IMPROVING WORKPLACE SAFETY BY THINKING ABOUT WHAT MIGHT HAVE BEEN: TO WHAT EXTENT, WHY, AND WHEN DOES COUNTERFACTUAL THINKING INFLUENCE WORKPLACE SAFETY BEHAVIOR?

A Thesis

by

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ABSTRACT

Human information processing theories of workplace safety suggest that cognition is an antecedent of safety behavior. However, little research has directly tested cognitive variables as predictors of workplace safety within the industrial/organizational psychology research domain. Counterfactual thinking is defined as cognitions about what might have been. Social psychologists propose that counterfactual thinking can be functional as it alters future behavior in a manner that is consistent with better outcomes. The purpose of the current study was to examine the influence of counterfactual thinking on safety behavior and mediators and moderators of that relationship. Safety knowledge and motivation are hypothesized to be two explanatory mechanisms for this relationship, and safety locus of control is proposed to enhance this relationship. A sample of 240 medical providers from a hospital in Guizhou Province of China responded to three surveys over a four-month time frame. Results showed that overall and upward counterfactual thinking (reflecting on how past events could have been better) were positively related to safety compliance and participation, which were mediated by safety knowledge but not by safety motivation. Furthermore, upward counterfactuals were found to be more strongly related to safety compliance and participation and safety knowledge than downward counterfactuals (reflecting on how past events could have been worse). Contrary to expectations, these relationships were not dependent on safety locus of control. In sum, the findings demonstrated that counterfactual thinking is positively associated with safety behavior and

safety knowledge, expanding the variables related to workplace safety and laying some initial groundwork for new safety interventions.

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INTRODUCTION

Workplace safety is critical to organizations, as incidents can result in property damage, worker injuries, or both, which in turn can lead to significant employee suffering and substantial financial costs to the organization. Workplace accidents result in millions of nonfatal injuries and illnesses, thousands of fatalities, and billions of dollars in costs (Liberty Mutual Research Institute for Safety, 2016; U.S. Bureau of Labor Statistics, 2015). For example, a 2015 economic report indicated nearly 66,000 workplace deaths in China (National Bureau of Statistics of the People's Republic of China, 2016). Therefore, it is critical for researchers to identify antecedents of workplace accidents and injuries, so that organizations can direct their efforts toward improving workplace safety and maintaining employees' physical well-being.

Workplace safety is a multi-disciplinary topic of interest to researchers. As a result, numerous theoretical models of workplace safety have been proposed and empirically tested within these various domains including Industrial/Organizational (I/O) psychology (e.g., Christian, Bradley, Wallace, & Burke, 2009; Neal & Griffin, 2004), human factors psychology (e.g., Kobes, Helsloot, de Vries, & Post, 2010; Proctor & Vu, 2010), and cognitive psychology (e.g., Ranney, 1994). Each discipline approaches workplace safety from a different level of analysis or perspective. I/O psychologists tend to study individuals, workgroups, and organizations. Therefore, models of workplace safety tend to be at the individual or group level of analysis. Human factors tend to study workplace safety from an

event-oriented perspective, modeling all the antecedents that contribute to a specific (often unsafe) event, like an incident. Cognitive psychologists are likely to take a much more micro-oriented perspective and analyze workplace safety at the task-level of analysis.

As a result, there is relatively little overlap in the theoretical models of workplace safety across disciplines making the prediction of workplace safety based on only one of these theoretical models arguably incomplete. For example, whereas cognition has been included in human factors models of workplace safety (Proctor & Vu, 2010), cognitive processes have not traditionally been included in workplace safety models in the I/O psychology literature.

The focus of this study is on the influence of a specific type of cognition, counterfactual thinking, on workplace safety, relative to other known predictors of workplace safety in the I/O psychology literature. Counterfactuals are thoughts of what might have been toward past negative events, actions, or states (Roese, 1997). According to the functional theory of counterfactual thinking, counterfactual thoughts are activated by past negative events which can evoke a change in behavior to make progress and improvements in the future (Epstude & Roese, 2008). It is proposed that employees who experience safety-related events in the workplace have the opportunity to reflect on those events. For example, employees might personally experience a minor injury. Subsequent counterfactual thinking could facilitate learning from that experience and lead to new behavioral strategies which in turn result in less workplace injuries.

This study is a relatively novel attempt to examine the extent to which counterfactual thinking can have meaningful and important applied implications for workplace safety. Beyond examining the direct relationship between counterfactual thinking and safety behavior, safety knowledge and safety motivation are proposed to be two underlying mechanisms explaining why counterfactual thinking is expected to relate to safety behavior. Additionally, an internal safety locus of control is proposed to enhance the counterfactual thinking-safety knowledge/motivation relationships. Correspondingly, there are three primary study objectives. The first objective is to determine the extent to which counterfactual thinking is positively related to supervisor-reported safety behavior. Assuming support for this relationship, the second objective is to test the extent to which safety knowledge and safety motivation serve as explanatory mechanisms (i.e., mediators) of the relationship between counterfactual thinking and safety behavior. The final objective is to examine the extent to which safety locus of control serves as a potential boundary condition for the counterfactual thinking-safety behavior relationship.

Antecedents of Workplace Safety

I/O psychology safety researchers have proposed various models of workplace safety and identified multiple determinants of workplace accidents and injuries. For example, Neal and Griffin (2004) offered a framework for conceptualizing safety climate and safety behavior in which the work environment (safety climate and organizational factors) and individual employee attitudes and individual differences are antecedents of

safety knowledge and motivation. These variables are depicted as determinants of safety performance which in turn lead to safety outcomes.

Christian, Bradley, Wallace, and Burke (2009) developed an integrated model of workplace safety (see Figure 1) grounded in Neal and Griffin's (2004) framework for conceptualizing safety climate and safety behavior. They differentiate person-related and situation-related distal predictors of workplace safety. Distal factors are expected to influence the more proximal person-related factors: safety motivation and safety knowledge. Moving from right to left within Christian et al.'s (2009) model, the most proximal cause of workplace accidents and injuries is safety behavior (Christian et al., 2009; Neal & Griffin, 2004). *Safety behavior* refers to actions that individuals engage in to promote the health and safety of employees, customers, and the environment (Burke, Sarpy, Tesluk, & Smith-Crowe, 2002). Based on the distinction between task and contextual performance (Borman & Motowidlo, 1993), researchers differentiate between two types of safety behaviors (Griffin & Neal, 2000; Neal, Griffin, & Hart, 2000). *Safety compliance* refers to "generally mandated" safety behaviors to maintain workplace safety, which include adhering to standard safety procedures and wearing personal protective equipment (Christian et al., 2009; Neal, Griffin, & Hart, 2000). *Safety participation* refers to the "frequently voluntary" safety behaviors, which describe behaviors that contribute to the safety environment in organizations, not just an individual's personal safety. Some examples of participation behaviors include voluntarily attending safety meetings and

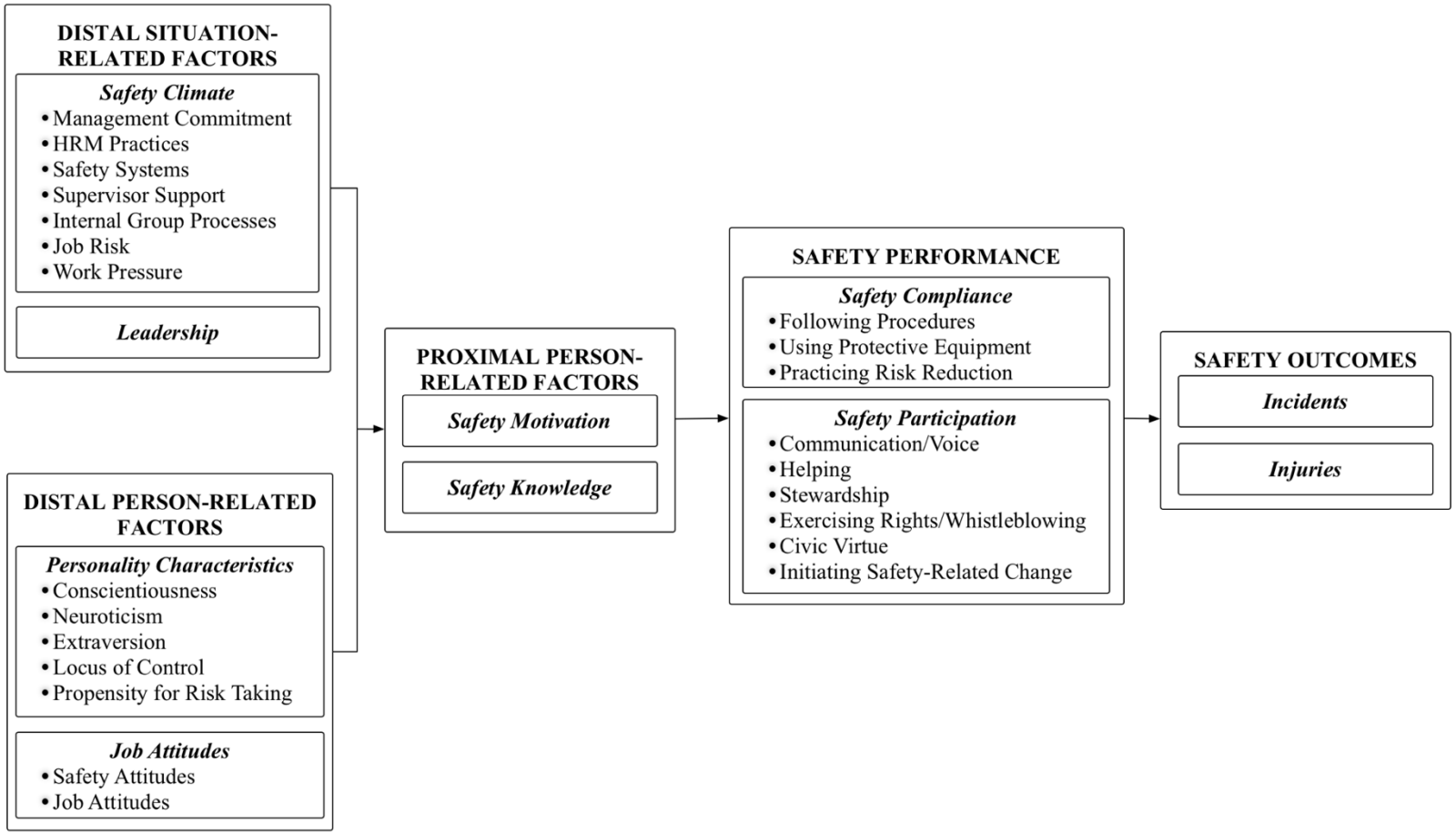

Figure 1. An integrative model of workplace safety (Christian et al., 2009)

helping coworkers with safety problems. In this study, both safety compliance and safety participation will be measured.

