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Improving workplace safety by thinking about what might have been: A first look at the role of counterfactual thinking

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ABSTRACT

Introduction: Information processing theories of workplace safety suggest that cognition is an antecedent of safety behavior. However, little research has directly tested cognitive factors as predictors of workplace safety within organizational psychology and behavior research. Counterfactuals (cognitions about "what might have been") can be functional when they consist of characteristics (e.g., "upward' – focusing on better outcomes) that alter behavior in a manner consistent with those outcomes. This field study aimed to examine the influence of counterfactual thinking on safety behavior and explanatory mechanisms and boundary conditions of that relationship. *Method:* A sample of 240 medical providers from a hospital in China responded to three surveys over a four-month time frame. *Results:* Results showed that upward counterfactuals were positively related to supervisor ratings of safety compliance and participation. These relationships were mediated by safety knowledge but not by safety motivation. Upward counterfactuals were more strongly related to safety behavior and knowledge than downward counterfactuals. As expected, safety locus of control strengthened the mediating effects of safety knowledge on the relationship between upward counterfactuals and safety behavior. *Conclusions and Practical Applications:* The findings demonstrated that counterfactual thinking is positively associated with safety behavior and knowledge, thus expanding the variables related to workplace safety and laying some initial groundwork for new safety interventions incorporating counterfactual thinking.

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 incidents result in millions of nonfatal injuries and illnesses, thousands of fatalities, and billions of dollars in costs (Liberty Mutual Research Institute for Safety, 2016; Bureau of Labor Statistics, 2015). For example, a 2015 economic report indicated nearly 66,000 workplace deaths in 2015 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.

Although human factors research has acknowledged the importance of cognitive factors in event-based explanations of accidents (e.g., Proctor & Vu, 2010), cognitive processes are not traditionally included in organizational workplace safety models. The current study focuses on a particular cognitive process, counterfactual thinking, and its influence on workplace safety. Counterfactuals are detailed 'if only' thoughts that specify how past events, actions, or states could have ended up differently (Kahneman & Miller, 1986; Roese, 1997). Counterfactual thinking is a common and pervasive feature of the mental landscape (Summerville & Roese, 2008). Given their evaluative nature and the fact that they are typically activated by negative events or failures, theorists suggest that counterfactuals may be helpful by providing information and motivation towards improving future behavior (Epstude & Roese, 2008; Roese & Epstude, 2017). It is proposed that employees who experience workplace-related safety events could benefit from counterfactual reflection about those events. For example, an employee might experience a minor injury (e.g., back strain). Subsequent counterfactuals could provide relevant insight into the event ("If only I had bent my knees, then I wouldn't have hurt my back"), which can facilitate experience-based learning and lead to new strategies that may reduce future workplace injuries (i.e., bending knees when lifting).

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Although organizational scholars have been interested in learning from failures for some time (e.g., Carmeli & Gittell, 2009; Frese, 1995), this study is a relatively novel and somewhat exploratory examination of the extent to which counterfactual thinking is related to workplace safety behavior. In addition to this direct relationship, theoretically-driven explanatory mechanisms and boundary conditions are examined. Correspondingly, there are three primary study objectives. The first objective is to determine the extent to which counterfactual thinking, particularly upward counterfactual thinking, is related to supervisor-reported safety behavior. The second objective is to test the extent to which safety knowledge and safety motivation serve as explanatory mechanisms of the relationship between counterfactual thinking and safety behavior. The third objective is to examine the extent to which internal safety locus of control enhances the counterfactual thinking-safety knowledge/motivation-safety behavior relationships. This study is a necessary first step to determine if it would be fruitful to pursue additional research on counterfactuals and workplace safety behavior and the possible development of counterfactual-based training as a workplace safety intervention. Correspondingly, these objectives drove our decisions regarding which variables to include in the study.

1. Antecedents of workplace safety

Previous organizational workplace safety models have identified multiple determinants of workplace accidents and injuries. Building on Neal and Griffin (2004) framework, Christian, Bradley, Wallace, and Burke (2009) developed an integrated model of workplace safety. They differentiate person-related and situation-related distal predictors of workplace safety. Distal factors are expected to influence more proximal person-related factors: safety motivation and safety knowledge. 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). Safety researchers differentiate between two types of safety behaviors (Griffin & Neal, 2000; Neal, Griffin, & Hart, 2000), both examined in this study. *Safety compliance* refers to generally mandated safety behaviors to maintain workplace safety (Christian et al., 2009; Neal et al., 2000). *Safety participation* refers to voluntary safety behaviors that contribute to the safety environment in the organization.

