Implications of Counterfactual Structure for Creative Generation and Analytical Problem Solving

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Implications of Counterfactual Structure for Creative Generation and Analytical Problem Solving

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In the present research, the authors hypothesized that additive counterfactual thinking mind-sets, activated by adding new antecedent elements to reconstruct reality, promote an expansive processing style that broadens conceptual attention and facilitates performance on creative generation tasks, whereas subtractive counterfactual thinking mind-sets, activated by removing antecedent elements to reconstruct reality, promote a relational processing style that enhances tendencies to consider relationships and associations and facilitates performance on analytical problem-solving tasks. A reanalysis of a published data set suggested that the counterfactual mind-set primes previously used in the literature tend to evoke subtractive counterfactuals. Studies 1 and 2 then demonstrated that subtractive counterfactual mind-sets enhanced performance on analytical problem-solving tasks relative to additive counterfactual mind-sets, whereas Studies 3 and 4 found that additive counterfactual mind-sets enhanced performance on creative generation tasks relative to subtractive counterfactual mind-sets.

Keywords: *counterfactual; mind-set; creativity; decision making; problem solving*

The capacity to reflect on what would, could, or should have been if events had transpired differently is a pervasive human tendency. These musings of what might have been have been termed counterfactual thinking. A substantial body of research has implicated counterfactuals in a variety of social judgments, including causal ascriptions (e.g., Wells & Gavanski, 1989), expressions of sympathy and blame (e.g., Davis, Lehman, Silver, Wortman, & Ellard, 1996), and emotion (e.g., Connolly & Zeelenberg, 2002). Moreover, research has suggested

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that there may be inferential benefits to engaging in counterfactual thinking (Markman & McMullen, 2003), finding that thoughts about what might have been can yield useful scripts for future behavior and heighten success-facilitating intentions and corresponding behaviors (Roese, 1994). Counterfactuals have been lauded not only for their practical utility but also for their apparent link to creativity. One of the major goals of this article is to explore the relationship between counterfactual thinking and creativity, classically defined as problem solving that involves finding solutions that exhibit fluency, flexibility, novelty, synthesis, analysis, reorganization and redefinition, complexity, and elaboration (Guilford, 1950).

Supporting the link between counterfactuals and creativity, counterfactual thinking has also been implicated in the generation and appreciation of the arts and cultural life. Byrne (2005), for example, contends that the ability to think about counterfactual possibilities is essential for the appreciation of fiction and art and for the suspension of disbelief in general. Counterfactuals play an essential role in children's play (Harris, 2000), and Byrne posits that moments of insight may be instances when a previously immutable aspect of one's mental representation of reality suddenly becomes mutable. Citing examples from American cinema such as *It's a Wonderful Life* (1946) and *Sliding Doors* (1998), Roese (2005) goes so far as to suggest that "counterfactuals are the essence of effective drama" (p. 153). Yet although the conceptual linkage between counterfactual thinking and creative generation has intuitive appeal, only a limited amount of empirical work has explored the relationship between them. Moreover, a recent set of studies found evidence for the opposite relationship: Counterfactual thinking led to impaired creative generation (Kray, Galinsky, & Wong, 2006).

The present article seeks to reconcile these recent data with the notion that counterfactual thinking and creative cognition should be positively related by examining the impact of counterfactual thinking on subsequent tasks involving creative generation and problem solving. A key question that we address is: Do counterfactuals elicit a particular type of mind-set that exerts predictable effects on information processing, or can they elicit different types of mind-sets that exert differential effects on information processing? In answering this question, we demonstrate for the first time that different structures of counterfactual thought (additive vs. subtractive) have disparate effects on two different types of thought processes (creative generation and analytical problem solving). We first turn to the prevalence of different counterfactual structures and the nature of counterfactual mind-sets before detailing their effects on creative and analytic task performance.

Counterfactual Structure

The logical structure of counterfactual thoughts can take either an *additive* or a *subtractive* form (Roese & Olson, 1993). Additive counterfactual structures are those that add new antecedent elements to reconstruct reality (e.g., "If only I owned an umbrella, I would not have gotten wet"), whereas subtractive structures are those that remove antecedent elements to reconstruct reality (e.g., "If only it hadn't rained today, I would not have gotten wet"). In addition, Roese and Olson (1993; Roese, 1994) suggested that additive counterfactuals might better serve a preparative function than would subtractive counterfactuals. One reason provided was that additive counterfactuals focus on response options that might have resulted in success and hence should be implemented in the future, whereas subtractive counterfactuals simply remove one previous response option from consideration. Second, however, and more germane to the present research, Roese (1994) noted that

> additive counterfactuals are more creative. Whereas subtractive counterfactuals are restricted to the original set of premises (i.e., what actually happened), additive counterfactuals are, by definition, those that go beyond the original premise set, fabricating novel options perhaps never considered in the past. (p. 807)

In kind, we contend that additive counterfactuals are more likely to inspire creative cognition than are subtractive counterfactuals because the former are more open to the construction of alternative antecedents that may not have been part of the factual event, whereas the latter are more narrowly focused on removing antecedent elements from the factual event that would change the outcome.

Counterfactual Mind-Sets

Exposure to scenarios that contain an obvious mutable component tends to elicit counterfactual thoughts (Kahneman & Miller, 1986), and the resulting cognitive orientation—a counterfactual mind-set that encourages the consideration of alternatives—influences subsequent cognition and performance (e.g., Galinsky & Kray, 2004; Galinsky & Moskowitz, 2000; Kray & Galinsky, 2003; see also Gollwitzer, Heckhausen, & Steller, 1990; Hirt & Markman, 1995; Hirt, Kardes, & Markman, 2004). For example, counterfactual mind-set activation has been shown to improve decision accuracy by increasing the discussion of unique information critical for group decision making and promoting synergistic coordination—the tendency of group members to build on and develop relationships between each other's ideas (Galinsky & Kray, 2004; Liljenquist, Galinsky, & Kray, 2004). In addition, counterfactual mind-sets encourage skepticism about the dominant hypothesis. Thus, consideration of an alternate reality reduces the confirmation bias, or the tendency to seek information that is consistent with an existing hypothesis (Galinsky & Moskowitz, 2000; Kray & Galinsky, 2003). Generally, then, it appears that mind-sets can transfer across tasks.