Cognition and Workplace Safety

The focus of this study is on the influence of counterfactual thinking on individual employee workplace safety knowledge, motivation, and behavior. Counterfactual thinking is an event-based cognitive process which consists of perception and interpretation of situations, knowledge structures, and beliefs (Breckler, 1984; Rosenberg & Hovland, 1960).

Despite the absence of cognition from workplace safety models published in the I/O psychology literature, human factors psychologists have long recognized the role that cognitions play in workplace safety. In fact, the *information processing approach*, a conceptual framework in which humans are characterized as communication systems comprised of various processes to manage information flow underlies an extensive amount of human factors research (Proctor & Vu, 2010). Building on the information processing approach, the accident sequence model illustrates multiple stages in the occurrence or prevention of incidents when individuals are exposed to hazardous situations (Figure 2, adapted from Ramsey, 1985). As depicted in the accident sequence model, an individual will first perceive the hazard, mentally interpret it, make a decision to avoid it, and then attempt to avoid it. Additionally, several cognitive factors (e.g., mental abilities and memory abilities) are proposed to influence each stage of the process. As noted in this model, experience is expected to influence the cognition (interpretation) of a hazard and the

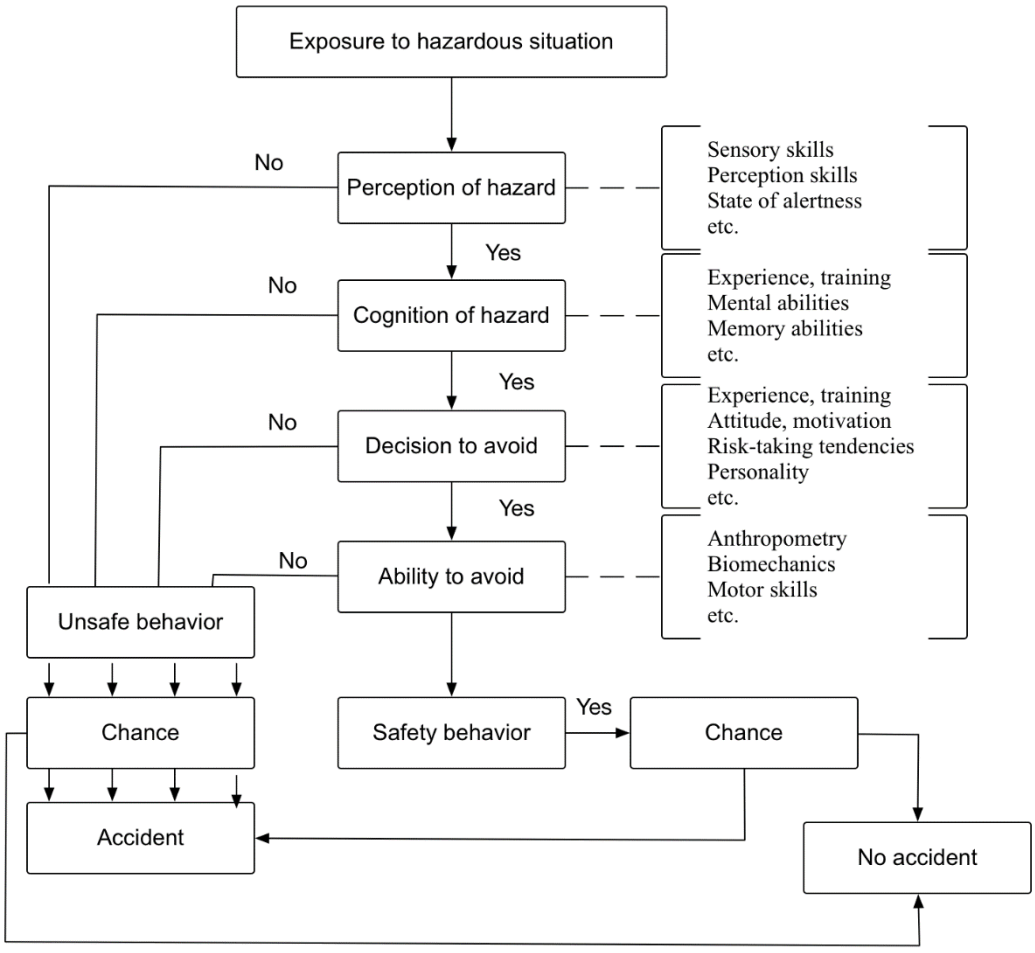

Figure 2. The accident sequence model (adapted from Ramsey, 1985)

decision to avoid it. Correspondingly, counterfactual thinking, a series of cognitive processes, is expected to influence the interpretation of hazards and decisions to avoid them. It seems that past experiences and counterfactual thinking might also influence perceptions of hazards in the first place.

Together, the accident sequence model and empirical studies informing and validating this model (e.g., Hayashi, 1985; Khan, Halim, & Iqbal, 2006) demonstrate the influence of cognitive processes on safety behavior. Correspondingly, I modified Christen et al.'s (2009) model adding cognitive processes as an antecedent of workplace safety and a reciprocal loop in which safety outcomes influence distal situation- and person-related factors (see dashed lines and box in Figure 3).

Counterfactual Thinking

Counterfactual thoughts are mental representations of alternatives to past occurrences, actions, features, and states (Epstude & Roese, 2008; Roese, 1997). They are thoughts about "what might have been" to specific situations or events —reflecting on alternative outcomes. In everyday life, counterfactuals take the form of ''if-then" conditional propositions in which the ''if" specifies an antecedent such as a person, action, or a circumstance change and the ''then" specifies a consequent or outcome.

The consideration of "what might have been" originated with philosophers such as Aristotle and Plato who contemplated the status of subjunctive conditions and nonexistent but tangible ideal outcomes in their writings. In the seventeenth century, the German

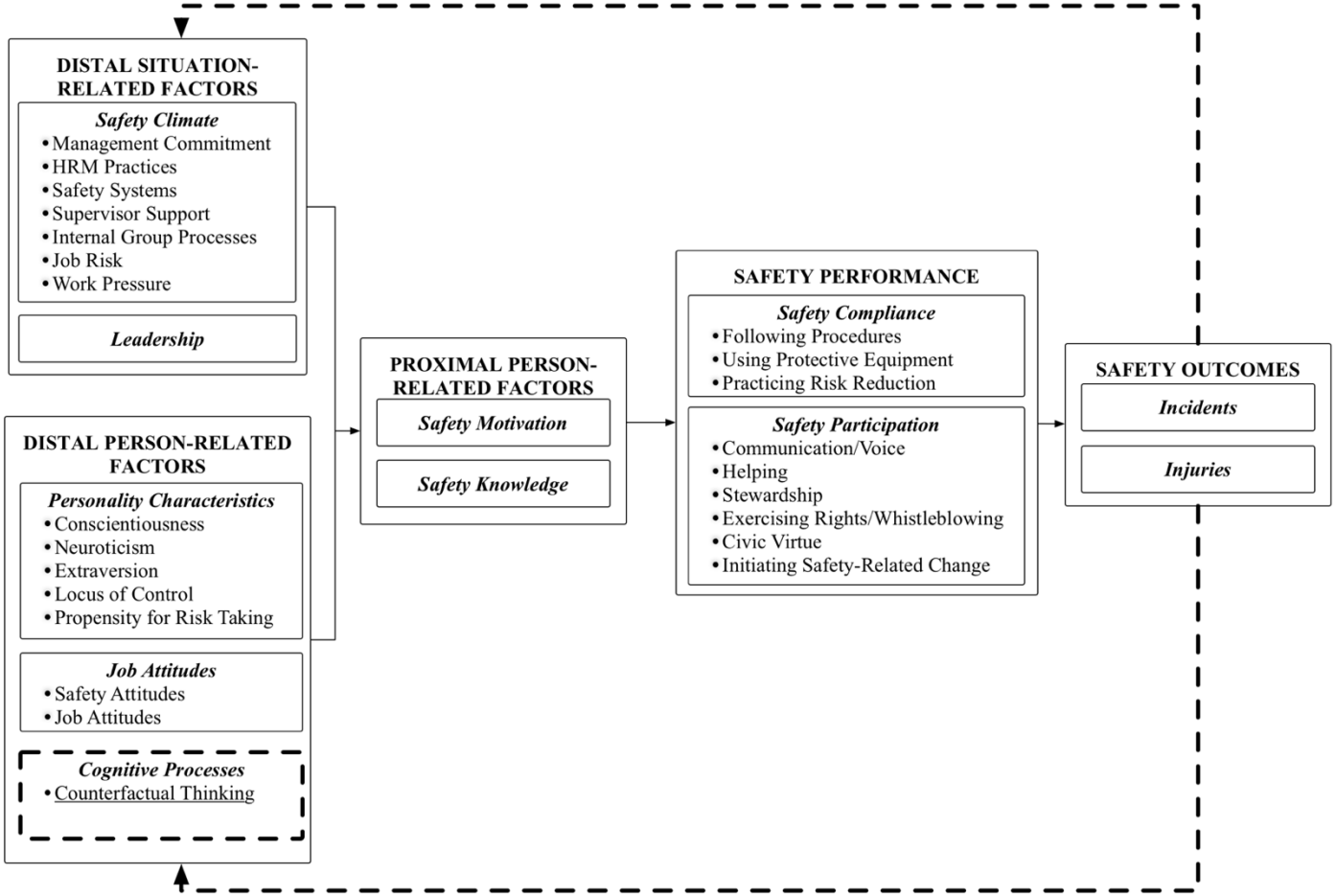

Figure 3. A modified integrative model of workplace safety (adapted from Christian et al., 2009)

philosopher, Leibniz, embraced these ideas by arguing that an infinite number of possible worlds or alternate realities could possibly exist on condition that they didn't contradict laws of logic (Roese, 1997; Roese, & Olson, 2014). A counterfactual thought typically posits an imaginary possible world that has some features different from the real world. Unlike philosophical counterparts, sociopsychological approaches to counterfactual thinking examine the totality of an individual's cognitive functioning within a social context (Roese, 1997). Although counterfactual thinking is an event-driven cognitive process and often assessed relative to a specific event, researchers have also assessed engagement in these thought processes more generally or globally in terms of an overall tendency to engage in counterfactual thinking (Rye et al., 2008). It can be assessed at the individual person-level of analysis in that some people will engage in this cognitive process following a specific event more so than others, despite having the same or very similar experience. Thus the act of engaging in counterfactual thinking varies across individuals. Further, some people will proceed to reflect on this event quite extensively, whereas others may only think about the event for a relatively brief period of time. Thus, the extent to which individuals engage in counterfactual thinking about a specific event will vary across individuals (Kasimatis & Wells, 1995). In a nutshell, across events, there is likely to be between-person variability in the extent to which individuals engage in counterfactual thinking.

