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Emotional intensity in episodic autobiographical memory and counterfactual thinking

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ABSTRACT

Episodic counterfactual thoughts—imagined alternative ways in which personal past events might have occurred—are frequently accompanied by intense emotions. Here, participants recollected positive and negative autobiographical memories and then generated better and worse episodic counterfactual events from those memories. Our results suggest that the projected emotional intensity during the simulated remembered/imagined event is significantly higher than but typically positively related to the emotional intensity while remembering/imagining the event. Furthermore, repeatedly simulating counterfactual events heightened the emotional intensity felt while simulating the counterfactual event. Finally, for both the emotional intensity accompanying the experience of remembering/imagining and the projected emotional intensity during the simulated remembered/imagined event, the emotional intensity of negative memories was greater than the emotional intensity of upward counterfactuals generated from them but lower than the emotional intensity of downward counterfactuals generated from them. These findings are discussed in relation to clinical work and functional theories of counterfactual thinking.

1. Introduction

Imagining alternative ways in which personal past events might have occurred is a kind of hypothetical thinking known as *episodic counterfactual thought* (De Brigard & Giovanello, 2012). Frequently, when individuals engage in counterfactual thinking, they imagine either alternative better ("upward") or worse ("downward") ways in which past events might have occurred, and often these kinds of mental simulations are accompanied by intense emotions (Byrne, 2016; Epstude & Roese, 2008). Although several published studies have examined the nature of episodic counterfactual thoughts generated from autobiographical memories (e.g., De Brigard & Giovanello, 2012; Dyczewski & Markman, 2012; Nasco & Marsh, 1999; Petrocelli, Seta, Seta, & Prince, 2012; Roese, 1994), the majority of published work on counterfactual thinking has largely utilized vignettes depicting hypothetical scenarios with little autobiographical relevance. Recent studies have raised reservations about the relevance of results from studies using impersonal and non-autobiographical vignettes to results from studies investigating episodic counterfactual simulations about one's own life (De Brigard & Giovanello, 2012; Girotto, Ferrante, Pighin, & Gonzalez, 2007; Pighin, Byrne, Ferrante, Gonzalez, & Girotto, 2011; De Brigard, Spreng, Mitchell, & Schacter, 2015). Furthermore, while intense emotional experiences are highly influential in shaping how we remember auto-

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biographical events from the personal past (Barlow, 1955; Talarico, LaBar, & Rubin, 2004), little is known about the emotional intensity of episodic counterfactual simulations generated from autobiographical memories.

There are two ways of thinking about emotional intensity for both autobiographical memories and their corresponding episodic counterfactual events. One refers to the emotional intensity at the time of simulating the event—a feature of the experienc*ing*—while the other refers to the emotional intensity ascribed to the simulated event—a feature of the experienc*ed* (Johnson, Foley, Suengas, & Raye, 1988). For example, suppose someone recalls a rather negative experience of being stuck in rush hour traffic a few months ago. He remembers having experienc*ed* intense negative emotions while he was stuck in traffic, but he is not currently experienc*ing* nearly the same intensity of emotion while remembering the event. This is not to suggest, however, that these two ways of thinking about emotional intensity are unrelated. When we remember events from the personal past, the projected emotional experience accompanying the originally experienced event colors the current experiencing, and vice versa (Holland & Kensinger, 2010; Levine & Pizarro, 2004).

But now suppose that after recalling the negative experience of being stuck in traffic, this person simulates a counterfactual event wherein he left work early that day and avoided rush hour traffic altogether. He might imagine that, had he left earlier, he would have experienc*ed* a positive emotion with a certain degree of intensity. However, his current experienc*ing* of the simulation is not accompanied by nearly the same intensity of emotion. What precisely is the relationship between the projected, imagined emotion and the current one? Recent evidence suggests that there is a common set of mechanisms that allows us to remember events from the personal past and also to construct episodic counterfactual thoughts (De Brigard, 2014; Schacter, Benoit, De Brigard, & Szpunar, 2015; Van Hoeck et al., 2013). As such, just as the projected emotional intensity during the remembered event might be related to the emotional intensity accompanying the experience of recalling the autobiographical memory, so too might the projected emotional intensity during the simulated imagined event be related to the experience while imagining the event.