Mind-set primes. To prime counterfactual mind-sets, Galinsky and colleagues (Galinsky & Moskowitz, 2000; Galinsky, Moskowitz, & Skurnik, 2000; Kray et al., 2006) developed two scenarios. In the "rock concert scenario," a woman is at a rock concert performance of her favorite band, and at the concert it is announced that a fan will win a trip to Hawaii and that the winner will be determined by the seat number currently occupied. In the downward counterfactual scenario, the woman wins the trip to Hawaii when the new seat she had just switched to was chosen (she switches to get a better view of the stage), whereas in the upward counterfactual scenario, she loses the trip to Hawaii when the seat she had just switched from wins. In the "spelling bee scenario," a boy named Paul competes to advance in the National Junior Spelling Bee. In the downward counterfactual scenario, Paul advances to the next round of the competition after his place in line is altered (because he had to use the restroom), and he is asked to spell a word he knows, whereas in the upward counterfactual scenario, Paul is eliminated from the competition after his place in line is altered, and he is asked to spell a word he does not know. In both cases, the counterfactual scenarios are contrasted with non-counterfactual scenarios where the protagonist simply experiences either a positive or negative outcome.

As is typical of scenarios that are specifically designed to evoke counterfactuals, those employed by Galinsky and colleagues (Galinsky et al., 2000; Galinsky & Moskowitz, 2000; Kray et al., 2006) contain an antecedent that is rendered highly mutable by virtue of its abnormality (e.g., Kahneman & Miller, 1986; Kahneman & Tversky, 1982; Miller & McFarland, 1986). In both the upward and downward versions of each scenario, the protagonist performs an (abnormal) action that alters the status quo—Jane switches from the seat she currently occupies, or Paul alters his place in line and thus receives a word to spell that is different from the one he would have received had he not altered his place in line.

Reanalysis of data from Kray et al. (2006, Experiment 3). Arguably, both the rock concert and spelling bee scenarios favor the generation of a counterfactual alternative that is subtractive in structure (e.g., "If only she had *not* switched seats," "What if he had *not* gone to the restroom?"). To examine whether these scenarios tend to favor the generation of subtractive counterfactuals, we reanalyzed data from Kray et al.'s (2006) Experiment 3. In this experiment, half of the participants read the rock concert scenario, whereas the other half read the spelling bee scenario. Moreover, half of the scenarios described a sequence of events that was designed to elicit counterfactual thoughts, whereas the other half described a sequence of events that was not expected to elicit counterfactual thoughts. All participants were then asked to list thoughts that might be going through the protagonist's mind.

In our reanalysis, two independent judges, blind to condition and hypotheses, coded the thought listings provided by participants who read the counterfactual versions of either the rock concert or spelling bee scenarios (14 males, 31 females), identified any counterfactual thoughts, and then categorized each thought as being either additive or subtractive. To do so, judges were carefully instructed to code as subtractive any counterfactual that focused solely on the specific set of elements that comprised the scenario. Thus, counterfactuals such as "I wish I hadn't moved" and "If only I had just remained where I was originally" were both coded as subtractive because they mutated antecedent elements (i.e., switching seats) that composed the specific set of elements on which the scenario was based.[1] On the other hand, judges were instructed to code as additive any counterfactual that, while remaining consistent with the general premise of the actual event, nevertheless added an element that was not restricted to the specific set of elements (i.e., the element base) that composed the scenario. Thus, counterfactuals such as "He's glad he had a lot to drink before the competition to cause him to have to go to the bathroom" and "He should have tried to learn new words" were coded as additive because they mutated antecedent elements (i.e., having a lot to drink before the competition, being better prepared) that were not part of the original element base. Interrater reliability was high (91%), and thus the ratings were averaged.

The number of additive and subtractive counterfactuals generated in response to both the rock concert and the spelling bee scenarios were then submitted to a 2 (direction: upward vs. downward) × 2 (scenario type: rock concert vs. spelling bee) × 2 (structure prime: additive vs. subtractive) mixed ANOVA, with Structure Prime serving as a within-subjects factor. The results revealed the predicted main effect of Structure Prime, $F(1, 43) = 35.99$, $p < .001$, $\eta^2 = .47$, indicating that participants generated more subtractive ($M = 1.43$, $SD = 0.88$) than additive counterfactuals ($M = 0.40$, $SD = 0.65$) in response to the scenarios. The Direction main effect was not significant, $F(1, 43) = 1.05$, $p = .31$, $\eta^2 = .02$, but there was a significant Direction × Structure Prime interaction, $F(1, 43) = 4.00$, $p = .05$, $\eta^2 = .09$. As depicted in Table 1, the interaction appears to be driven by the fact that although the

TABLE 1: Number of Additive and Subtractive Counterfactuals Generated as a Function of Counterfactual Direction

	Direction			
	Upward		*Downward*	
Structure Prime	M	SD	M	SD
Additive	0.32	(0.57)	0.48	(0.73)
Subtractive	1.68	(0.92)	1.20	(0.78)

NOTE: Values correspond to the mean number of additive and subtractive counterfactuals generated by participants in Kray, Galinsky, and Wong (2006, Experiment 3), collapsed across scenario type.

upward and downward counterfactual scenarios elicited equivalent numbers of additive counterfactuals, $t < 1$, $d = 0.25$, the upward counterfactual scenarios elicited somewhat more subtractive counterfactuals than did the downward counterfactual scenarios, $t(43) = 1.92$, $p = .06$, $d = 0.56$. Importantly, however, both the upward counterfactual scenarios and the downward counterfactual scenarios elicited more subtractive than additive counterfactuals, $t(21) = 5.34$, $p < .001$, $d = 1.92$, for the former, $t(22) = 3.57$, $p = .002$, $d = 0.96$, for the latter. Finally, Scenario Type did not interact with either Direction or Structure Prime, all p values $> .14$, all η^2 values $< .05$. Overall, then, it appears that the counterfactual mind-set primes used by Kray et al. (2006) were more prone to eliciting subtractive than additive counterfactuals.

Relational and Expansive Processing

Recently, Kray et al. (2006) conducted a series of studies that examined the mechanism by which the counterfactual mind-set enhances problem-solving performance. According to Kray et al., the counterfactual mind-set promotes a *relational processing style*, characterized by a tendency to consider associations and make connections between a set of stimuli. As such, they reasoned, counterfactual mind-sets should improve performance on analytic tasks. Providing initial support (Experiment 2), these researchers found that the counterfactual mind-set improved performance on a task involving the assessment of relationships (i.e., the analytic section of the Law School Admissions Test). Moreover, mind-set activation increased the tendency to structure imagination around existing knowledge structures (Experiments 3 and 4; see Ward, 1994) and improved performance on a task involving the consideration of associations between task stimuli (i.e., the Remote Associates Test, RAT).

