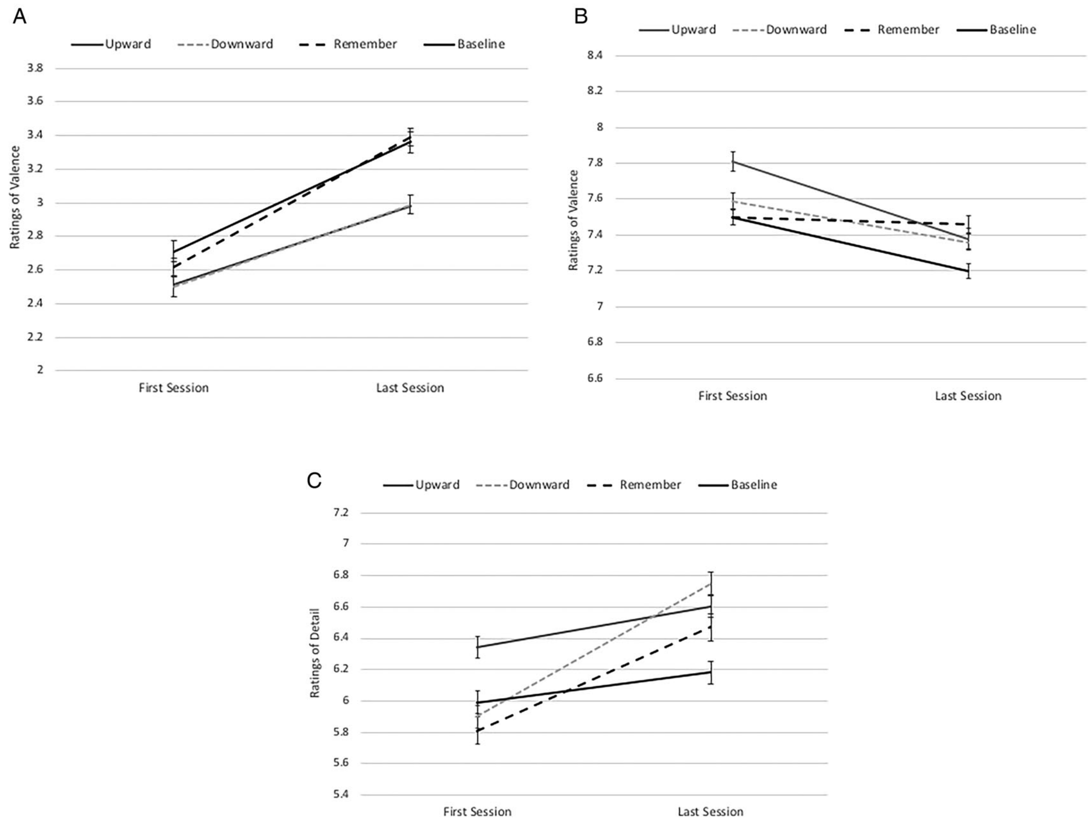

Figure 1. Results from Experiments 1 and 2 combined. (A) Effects for the ratings of valence for negative memories. The scale ranged from 1 (Negative) to 9 (Positive), thus lower values indicate more negative valence. (B) Effects for the ratings of valence for positive memories. Higher values indicate more positive valence. (C) Effects for the ratings of detail for negative memories. The scale ranged from 1 (Vague) to 9 (Clear), thus higher values indicate more detail. Error bars indicate SEM.