Furthermore, while counterfactual simulations are often emotionally charged, little is known about the affective consequences of repeatedly simulating episodic counterfactual events. Some clinical and sub-clinical evidence suggests that rumination on counterfactual thoughts is associated with emotional dysfunction, impaired coping with traumatic events, and insomnia (Davis, Lehman, Wortman, Silver, & Thompson, 1995; El Leithy, Brown, & Robbins, 2006; Gilbar, Plivazky, & Gil, 2010; Schmidt & Van der Linden, 2009). Simulations of episodic personal *future* events in healthy individuals are also often emotionally charged (D'Argembeau, Renaud, & Van der Linden, 2011), and recent work has demonstrated that repeatedly simulating episodic future events heightens emotional arousal (Szpunar & Schacter, 2013). Considerable evidence has shown that episodic future thinking and episodic counterfactual thinking exhibit striking behavioral and neural similarities (Schacter et al., 2015). A set of common mechanisms allows us to remember events from the personal past, construct thoughts about possible events that could happen in the personal future, and also construct thoughts about possible events that could have happened in our past but did not (De Brigard, 2014). Given these cognitive and neural commonalities between episodic future and counterfactual thinking, it is possible that repeatedly simulating episodic counterfactual thoughts will also heighten emotional intensity accompanying the simulation. Alternatively, it is possible that repeated simulation of counterfactual events will produce an emotional habituation effect whereby repeated exposure to an emotionally salient stimulus reduces the accompanying emotional intensity (Averill, Malmstrom, Koriat, & Lazarus, 1972; Groves & Thompson, 1970).

We investigate three main questions of interest in the current study. First, for autobiographical memories and episodic counterfactual simulations taken separately, we investigate the relationship between the emotional intensity of the experience while recalling/imagining the event and the projected emotional intensity during the simulated remembered/imagined event. We hypothesize that the projected emotional intensity that was experienced or would have been experienced during the simulated remembered/imagined event will be greater than but positively correlated with the emotional intensity while recalling/imagining the event.

Second, we investigate whether repeated simulation impacts the reported emotional intensity of episodic counterfactual simulations and whether this is dependent on counterfactual direction or the valence of the memory from which the counterfactual was generated. The current study aims to adjudicate between two possible outcomes: (1) mirroring results from prior work on episodic future thinking (Szpunar & Schacter, 2013), repeated simulation of emotional counterfactual events will heighten emotional intensity; or (2) repeated simulation of episodic counterfactual events will produce an emotional habituation effect that reduces emotional intensity. Furthermore, we hypothesize that this heightening or reduction in emotional intensity with repeated simulation will only occur for emotional intensity during the imagining of the event and not for the emotional intensity participants imagined they would have experienced during the event had it occurred.

Third, we investigate the relationship between the emotional intensity of autobiographical episodic memories and their corresponding counterfactual events. De Brigard and Giovanello (2012) showed that recollecting memories tended to be felt more intensely than simulating episodic counterfactuals. However, De Brigard and Giovanello (2012) only asked participants to generate opposite direction counterfactuals (i.e., worse alternative to a positive event or a better alternative to a negative event) and not same direction counterfactuals (i.e., better alternative to an already positive event or a worse alternative to an already negative event). Extending work from De Brigard and Giovanello (2012), we hypothesize that the emotional intensity during the remembered event itself will be lower than emotional intensity participants imagined they would have experienced during the event for same direction counterfactuals. Same direction counterfactuals should have more extreme valence ratings which should, in turn, be associated with more intense emotional responses. Similarly, we hypothesize that emotional intensity presently recalling the memory will be lower than emotional intensity simulating the corresponding

counterfactual for same direction counterfactuals. Our hypotheses accompanying this third question are further supported by the Reflection and Evaluation Model (REM; Markman & McMullen, 2003). The REM posits that reflective processing prompts assimilation effects where the simulated counterfactual becomes a reinterpretation or reappraisal of reality, momentarily treated as if it were true. Under reflective processing, more positive affect results from upward counterfactual simulation, whereas more negative affect results from downward counterfactual simulation. In the present study, participants simulate counterfactual events and rate the emotional qualities associated with the counterfactual events themselves, which should facilitate a reflective processing mode.

2. Methods

2.1. Participants

Thirty-three individuals participated in all sessions of the study (M_{age} = 23.29, SD = 2.99; 20 females). Written informed consent was obtained from each participant in accordance with protocol approved by the Duke University Campus Institutional Review Board.