Given that Kray et al. (2006) only used scenarios that seem to generate more subtractive counterfactual thoughts, the apparent link between counterfactual mind-sets and relational processing style may be moderated by the structure of counterfactual thoughts. The relationship between subtractive counterfactual thinking and relational processing can be further clarified by drawing an analogy to the building game Jenga. This game involves building a tower consisting of wooden rectangular bricks, in layers (i.e., stories) of three, placed at right angles to each other. Each player in turn removes one brick from anywhere below the highest complete story and places it on the top of the tower, at right angles to the blocks immediately below it. The last player to stack a block without making the tower fall over wins the game. Importantly, when one removes (i.e., subtracts) pieces, one has to focus on the interconnections among the pieces, as removing one piece necessarily has consequences for the integrity of the entire structure. Analogously, subtractive counterfactuals require a focus on the interconnections and relationships between the various antecedent elements that compose the structure of a scenario because subtracting one element has consequences for all of the other elements.[2]

Kray et al. (2006) also argued that because a counterfactual mind-set evokes a relational processing style that structures imagination, the instantiation of such a mind-set actually hinders the generation of novel ideas. In support, Kray et al. found that the tendency to structure imagination around existing knowledge following mind-set activation (Experiments 3 and 4) led to more descriptiveness on the task but less novelty. Likewise, although the activation of a counterfactual mind-set led to better performance on the RAT, it also impaired performance on a creative generation task (i.e., creating new labels for products).

Given that the rock concert and spelling bee scenarios appear to favor the elicitation of subtractive over additive counterfactual thoughts, perhaps the direct solicitation of additive versus subtractive counterfactual thoughts can evoke different processing styles and exert differential effects on subsequent task performance. Because additive counterfactuals are more open to the construction of alternative antecedents that may not have been part of the factual event, the activation of an additive counterfactual mind-set may encourage an expansive processing style that enhances performance on creative generation tasks that require a broadening of conceptual attention that goes beyond the boundaries of what is currently known or salient (Guilford, 1950). To return to the Jenga analogy, adding pieces to the tower is comparatively easier than removing them because one does not need to monitor all of the interconnections among the various pieces. In kind, additive counterfactuals need not focus on all of the antecedent elements that compose a scenario. Rather, they are more free to explore new and multiple possibilities. Because the scenarios that Kray et al. (2006) used did not evoke additive counterfactuals, the connection between additive counterfactual mind-sets and an expansive processing style has not yet been explored.

OVERVIEW OF THE STUDIES

We hypothesized that subtractive counterfactual mind-sets would produce a relational processing style that would facilitate performance on analytical problem-solving tasks but that additive counterfactual mind-sets promote an expansive processing style that broadens conceptual attention and facilitates performance on creative generation tasks. Studies 1 and 2 were designed to demonstrate that subtractive counterfactual thinking enhances performance on tasks involving relational processing to a greater extent than does additive counterfactual thinking. To do so, Study 1 employed the RAT (M. T. Mednick, Mednick, & Mednick, 1964), and Study 2 used a syllogism task. Conversely, Studies 3 and 4 were designed to demonstrate that additive counterfactual thinking enhances performance on tasks involving expansive processing to a greater extent than does subtractive counterfactual thinking. Specifically, Study 3 participants played a modified version of the popular game Scattergories, and participants in Study 4 generated creative uses for an object. Finally, in light of the proposal in the creativity literature that enjoyment (i.e., intrinsic motivation) facilitates creativity (Amabile, 1983), a measure of task liking was included in Studies 2 to 4 and employed as a statistical covariate in all of the key analyses.

STUDY 1

Because counterfactual mind-sets promote a relational processing style involving the consideration of relationships between task stimuli, Kray et al. (2006) argued that the mind-set should improve performance on tasks involving the identification of associations that are adaptive and responsive to the current context. To provide support for this argument, Kray et al. (Experiment 5) exposed participants to a counterfactual mind-set prime and then observed their subsequent performance on the RAT. According to S. A. Mednick (1962), the RAT requires an individual to form "mentally distant associative elements into new combinations which are useful and meet specified as well as unforeseen requirements" (p. 221). Specifically, the test requires identifying an association among three distinct words. For example, the common link for the words *sore-shoulder-sweat* is cold, and the common link for the words *broken-clear-eye* is glass. Thus, by considering the relationship among task stimuli, performance on the RAT improves. Consistent with predictions, Kray et al. found that those exposed to a counterfactual mind-set prime performed better on the RAT than did those not exposed to the prime.

The goal of Study 1 was to demonstrate that the effectiveness of counterfactual mind-set primes on facilitating RAT performance is moderated by the structure of the counterfactual. Participants were induced to generate either additive or subtractive counterfactuals and then complete the RAT. We predicted that those who generated subtractive counterfactuals would solve more RAT items correctly than would those who generated additive counterfactuals because the former are more likely to elicit a relational processing style.

Although prior research has never demonstrated effects of counterfactual structure on mood (e.g., Roese, 1994), we chose to examine the potential role of affect in mediating the relationship between mind-set activation and problem-solving performance by manipulating both the direction of the counterfactual (i.e., upward or downward) and its structure. According to past research (e.g., Markman, Gavanski, Sherman, & McMullen, 1993; Sanna, 1996), upward ("it could have been better") counterfactuals tend to evoke negative affect, whereas downward ("it could have been worse") counterfactuals tend to evoke positive affect (but see Markman & McMullen, 2003). Although the direction of the counterfactual has never moderated any of the findings to date involving the effects of counterfactual mind-sets on problem-solving performance (e.g., Galinsky & Moskowitz, 2000; Kray et al., 2006; Kray & Galinsky, 2003), the interactive effects of counterfactual direction and structure on mood and subsequent problem-solving performance have not been examined. Thus, the present study assessed mood following the generation of upward additive, upward subtractive, downward additive, and downward subtractive counterfactuals and examined its potential role in accounting for performance differences.

Method

Participants and design. In all, 26 male and 51 female introductory psychology students at Ohio University were recruited in exchange for course credit and were randomly assigned to the conditions of a 2 (direction: upward vs. downward) × 2 (structure prime: additive vs. subtractive) between-subjects factorial design. Participants were run on separate IBM computers in groups no larger than 4.