Over the past several decades, counterfactual thinking has received considerable

attention by social psychologists (Roese, 1997). The propensity to wonder about what might have been, about alternatives to past events, is a pervasive feature of human thinking (Roese, 1994). For example, "if I had studied harder, I would have gotten better grades", "If I had cared more about my partner, I would have not lost my love". Surprising or negative life events tend to increase an individual's propensity for generating counterfactuals (e.g., Epstude & Roese, 2008; Miller, Turnbull, & McFarland, 1990; Roese, 1994). This research has extended our understanding of counterfactuals and their influence on various outcomes in multiple areas of psychology. Counterfactuals influence an individuals' reasoning about, and meaning ascribed to, past events (McAdams & Albaugh, 2008) and impact a range of judgments such as decision-making and blame (Roese, 1997). Counterfactuals also impact a range of cognitive and affective reactions including causal ascriptions (Wells & Gavanski, 1989), persistence (Markman, McMullen, & Elizaga, 2008), regret and disappointment (Zeelenberg, van Dijk, Van der Pligt, Manstead, Van Empelen, & Reinderman, 1998), and happiness (J. T. Johnson, 1986).

Upward versus Downward Counterfactuals. There are a number of different characteristics on which counterfactual thinking can be differentiated and organized. Perhaps the most studied counterfactual characteristic is the *direction* of the counterfactual - whether the alternative outcome is better or worse than what originally occurred. *Upward* counterfactuals involve better alternatives (e.g., "if I had worn gloves, I would have protected myself from the patient's blood"). Contrarily, *downward* counterfactuals involve

worse alternatives (e.g., "if the patient's blood splattered on my skin, I would have been infected" (Markman, Gavanski, Sherman, & McMullen, 1993; Roese, 1994).

Upward counterfactuals benefit individuals' performance by envisioning future changes and elevating intentions to perform future success-facilitating behaviors (Krishnamurthy & Sivaraman, 2002; Landman, Vandewater, Stewart, & Malley, 1995; Roese, 1994). Nasco and Marsh (1999) showed that upward counterfactual thinking enhanced individuals' subjective control and led to better performance. Using an anagram paradigm, Markman et al. (2008) examined the relationship between counterfactual thinking and persistence. They found that upward counterfactual thinking was associated with a higher level of persistence, which enhanced performance in subsequent tasks. Several empirical studies have demonstrated that upward counterfactuals have stronger effects on performance than downward ones (e.g., Krishnamurthy & Sivaraman, 2002; Morris & Moore, 2000; Roese, 1994). Both upward and downward counterfactual thinking are measured in the current study.

Self versus Other Counterfactuals. Counterfactual researchers also differentiate counterfactuals based on *self-* and *other-referents*. The self versus other distinction simply distinguishes between a focus on the actions of oneself or other people (Roese & Olson, 1995). For example, "I should have worn gloves to avoid exposure to the patient's blood" versus "The patient should have followed my instructions during a blood test." The focus of this study is on the direction (upward vs. downward), not the referent, of counterfactuals.

Functional Theory of Counterfactual Thinking

Social psychologists propose that counterfactual thinking is a beneficial component of behavior regulation that may help to promote performance and facilitate improvement in behavior (Epstude & Roese, 2008; Markman & McMullen, 2003; Roese, 1994, 1999). According to the functional theory of counterfactual thinking, counterfactuals are activated by errors, problems, or other negative experiences, and should induce corresponding behaviors that avoid these negative experiences in the future (Epstude & Roese, 2008).

Counterfactual thoughts are believed to serve a behavior-regulating function by eliciting cognitive and affective functions (Roese & Epstude, in press; Roese & Olson, 1997). The cognitive mechanism involves incorporating the information from the counterfactual inference (i.e., the lesson learned or the causal inferences of a particular action) into behavioral intentions, which in turn evoke corresponding behaviors to avoid the negative situation. Additionally, counterfactual thinking also operates through an affective mechanism which increases an individual's motivation to demonstrate effective behaviors (Epstude & Roese, 2008; Roese & Epstude, in press). These two processes are not mutually exclusive; in other words, they can occur simultaneously.

In terms of a cognitive mechanism, counterfactuals influence behaviors through a regulatory loop consisting of a negative event (e.g., accident), followed by a counterfactual thought and cognitive inference, behavioral intentions to engage in behavior that will improve the outcome, followed by the corresponding behavior to avoid similar negative

events in the future (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001; Roese & Olson, 1997). This process includes three important contingencies: (1) negative events activate counterfactual thinking, (2) counterfactual thinking activates a behavioral intention, and (3) the behavioral intention leads to corresponding behavior. This regulatory loop maintains homeostasis by increasing behaviors when facing problems and decreasing behaviors when problems are solved (Epstude & Roese, 2008).

With regard to the affective mechanism, counterfactual thinking triggers affective reactions (Roese, 1994), which motivate individuals to change their behavior to improve performance. Research in social psychology has demonstrated empirical support for affective effects of counterfactual thinking (e.g., Markman, McMullen, & Elizaga, 2008; McMullen & Markman, 2000). Negative affect triggered by upward counterfactuals (i.e., feeling bad because something better could have happened) or downward counterfactuals (i.e., feeling bad because something worse could have happened) motivates individuals to exert greater effort and striving on a subsequent task (Markman et al., 2008; McMullen & Markman, 2000), which should theoretically result in better performance.

Counterfactual Thinking and Health-related Behavior

As noted earlier, there are a number of safety-related events in the workplace that could trigger counterfactual thoughts about workplace safety. These include actual incidents that result in injury or property damage, as well as "near misses" (also called near accidents or close calls in which something with significant consequences almost occurred).

These events are expected to activate counterfactual thinking (Dillon & Tinsley, 2008), which in turn produce corresponding corrective behaviors that could result in less workplace injuries and incidents. For example, a medical provider might think "if I had bent my knees when lifting the patient, I would not have injured my back."

Although there are numerous studies of counterfactual thinking, relatively few studies have examined counterfactual thinking with regard to safe or unsafe behavior. Within social psychology, some researchers have begun to examine counterfactual thinking with regard to personal health and safety. For example, Epstude and Jonas (2014) conducted a study on sexual behavior using a sample of participants who were HIV-positive. Participants were asked to write down an "if only" thought about their HIV infection, perceptions of control related to their infection, and intentions for future safe behavior. Two independent raters coded the responses for the inclusion of a counterfactual thought. The findings revealed that 39.5% participants reported one or more counterfactuals regarding their infection and these individuals had stronger intentions to practice safe sex in the future than participants who did not produce counterfactual thoughts.

Page and Colby (2003) designed a series of four experiments to examine the role of counterfactuals on anti-smoking behaviors using a sample of college students. Participants were randomly assigned to an upward or downward counterfactual condition and then asked to generate corresponding counterfactuals in response to a detrimental smoking scenario. Then they were asked to rate their affective reactions toward that scenario as well

as their intentions to participate in a smoking-related behavioral test (i.e., a lung-capacity test). Page and Colby found that upward counterfactuals had a negative effect on individuals' affective evaluations of the detrimental smoking scenario. However, they found no impact of upward counterfactuals on individuals' willingness to schedule a lung-capacity test.

Ramos and colleagues (2016) examined the role of counterfactual thinking as an intervention strategy to promote adherence to the proper use of Attention-Deficit Hyperactivity Disorder (ADHD) medications. In their study, college students who read a negative scenario (misuse of the medication resulted in a trip to the hospital and poor performance on a test) generated more upward counterfactuals and fewer downward counterfactuals than those who read a positive scenario (misuse of the medication resulted in better performance on a test). Further, participants who generated counterfactual thoughts reported more positive attitudes toward ADHD medication than those who did not generate counterfactuals. However, unexpectedly, upward counterfactuals were associated with more positive attitudes toward ADHD medication than downward counterfactuals. One explanation is that under some conditions, upward counterfactuals provide justification or excuses for negative behaviors or outcomes, resulting in dysfunctional consequences (Petrocelli, Seta, Seta, & Prince, 2012).

The association of upward counterfactuals with functional outcomes is a relatively robust phenomenon in the broad counterfactual literature (Roese, 1994; Schwartz & Bless,

1992; Sherif & Hovland, 1961) as it helps individuals to identify preparative behaviors for the prevention of negative outcomes in the future. However, the association of upward counterfactuals with health-related attitudes and behavior appears to be quite mixed and inconclusive to date, warranting additional research.

Counterfactual Thinking and Workplace Safety Behavior

Within the I/O psychology literature, there appear to be only three articles describing research examining counterfactual thinking with regard to workplace safety. The first publication linking counterfactual thinking to workplace safety describes a series of two studies conducted by Morris and Moore (2000). They explored the relationship between counterfactual thinking and learning by coding narrative reports about near misses submitted by experienced pilots to the Aviation Safety Reporting System, a near miss database. They coded the statements about counterfactual alternatives to near incidents and their intentions to prevent a reoccurrence in the future. Their findings suggested that self-focused, upward counterfactuals were positively associated with safety-related lessons from work experiences, which serve as prescriptions for future behavior.

Morris, Moore, and Sim (1999) conducted a series of two experimental studies exploring the role of counterfactual thinking in the decision-making processes in which organizational decision-makers respond to incidents or injuries with remedy plans that focused on human error correction or generally focused on environments or systems. They asked a sample of management students to generate "if only" statements in response to the

incident and then to make decisions on how to remedy the existing problem. Then, they tested the generalizability of their findings on a sample of museum goers. The results indicated that a substantial portion of participants proposed to use human-focused remedies rather than environment-focused remedies after they generated "if only" thoughts about the incident. This reflects that "if only" thoughts are associated with more human-focused actions and subsequent human-focused remedies at a greater rate than would occur otherwise.