2.2. Materials and procedure

The experimental paradigm employed in the current study (see Fig. 1) was adapted from De Brigard, Szpunar, and Schacter (2013) and Szpunar and Schacter (2013). This study consisted of three sessions. In session 1, participants visited the laboratory to generate 33 negative and 33 positive autobiographical memories of specific events that they had personally experienced within the past five years. Participants were asked to be as specific as possible and to avoid events that blend into other similar events. For each memory, participants typed a short description of the remembered event (2–4 sentences), the location where the event took place, and a brief title for the memory. Participants were told that the brief title and location needed to be specific enough such that they would be able to recollect that same exact memory in session 2 if cued with those two pieces of information. From the Autobiographical Memory Questionnaire (Johnson et al., 1988), participants were asked to provide ratings for emotional intensity during the remembered event itself (1 = *not intense*, 7 = *very intense*) and emotional intensity while recollecting (1 = *not intense*, 7 = *very intense*) for each memory.

One week later, participants returned to the lab for an episodic counterfactual simulation session. Participants were told that they would be engaging in two different kinds of counterfactual simulations—better (upward) and worse (downward) counterfactual alternatives to their actual memories—and that each simulation would be prompted by a display on a computer monitor. When the heading on the screen was "Better," they would be presented with the brief title and location of a memory from the first session, and they would be asked to imagine a better way in which the cued memory could have occurred. When the heading on the screen was "Worse," they would be presented with the brief title and location of a memory from the first session, and they would be asked to imagine a worse way in which the cued memory could have occurred. Half of the cued memories were negative, and the other half were positive, evenly split across the two conditions. Exactly one counterfactual was generated for each individual memory. Participants were allotted 12.5 s to simulate each episodic counterfactual event. After each imagining, they were prompted to write a short new title for the simulated counterfactual event. To ensure that participants understood all instructions, we conducted two practice trials in which participants simulated one downward and one upward episodic counterfactual event randomly chosen from the set of memories provided during session 1. Materials were presented with E-Prime software (Psychology Software Tools, Pittsburgh, PA), and participants used a keyboard to type the titles for the simulated counterfactual events.

The third and final session took place 1 day later, and it consisted of two parts. In the first part, participants were asked to re-simulate the counterfactuals that they had generated during the second session. For each participant, eight upward counterfactuals generated from positive memories, 8 downward counterfactuals generated from positive memories, 8 upward counterfactuals generated from negative memories, and 8 downward counterfactuals generated from negative memories were randomly chosen from the full set of 64 counterfactual events to be simulated three times each distributed randomly throughout the session. For each individual stimulus display, participants were given the brief title of the original memory provided during session 1, the location of the original memory provided during session 1, and the title for the counterfactual event provided during session 2. Participants were given 12.5 s to re-simulate each counterfactual event. Participants were explicitly asked to re-simulate the very same counterfactuals they had generated the day before.

Next, participants had a 10-min break, during which they engaged in a distraction task (Sudoku) to minimize rehearsal of recently simulated counterfactual events. Then, in the second part of the session, participants re-simulated each of the 64 counterfactuals exactly once. After each individual counterfactual event was re-simulated, participants provided phenomenological ratings for each counterfactual, according to their valence (1 = *very negative*, 7 = *very positive*), emotional intensity participants imagined they would have experienced during the event had it occurred (1 = *not intense*, 7 = *very intense*) and emotional intensity while imagining the counterfactual event (1 = *not intense*, 7 = *very intense*). The order of these phenomenological ratings was random. Participants were told that the main task was to determine whether or not they had simulated each counterfactual earlier that day. Post-experimental interviews indicated that the recognition test