Procedure. Participants arrived at the laboratory for a study titled "Thinking and Reasoning" and were seated at computers running MediaLab software (Jarvis, 2004). To begin, participants were instructed to recall a negative interpersonal event and provide some details about that event in a few sentences. The specific instructions read,

> Please take a moment to think of a single event in the last year that happened to you and that was especially negative and/or disappointing. It should also directly involve at least one other person of your approximate age (for example, a fight between you and a friend).

Participants then generated counterfactuals, imagining what things could have been different to change the recorded outcome. Half of the participants were instructed to generate upward counterfactuals, and half generated downward counterfactuals. Orthogonally, half of the participants were instructed to generate additive counterfactuals, and half generated subtractive counterfactuals. The counterfactual solicitations (see Appendix A) were based closely on those developed by Roese (1994). Participants were free to record as many counterfactual thoughts as they wished. Next, participants rated their affect on 13 items (well, concerned, content, happy, relaxed, nervous, down, disappointed, joyful, calm, tense, depressed, and relieved) along 9-point scales ranging from 1 (*not at all*) to 9 (*extremely*).

After responding to the affect items, participants completed a modified version of the RAT (M. T. Mednick et al., 1964). As in Kray et al. (2006), the original task designed by M. T. Mednick et al. (1964) was shortened to include only 10 items.

Results and Discussion

Participants were free to generate as many counterfactuals as they wished ($M = 5.73$, $SD = 2.47$, range = 2-15). To provide a more conservative test of our hypotheses, however, participants were eliminated from analyses if the structure of any of the first three counterfactuals they generated was inconsistent with the structure that they had been told to employ on the generation task. Application of this "rule-of-three" exclusion criteria resulted in the elimination of 7 participants in the upward additive condition and 7 participants in the downward additive condition. Thus, analyses focused on the remaining 63 participants. Across both the additive and subtractive conditions, participants generated more subtractive counterfactuals ($M = 3.49$, $SD = 2.95$) than additive counterfactuals ($M = 2.22$, $SD = 3.58$), but this effect was only marginally significant, $t(63) = 1.76$, $p = .08$, $d = 0.39$.

A 2 (direction) × 2 (structure prime) ANOVA conducted on the number of RAT items correctly solved revealed the predicted main effect of Structure Prime, $F(1, 59) = 6.09$, $p = .02$, $\eta^2 = .09$. Participants who generated subtractive counterfactuals subsequently solved more RAT items correctly ($M = 3.80$, $SD = 2.54$) than did those who generated additive counterfactuals ($M = 2.26$, $SD = 2.09$; see Figure 1).[3] Moreover, this main effect was not moderated by the direction of the counterfactual, as the Direction × Structure Prime interaction was not significant, $F < 1$, $\eta^2 = .005$. In addition, the Direction main effect was also not significant, $F < 1$, $\eta^2 = .002$. Thus, and consistent with past research (e.g., Galinsky & Moskowitz, 2000; Kray et al., 2006), the effects of the counterfactual mind-set prime did not depend on the direction of the counterfactual.

Analyses performed on the affect measure ($\alpha = .91$) revealed a marginally significant main effect of Direction, $F(1, 59) = 3.18$, $p = .08$, $\eta^2 = .05$, such that participants who generated upward counterfactuals expressed less positive affect ($M = 5.83$, $SD = 1.41$) than did those who generated downward counterfactuals ($M = 6.60$, $SD = 1.42$). The main effect of Structure Prime, however, was not significant, $F < 1$, $\eta^2 = .02$. Importantly, moreover, the main effect of Structure Prime on the number of RAT items correctly solved remained significant when affect was included as a covariate in the analyses, $F(1, 58) = 5.65$, $p = .02$, $\eta^2 = .09$. Thus, affect cannot account for the influence of the counterfactual mind-set primes on RAT performance.

STUDY 2

To provide further support for the role of counterfactual structure in determining the effects of counterfactual mind-set primes on tasks involving relational processing, participants in Study 2 solved syllogisms. In a syllogism task, individuals have to decide which, if any, of several statements or conclusions about the relationship between two variables, such as A and C (e.g., "All A are C," "No A are C," "Some A are C," or "Some A are not C"), logically and necessarily follow from the two previous statements or premises. Because the task requires identifying the correct response from a set of known alternatives but does not require response generation, performance on the task should be improved to the extent that one is engaging in relational processing.

Because the results of Study 1 (and a host of previous studies) failed to reveal any moderating effects of counterfactual direction on task performance following mind-set priming, Studies 2 to 4 only examined the effects of generating upward additive and upward subtractive counterfactuals. On the other hand, Studies 2 to 4 did feature the inclusion of a no-prime control group. In Study 2, we predicted that those who generated subtractive counterfactuals would solve more syllogisms correctly than would either control participants or those who generated additive counterfactuals.

Method

Participants and design. A total of 20 male and 27 female introductory psychology students at Ohio