reactivating them at all. Five general hypotheses were explored. First, based upon previous evidence showing similarities between CFT and perspective-shift in AM (St. Jacques et al., 2018) as well as reactivation-related effects of perspective-shifts in AM (e.g. Butler et al., 2016; Sekiguchi & Nonaka, 2014; St. Jacques et al., 2017), we expected changes from the first to the last session for ratings of valence, arousal and detail in AM reactivated in the CFT conditions relative to those reactivated in the attentive remembering and baseline conditions. Second, based upon previous results showing increases in ease and reliving as a function of repetition for both CFT and AM (De Brigard, Szpunar, et al., 2013; Stanley, Stewart, et al., 2017), we expected ease and reliving to equally increase after reactivation for the attentive remembering and CFT conditions relative to baseline. Third, we hypothesised that the direction of this effect would differ between negative and positive memories depending on whether the original memory is reactivated in the context of an upward or a downward CFT. Fourth, based upon previous research on attentive retrieval and emotional reappraisal (Ochsner & Gross, 2005; Todd et al., 2012), we anticipated lasting down-regulation of both negative and positive AM in the attentive remembering condition without counterfactual modification relative to the condition with no reactivation. Finally, we expected minimal to no changes between the first and third sessions in the AM that were not reactivated in session 2.

Experiments 1 and 2 yielded four general findings. First, in Experiment 1, negative AM were rated as less negative during the last relative to the first session regardless of condition, with effect sizes larger for the remember and baseline relative to the CFT conditions. In Experiment 2, this reduction in negativity was significant only for the downward and remember conditions, with the latter showing the same large effect as in Experiment 1. When the results of Experiments 1 and 2 are analyzed together, it is clear that this reduction in negative valence for negative memories was greater for the remember and baseline conditions relative to both CFT conditions—although the effect size in the remember condition was much larger than in the baseline condition. Second, positive AM were rated as less positive in the last relative to the first session in all but the attentive remembering condition. This pattern of results was evident in Experiment 1 and also when results from Experiment 1 and 2 were analyzed together; however, it failed to reach significance in Experiment 2, suggesting that perhaps the absence of the memory test at the end of Experiment 2 reduced the size of the effect. Third, Experiments 1 and 2 showed a reduction of arousal ratings for positive—but not negative—AM from the first to the last session in the baseline and both CFT conditions; however, only in Experiment 2 was this effect evident for the remember condition. Finally, both Experiments 1 and 2—individually and analyzed together—showed that negative AM reactivated either in a downward CFT or in the attentive remembering conditions were rated as more detailed in the last relative to the first session. The impact of each finding for our hypotheses is discussed in turn.

First, although both studies revealed a reduction in negative valence for negative AM across all conditions, the reduction was larger for the conditions in which there was no CFT modification—that is, the remember and baseline conditions—and the effect size was much larger for the remember than the baseline condition. We interpret this finding in the context of recent research on attentive-bias and emotional up-regulation (Ochsner & Gross, 2005; Todd et al., 2012). According to this view, attentively focusing on particular details of emotional stimuli tends to modulate the affect associated with them. In the case of negative stimuli, attending to negative details of the stimulus tends to up-regulate (i.e. lessen the negativity of) the emotion with which it is appraised. Thus, actively focusing on specific details of negative memories—as participants were asked to do in the remember condition—may bias their attention toward salient aspects of their negative experiences, which in turn instigates emotional up-regulation. Indeed, it seems that a single reactivation of a negative AM a week later—as in the baseline condition—may suffice to bring about the effect, albeit the difference in effect sizes indicates that the attentive reactivation of AM during the second session was more effective. Therefore, this finding suggests that attentively reactivating a memory in a non-imaginative context may be a more successful emotional reappraisal strategy to up-regulate negative AM than reactivating them in a CFT context.

By contrast, we found a reduction in positive valence for positive AM from the first to the last session across all conditions except the remember condition. This result is consistent with numerous studies on fading affect bias, according to which emotional information associated with positive memories tends to fade slower than emotional information associated with negative memories (Walker, Skowronski, & Thompson, 2003; Walker & Skowronski, 2009). Additionally, in the current study the lack of decline in valence for positive AM from the first to the last session in the remember condition suggests that the act of attentively reactivating positive AM slows the rate of fading affect. Moreover, our results also suggest that not reactivating a memory, or reactivating it within the context of generating a counterfactual simulation, may increase the rate with which the associated affect fades. Taken together, the results of valence ratings for both negative and positive AM suggest a clear picture: attentive remembering is the best strategy to both reduce the negative affect associated with negative AM, and to prevent the decay of positive affect associated with positive AM.