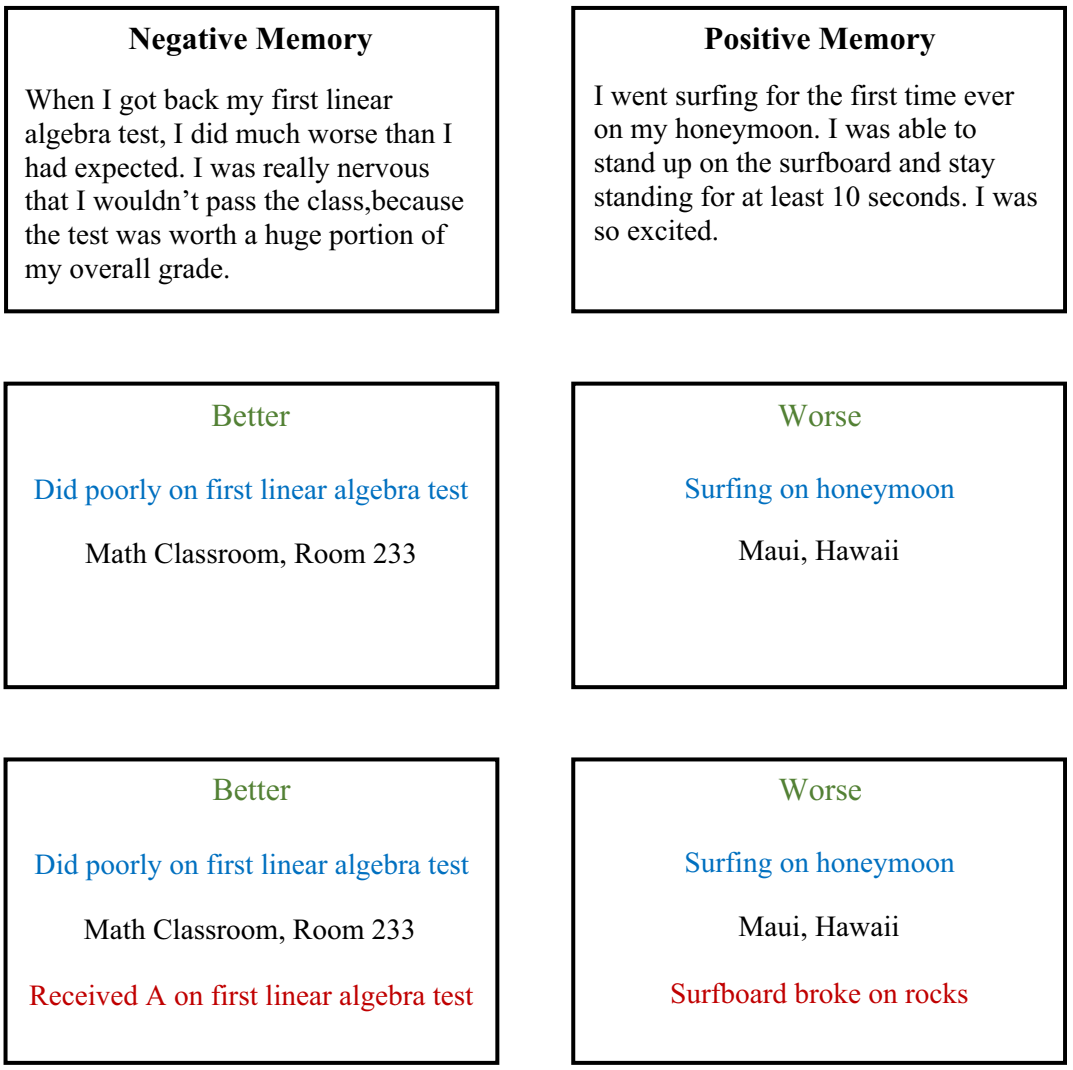

Fig. 1. Examples of autobiographical memories reported in Session 1 and the corresponding stimulus displays and counterfactual generations from the following sessions. The top row shows examples of negative and positive autobiographical memories. The second row shows the stimulus displays used to prompt the generation of upward ("Better") and downward ("Worse") counterfactual simulations for these events. During Session 2, participants saw the brief title (shown in blue) of each memory on separate displays, the location where it took place, and a header on the screen (shown in green) indicating the direction of the counterfactual. Participants generated upward and downward counterfactuals for both positive and negative memories. The third row illustrates examples of counterfactuals generated by participants that were then re-presented to them during Session 3; in each case, the new title given to the counterfactual event is shown in red. Before making phenomenological ratings in the third session, half of the generated counterfactuals were re-simulated four times while the other half were re-simulated only once. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

(hit rate = 0.99) masked the real purpose of the study. At the end, participants were debriefed and monetarily compensated for their time.

3. Results

After removing all responses faster than 200 ms and taking into account the number of missing responses for each participant, an average of 58.48 (SD = 4.20) memories (and corresponding counterfactuals) were retained per participant for all analyses herein. Because each memory and corresponding counterfactual simulation does not represent a truly independent event, autobiographical memories and their corresponding episodic counterfactuals were aggregated via averaging to obtain a single value for each cell within each participant (e.g., repeated, upward counterfactuals generated from negative memories) for each of the self-reported measures.

3.1. Memories

Emotional intensity during the remembered event was significantly higher for negative ($M = 5.60$, $SD = 0.81$) than positive ($M = 5.15$, $SD = 0.94$) memories ($t(262) = 4.16$, $p < 0.001$, Cohen's d = 0.51). However, there were no significant differences in emotional intensity when remembering negative ($M = 3.65$, $SD = 1.17$) and positive ($M = 3.77$, $SD = 1.25$) memories ($p > 0.44$).