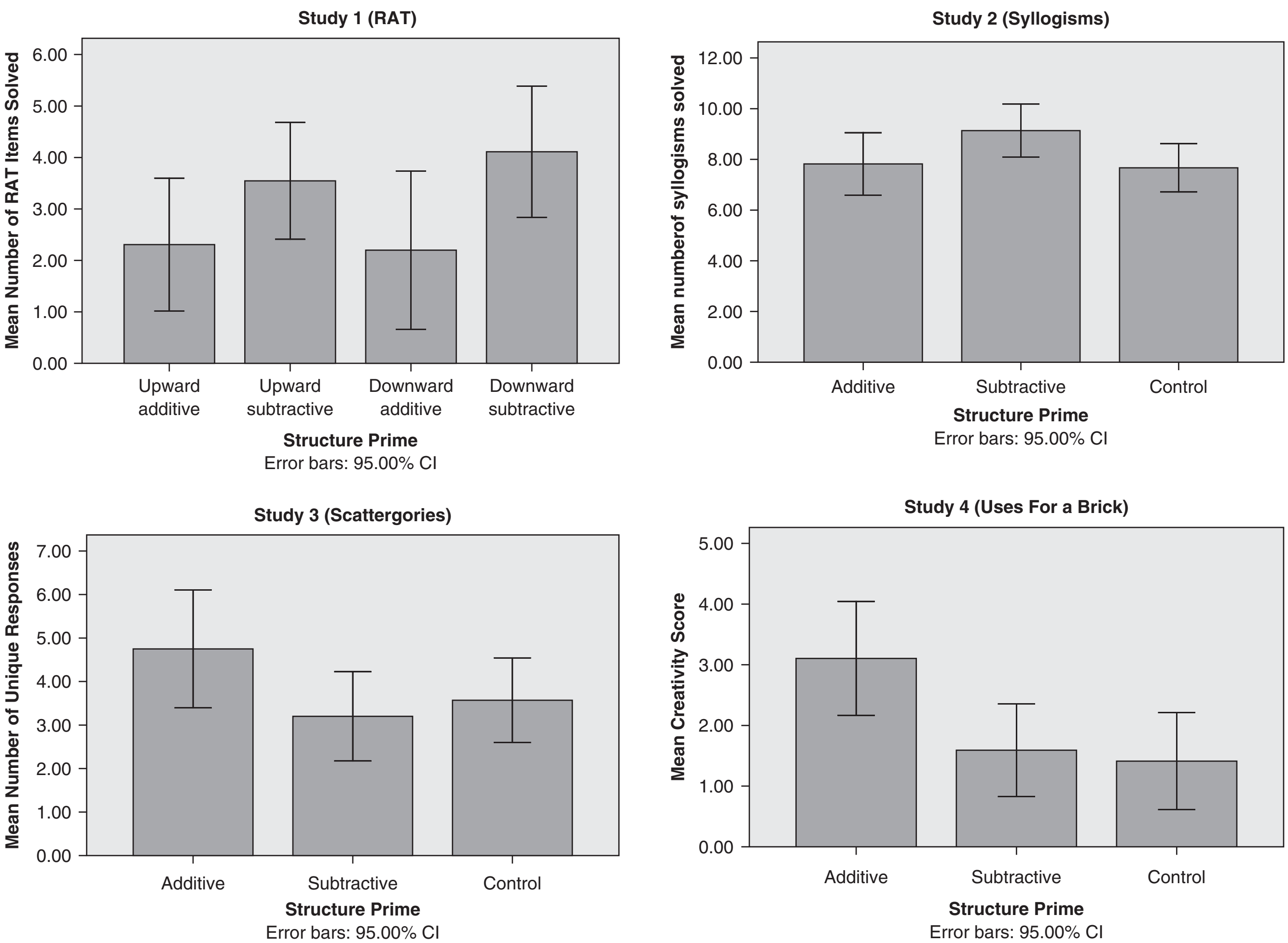

Figure 1 Results from Studies 1 to 4.

University were recruited in exchange for course credit and were randomly assigned to the conditions of a one-way (structure prime: control vs. additive vs. subtractive) between-subjects design. Participants were run on separate IBM computers in groups no larger than 4.

Procedure. Participants arrived at the laboratory for a study titled "Thinking and Reasoning" and were seated at computers running MediaLab software (Jarvis, 2004). Participants assigned to the additive and subtractive conditions were instructed to recall a negative academic event and provide some details about that event in a few sentences.[4] Next, half of the experimental participants were instructed to generate upward additive counterfactuals, and half were instructed to generate upward subtractive counterfactuals employing the same counterfactual solicitation format employed in Study 1 (see Appendix A). After completing the thought-listing task, experimental participants responded to the same affect items employed in Study 1. Participants in the control condition, on the other hand, did not recall a negative academic event and, thus, were not asked to generate counterfactuals. Rather, they began the study by responding to the affect items.

All participants were then provided with instructions for the Nonsense Syllogism Test (NST; Ekstrom, French, Harman, & Dermen, 1976), a test of deductive logic. The instructions read as follows:

> This is a test of your ability to tell whether the conclusions drawn from certain statements are correct or incorrect. Although all of the statements are really nonsense, you are to assume that the first two statements in each problem are correct. The conclusion drawn from them may or may not show good reasoning. You are only to think about the reasoning. If the conclusion drawn from the statements shows GOOD REASONING, click on the letter G. If the conclusion drawn from the statements shows POOR REASONING, click on the letter P.

Participants were then given 4 minutes to assess the validity of the logic employed in each of 15 syllogisms. An example of a syllogism employing good reasoning appears below:

> No one with a pink nose can be President.
> All men have pink noses.
> Therefore, no man can be President.

In addition, an example of a syllogism employing poor reasoning appears below:

> All alligators are art collectors.
> Some art collectors live in caves.
> Therefore some alligators live in caves.

Finally, participants responded to a measure of task liking ("How much did you like working on this task?") on a 9-point scale ranging from 1 (*not at all*) to 9 (*extremely*).

Results and Discussion

Application of the rule-of-three exclusion criteria resulted in the elimination of 6 participants from the additive condition. Thus, analyses were run on the remaining 41 participants. Among those participants who were instructed to generate counterfactuals, there were no differences in the total number of additive versus subtractive counterfactuals generated, $t < 1$, $d = 0.18$. An ANCOVA was then conducted on the number of syllogisms correctly solved, with the task-liking measure serving as a covariate—the correlation between task liking and the number of syllogisms correctly solved was not significant, $r(39) = .20$, $p = .22$. This analysis revealed a significant main effect of Structure Prime, $F(2, 37) = 3.52$, $p = .04$, $\eta^2 = .16$ (see Figure 1). As predicted, participants who generated subtractive counterfactuals subsequently solved more syllogisms correctly ($M = 9.13$, $SD = 1.88$) than did participants in either the control condition ($M = 7.67$, $SD = 1.72$), $t(37) = 2.46$, $p = .02$, $d = 0.81$, or the additive condition ($M = 7.82$, $SD = 1.83$), $t(37) = 2.04$, $p = .05$, $d = 0.71$. Moreover, the main effect of Structure Prime on the number of syllogisms correctly solved remained significant when affect was included as a covariate in the analyses, $F(2, 36) = 3.21$, $p = .05$, $\eta^2 = .15$. Overall, and consistent with the results of Study 1, a subtractive counterfactual mind-set prime enhanced performance on an analytical problem-solving task.