Baran, Beck, and Antes (2015) presented a study exploring learning from near misses by analyzing 247 reports from the National Firefighter Near Misses Reporting System. They created a coding scheme to measure narrative details of the near misses, self-report of learning from them, and engagement of various types of counterfactual thoughts. The results revealed that a higher level of engagement in success-oriented thinking (similar to upward counterfactual thinking) led to greater learning from near misses, which helps to formulate appropriate corrective actions in the future. In summary, research to date on counterfactual thinking and workplace safety-related variables suggests that counterfactual thinking is functional as it supports learning from previous experiences, is associated with intentions to engage in safe behavior, and shapes remedy decisions in response to the safety-related events. Table 1 summarizes the characteristics of counterfactual thinking that are predicted to promote workplace safety.

Table 1

Characteristics of Counterfactual Thinking that Promote Workplace Safety Behavior

CFT Characteristic	Description	Example	Supporting Studies	Findings
Upward vs. Downward	Comparison of an actual outcome to a better (upward) or worse (downward) alternative	"If I had worn gloves, I would have protected myself from the patient's blood" (upward) "If the patient's blood had splashed on me, I might have been infected by the patient's blood." (downward)	Morris & Moore, 2000	Compared to downward counterfactuals, upward counterfactuals were associated with greater self-report of learning from negative outcomes, which may help to improve safety performance.
Additive vs. Subtractive (Action vs. Inaction)	Addition or subtraction of an aspect from the present state	"I should have worn gloves to protect myself from blood." (additive) "I should not have talked to coworkers while drawing blood." (subtractive)	Page & Colby, 2003	Compared to subtractive counterfactuals, additive counterfactuals had a positive impact on individuals' willingness to schedule a lung-capacity test.

Table 1

Continued

CFT Characteristic	Description	Example	Supporting Studies	Findings
Self vs. Other	Focus is on the actions of oneself or other people	"I should have worn gloves to avoid exposure to the patient's blood" (self) "The patient should have followed my instructions during a blood test." (other)	Morris & Moore, 2000	Self-focused, upward counterfactuals can facilitate performance-improving lessons from safety outcomes (more so than other types of counterfactual such as other-focused, upward counterfactual).
Controllable vs. Uncontrollable	The controllability of the events	"If I had worn gloves, I would have protected myself from the patient's blood" (controllable) "It is beyond my ability to save that patient without matched bone marrow." (uncontrollable)		

Hypothesis 1: Counterfactual thinking is positively related to (a) safety compliance and (b) safety participation.

Upward versus Downward Counterfactuals and Safety Behavior

The strength of the effect that counterfactuals have on safety behaviors may depend on whether they are upward or downward. Upward alternatives might be interpreted as schemas or scripts for safe future actions (Roese, 1994). Consequently, individuals focusing on better outcomes should be motivated to make the workplace safer. Thinking about better alternatives could trigger several negative emotions (e.g., regret, disappointment, shame, guilt; Mandel, 2003; Miller & Taylor, 1995; Niedenthal, Tangney, Price, & Gavanski, 1994), prompting individuals to make improvements in safety performance to avoid such feelings. Moreover, upward counterfactuals are likely to increase feelings of perceived control (Nasco & Marsh, 1999) and self-efficacy (Tal-Or, Boninger, Poran, & Gleicher, 2004), which are likely to positively influence individuals' subsequent effort and persistence to be safe (Brown, Willis, & Prussia, 2000).

Hypothesis 2: Upward counterfactual thinking is positively related to (a) safety compliance and (b) safety participation.

Downward counterfactual thinking may be either functional or dysfunctional depending on whether it elicits *contrast* or *assimilation effects* (e.g., Markman, McMullen, & Elizaga, 2008; McMullen & Markman, 2000). Contrast effects occur when the evaluation of an existing outcome is displaced in a direction away from the hypothetical alternative

outcome (Hovland, Harvey, & Sherif, 1957; Sherif & Hovland, 1961). Through contrast effects, an existing outcome may appear better compared to a less desirable alternative or worse compared to a more desirable alternative. Assimilation effects occur when the evaluation of an existing outcome shifts toward that hypothetical outcome (Hovland et al., 1957; Sherif & Hovland, 1961). By way of assimilation effects, focusing on an alternative outcome may drive individuals to assimilate the emotions or attitudes contained in it.

Specifically, downward counterfactuals, in which employees reflect on worse alternatives, could be functional when individuals focus on those worse alternatives and assimilate negative emotions (e.g., sadness, anxiety) contained in those worse outcomes, as such negative emotions may prompt individuals to be safer by virtue of not wanting to experience those negative emotions (Markman & McMullen, 2003; McMullen, 1997). It is possible, however, that downward counterfactual thinking could trigger contrast effects resulting in positive affective reactions as the employee could be grateful that the worse outcome did not happen and therefore experience relief and happiness that the worse alternative did not occur. In fact, Dillon and Tinsley (2008) found that people were more likely to interpret near misses as "events that almost happened" and therefore successes rather than failures "that could have happened". Further, they reported that counterfactual thinking and subsequent learning does not occur as much as it should following a near miss. Instead, the employee might be satisfied with the status quo and be less motivated to change behaviors. In this situation, the worse outcome is particularly salient, thus prompting

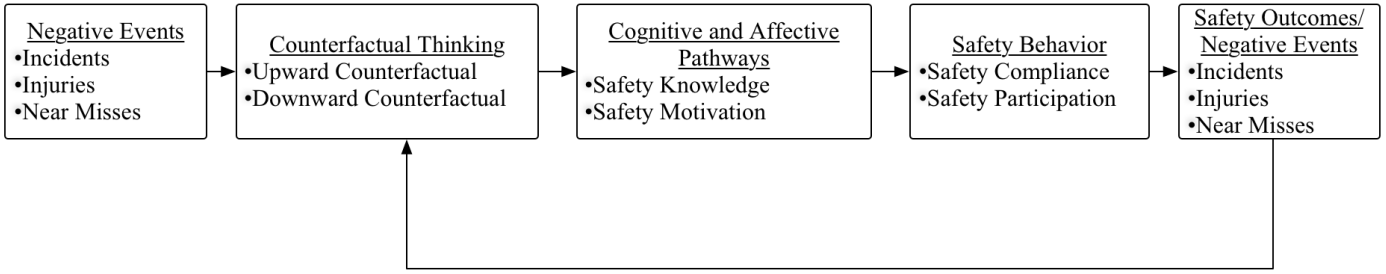

Figure 4. The hypothesized influence of counterfactual thinking on workplace safety

downward counterfactuals. Therefore, the functionality of downward counterfactual thinking on safety behavior may be dependent on the emotions that follow the thoughts.

Nevertheless, given the extensive empirical support for upward counterfactuals to have a stronger effect on behavior than downward counterfactuals (Krishnamurthy & Sivaraman, 2002; Morris & Moore, 2000; Roese, 1994), it is expected that upward counterfactuals will be more strongly related to safety behavior than downward counterfactuals.

Hypothesis 3: Upward counterfactual thinking is more strongly related to (a) safety compliance and (b) safety participation than downward counterfactual thinking.

Safety Knowledge and Safety Motivation as Counterfactual Pathways

Integrating Neal and Griffin's (2004) framework for conceptualizing safety climate and safety behavior with the functional theory of counterfactual thinking (Epstude & Roese, 2008) implies that safety knowledge and motivation are potential mechanisms, explaining why counterfactual thinking would lead to safe behavior. A pictorial representation combining elements of Neal and Griffin's (2004) framework with the functional theory of counterfactual thinking appears in Figure 4.

Safety Knowledge. *Safety knowledge* is defined as an employee's understanding of safety instructions and safety procedures (Probst & Brubaker, 2001). For example, safety-related information (e.g., risks, value of protective equipment) from a counterfactual inference could alter behavioral intentions (e.g., plans to put on gloves before drawing

blood), which in turn are expected to result in corresponding safety behaviors (e.g., always wearing gloves when drawing blood). Counterfactual thinking is expected to relate positively to safety knowledge as reflecting on alternative realities is likely to promote learning. With regard to the direction of counterfactuals, upward counterfactuals are especially beneficial for promoting learning (Morris & Moore, 2000). Given the numerous positive outcomes associated with upward counterfactuals, they are proposed to result in more learning and therefore a higher level of safety knowledge than downward counterfactuals.

Hypothesis 4: Counterfactual thinking is positively related to safety knowledge.

Hypothesis 5: Upward counterfactual thinking is positively related to safety knowledge

Hypothesis 6: Upward counterfactual thinking is more strongly related to safety knowledge than downward counterfactual thinking.

Safety knowledge is proposed to be a cognitive pathway by which counterfactuals enhance safety behavior. Counterfactual thinking prompts individuals to think about alternative behaviors, situational characteristics, and outcomes, expanding the way they think about specific events. As a result, employees are likely to come up with alternative solutions to safety-related challenges or problems. Consistent with this theorizing, Morris and Moore (2000) found that counterfactual thinking, especially upward and self-focused counterfactuals, promotes learning in how to behave more safely in the future. In addition,

negative affect evoked by a counterfactual judgment about a safety-related event might result in greater effort to seek information that is useful to prevent a reoccurrence. Ideally, this newly acquired knowledge will lead to safer behavior in the future. Research in social psychology has indicated that one kind of negative affect (i.e., regret) following counterfactual thinking played a functional role in learning to achieve a better outcome and avoid future regret (Coricelli & Rustichini, 2010). Summerville (2011) demonstrated that when individuals experienced disappointment with the outcomes compared to better alternatives, they were more inclined to seek information and means to minimize this discrepancy.

Hypothesis 7: The relationships between counterfactual thinking and (a) safety compliance and (b) safety participation are mediated by safety knowledge.

Hypothesis 8: The relationships between upward counterfactual thinking and (a) safety compliance and (b) safety participation are mediated by safety knowledge.