Our third finding indicates that reactivation of AM affects arousal ratings differently than it does valence ratings. For one, we found no reduction of arousal for negative AM. By contrast, we found a reduction in arousal ratings from the first to the last session for positive AM regardless of condition in Experiment 2, suggesting that whether or not a positive memory is reactivated, and whether or not it is mentally modified in a counterfactual context, positive AM tend to become less arousing over time. However, it is important to note that this effect was not evident for the remember condition in Experiment 1, suggesting that either the repetitive reactivation or the elimination of the surprise memory test in session 3 may have boosted the reduction of arousal ratings in the last relative to the first session. Further studies would be needed to fully clarify why feelings of arousal associated with positive AM are influenced by reactivation.

The final result yielded by our studies—an increase in detail ratings from the first to the last session for negative AM reactivated either in a downward CFT or in the remember conditions—supports our hypothesis that increasing attention to negative AM-based simulations modulates the perceived detail with which such simulation is experienced at a later time. Moreover, the effect sizes were equivalent between these two conditions, and across both experiments, which further suggests that imagining how a negative event could have been worse can increase the level of detail with which an episodic memory is experienced to the same degree as focusing on a specific detail of such memory without mentally modifying it. The idea that negative valence is correlated with increased attention to detail has been consistently reported in the literature (Schwarz, 1990; Wegner & Vallacher, 1986). In turn, these attentional effects have been shown to have downstream consequences during remembering, as negative affect at retrieval has been associated with enhanced vividness and more detailed AM (Mickley & Kensinger, 2009). If so, then, the negative affect associated with reflecting upon a worse alternative to a bad event, or with attentively focusing on a detail of negative AM, is likely to increase the perceived detail with which such a mental simulation is experienced later on.

Taken together, our findings lend mixed support to some of our initial hypotheses. We found partial support for our first hypothesis, according to which there would be differential effects for valence, arousal and detail of AM reactivated in the context of CFT relative to attentive remembering and baseline. Our findings suggest differential effects of valence and detail, but not arousal. More precisely—and related to our third hypothesis—we found clear differences in the rate of change from the first to the last session in valence ratings for negative AM, with higher change for those reactivated in the Remember condition. Conversely, we found no difference in effect of session for valence ratings of positive AM when these were reactivated in either the CFT or the baseline condition. Likewise, ratings of detail increased for negative AM reactivated in the remember or the downward CFT, but there was no increase for the baseline and upward CFT conditions, or for positive AM.

Our results yielded no support for our second hypothesis—that ease and reliving would increase similarly in the CFT and remember conditions relative to the baseline condition. It is possible that this hypothesis was not supported in the current study because the AM provided by the participants had already been sufficiently rehearsed such that the experimental manipulation of reactivation in the lab did not affect base-rates of ease and reliving. Nevertheless, our results lend strong support to our fourth hypothesis, according to which attentive retrieval of emotional information modulates affective information for both negative and positive AM. As discussed, our findings suggest that this attentive-bias influences valence ratings differentially for negative and positive memories, and also when contrasted with AM reactivation in a CFT context. Finally, our fifth hypothesis—whereby we predicted no changes due to time in ratings made for AM in the baseline condition—was only supported for detail, ease and reliving. We did find changes in ratings of valence for negative AM and valence and arousal for positive AM in the baseline condition that, again, may be related to an expected fading affect bias.

It is important to mention two limitations of the current experimental design. First, despite having been randomly selected, we often found differences in ratings between conditions for both positive and negative AM. Given how difficult it is to generate usable emotional AM, equating them across all conditions for all ratings is challenging. Perhaps further studies looking at more specific subsets of emotional AM may be able to control for baseline differences to help to clarify the effects uncovered by our current studies. Second, and relatedly, an experimental design whereby AM are fully counterbalanced across participants may eliminate possible concerns derived from the randomisation strategy employed here, where possible carry-over effects from one trial to the next may have influenced our results—although the fact that many of our results were consistent across Experiments 1 and 2 assuages that concern.