STUDY 3

The results of Studies 1 and 2 provided support for the hypothesis that subtractive counterfactual thinking would enhance performance on analytic tasks, ones that require relational processing for optimal performance. Studies 3 and 4, on the other hand, employed tasks involving creative generation, and we hypothesized that for such tasks additive as opposed to subtractive counterfactual thinking would facilitate performance on these tasks that require an expansive processing style. Study 3 made use of the popular word game Scattergories. Scattergories is a group word game involving quick thinking and originality. During regular play, a category list containing 12 separate categories (e.g., colors, animals, school subjects) is picked at random, and a letter die is rolled to determine the key letter that all answers must begin with for that list. Players are given 2.5 minutes to generate responses to all of the categories on the list (i.e., thereby constituting a round of play), and each round is then scored by awarding a point for each answer generated by a player that was not generated by any other member of the group of players (i.e., as long as the response is deemed by the group to be applicable to the category).

Notably, the use of Scattergories as an assessment of creativity has conceptual roots in earlier work conducted by Wallach and Kogan (1965). These researchers noted,

> If we return to the introspection of highly creative artists and scientists, one major focus emerges. The majority of the available introspective accounts have in common a concern with associative freedom and uniqueness. These accounts consistently stress the ability to give birth to associative content that is abundant and original, yet relevant to the task at hand rather than bizarre. (p. 289)

To assess creativity, Wallach and Kogan asked 151 children to generate possible instances of a particular category (e.g., round things). The key dimension on which their responses were scored was uniqueness—generating a response that no other child in the sample of 151 had provided. Likewise, the reward structure of Scattergories was slightly altered in Study 3, such that participants received a point for any response that was unique across the entire participant sample. We predicted that participants who made additive counterfactuals would subsequently generate more novel responses in the Scattergories task than would either control participants or those who made subtractive counterfactuals.

Method

Participants and design. In all, 24 male and 37 female introductory psychology students at Ohio University were recruited in exchange for course credit and were randomly assigned to the conditions of a one-way (structure prime: control vs. additive vs. subtractive) between-subjects design. Participants were run on separate

IBM computers in groups that ranged in size between 2 and 4.

Procedure. The procedure was identical to those of Studies 1 and 2 until the description of the Scattergories task. After responding to the affect items, participants were informed that they would be playing a modified version of the popular game Scattergories and that they could potentially win $5. Participants were given four lists, each containing 12 categories, and were further provided with a letter for each list, with the goal being to generate a unique item for each category as long as every item began with the letter provided for each list. Participants were also told that at the end of the study, the individual in the room who had generated the greatest number of unique items would win $5. Participants were then given 3 minutes to complete each list. After completing all four lists, participants responded to the same task-liking measure employed in Study 2. Participants were then told that everyone had won $5, after which they were debriefed, paid $5, and thanked for their participation.

Task scoring. From the outset, our scoring scheme for the Scattergories task was to award each participant a point for any unique response they gave across the entire participant sample. After examining participants' responses to the various categories, however, it became clear that some categories elicited very little response variability (i.e., most participants provided the same response), whereas other categories elicited substantial response variability (i.e., very few, if any, participants provided the same response). To remove categories that appeared to be eliciting very low (e.g., "notorious people") or very high (i.e., "street names") response variability, we examined the mean and standard deviation of the distribution of responses across all categories. On average, 34% of the participants provided the same response to a given category, with a standard deviation of 19%. Subsequently, all categories that elicited a commonality of responses 1 *SD* either above or below the mean of 34% were retained. In all, 13 categories were removed, and analyses focused on responses to the remaining 35 categories (see Appendix B).

Results and Discussion

Application of the rule-of-three exclusion criteria resulted in the elimination of 4 participants from the additive condition. Thus, analyses were run on the remaining 57 participants. Among those participants who were instructed to generate counterfactuals, there were no differences in the total number of additive versus subtractive counterfactuals generated, $t < 1$, $d = 0.04$. We then conducted an ANCOVA on the number of novel responses generated for the Scattergories task, with task liking serving as a covariate—the correlation between task liking and scores on the Scattergories task was not significant, $r(55) = .06$, $p = .62$. The analysis revealed a significant effect of Structure Prime, $F(2, 53) = 3.35$, $p = .04$, $\eta^2 = .11$, and contrasts revealed that participants in the additive condition generated significantly more unique responses ($M = 4.75$, $SD = 2.54$) than did participants in either the control condition ($M = 3.57$, $SD = 2.13$), $t(53) = 1.96$, $p = .05$, $d = 0.50$, or the subtractive condition ($M = 3.20$, $SD = 2.19$), $t(53) = 2.51$, $p = .015$, $d = 0.65$. Moreover, the main effect of Structure Prime on the number of unique responses generated remained significant when affect was included as a covariate in the analyses, $F(2, 52) = 3.04$, $p = .05$, $\eta^2 = .11$. Overall, then, and in contrast to the results of Studies 1 and 2 that demonstrated the enhancing effects of a subtractive counterfactual mind-set prime on analytic task performance, Study 3 provided support for the hypothesis that an additive counterfactual mind-set prime can enhance performance on a creative generation task.

STUDY 4

The participants in Study 4 were asked to generate novel uses for an object, a creative generation task that has been frequently employed in past research (e.g., Friedman & Förster, 2001; Guilford, Christensen, Merrifield, & Wilson, 1978). We predicted that those who made additive counterfactuals would generate more creative uses for the object than would either control participants or those who made subtractive counterfactuals.

Method

Participants and design. A total of 37 male and 23 female introductory psychology students at Ohio University were recruited in exchange for course credit and randomly assigned to the conditions of a one-way (structure prime: control vs. additive vs. subtractive) between-subjects design. Participants were run on separate IBM computers in groups no larger than 4.

Procedure. The procedure was identical to those of Studies 1 to 3 until the description of the creative generation task. After responding to the affect items, participants were given 1 minute to generate as many novel uses as they could for a brick. Following the generation task, participants responded to the same measure of task liking employed in Studies 2 and 3.

Coding. The various uses for a brick generated by participants were initially broken down into 19 separate categories via discussion between the first two authors. After establishing these mutually agreed-on categories, the first two authors, blind to experimental condition, subsequently and separately coded each of the participants' responses along a 0 (*not at all creative*) to 5 (*very creative*) scale (see Friedman & Förster, 2001; Hirt, Levine, McDonald, Melton, & Martin, 1997). Interrater agreement was high, r = .81, and thus these ratings were averaged together to generate a creativity index. An example of a use for a brick that scored high on creativity was "an object for carving," whereas an example of a use for a brick that scored low on creativity was "to build something."