Safety Motivation. *Safety motivation* is an employee's willingness to exert effort to perform a job in a safe manner (Christian et al., 2009; Neal & Griffin, 2006). Glove wearing counterfactuals might increase an individual's motivation to wear other personal protective equipment such as gowns, aprons, masks, and goggles to avoid exposure to bodily fluids. Counterfactual thinking is expected to positively relate to safety motivation and upward counterfactual thinking is especially useful for inducing motivation (Markman

et al., 2008). Thus, upward counterfactual thinking is proposed to have a stronger effect than downward counterfactual thinking.

Hypothesis 9: Counterfactual thinking is positively related to safety motivation.

Hypothesis 10: Upward counterfactual thinking is positively related to safety motivation.

Hypothesis 11: Upward counterfactual thinking is more strongly related to safety motivation than downward counterfactual thinking.

Safety motivation is proposed to mediate the influence of counterfactuals on safety behavior by way of inducing affective responses. Negative affect induced by counterfactuals are expected to increase motivation to expend greater effort to engage in greater cognitive activity directed at self-enhancement, and to seek more ways that could have changed the outcome (Roese & Olson, 1995). Moreover, counterfactual thoughts about negative events following unsafe behavior are expected to help employees establish a reference point, likely related to a safer outcome, to which the present may be compared. This goal could induce a desired end state (Förster, Liberman, & Friedman, 2007), which serves as a strong motivator to initiate action to achieve the goal.

Hypothesis 12: The relationships between counterfactual thinking and (a) safety compliance and (b) safety participation are mediated by safety motivation.

Hypothesis 13: The relationships between upward counterfactual thinking and (a) safety compliance and (b) safety participation are mediated by safety motivation.

Hypothesis 14a: The mediating effect of safety knowledge on the relationship between counterfactual thinking and safety compliance is stronger than the mediating effect of safety motivation on the relationship between counterfactual thinking and safety compliance.

Hypothesis 14b: The mediating effect of safety knowledge on the relationship between upward counterfactual thinking and safety compliance is stronger than the mediating effect of safety motivation on the relationship between upward counterfactual thinking and safety compliance.

Hypothesis 15a: The mediating effect of safety motivation on the relationship between counterfactual thinking and safety participation is stronger than the mediating effect of safety knowledge on the relationship between counterfactual thinking and safety participation.

Hypothesis 15b: The mediating effect of safety motivation on the relationship between upward counterfactual thinking and safety participation is stronger than the mediating effect of safety knowledge on the relationship between upward counterfactual thinking and safety participation.

A Potential Moderator: Safety Locus of Control

Individual differences may influence how much individuals learn and are motivated by counterfactuals. One individual difference variable that may impact this process is locus of control. Locus of control is the extent to which individuals feel that the events in their

lives are personally controlled versus controlled by external factors such as fate and luck (Rotter, 1966). An *internal* locus of control represents the belief that life events are personally controlled, whereas an *external* locus of control represents the belief that life events are dependent on external forces (Rotter, 1966). Related to this, counterfactual researchers have noted that the controllability of an event is related to efforts to make improvements elicited by counterfactuals (Girotto, Legrenzi, & Rizzo, 1991). In other words, individuals who generate controllable counterfactuals (behaviors within their control) tend to have stronger intentions to change behavior than those who generate uncontrollable counterfactuals (events that are not within their control).

Safety locus of control, as opposed to generalized locus of control, is the extent to which individuals believe that safety-related events could be personally controlled or determined by external factors (Jones & Wuebker, 1985; 1993). Although some researchers examine locus of control as a unidimensional construct, Joe (1971) and Rotter (1975) conceptualize and advocate for measuring locus of control as a multidimensional construct. Thus, both internal and external locus of control will be measured in the current study. Both locus of control and safety locus of control have been studied extensively in the safety literature. For example, Jones and Wuebker (1993) found that employees with an external safety locus of control reported more occupational injuries than employees with an internal safety locus of control. Christian et al.'s (2009) meta-analysis demonstrated that locus of

control was positively associated with safety behavior and negatively associated with safety outcomes (e.g., injuries).

Internal safety locus of control is proposed to moderate the relationship between counterfactuals and safety knowledge and motivation, such that individuals with an internal locus of control are likely to experience stronger relationships than individuals with an external locus of control. As noted earlier, counterfactuals evoked by negative events are expected to activate behavioral intentions to improve the outcome (Epstude & Roese, 2008). An internal safety locus of control is expected to exacerbate this relationship by influencing employees' intentions to learn from counterfactuals and engage in safety actions. In contrast, individuals who believe injuries and accidents are caused primarily by external factors will regard safety-related knowledge, motivation and behaviors as less useful, and thus less likely to put effort into learning about safety practices and changing behaviors. Correspondingly, internal safety locus of control is expected to strengthen the relationship between counterfactuals and safety knowledge and motivation. The conceptual model of the hypothesized relationships is shown in Figure 5.

Hypothesis 16: Internal safety locus of control moderates the relationships between counterfactual thinking and (a) safety knowledge and (b) safety motivation, such that individuals with higher internal locus of control are likely to experience stronger relationships than individuals with lower internal locus of control.

Hypothesis 17: Internal safety locus of control moderates the relationships between upward counterfactual thinking and (a) safety knowledge and (b) safety motivation, such that individuals with higher internal locus of control are likely to experience stronger relationships than individuals with lower internal locus of control.

Hypothesis 18: External safety locus of control moderates the relationships between counterfactual thinking and (a) safety knowledge and (b) safety motivation, such that individuals with higher external locus of control are likely to experience weaker relationships than individuals with lower external locus of control.

Hypothesis 19: External safety locus of control moderates the relationships between upward counterfactual thinking and (a) safety knowledge and (b) safety motivation, such that individuals with higher external locus of control are likely to experience weaker relationships than individuals with lower external locus of control.

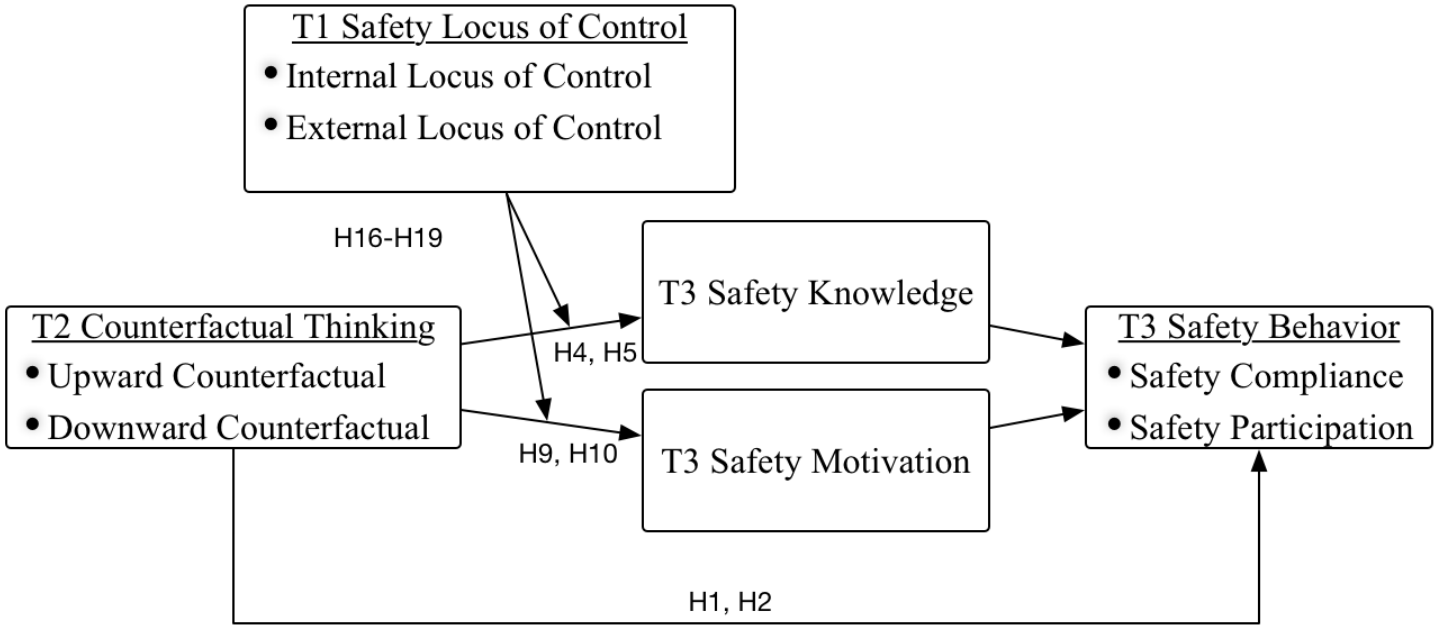

Figure 5. The conceptual model of the hypothesized relationships

METHOD

Participants and Procedure

Healthcare employees (e.g., nurses, doctors, and administrators) and their supervisors were recruited from a hospital in Guizhou Province in China to participate in a study about workplace safety. Employees were asked to complete three online surveys with approximately one-month in between each administration. In the three surveys, 295, 289, and 272 employees provided usable responses, resulting in 98.3%, 96.3%, and 90.7% response rates. The final sample consisted of 240 participants who responded to all three surveys with matched supervisor ratings. A majority (71.3%) of the respondents were male. They ranged in age from 22 to 58 years old (M = 33.40, SD = 7.69). On average, participants worked in the focal hospital for 8.53 (SD = 8.39) years. A total of 33 supervisors provided ratings for employees and each supervisor rated on average 7.27 (SD = 4.42) employees.

By using a longitudinal design and gathering data from multiple sources, the potential for common method bias was minimized (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). At Time 1, employees responded to demographic questions (e.g., age and gender), background information (e.g., work experience and occupational title), and safety locus of control. The Time 2 survey contained measures of upward and downward counterfactual thinking. The Time 3 survey assessed safety motivation. Also at Time 3, employees were instructed to forward a link to their supervisors to complete a brief

assessment about them. Supervisors provided ratings of each employee's safety knowledge and safety behavior including safety compliance and participation. The surveys were originally written in English and then translated into Chinese using the back-translation procedure recommended by Brislin (1970), which ensures that translated versions preserve their original meaning. All surveys were administered online and linked over time and with supervisor ratings using employee identification numbers.