Conclusion and future directions

When remembering AM, people often mentally modify the retrieved contents in different ways. One way is to think about alternative ways past personal events could have occurred, an autobiographically based mental simulation known as episodic CFT. The current study reports the results of two experiments comparing how engaging in upward or downward episodic CFT about positive and negative AM altered their phenomenological content relative to attentively reactivating AM with no CFT modification. It was found that negative AM that were reactivated in a CFT condition decreased their negative valence in the last relative to the first session less so than negative AM that were merely attentively remembered or not reactivated at all. Conversely, positive AM decreased their positive valence from the first to the last session in all conditions except during attentive remembering, where no change was registered. These results suggest that attentive remembering is the best strategy to reduce the negative affect associated with negative AM, and to preserve the positive affect associated with positive AM. Additionally, positive AM were experienced as less arousing during the last relative to the first session across all conditions. Finally, we also found that negative AM that were reactivated in either a downward CFT or merely attentively remembered were perceived with more detail during the last relative to the first session.

The current results contribute to a related line of research exploring phenomenological effects of shifting visual perspective during the retrieval of AM (Berntsen & Rubin, 2006; Butler et al., 2016; Robinson & Swanson, 1993; Vella & Moulds, 2014). For instance, Sekiguchi and Nonaka (2014) found that mentally shifting perspective from first- to third-person perspective during the second session reduced the reported emotional intensity a month later, relative to a condition in which no perspectival change was involved. More recently, St. Jacques et al. (2017) found that shifting visual perspective during retrieval of AM reduced ratings of emotional intensity relative to maintaining the same perspective. Taken together, these results suggest that mentally modifying certain aspects of AM at retrieval, such as visual perspective, reshapes the phenomenological experience with which AM are retrieved online and subsequently remembered. Given recent results indicating strong commonalities between neural structures engaged during episodic CFT and perspective shift in AM (St. Jacques et al., 2018), a fruitful avenue for future research would be to compare long-term changes in AM as a result of either engaging in episodic CFT or shifting perspective.

Finally, and perhaps more importantly, our results contribute to the growing literature on the long-lasting effects of mental modifications on AM (Butler et al., 2016; Sekiguchi & Nonaka, 2014; St. Jacques et al., 2017). Moreover, we also hope they help to evaluate the effectiveness of employing episodic CFT during memory reactivation as an emotion regulation strategy to mollify positive and negative aspects of AM, both in experimental as well as clinical settings (De Brigard & Hanna, 2015). For instance, our results clearly indicate that reactivating negative AM in counterfactual contexts, such as regret-producing upward CFT, does not decrease the negative affect associated with the memory experience, whereas simply reactivating the memory without imaginative modifications does. Given our unfortunate tendency to generate regret producing upward CFT when remembering negative AM (Summerville & Roese, 2008), it may be advisable then to re-orient one's attention toward details of the actual event while avoiding mental modifications. For therapeutic purposes it may be best to prevent regret inducing CFT that get in the way of memory's natural tendency to up-regulate negative emotions during attentive AM reactivation. Somewhat paradoxically, the best strategy to let the negative emotion fade may be to remember it.

Notes

1. Although we did not have a prior hypothesis as to whether or not these results would depend upon correctly remembering having reactivated the memory in the context of a CFT, we decided to conduct a second analysis, following the same logic as the analysis above, but including only correctly remembered trials. However, the pattern of results was essentially the same. We include these analyses and results in Supplementary Information.
2. For completeness, we are including the analyses of Ease and Reliving across both Experiments in Supplementary Information.

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References

Akhtar, S., Justice, L. V., Loveday, C., & Conway, M. A. (2017). Switching memory perspective. *Consciousness & Cognition*, *56*, 50–57.

Allen, M. S., Greenlees, I., & Jones, M. V. (2014). Personality, counterfactual thinking, and negative emotional reactivity. *Psychology of Sport and Exercise*, *15*, 147–154.