Results and Discussion

Application of the rule-of-three exclusion criteria resulted in the elimination of 2 participants from the additive condition. Thus, analyses were run on the remaining 58 participants. Among those participants who were instructed to generate counterfactuals, there were no differences in the total number of additive versus subtractive counterfactuals generated, $t < 1$, $d = 0.22$. We then conducted an ANCOVA on the creativity index, with task liking serving as a covariate—the correlation between task liking and scores on the creativity index was not significant, $r(56) = .02$, $p = .88$. This analysis revealed a significant main effect of Structure Prime, $F(2, 54) = 5.21$, $p = .009$, $\eta^2 = .16$. As predicted, the uses for a brick generated by participants in the additive condition were judged as more creative ($M = 3.11$, $SD = 1.95$) than were those generated by participants in either the control condition ($M = 1.41$, $SD = 1.55$), $t(54) = 2.86$, $p = .006$, $d = 0.97$, or the subtractive condition ($M = 1.59$, $SD = 1.72$), $t(54) = 2.70$, $p = .009$, $d = 0.83$.[5] Moreover, the main effect of Structure Prime on creativity scores remained significant when affect was included as a covariate in the analyses, $F(2, 53) = 4.27$, $p = .02$, $\eta^2 = .14$. Consistent with the findings of Study 3, these results indicated that an additive counterfactual mind-set prime can enhance performance on a creative generation task.

GENERAL DISCUSSION

Our investigation began by examining whether recent findings regarding the effects of mind-set activation on creative generation (Kray et al., 2006) were a result of the fact that the typical mind-set primes used in past research favor the elicitation of subtractive counterfactual thoughts. A reanalysis of an existing data set (Kray et al., 2006, Experiment 3) confirmed that the rock concert and spelling bee scenarios tend to evoke more subtractive than additive counterfactuals. Studies 1 and 2 then provided evidence that subtractive counterfactual mind-sets enhance performance on analytical problem-solving tasks that are facilitated by a relational processing style, whereas Studies 3 and 4 provided evidence that additive counterfactual mind-sets enhance performance on creative generation tasks that are facilitated by an expansive processing style. Moreover, the effects of counterfactual generation on creative cognition were independent of the influence of transient affective states (e.g., Isen, 1987) and task enjoyment. In all, additive and subtractive counterfactual thinking appear to elicit transfer-appropriate processing shifts, a phenomenon in which cognitive procedures activated in the course of engaging in one task remain active so that they are carried over or transferred to subsequent tasks (Schooler, 2002; Schooler, Fiore, & Brandimonte, 1997).

The distinction we draw between the expansive processing style elicited by an additive counterfactual mind-set and the relational processing style elicited by a subtractive counterfactual mind-set has interesting implications for the study of group decision making. Previous studies conducted by Kray and Galinsky (2003) and Galinsky and Kray (2004) found that group performance on tasks requiring synergistic coordination to arrive at the best possible solution was facilitated following exposure to a subtractive counterfactual mind-set prime. Relatedly, Beersma and De Dreu (2005) found that priming a prosocial motivation facilitated performance on a convergent task involving a joint venture negotiation, but priming a proself motivation facilitated performance on a divergent task involving generating multiple ideas for an advertisement campaign. Intriguingly, these results suggest a promising two-stage approach toward improving group decision making. During the initial stages of a group project, an additive counterfactual mind-set might be instantiated to facilitate creative brainstorming and the generation of multiple novel ideas (e.g., McGrath, 1984), whereas a subtractive counterfactual mind-set might be instantiated during the latter stages of a group project when the focus shifts to coordinating group efforts toward finding and implementing the best possible solution. More generally, the strategic manipulation of various types of counterfactual mind-sets can potentially heighten the likelihood of innovation, which involves both the generation of novel ideas and their successful implementation (Amabile, Conti, Coon, Lazenby, & Herron, 1996).

Caveats

Although Kray et al. (2006) found that a counterfactual mind-set prime impaired performance on creative tasks relative to a no-prime control condition, Studies 3 and 4 in the present work found no evidence of impairment. Rather, participants who generated subtractive counterfactuals performed no differently than controls. Likewise, Studies 1 and 2 found no evidence that additive counterfactuals impaired performance on analytical problem-solving tasks, as they performed no differently than controls. This difference may be because of, in part, the fact that the mind-set manipulation employed by Kray et al. focused participants on a particular event that tends to evoke a specific counterfactual, whereas the mind-set manipulations used in the present work asked participants to recall an idiosyncratic event and generate their own counterfactuals. In future research, we plan to compare multiple methodologies for instantiating counterfactual mind-sets to more closely examine their effects on creativity and problem solving.

One question that might be asked is whether there is something unique about priming counterfactual mind-sets that produces the reported effects. On one hand, we certainly believe that other psychological phenomena are capable of facilitating creative versus analytical thinking vis-à-vis expansive versus relational processing. For instance, having a promotion and approach regulatory focus appears to induce an expansive processing style (Förster, Friedman, Ozelsel, & Denzler, 2006). Similarly, having people describe three times when they had behaved creatively prevents stereotypes and associations in general from becoming automatically activated (Sassenberg & Moskowitz, 2005). Presumably, such a disruption of the automatic activation of associations should have the downstream consequence of favoring expansive over relational processing.

On the other hand, however, we would argue that counterfactual mind-sets *are* special because (a) they are ubiquitous and common and (b) they produce a cascading effect that results in the generation of multiple alternatives. In particular, work by Hirt and Markman (1995) and Hirt et al. (2004) has demonstrated how encouraging participants to consider one plausible alternative outcome to a previously explained outcome "breaks the inertia" established by the initial conditional reference frame (Koehler, 1991) and prompts the spontaneous consideration of additional alternatives beyond those explicitly specified. Thus, the consideration of one subtractive counterfactual may encourage the consideration of additional subtractive counterfactuals, whereas the consideration of one additive counterfactual may encourage the consideration of additional additive counterfactuals. This cascading effect exerts a substantial influence on information processing without necessarily alerting the individual to the relationship between the mind-set prime and the subsequent task.