Measures

Counterfactual Thinking. Counterfactual thinking was measured using a scale based on Rye, Cahoon, Ali, and Daftary's (2008) counterfactual thinking for negative event scale. Counterfactual thinking was assessed using six items: three items for upward counterfactuals and three for downward ones. Participants were asked to think about a negative safety-related event that occurred in the past month while working in the hospital. Example items for upward and downward counterfactuals, respectively, were: *"I think about how much better things could have been."* and *"Although what happened was negative, it clearly could have been a lot worse."* Participants rated these items on a five-point scale (1 = "Never"; 5 = "Very Often"). Internal consistency reliabilities for upward, downward, and overall (upward and downward combined) counterfactual thinking were .88, .90, and .93, respectively.

Safety Locus of Control. Jones and Wuebker's (1985) safety locus of control scale was used to measure safety locus of control. Five of the six original items were utilized to

assess internal safety locus of control and nine items were used to assess external safety locus of control. One item (i.e., "*Most of my accidental injuries are preventable*") was not included because it refers to individuals' own accidents which may confuse participants if they have not recently experienced an injury. Example items for internal and external safety locus of control, respectively, were: "*Industrial accidents are due to employee carelessness.*" "*For me avoiding accidents is a matter of luck.*" Participants responded to all items on a five-point agreement scale. Internal consistency reliability for internal and external safety locus of control was .86 and .70, respectively.

Safety Motivation. Safety motivation was measured using six items adapted from Neal, Griffin, and Hart's (2000) measure. Three of the items assessed individuals' motivation to improve patients' safety and three of the items measured individuals' motivation to improve workgroup safety. An example item reads: *"I am driven to improve workgroup safety."* Participants rated these items on a five-point agreement scale. Internal consistency reliability was .95.

Safety Knowledge. Safety knowledge was measured using a scale of three items adopted from Griffin and Neal (2000) (e.g., *"This employee knows how to perform the job in a safe manner"*). Supervisors responded to these items on a five-point agreement scale. Internal consistency reliability was .96.

Safety Behavior. Safety behavior was measured using Griffin and Neal's (2000) two-dimensional measure. Four items were utilized to assess safety compliance (e.g., *"This*

employee uses all the necessary safety equipment to do the job") and four items were used to assess safety participation (e.g., *"This employee promotes the safety program within the organization"*). Supervisors responded to all items on a five-point agreement scale. Internal consistency reliability was .92 and .94 for safety compliance and participation, respectively.

Data Analysis

Hypotheses were tested in three steps. First, the main effects of counterfactuals on safety knowledge, motivation, and behavior (Hypotheses 1-2, 4-5 and 9-10), as well as the potential moderating effect of safety locus of control (Hypotheses 16-19) were tested using multiple regression. Second, Steiger's *z* test was utilized to examine the differences in magnitude between the effects of upward and downward counterfactuals on safety knowledge, motivation, and behavior (Hypotheses 3, 6, 11; Hoerger, 2013; Steiger, 1980). Third, simple mediation models (Hypotheses 7-8 and 12-15) were tested using a SPSS macro developed by Preacher and Hayes (2004) that facilitates an estimation of the mediation effect with a bootstrap approach to obtain confidence intervals. Bootstrapping is recommended by researchers for mediational analyses, because of its advantage to avoid power issues induced by nonnormal sampling distributions of an indirect effect (MacKinnon, Lockwood, & Williams, 2004). Consistent with recommendations in the literature, the significance of the indirect effects was determined based on the 95% bias-corrected bootstrap confidence intervals using 5,000 bootstrap samples (Preacher, Rucker,

& Hayes, 2007). Also, bootstrapping was used to obtain the standard errors for the path coefficients.

RESULTS

Because of the nested nature of the data with one supervisor rating multiple employees, supervisor ratings of employee's safety knowledge, safety compliance, and safety participation were not independent. Accordingly, the extent of the dependence was assessed using the intraclass correlation coefficient (ICC). ICC represents the percentage of variance accounted for by group differences (Hox, 2002). The ICC values for safety knowledge, safety compliance, and safety participation were 0, 0, and .65, respectively. Notably, the ICCs of the two variables (i.e., safety knowledge and safety compliance) were zero and only the ICC for safety participation had a large effect. This fluctuation may be the result of a small sample of groups ($N = 33$), which could inflate group-level variance resulting in unreliable estimates of ICC (Kreft, 1996).[1]

Descriptive statistics and correlations among the variables are presented in Table 2. The correlations indicated that counterfactual thinking was positively related to supervisor-ratings of safety knowledge ($r = .17$, $p < .001$) and safety compliance ($r = .17$, $p < .01$), but not significantly related to supervisor ratings of safety participation ($r = -.01$, $p > .05$) and

[1] Multilevel analyses revealed similar results to the single-level analyses presented in this paper.

Table 2

Descriptive Statistics and Correlations among the Variables

		M	*SD*	1	2	3	4	5	6	7	8	9	10	11
1	Age	33.40	7.69											
2	Sex	1.71	.45	.02										
3	CFT	3.09	.84	-.07	-.15*	.93								
4	Upward CFT	3.19	.89	-.05	-.12	.94**	.88							
5	Downward CFT	2.99	.88	-.08	-.16*	.94**	.78**	.90						
6	Internal SLOC	3.54	.68	.08	-.02	.08	.07	.09	.86					
7	External SLOC	3.00	.50	.12	-.07	.15*	.12*	.16*	.15*	.70				
8	Safety Knowledge	4.24	.66	-.09	.13*	.17**	.21**	.11	.00	-.15*	.96			
9	Safety Motivation	4.08	.58	-.07	.09	-.01	.00	-.03	.07	.14*	-.02	.95		
10	Safety Compliance	4.03	.57	-.09	.16*	.17**	.21**	.11	-.02	.10	.89**	.03	.92	
11	Safety Participation	3.91	.67	-.07	.13*	.09	.15*	.02	-.05	.13*	.83**	.00	.85**	.94

Note. $N = 240$; Sex: 1 = male, 2 = female; CFT = counterfactual thinking; SLOC = safety locus of control. Internal consistency reliabilities are shown on the diagonal.

* $p<.05$; ** $p<.01$ (two-tailed). The results for the effects of overall and upward counterfactual thinking on safety-related variables with sex controlled in the regression analyses were similar to those without sex controlled.

self-report of safety motivation ($r = .09$, $p > .05$). Upward counterfactual thinking was positively related to supervisor-ratings of safety knowledge ($r = .21$, $p < .001$), safety compliance ($r = .21$, $p < .01$), and safety participation ($r = .15$, $p < .01$), but not significantly related to self-report of safety motivation ($r = .00$, $p > .05$). The relationships between downward counterfactual thinking and safety motivation, knowledge, compliance, and participation were not significant ($r = -.03$, $p > .05$; $r = .11$, $p > .05$; $r = .11$, $p > .05$; $r = .02$, $p > .05$).

Tests of the Effects of Overall Counterfactual Thinking on Safety-related Outcomes

Multiple regression was conducted to test the effects of *overall* counterfactual thinking on safety knowledge, motivation, and behavior (Hypotheses 1, 4, and 9), as well as the potential moderating effect of safety locus of control (Hypotheses 16 and 18). Tables 3 and 4 presents the results. Counterfactual thinking was positively related to safety knowledge ($\beta = .18$, $p < .01$) and safety compliance ($\beta = .19$, $p < .01$), but was not related to safety participation ($\beta = .11$, $p > .05$) and safety motivation ($\beta = -.02$, $p > .05$). Therefore, Hypothesis 1 received partial support, Hypotheses 4 was supported, and Hypothesis 9 was not supported.

Next, the extent to which internal and external safety locus of control moderated the relationships between counterfactuals and safety knowledge and motivation was tested. Specifically, neither internal nor external locus of control interacted significantly with counterfactual thinking to predict safety knowledge ($\beta = .03$, $p > .05$; $\beta = -.03$, $p > .05$) and

Table 3

Regression Results for Safety Knowledge and Motivation

Factor and statistic	Safety knowledge				Safety motivation			
	Counterfactual		Upward counterfactual		Counterfactual		Upward counterfactual	
	ILOC	ELOC	ILOC	ELOC	ILOC	ELOC	ILOC	ELOC
Age	-.07	-.10	-.07	-.08	-.07	-.05	-.07	-.07
Sex	.16*	.17**	.16*	.16*	.09	.09	.09	.09
CFT	.18**	.17**			-.02	.02		
Upward CFT (UCFT)			.22**	.23**			-.01	.00
Internal safety LOC (ILOC)	-.01		-.01		.07	-.15*	.07	.01
External safety LOC (ELOC)		.14*		.00				.08
CFT×ILOC	.03				.03			
UCFT×ILOC			.02				.05	
CFT×ELOC		-.03				.02		
UCFT×ELOC				.01				.01
R^2	.06**	.09**	.09**	.08**	.02	.03	.02	.02
F	3.10**	3.98**	3.95**	3.93**	.93	1.58	1.02	.87
df	5, 234	5, 234	5, 234	5, 234	5, 234	5, 234	5, 234	5, 234

Note. $N = 240$; CFT = counterfactual thinking; LOC = locus of control. UCFT = upward counterfactual thinking. ILOC = Internal safety locus of control. ELOC = external safety locus of control.

* $p<.05$; ** $p<.01$ (two-tailed).

Table 4

Regression Results for Safety Compliance and Participation

Factor and statistic	Safety compliance				Safety participation			
	Counterfactual		Upward counterfactual		Counterfactual		Upward counterfactual	
	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2
Age	-.08	-.01	-.08	-.01	-.06	.00	-.06	.00
Sex	.19**	.05	.19**	.05	.15*	.02	.16*	.02
CFT	.19**	.03			.11	-.05		
Upward CFT			.23**	.02			.16*	-.03
Safety knowledge		.88**		.88**		.83**		.83**
Safety motivation		.04		.04		.01		.01
R^2	.08**	.79**	.08**	.79**	.04*	.68**	.05**	.68**
F	5.90**	176.57**	7.18**	176.48**	2.83*	101.44**	4.07**	100.72**
df	3, 236	5, 234	3, 236	5, 234	3, 236	5, 234	3, 236	5, 234

Note. $N = 240$; CFT = counterfactual thinking.

* $p<.05$; ** $p<.01$ (two-tailed).