For positive memories, emotional intensity during the remembered event and emotional intensity when remembering were positively correlated ($r(130) = 0.70$, $p < 0.001$), and ratings of emotional intensity during the remembered event were significantly higher than those of emotional intensity when remembering ($t(131) = 17.67$, $p < 0.001$, Cohen's d = 1.68). Similarly, for negative memories, emotional intensity during the remembered event and emotional intensity when remembering were significantly correlated ($r(130) = 0.58$, $p < 0.001$), and ratings of emotional intensity during the remembered event were significantly higher than those of emotional intensity when remembering ($t(131) = 23.08$, $p < 0.001$, Cohen's d = 2.61).

3.2. Counterfactual simulations

Table 1 presents mean phenomenological ratings of valence and emotional intensity for counterfactual simulations split by memory valence from which counterfactual events were generated and counterfactual direction, all as a function of counterfactual repetition. Regardless of counterfactual direction, repetition, or the valence of the memory from which the counterfactual was generated, the projected emotional intensity participants thought they would have experienced during the alternative event had it occurred were significantly higher than the emotional intensity felt while imagining the counterfactual event (smallest $t(32) = 5.97$, $p < 0.001$, Cohen's d = 1.27). Before correction for multiple comparisons, the projected emotional intensity participants thought they would have experienced during the alternative event had it occurred, was significantly and positively correlated with the emotional intensity felt while imagining the counterfactual event for repeated, upward counterfactuals generated from negative memories ($r(31) = 0.49$, $p = 0.004$), non-repeated, upward counterfactuals generated from negative memories ($r(31) = 0.46$, $p = 0.007$), and non-repeated, upward counterfactuals generated from positive memories ($r(31) = 0.61$, $p < 0.001$), non-repeated, downward counterfactuals generated from positive memories ($r(31) = 0.36$, $p = 0.038$), and repeated, upward counterfactuals generated from positive memories ($r(31) = 0.44$, $p = 0.010$). However, after Bonferroni correction for multiple comparisons, only the results for repeated upward counterfactuals generated from negative memories and non-repeated, upward counterfactuals generated from positive memories remained significant. No other correlations yielded significant results.

An initial three-way ANOVA testing the effect of memory valence, counterfactual direction, and repetition on counterfactual valence revealed a significant main effect of counterfactual direction ($F(1, 256) = 2300.97$, $p < 0.001$, $\eta_p^2 = 0.900$), such that downward counterfactuals ($M = 1.89$, $SD = 0.61$) were rated as more negative (or less positive) than upward counterfactuals ($M = 5.75$, $SD = 0.80$). There was also a significant main effect of memory valence ($F(1, 256) = 49.35$, $p < 0.001$, $\eta_p^2 = 0.162$), such that counterfactuals generated from positive memories ($M = 4.10$, $SD = 2.11$) also tended to be more positive while counterfactuals generated from negative memories ($M = 3.53$, $SD = 1.97$) also tended to be more negative. There was no significant effect of repetition on counterfactual valence ($F(1, 256) = 0.54$, $p > 0.46$, $\eta_p^2 = 0.002$).

A second three-way ANOVA testing the effect of memory valence, counterfactual direction and repetition on emotional intensity while simulating the event revealed a significant main effect of repetition ($F(1, 256) = 4.22$, $p = 0.041$, $\eta_p^2 = 0.016$), such that repeated counterfactuals ($M = 3.78$, $SD = 1.21$) were rated as more emotionally intense than non-repeated counterfactuals ($M = 3.48$, $SD = 1.20$), and also a significant interaction between memory valence and counterfactual direction ($F(1, 256) = 11.19$, $p = 0.001$, $\eta_p^2 = 0.042$). To further investigate this interaction, we computed a two-way ANOVA and tests of simple main effects, collapsing across repetition, to test the effect of memory valence and counterfactual direction on emotional intensity that the participant is experiencing while simulating the event. Same direction counterfactual simulations (i.e., better alternative to an already positive memory or a worse alternative to an already negative memory)

Table 1
Mean phenomenological ratings of valence and emotional intensity for counterfactual simulations are presented and split by the valence of the memory from which counterfactual were generated and counterfactual direction, all as a function of counterfactual repetition.