It is also not our intention to suggest that subtractive counterfactuals are not creative. Rather, subtractive counterfactuals are relatively more constrained than are additive counterfactuals to focusing on interconnections among the various antecedent elements that compose the structure of a story or an event. Importantly, however, constructing subtractive counterfactuals may lead to subsequent additive counterfactual considerations. The film *It's a Wonderful Life* (1946) provides a fascinating illustration of the interplay between additive and subtractive counterfactuals. In the film, George Bailey (played by James Stewart) is given the opportunity to see what the town of Bedford Falls would be like if George had *never* been born. Although the initial premise is subtractive, the rest of the film progresses in a manner that reveals an additive structure. George learns that if he had not been born, his wife Mary would have instead become a bitter old maid, and Bedford Falls would have instead become run-down because the family-owned Bailey Loan Company would have gone out of business. Thus, an initial subtractive counterfactual premise spawns an additional set of additive (and nonbinary) counterfactuals that advance the story in a delightful and creative manner. Subtractive counterfactuals that are a springboard to additive counterfactual constructions may enhance creativity.

Conclusion

Across four studies, we found that a pervasive tendency of human cognition, the generation of counterfactual thoughts, had systematic effects on subsequent performance. Counterfactual thoughts not only reconstruct the past but they drive forward the future by affecting the way individuals approach new tasks. The current studies go beyond past research by demonstrating that the structure of counterfactual thoughts is a crucial determinant of how thoughts of what might have been affect approaches to and performance on tasks in the here and now. Subtractive counterfactuals—those that remove antecedent elements to reconstruct reality—evoke a relational processing style that facilitates analytic task performance, whereas additive counterfactuals—those that add new antecedent elements to reconstruct reality—evoke an expansive processing style that facilitates creative generation. Our findings have clear implications for a range of individuals, from artists to managers, and a diverse set of contexts, from college entrance exams to family activities. To achieve success, the astute thinker will benefit from employing the right type of counterfactual at the right time.

Appendix A

Counterfactual Solicitations

Upward Additive Counterfactuals

People often have thoughts like "if only . . ." after negative events, in that they can see how things might have turned out better. For example, a New York woman who recently sustained minor injuries when she was hit by a car told reporters, "If only I had looked down that street a second time, I would've been fine." Often, we wish we had done something to avoid a negative outcome. In the space below, please list some specific actions that, in retrospect, could have been taken to improve the outcome. You will have three minutes to list as many thoughts as come to mind. Each thought you list should complete the phrase "If I had . . . the outcome would have been better."

Upward Subtractive Counterfactuals

People often have thoughts like "if only . . ." after negative events, in that they can see how things might have turned out better. For example, a New York woman who recently sustained minor injuries when she was hit by a car told reporters, "If only I had NOT been in such a rush, I would've been fine." Often, we wish we hadn't done something that led to a negative outcome. In the space below, please list some specific actions that you took that, in retrospect, would have improved the outcome if you had not done them. You will have three minutes to list as many thoughts as come to mind. Each thought you list should complete the phrase "If I had not . . . the outcome would have been better."

Downward Additive Counterfactuals

People often have thoughts like "well, at least . . ." after events, in that they can see how things might have turned out even worse. For example, a New York woman who recently sustained minor injuries when she was hit by a car told reporters, "At least I didn't try to move around after the accident, or it would've been a lot worse." Often, there are things that could have happened that would have made a negative outcome worse. In the space below, please list some specific actions that could have been taken that would have made the outcome of the event even worse. You will have three minutes to list as many thoughts as come to mind. Each thought you list should complete the phrase "If I had . . . the outcome would have been even worse."

Downward Subtractive Counterfactuals

People often have thoughts like "well, at least . . ." after events, in that they can see how things might have turned out even worse. For example, a New York woman who recently sustained minor injuries when she was hit by a car told reporters, "At least I had my medic-alert bracelet on, or it would've been a lot worse." Often, negative outcomes could have been worse if certain actions had not been taken. In the space below, please list some specific actions that you took that, in retrospect, would have made the outcome of the event even worse if you had not done them. You will have three minutes to list as many thoughts as come to mind. Each thought you list should complete the phrase "If I had not . . . the outcome would have been even worse."

Appendix B

Category Lists Employed in Scattergories Task (Study 3)

List 1	*List 2*	*List 3*	*List 4*
Sandwiches	Articles of clothing	Baby foods	Famous females
Excuses for being late	Desserts	Games	People in uniform
Ice cream flavors	Car parts	Vacation spots	Medicine/drugs
Things that bounce	Four-letter words	Diseases	Animals
Things in a park	Athletes	Famous duos	Junk food
Foreign cities	Farm animals	Items/vending machine	Things that grow
Stones and gems	Things at the beach	Things that you wear	Things made of metal
Musical instruments	Colors	Things found in a desk	Hobbies
	Things found on map	Things at a circus	
		Words assoc. w/money	

Notes

1. Both the rock concert and spelling bee scenarios depict situations involving binary response options: Specifying switching, for example, implies remaining, and specifying remaining implies not switching. In such cases, the presence of the linguistic devices *had* versus *had not* should not be the critical feature that determines whether a given counterfactual is additive or subtractive because the feature is uninformative, at least on purely logical grounds (Roese & Olson, 1995). Rather, we chose to code such counterfactuals as subtractive because they focused solely on the specific set of antecedent elements described in the situation. In everyday social interaction, however, behavioral choices are rarely binary. Rather, individuals typically select behaviors from among multiple possibilities. Thus, in such cases, additions and subtractions do not imply one another; each provides distinct information. If one participates in a spelling bee, misses a word, and thinks, "I should have prepared more," this counterfactual does not logically imply the absence of all preparation or indicate which words were not studied. In other words, "I should have prepared more" is an additive counterfactual with no logical subtractive negation that adds an element that is not restricted to the specific set of antecedent elements that existed in the situation. To avoid scenarios whose most mutable component is a dichotomous response option, the reported studies instead employed a more open-ended "life events" paradigm (Roese, Hur, & Pennington, 1999) that enhanced the likelihood that participants could make counterfactuals that selected from multiple possibilities.

2. We thank an anonymous reviewer for suggesting this example.

3. In all four studies, there were no significant correlations between task performance and either the number of additive counterfactuals generated, the number of subtractive counterfactuals generated, or the overall number of counterfactuals generated.

4. For generalizability purposes, we switched the interpersonal context in Study 1 to an academic context in Studies 2 to 4.

5. An analysis performed on the total number of different uses generated for a brick revealed no differences among the three groups,

$F < 1$, $\eta^2 = .02$, suggesting that additive counterfactuals exerted qualitative, as opposed to quantitative, effects on performance (e.g., Hirt, Levine, McDonald, Melton, & Martin, 1997).

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