Table 5

Simple Mediation Results

Predictor	Outcome	Mediator	Indirect Effect	Boot SE	LL95%CI	UL95%CI
CFT	Safety compliance	Safety knowledge	.17	.08	.03	.34
		Safety motivation	.00	.00	-.01	.01
	Safety participation	Safety knowledge	.16	.07	.03	.32
		Safety motivation	.00	.00	-.01	.00
Upward CFT	Safety compliance	Safety knowledge	.20	.08	.06	.37
		Safety motivation	.00	.00	.00	.01
	Safety participation	Safety knowledge	.19	.07	.06	.34
		Safety motivation	.00	.00	.00	.01

Note. $N = 240$; CFT = counterfactual thinking; SE = standard error; LL = lower level; CI = confidence interval; UL = upper level.

safety motivation ($\beta = .03$, $p > .05$; $\beta = .02$, $p > .05$). Thus, Hypotheses 16 and 18 were not supported.

Bootstrap analyses were conducted to test the indirect effects of safety knowledge and motivation on the relationships between counterfactual thinking and safety compliance and participation. The results, presented in Table 5, indicate that safety knowledge had an indirect effect on the relationship between counterfactual thinking and safety compliance (95% bootstrap CI = .03 to .34) and safety participation (95% bootstrap CI = .03 to .32, providing support for Hypothesis 7. However, the results did not support an indirect effect of counterfactual thinking on safety behavior through safety motivation (safety compliance, 95% bootstrap CI = -.01 to .01; safety participation, 95% bootstrap CI = -.01 to .00). Thus, Hypothesis 12 was not supported. Also, the mediating effect of safety knowledge on the relationship between counterfactual thinking and safety compliance was shown to be stronger than the mediating effect of safety motivation on the relationship between counterfactual thinking and safety compliance. Therefore, Hypothesis 14a was supported. However, the mediating effect of safety motivation on the relationship between counterfactual thinking and safety participation was shown to be weaker than the mediating effect of safety knowledge on the relationship between counterfactual thinking and safety participation, which did not support Hypothesis 15a.

Tests of the Effects of Upward Counterfactual Thinking on Safety-related Outcomes

Similarly, multiple regressions were conducted to test the effects of upward counterfactual thinking on safety knowledge, motivation, and behavior (Hypotheses 2, 5, and 10), as well as the potential moderating effect of safety locus of control (Hypotheses 17 and 19). Tables 3 and 4 presents the results. In support of Hypotheses 2 and 5, upward counterfactual thinking was positively related to safety knowledge ($\beta = .22$, $p < .01$), safety compliance ($\beta = .23$, $p < .01$), and safety participation ($\beta = .16$, $p < .05$). However, upward counterfactual thinking was not significantly related to safety motivation ($\beta = -.01$, $p > .05$), thus Hypothesis 10 was not supported.

Next, the extent to which internal and external safety locus of control moderated the relationships between upward counterfactuals and safety knowledge and motivation was tested. Specifically, neither internal nor external locus of control interacted significantly with upward counterfactual thinking to predict safety knowledge ($\beta = .02$, $p > .05$; $\beta = .01$, $p > .05$) and safety motivation ($\beta = .05$, $p > .05$; $\beta = .01$, $p > .05$). Thus, Hypotheses 17 and 19 were not supported.

Steiger's z test was used to examine whether upward counterfactual thinking has a significantly stronger relationship with safety knowledge, motivation, compliance and participation than downward counterfactual thinking (Hoerger, 2013; Steiger, 1980). The results indicated that the relationships between upward counterfactual thinking and safety compliance as well as participation were stronger than the relationships between downward counterfactual thinking and safety compliance as well as participation ($z = 2.36$, $p < .05$; $z =$

3.03, $p < .05$). Therefore, Hypotheses 3a and 3b were supported. In addition, upward counterfactual thinking was found to be more strongly related to safety knowledge than downward counterfactual thinking ($z = 2.36$, $p < .05$), but revealed no difference from downward counterfactuals in relation with safety motivation ($z = .70$, $p > .05$). Thus, Hypothesis 6 was supported and Hypothesis 11 was not supported. Bootstrap analyses were conducted to test the indirect effects of safety knowledge and motivation on the relationships between upward counterfactual thinking and safety compliance and participation. The results, presented in Table 5, showed that safety knowledge had an indirect effect on the relationships between upward counterfactuals and safety compliance (95% bootstrap CI = .06 to .37) and safety participation (95% bootstrap CI = .06 to .34), providing support for Hypothesis 8. However, the results did not support an indirect effect of upward counterfactual thinking on safety behavior through safety motivation (safety compliance, 95% bootstrap CI = .00 to .01; safety participation, 95% bootstrap CI = .00 to .01). Thus, Hypothesis 13 was not supported. Also, the mediating effect of safety knowledge on the relationship between upward counterfactual thinking and safety compliance was shown to be stronger than the mediating effect of safety motivation on the relationship between upward counterfactual thinking and safety compliance. Therefore, Hypothesis 14b was supported. However, the mediating effect of safety motivation on the relationship between upward counterfactual thinking and safety participation was shown to be weaker than the mediating effect of safety knowledge on the relationship between

upward counterfactual thinking and safety participation, which did not support Hypothesis 15b. A summary of statistical support for all the hypotheses is presented in Table 6.

Table 6

Statistical Support for Hypotheses

Hypotheses	Statistical Support
Hypothesis 1: Counterfactual thinking is positively related to (a) safety compliance and (b) safety participation.	Supported
Hypothesis 2: Upward counterfactual thinking is positively related to (a) safety compliance and (b) safety participation.	Supported
Hypothesis 3: Upward counterfactual thinking is more strongly related to (a) safety compliance and (b) safety participation than downward counterfactual thinking.	Supported
Hypothesis 4: Counterfactual thinking is positively related to safety knowledge.	Supported
Hypothesis 5: Upward counterfactual thinking is positively related to safety knowledge.	Supported
Hypothesis 6: Upward counterfactual thinking is more strongly related to safety knowledge than downward counterfactual thinking.	Supported
Hypothesis 7: The relationships between counterfactual thinking and (a) safety compliance and (b) safety participation are mediated by safety knowledge.	Supported
Hypothesis 8: The relationships between upward counterfactual thinking and (a) safety compliance and (b) safety participation are mediated by safety knowledge.	Supported
Hypothesis 9: Counterfactual thinking is positively related to safety motivation.	Not Supported
Hypothesis 10: Upward counterfactual thinking is positively related to safety motivation.	Not Supported
Hypothesis 11: Upward counterfactual thinking is more strongly related to safety motivation than downward counterfactual thinking.	Not Supported
Hypothesis 12: The relationships between counterfactual thinking and (a) safety compliance and (b) safety participation are mediated by safety motivation.	Not Supported
Hypothesis 13: The relationships between upward counterfactual thinking and a) safety compliance and b) safety participation are mediated by safety motivation.	Not Supported
Hypothesis 14a: The mediating effect of safety knowledge on the relationship between counterfactual thinking and safety compliance is stronger than the mediating effect of safety motivation on the relationship between counterfactual thinking and safety compliance.	Supported

Table 6

Continued

Hypotheses	Statistical Support
Hypothesis 14b: The mediating effect of safety knowledge on the relationship between upward counterfactual thinking and safety compliance is stronger than the mediating effect of safety motivation on the relationship between upward counterfactual thinking and safety compliance.	Supported
Hypothesis 15a: The mediating effect of safety motivation on the relationship between counterfactual thinking and safety participation is stronger than the mediating effect of safety knowledge on the relationship between counterfactual thinking and safety participation.	Not Supported
Hypothesis 15b: The mediating effect of safety motivation on the relationship between upward counterfactual thinking and safety participation is stronger than the mediating effect of safety knowledge on the relationship between upward counterfactual thinking and safety participation.	Not Supported
Hypothesis 16: Internal safety locus of control moderates the relationships between counterfactual thinking and (a) safety knowledge and (b) safety motivation, such that individuals with higher internal locus of control are likely to experience stronger relationships than individuals with lower internal locus of control.	Not Supported
Hypothesis 17: Internal safety locus of control moderates the relationships between upward counterfactual thinking and (a) safety knowledge and (b) safety motivation, such that individuals with higher internal locus of control are likely to experience stronger relationships than individuals with lower internal locus of control.	Not Supported
Hypothesis 18: External safety locus of control moderates the relationships between counterfactual thinking and (a) safety knowledge and (b) safety motivation, such that individuals with higher external locus of control are likely to experience weaker relationships than individuals with lower external locus of control.	Not Supported
Hypothesis 19: External safety locus of control moderates the relationships between upward counterfactual thinking and (a) safety knowledge and (b) safety motivation, such that individuals with higher external locus of control are likely to experience weaker relationships than individuals with lower external locus of control.	Not Supported

DISCUSSION

The current study extends the workplace safety literature by examining the role of counterfactual thinking on workplace safety behavior. This study addresses three specific gaps identified in the literature of workplace safety. First, study results supported the functional effects of overall and upward counterfactual thinking on safety compliance and safety participation, but indicated no effect of downward counterfactual thinking on safety behavior, demonstrating that the magnitude of the effect of counterfactual thinking on safety behavior was contingent on whether it is upward or downward. Second, results demonstrated that safety knowledge operates as a mediating mechanism between overall and upward counterfactual thinking and safety compliance, as well as safety participation. However, safety motivation did not mediate the relationship between counterfactual thinking and safety behavior. Third, although safety locus of control was predicted to amplify the effects of counterfactual thinking on safety knowledge and motivation, results did not support this. Thus, the effects of counterfactual thinking on safety knowledge appear to be independent of safety locus of control.

Theoretical Implications

The results of this study contribute to the counterfactual and workplace safety research literatures by extending prior knowledge in several ways. Past workplace safety research within I/O psychology does not explicitly take into consideration counterfactual thinking, or even broad cognitive processes. The current study is the first known empirical

test of the relationship between counterfactual thinking and supervisor-reported safety behavior. On the basis of the current results, individuals reflecting on better alternatives when encountering negative experiences are more likely to engage in safe behavior in the future. This finding begins to reveal the role of one specific cognitive process when predicting workplace safety behavior, which is directly related to workplace incidents and injuries. According to the accident sequence model proposed by Ramsey (1985), cognitive processes influence perception and interpretation of hazards and decisions to avoid them in hazardous situations. Consistent with the previous findings from social and I/O psychology (e.g., Morris & Moore, 2000; Page & Colby, 2003), the current study demonstrated that counterfactual thinking is an important antecedent of safety behavior in the workplace. Future research could examine broader cognitive constructs that impact safety behavior.