Rating	Positive memory		Negative memory	
	Upward	Downward	Upward	Downward
Valence of imagined event				
Four Times	6.24 (0.55)	2.08 (0.60)	5.38 (0.91)	1.70 (0.55)
One Time	6.00 (0.59)	2.09 (0.67)	5.38 (0.75)	1.69 (0.50)
Intensity while imagining the event				
Four Times	3.88 (1.26)	3.47 (1.18)	3.59 (1.07)	4.15 (1.24)
One Time	3.67 (1.20)	3.23 (1.15)	3.23 (1.13)	3.77 (1.25)
Intensity of imagined event				
Four Times	5.46 (0.77)	4.91 (1.12)	5.00 (0.75)	5.79 (0.82)
One Time	5.28 (0.78)	4.88 (1.01)	4.80 (0.89)	5.63 (0.87)

were more emotionally intense than opposite direction counterfactual simulations (i.e., worse alternative to a positive memory or a better alternative to a negative memory). More specifically, downward counterfactuals generated from negative memories were rated as more emotionally intense than upward counterfactuals generated from negative memories ($t(130) = 2.68$, $p = 0.008$, Cohen's d = 0.47; Table 1), and downward counterfactuals generated from positive memories were rated as less emotionally intense than upward counterfactuals generated from positive memories ($t(130) = 2.05$, $p = 0.042$, Cohen's d = 0.36; Table 1).

A final three-way ANOVA testing the effect of memory valence, counterfactual direction and repetition on emotional intensity participants imagined they would have experienced during the counterfactual scenario revealed only a significant interaction between counterfactual direction and memory valence ($F(1, 256) = 35.04$, $p < 0.001$, $\eta_p^2 = 0.120$). To further investigate this interaction, we computed a two-way ANOVA and tests of simple main effects collapsing across repetition to test the effect of memory valence and counterfactual direction on emotional intensity participants imagined they would have experienced during the event. Same direction counterfactual simulations were more emotionally intense than opposite direction counterfactual simulations. More specifically, downward counterfactuals generated from negative memories were rated as more emotionally intense than upward counterfactuals generated from positive memories ($t(130) = 5.63$, $p < 0.001$, Cohen's d = 0.98; Table 1), and downward counterfactuals generated from positive memories were rated as less emotionally intense than upward counterfactuals generated from positive memories ($t(130) = 2.94$, $p = 0.004$, Cohen's d = 0.52; Table 1). There was no significant effect of repetition on emotional intensity participants imagined they would have experienced during the counterfactual scenario ($F(1, 256) = 1.65$, $p > 0.20$, $\eta_p^2 = 0.006$).

3.3. Relationship between memories and counterfactual thoughts

Planned comparisons revealed that the projected emotional intensity during the remembered event was significantly lower than the emotional intensity participants imagined they would have experienced during the corresponding counterfactual event had it occurred for downward counterfactuals generated from negative memories ($t(65) = 2.06$, $p = 0.043$, Cohen's d = 0.27) but higher for upward counterfactuals generated from negative memories ($t(65) = 9.42$, $p < 0.001$, Cohen's d = 1.03). There was no significant difference in emotional intensity during the remembered event and emotional intensity participants imagined they would have experienced during the corresponding counterfactual event for downward counterfactuals generated from positive memories ($t(65) = 0.60$, $p > 0.55$) or upward counterfactuals generated from positive memories ($t(65) = 0.66$, $p > 0.51$).

Planned comparisons also revealed that the emotional intensity while recalling the memory was significantly lower than emotional intensity while simulating the corresponding counterfactual event for downward counterfactuals generated from negative memories ($t(65) = 2.81$, $p = 0.007$, Cohen's d = 0.35), but higher for upward counterfactuals generated from negative memories ($t(65) = 2.50$, $p = 0.015$, Cohen's d = 0.31). There was no significant difference in emotional intensity when remembering and emotional intensity while imagining the corresponding counterfactual event for downward counterfactuals generated from positive memories ($t(65) = 1.68$, $p = 0.10$) or upward counterfactuals generated from positive memories ($t(65) = 1.01$, $p > 0.31$).

4. Discussion

This study on affective properties of autobiographical memories and episodic counterfactual simulations yielded three main findings. First, for both positive and negative autobiographical memories, ratings of emotional intensity during the remembered event were significantly higher than but positively correlated with those of emotional intensity while remembering. And regardless of counterfactual direction, repeated simulation, or the valence of the memory from which the episodic counterfactual was generated, the emotional intensity participants thought they would have experienced during the simulated event had it occurred was significantly higher than the emotional intensity felt while imagining the counterfactual event. Second, repeatedly simulating counterfactual events heightened the emotional intensity felt while simulating the counterfactual event but did *not* alter the emotional intensity participants believed they would have experienced during the alternative scenario had it occurred as imagined. Third, for both the emotional intensity accompanying the experience of remembering/imagining the event and the projected emotional intensity during the simulated remembered/imagined event, the emotional intensity of negative memories was greater than the emotional intensity of the upward counterfactuals generated from them but lower than the emotional intensity of downward counterfactuals generated from them. Unexpectedly, however, the emotional intensity of positive memories was effectively the same as the emotional intensity of the counterfactuals generated from them.