Berntsen, D., & Rubin, D. C. (2006). Emotion and vantage point in autobiographical memory. *Cognition & Emotion*, *20*, 1193–1215.

Butler, A. C., Rice, H. J., Wooldridge, C. L., & Rubin, D. C. (2016). Visual imagery in autobiographical memory: The role of repeated retrieval in shifting perspective. *Consciousness and Cognition*, *42*, 237–253.

De Brigard, F., Addis, D. R., Ford, J. H., Schacter, D. L., & Giovanello, K. S. (2013). Remembering what could have happened: Neural correlates of episodic counterfactual thinking. *Neuropsychologia*, *51*, 2401–2414.

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.

De Brigard, F., & Hanna, E. (2015). Clinical applications of counterfactual thinking during memory reactivation. *Behavioral and Brain Sciences*, *38*, 22–23.

De Brigard, F., Parikh, N., Stewart, G. W., Szpunar, K. K., & Schacter, D. L. (2017). Neural activity associated with repetitive simulation of episodic counterfactual thoughts. *Neuropsychologia*, *106*, 123–132.

De Brigard, F., Spreng, R. N., Mitchell, J. P., & Schacter, D. L. (2015). Neural activity associated with self, other, and object-based counterfactual thinking. *NeuroImage*, *109*, 12–26.

De Brigard, F., Szpunar, K. K., & Schacter, D. L. (2013). Coming to grips with the past: Effect of repeated simulation on the perceived plausibility of episodic counterfactual thoughts. *Psychological Science*, *24*, 1329–1334.

Finn, B., & Roediger, H. L. (2011). Enhancing retention through reconsolidation: Negative emotional arousal following retrieval enhances later recall. *Psychological Science*, *22*(6), 781–786.

Forcato, C., Rodriguez, M. L., Pedreira, M. E., & Maldonado, H. (2010). Reconsolidation in humans opens up declarative memory to the entrance of new information. *Neurobiology of Learning and Memory*, *93*(1), 77–84.

Gerlach, K. D., Dornblaser, D. W., & Schacter, D. L. (2014). Adaptive constructive processes and memory accuracy: Consequences of counterfactual simulations in young and older adults. *Memory*, *22*, 145–162.

Gilovich, T., & Medvec, V. H. (1995). The experience of regret: What, when, and why. *Psychological Review*, *102*, 379–395.

Hupbach, A., Gomez, R., Hardt, O., & Nadel, L. (2007). Reconsolidation of episodic memories: A subtle reminder triggers integration of new information. *Learning & Memory*, *14*, 47–53.

Kahneman, D., & Miller, D. T. (1986). Norm theory: Comparing reality to its alternatives. *Psychological Review*, *93*, 136–153.

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

McMullen, M. N., & Markman, K. D. (2000). Downward counterfactuals and motivation: The “wake-up call” and the “Pangloss” effect. *Personality and Social Psychology Bulletin*, *26*, 575–584.

Mickley, K. R., & Kensinger, E. A. (2009). Phenomenological characteristics of emotional memories in younger and older adults. *Memory*, *17*, 528–543.

Nigro, G., & Neisser, U. (1983). Point of view in personal memories. *Cognitive Psychology*, *15*, 467–482.

Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Sciences*, *9*(5), 242–249.

Rim, S., & Summerville, A. (2014). How far to the road not taken? The effect of psychological distance on counterfactual direction. *Personality and Social Psychology Bulletin*, *40*, 391–401.

Robinson, J. A., & Swanson, K. L. (1993). Field and observer modes of remembering. *Memory*, *1*, 169–184.

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

Roese, N. J. (1997). Counterfactual thinking. *Psychological Bulletin*, *121*, 133–148.

Roese, N. J. (1999). Counterfactual thinking and decision making. *Psychonomic Bulletin and Review*, *6*, 570–578.

Roese, N. J., & Epstude, K. (2017). The functional theory of counterfactual thinking: New evidence, new challenges, new insights. *Advances in Experimental Social Psychology*, *56*, 1–79.