Second, the findings highlight that safety knowledge is one explanatory mechanism linking overall and upward counterfactual thinking to safety compliance, as well as safety participation. These findings extend our understanding of why counterfactual thinking is relevant to workplace safety behavior by demonstrating further support for previously identified cognitive mechanisms associated with counterfactual thinking and regulatory behavior. These findings are in line with the functional theory of counterfactual thinking (Epstude & Roese, 2008; Roese & Olson, 1997). Consistent with the previous cross-sectional research on safety-related counterfactual thinking on self-reported learning (Baran

et al., 2015; Morris & Moore, 2000), upward counterfactual thinking may facilitate safety behavior by fostering individuals' learning about safety practices.

Third, unexpectedly, safety motivation was not found to be a mediating mechanism in explaining how overall and upward counterfactual thinking influence safety behaviors. This unanticipated result might be due to the vague time period over which participants were instructed to reflect when responding to the safety motivation items. This study measured safety motivation following the safety-related event that occurred in the past month. However, as safety motivation is theoretically aligned with the counterfactual thinking affective pathway, it should be more intense immediately following the negative event and likely declines over time. Future research could utilize an experience sampling method in which counterfactual thinking and motivation could be assessed immediately after a negative event.

Finally, safety locus of control was expected to strengthen the effect of counterfactual thinking on safety knowledge and motivation. However, this proposition was not supported. With a sample size of 240, this study had a power of .33 to detect a $f^2 = .01$ moderation effect and it had power of .58 to detect a $f^2 = .02$ moderation effect. Based on these analyses, it may be premature to eliminate safety locus of control from future investigations as a lack of power may have contributed to the failure to detect moderation, as previous research has suggested that the perceived controllability of events in counterfactual thinking is an important precursor to engagement in learning from counterfactuals (Girotto et al.,

1991). Another possible reason for the failure to detect moderation is that safety locus of control might only facilitate learning from self-focused upward counterfactual thinking, however, self- versus other-focused counterfactuals were not differentiated in this study. Future research with larger sample sizes differentiating self- and other-focused counterfactuals may find evidence for safety locus of control as a moderator of the self-focused upward counterfactual thinking-safety knowledge/safety motivation relationships.

Practical Implications

The results of this study have several practical implications for the improvement of workplace safety. First, the results provide evidence and support for the relationship between counterfactual thinking and safety behavior, suggesting that counterfactual thinking training may be a useful workplace safety intervention (cf. Dillon & Tinsley, 2008). Such training should highlight the distinction between upward and downward counterfactual thinking and the advantages of upward counterfactual thinking. Managers could also encourage their employees to think about better alternatives when incidents, injuries, or near misses occur in order to learn from them and prevent them from happening again. In addition to training and motivating individuals to pursue counterfactual thinking (cf., Dillon & Tinsley, 2008), organizations could recruit individuals who are more likely to engage in counterfactual thinking and/or continuously learn from their experiences, as well as others' experiences.

Moreover, the finding that safety knowledge plays a central role in explaining the effects of counterfactual thinking on safety behavior also suggests that learning from past negative experiences is critical to behavioral improvement. Correspondingly, organizations could use learning potential as an employee selection criterion and create climates that promote learning and personal growth, encouraging individuals to obtain knowledge and develop skills and abilities from past negative experiences in order to avoid them in the future. Leaders should also make an effort to raise employees' awareness of the importance of learning from these safety-related events.

Limitations and Future Research Directions

Despite collecting data from two sources at three different time periods and thereby avoiding issues of same-source bias for some relationships examined (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), this study has some limitations. An initial concern is that specific cognition and affect following the negative events was not directly measured. Thus, the nature and intensity of these emotions and how they relate to the variables examined remain to be tested in future research, perhaps using more real-time assessment or experience sampling methodology.

A second issue is that this study did not directly measure learning from past safety-related events and instead assessed safety knowledge as a learning outcome. Learning from past events, or experiential learning, is the extent to which individuals draw lessons and accumulate knowledge, skills, and abilities through their experiences (Kolb, 2014). In this

sense, experiential learning involves cognitive and behavioral engagement in enhancing understanding and knowledge and broadening capacities and capabilities through the particular event they experienced in the past. However, because information about the specific safety-related events was not collected, learning from these events cannot be directly measured. Instead, safety knowledge, as the state of overall knowledge level following those events, was measured representing a learning outcome that can be influenced by learning processes. Moreover, safety knowledge is a narrower term that cannot capture skill expansion and ability development via past experiences. Future research should choose a direct way to measure experiential learning by gathering information about safety-related events and lessons drawn from these events to determine whether counterfactual thinking is conducive to effective learning.

A third concern is that because specific information about the safety-related events was not collected, details surrounding the event and differentiating it from other events remain unknown. Dillon and Tinsley (2008) noted two definitions of a near miss: as an event that *almost* happens or an event that *could have* happened and how it is interpreted influences counterfactual thinking that follows. They found that events that almost happened induce counterfactual thinking and subsequent learning, whereas events that could have happened may not induce counterfactual thinking (Kahneman & Varey 1990; McMullen, 1997). Near misses can also be differentiated in terms of the severity of the potential incident or injury. Future research could take into consideration these near miss

characteristics, and explore how different near misses influence the intensity and direction of counterfactual thinking.

Future studies could gather more information about the negative event. This would allow for a more nuanced examination of the event (e.g., differentiating near misses from injuries, self vs. other, etc.) and how these different types of events relate to the generation and types of counterfactuals. Previous research has proposed and found evidence for self-referent counterfactuals to be more beneficial to learning than other-referent counterfactuals (Morris & Moore, 2000; Roese & Olson, 1995).

Future research could examine other potential mechanisms linking counterfactual thinking to safety behavior. For instance, risk perception has been demonstrated to be an important antecedent of safety behavior (e.g., Deery, 2000; Rundmo, 1996). Future research could examine whether counterfactual thinking influences employees' perception of risk, which in turn is associated with subsequent safety behavior. To better understand the mechanisms underlying the relationship between counterfactual thinking and safety-related behaviors and outcomes, multiple mediators should be assessed simultaneously.

To further our understanding of the moderating effects of individuals differences on the functional impact of counterfactual thinking, future research should expand the types of individual differences assessed. For instance, personality traits (e.g., conscientiousness and openness) and self-efficacy might influence how counterfactuals impact safety knowledge, motivation, and behavior. Additionally, given that counterfactual thinking is a series of

cognitive processes reflecting on events that happened in the past, situational factors such as safety climate might influence how individuals benefit from counterfactuals. Therefore, future research could conceptualize safety climate as a boundary condition and examine how safety climate facilitates safety knowledge, motivation, and behavior. Finally, other studies should attempt to replicate the current study findings by collecting data in different industries (e.g., construction, oil and gas industry) to determine the generalizability of the results.

CONCLUSION

This study is the first empirical study demonstrating the influence of counterfactual thinking on safety behavior in workplace. Specifically, overall and upward counterfactual thinking were positively associated with safety compliance and participation. With regard to the direction of counterfactuals, upward counterfactuals exerted stronger influences on safety compliance and participation and safety knowledge than downward counterfactuals. Moreover, empirical evidence was revealed for safety knowledge as a cognitive mechanism that explains the relationships between overall and upward counterfactual thinking with safety behavior. This study provides a foundation from which future research could build to advance our understanding of how and why cognitive processes influence workplace safety behavior.

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APPENDIX

Counterfactual Thinking for Negative Events Scale (adapted from Rye, Cahoon, Ali, & Daftary, 2008)

Safety of employees and patients is critical in a hospital setting. Everyone intends to be safe, but unfortunately, incidents and injuries happen sometimes.

Please think of a safety-related event working in the hospital that occurred **in the past month** that had a negative impact on you. An "event" is defined as any type of error, mistake, incident, accident, or deviation, regardless of whether or not it results in patient harm. Take a few moments to vividly recall that experience and what it was like for you.

Now, think about the types of thoughts you experienced following that undesirable event. Using the following scale, rate the frequency with which you experienced the thoughts described below.

Upward Counterfactual Thinking

1. I think about how much better things could have been.
2. I cannot stop thinking about how I wish things would have turned out.
3. Although the bad situation was nobody's fault, I think about how things could have turned out better.

Downward Counterfactual Thinking

4. I think about how much worse things could have been.
5. I count my blessings when I think about how much worse things could have been.
6. Although what happened was negative, it clearly could have been a lot worse.

Safety Motivation (revised version based on Neal, Griffin, & Hart, 2000)

1. I am driven to improve patient safety.

2. I am motivated to maintain patient safety at all times.
3. I strive to reduce the risk of patient incidents.
4. I am driven to improve workgroup safety.
5. I am motivated to maintain workgroup safety at all times.
6. I strive to reduce the risk of workgroup incidents.

Safety Locus of Control (Jones & Wuebker, 1985)

Internal safety locus of control

1. Industrial accidents are due to employee carelessness.
2. Most on-the-job accidents and injuries result from employees' mistakes.
3. Most accidents are avoidable.
4. Most accidents and injuries at work can be avoided.
5. Occupational accidents and injuries occur because employees do not take enough interest in safety.

External safety locus of control

6. I think I am a victim of misfortune whenever I have an accident.
7. No matter how hard employees try to prevent them, there will always be on-the-job accidents.
8. For me avoiding accidents is a matter of luck.
9. There are so many dangers in this world that I never know how or when I might be in an accident.

10. With my luck, I will probably have an accident in the near future.

11. The odds are in favor of me having an accident in the near future.

12. Industrial accidents are usually caused by unsafe equipment and poor safety regulations.

13. Most on-the-job accidents can be blamed on poor management.

14. It is the company's responsibility to prevent all accidents at work.

Safety Knowledge (Griffin & Neal, 2000)

1. This employee knows how to perform the job in a safe manner.
2. This employee knows how to maintain or improve workplace health and safety.
3. This employee knows how to reduce the risk of accidents and incidents in the workplace.

Safety Behavior (Griffin & Neal, 2000)

Safety Compliance

1. This employee carries out work in a safe manner.
2. This employee uses all the necessary safety equipment to do the job.
3. This employee uses all the correct safety procedures for carrying out the job.
4. This employee ensures the highest levels of safety when I carry out the job.

Safety Participation

5. This employee promotes the safety program within the organization.
6. This employee puts in extra effort to improve the safety of the workplace.
7. This employee helps others when we are working under risky or hazardous conditions.

8. This employee voluntarily carries out tasks or activities that help to improve workplace safety.