It is worth considering these results from the perspective of Markman and McMullen's (2003) REM. The REM differentiates two psychologically distinct modes of mental simulation thought to operate in parallel: reflection and evaluation. Reflective processing prompts assimilation effects where the simulated counterfactual becomes a reinterpretation or reappraisal of reality, momentarily treated as if it were true; in contrast, evaluative processing produces contrast effects where the *comparison* of the actual event to the counterfactual event elicits certain affective responses. The REM posits that positive affect results from upward reflection and downward evaluation, whereas negative affect results from upward evaluation and downward reflection. Given that (1) same direction counterfactual simulations tended to be more extreme in valence and

emotional intensity compared to opposite direction counterfactual simulations (Table 1) as well as (2) the fact that participants were asked to simulate the episodic counterfactual event and provide ratings for the phenomenological qualities of the simulation only, our pattern of results suggests that participants did, in fact, take a reflective stance bringing about affect assimilation.

It is critical to distinguish how our effects ascertained under reflective processing might differ in contexts where evaluative processing occurs. As mentioned, during evaluative processing the *comparison* between actual and counterfactual events elicits particular emotional responses. Prior work has shown that upward counterfactuals generated under evaluative processing tend to elicit feelings of regret, shame, guilt, disappointment and remorse that can severely reduce well-being, especially if they persist over time (Davis et al., 1995; Epstude & Jonas, 2015; Mandel, 2003; Niedenthal, Tangney, & Gavanski, 1994). In contrast, downward counterfactuals generated under evaluative processing tend to elicit feelings of contentment, satisfaction, and relief (Mandel, 2003; Markman & McMullen, 2003; Epstude & Roese, 2008). Because the emotions elicited during upward counterfactual thinking tend to be less emotionally intense than the emotions elicited during downward counterfactual thinking (Reisenzein, 1994), it is possible that there would be asymmetries in emotional intensity during evaluative processing as a function of counterfactual direction. Furthermore, because upward counterfactuals elicit emotions with negative valence and downward counterfactuals elicit emotions with positive valence under evaluative processing, it is likely that there would be a main effect of counterfactual direction on counterfactual valence during evaluative processing such that upward counterfactuals elicit more negative affect while downward counterfactuals elicit more positive affect. At any rate, further research is needed to fully understand the relationship between experienced and simulated emotions as a function of counterfactual direction and repetition in the REM framework.

Nevertheless, the majority of the non-clinical research forming the foundation of the REM and other functional theories of counterfactual thinking (e.g., Epstude & Roese, 2008) have utilized vignettes depicting hypothetical scenarios with little autobiographical relevance (Schacter et al., 2015; however, see Roese, 1994). Results from studies using impersonal and non-autobiographical vignettes may not be clearly applicable to results from studies investigating episodic counterfactual simulations about one's own life (De Brigard & Giovanello, 2012; Girotto et al., 2007; Pighin et al., 2011). Recent neural evidence has even shown that different brain regions are engaged when individuals simulate personal and impersonal counterfactual thoughts (De Brigard et al., 2015). As such, the results reported here should be interpreted carefully in light of prior literature employing non-personal simulations.

Additionally, work in affective forecasting suggests that self-reported ratings of emotional intensity are often exaggerated for simulated possible *future* events, especially negative ones (Gilbert, Pinel, Wilson, Blumberg, & Wheatley, 1998). However, Levine, Lench, Kaplan, and Safer (2012) have shown that over-exaggeration is greatly diminished when participants are explicitly told what to focus on when reporting emotional intensity. Although it remains unclear whether self-reported ratings of emotional intensity are typically exaggerated for simulated possible *past* events in the same way that they are for simulated possible *future* events, participants in the current study were asked specifically to make emotional intensity judgments while imagin*ing* the counterfactual event and the projected emotional intensity they imagin*ed* that they would have felt if they had actually experienced the simulated event; thus, this specificity should help to combat the possibility that responses were overblown.