Schacter, D. L. (1996). Illusory memories: A cognitive neuroscience analysis. *Proceedings of the National Academy of Sciences*, *93*, 13527–13533.

Schacter, D. L., & Addis, D. R. (2007). The cognitive neuroscience of constructive memory: Remembering the past and imagining the future. *Philosophical Transactions of the Royal Society (B)*, *362*, 773–786.

Schacter, D. L., Benoit, R., De Brigard, F., & Szpunar, K. K. (2015). Episodic future thinking and episodic counterfactual thinking: Intersections between memory and decisions. *Neurobiology of Learning and Memory*, *117*, 14–21.

Schwabe, L., & Wolf, O. T. (2010). Stress impairs the reconsolidation of autobiographical memories. *Neurobiology of Learning and Memory*, *94*, 153–157.

Schwarz, N. (1990). Feelings as information: Informational and motivational functions of affective states. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Vol. 2, pp. 527–561). New York, NY: Guilford Press.

Sekiguchi, T., & Nonaka, S. (2014). The long-term effect of perspective change on the emotional intensity of autobiographical memories. *Cognition and Emotion*, *28*, 375–383.

Stanley, M. L., Parikh, N., Stewart, G. W., & De Brigard, F. (2017). Emotional intensity in autobiographical memory and counterfactual thinking. *Consciousness and Cognition*, *48*, 283–291.

Stanley, M. L., Stewart, G. W., & De Brigard, F. (2017). Counterfactual plausibility and comparative similarity. *Cognitive Science*, *41*(Suppl. 5), 1216–1228.

St. Jacques, P. L., Carpenter, A. C., Szpunar, K. K., & Schacter, D. L. (2018). Remembering and imagining alternative versions of the personal past. *Neuropsychologia*, *110*, 170–179.

St. Jacques, P. L., Montgomery, D., & Schacter, D. L. (2015). Modifying memory for a museum tour in older adults: Reactivation-related updating that enhances and distorts memory is reduced in aging. *Memory*, *23*(6), 876–887.

St. Jacques, P. L., & Schacter, D. L. (2013). Modifying memory: Selectively enhancing and updating personal memories for a museum tour by reactivating them. *Psychological Science*, *24*, 537–543.

St. Jacques, P. L., Szpunar, K. K., & Schacter, D. L. (2017). Shifting visual perspective during retrieval shapes autobiographical memories. *NeuroImage*, *148*, 103–114.

Summerville, A., & Roese, N. J. (2008). Dare to compare: Fact-based versus simulationbased comparison in daily life. *Journal of Experimental Social Psychology*, *44*, 664–671.

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*, *142*, 323–327.

Todd, R. M., Cunningham, W. A., Anderson, A. K., & Thomson, E. (2012). Affect-biased attention as emotion regulation. *Trends in Cognitive Sciences*, *16*(7), 365–372.

Van Hoeck, N., Ma, N., Ampe, L., Baetens, K., Vandekerckhove, M., & Van Overwalle, F. (2013). Counterfactual thinking: An fMRI study on changing the past for a better future. *Social Cognitive and Affective Neuroscience*, *8*, 556–564.

Vella, N. C., & Moulds, M. L. (2014). The impact of shifting vantage perspective when recalling and imagining positive events. *Memory*, *22*, 256–264.

Walker, W. R., & Skowronski, J. J. (2009). The fading affect bias: But what the hell is it for? *Applied Cognitive Psychology*, *23*, 1122–1136.

Walker, W. R., Skowronski, J. J., & Thompson, C. P. (2003). Life is pleasant – and memory helps to keep it that way! *Review of General Psychology*, *7*, 203–210.

Wegner, D. M., & Vallacher, R. R. (1986). Action identification. In R. M. Sorrentino, & E. T. Higgins (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (pp. 550–582). New York, NY: Guilford.

White, K., & Lehman, D. R. (2005). Looking on the bright side: Downward counterfactual thinking in response to negative life events. *Personality and Social Psychology Bulletin*, *31*(10), 1413–1424.