The emotional intensity when remembering/imagining an event was substantially lower than the projected emotional intensity during the simulated remembered/imagined event. This observed difference lends credence to the idea that there are two distinct ways of thinking about emotional intensity for both autobiographical memories and their episodic counterfactual simulations. One is a feature of the experienc*ing*, while the other is a feature of the experienc*ed* (Johnson et al., 1988). This is not to suggest, however, that these two ways of thinking about emotional intensity are unrelated; in fact, in most cases they were strongly and positively correlated in the current study. These results support a view corroborated using diverse experimental paradigms: when we remember events from the personal past, the emotional experience accompanying the originally experienced event colors the current experiencing, and vice versa (Holland & Kensinger, 2010; Levine & Pizarro, 2004). Our results also extend this idea to episodic counterfactual simulations, suggesting that a belief in whether or not the event actually occurred does not affect how the imagined experienced event is related to current experiencing (at least for emotional intensity ratings). Because our autobiographical memory and episodic counterfactual results show the same exact pattern, this further supports the idea that reconstructing memories of personal past events and constructing thoughts about alternative events that could have happened in our past rely on a similar set of mechanisms (De Brigard, 2014; Schacter et al., 2015).

Our results also show that counterfactual thoughts simulated four times were rated as more emotionally intense than those simulated once, regardless of counterfactual direction or the valence of the memory from which the counterfactual was generated, but this was only the case for the emotional intensity experienced while presently imagining the counterfactual event and not for the emotional intensity participants believed that they would have experienced during the event itself. Furthermore, counterfactual valence did not differ as a function of repetition, suggesting that heightened emotional intensity with repeated simulation is not the product of a concomitant change in valence with repetition. These findings complement recent work showing that repetition increases arousal ratings for both positive and negative simulations of possible personal *future* events (Szpunar & Schacter, 2013). Moreover, prior work on both counterfactual and future thinking has shown that repetition of imagined events makes those events seem more vivid and detailed (De Brigard et al., 2013; Szpunar & Schacter, 2013). Increases in the vividness and detail of imagined scenarios as a function of repeated simulation may cause

them to become more emotionally intense, thereby reversing what might otherwise be an expected emotional habituation effect.

This effect of repetition on emotional intensity might have potentially important implications for understanding and treating disorders that involve repetitive thought or rumination. Repetitive thinking about counterfactual events is associated with certain pathologies, such as anxiety, depression, and post-traumatic stress disorder (El Leithy et al., 2006; Nolen-Hoeksema, 2000; Roese et al., 2009). In subclinical populations, generating a greater quantity of counterfactual thoughts after a traumatic event has been linked to higher stress and reduced well-being (Davis et al., 1995). In all of these cases, repeatedly thinking about alternative ways in which certain events might have happened instead seems to produce greater negative affect, stress, and even disordered thinking. Our results suggest that when we reappraise actual events as worse and repeatedly simulate those events, emotional intensity experienced while re-simulating those events is heightened. Heightened emotional intensity under these circumstances may increase stress and disordered thinking. It may be possible to reduce the intensity of negative affect by encouraging individuals to generate and focus attention on upward counterfactual events instead of actual events and to use reflective instead of evaluative or comparison-based processing. Future work using adaptations of this paradigm will investigate which negative emotions are amplified with counterfactual thinking in different clinical populations.

Contrary to our original hypothesis, the emotional intensity accompanying counterfactual simulations generated from negative memories tended to differ from the emotional intensity of the memories themselves, but the emotional intensity of counterfactual simulations generated from positive memories tended to remain very similar to the emotional intensity of the memories. However, we believe that this unexpected result is related to prior work showing that people react more strongly to negative events and stimuli than positive ones and that negative events have a greater impact on our lives than positive events (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001). Individuals also have a natural motivation to avoid or alter negative, aversive stimuli. Focusing attention on better reappraisals of remembered events instead of the actual events themselves provides a means of avoiding or altering negative memories. If entertaining better reappraisals of negative events reduces negatively intense emotions, this could be an effective emotion regulation strategy. Consistent with this explanation, negative affect is more likely to activate counterfactual thinking than positive affect, and the vast majority of naturally generated counterfactual thoughts (>90%) are upward rather than downward (Roese & Hur, 1997). Given that worse reinterpretations of negative memories are even more emotionally intense than the negative memories themselves, it is unsurprising that we naturally generate these counterfactual thoughts very rarely. A greater propensity for generating downward counterfactual simulations from negative events while in a reflective processing mode may be characteristic of disordered thinking.

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