2. Cognition and workplace safety

Information processing models acknowledge the role of cognitive processes in workplace safety. For example, in Ramsey (1985) accident sequence model, an individual first perceives the hazard, mentally interprets it, makes a decision to avoid it, and then attempts to avoid it. At each stage of this process, cognitive factors play a role. For example, previous experiences influence the interpretation of a hazard and the decision to avoid it. Correspondingly, counterfactual thinking (a cognitive process that involves perception and interpretation of previous situations, knowledge structures, and beliefs; Breckler, 1984) should influence the perception and interpretation of hazards and decisions to avoid them. Together, the accident sequence model and relevant research (e.g., Hayashi, 1985; Khan, Halim, & Iqbal, 2006) demonstrate the influence of cognitive processes on safety behavior.

Theories about learning posit that counterfactual thinking promotes learning across situations and facilitates behavioral change (e.g., DeRue, Ashford, & Myers, 2012). Engaging in counterfactual thinking enables individuals to evaluate causal relationships (Spellman & Gilbert, 2014; Wells & Gavanski, 1989), which can enhance problem-solving capabilities (Kray & Galinsky, 2003; Markman, Lindberg, Kray, & Galinsky, 2007), highlight effective behavioral strategies (Morris & Moore, 2000; Roese, 1994), increase motivation towards performance improvement (Markman, McMullen, & Elizaga, 2008), and heighten perceptions of control (Nasco & Marsh, 1999; Tal-Or, Boninger, & Gleicher, 2004). This process should help individuals quickly extract insight from these events and deploy this insight to future problems.

Furthermore, counterfactual thinking helps individuals consider a broad range of alternative actions applicable for similar mishaps, which could increase the likelihood of making connections across various experiences and maximize learning from those experiences. Importantly, these effects are triggered by one's own failure and near misses (Morris & Moore, 2000; Roese, 1994), as well as by negative events experienced by other group members (Walker, Smallman, Summerville, & Deska, 2016). Applied to work-related learning, counterfactual thinking after unsafe events (e.g., injuries) should promote learning from one's own and others' experiences, applying those lessons learned to relevant similar situations, and engaging in safer behaviors in the future.

3. Counterfactual thinking

Counterfactual thoughts are mental representations of alternatives to past events, actions, or states (Kahneman & Miller, 1986). Typically, counterfactuals take an if-then conditional format in which the antecedent (the 'if') specifies a person, action, or circumstance change and the consequent (the 'then') specifies a better or worse alternative outcome. Counterfactuals can range from very broad and general (e.g., "If only I was more careful") to very detailed and specific ("If only I had double-checked my safety monitor") and can modify specific behaviors ("If only I had worn gloves"), traits ("If only I was more conscientious"), or other situational features ("If only it wasn't raining"). Research has shown that more specific counterfactuals and those focused on modifying one's own behaviors are most useful for improving future outcomes (Roese & Epstude, 2017; Smallman, 2013).

Over the past few decades, counterfactual thinking has received considerable attention in social and cognitive psychology (Byrne, 2016; Roese, 1997). This work has extended our understanding of counterfactuals and their consequences. Accordingly, counterfactuals can influence causal reasoning and meaning ascribed to an event (Kray et al., 2010; Wells & Gavanski, 1989). They can provide insight and increase motivation towards a goal (Markman et al., 2008). Similarly, they may heighten feelings of relief and increase feelings of organizational commitment (Ersner-Hershfield, Galinsky, Kray, & King, 2010; Sweeny & Vohs, 2012). These effects are in part driven by the type of counterfactual generated.

3.1. Upward versus downward Counterfactuals.

Counterfactuals can be categorized on multiple dimensions. Most typically, they are characterized by their *direction*, or whether the alternative outcome is better or worse than the actual outcome. *Upward* counterfactuals involve better alternatives (e.g., "if I had worn gloves, then I would have been protected from the patient's blood"). In contrast, *downward* counterfactuals involve worse alternatives (e.g., "if the patient's blood spattered, then I would have been infected" (Markman, Gavanski, Sherman, & McMullen, 1993). Upward and downward counterfactuals are driven by different motives and have different affective and behavioral consequences. Specifically, upward counterfactuals are associated with self-improvement motives; identifying how an outcome could have turned out better highlights successful behavioral strategies. In

doing so, upward counterfactuals can increase motivation (Markman et al., 2008), heighten perceived control (Nasco & Marsh, 1999), and strengthen intentions toward success-facilitating behaviors (Roese, 1994), all of which ultimately improve future performance. However, by forcing an individual to contrast the more successful imagined alternative with their own failed reality, they may also exacerbate negative affect (Broomhall, Phillips, Hine, & Loi, 2017; Gilovich & Medvec, 1995; Roese, 1997). In contrast, downward counterfactuals are associated with self-protective motivation. Focusing on how an outcome could have been worse reduces negative affect and elicits positive feelings like relief and satisfaction (Sweeny & Vohs, 2012; White & Lehman, 2005), which theoretically inhibits performance improvements. Several empirical studies have demonstrated that upward counterfactuals have stronger behavioral effects compared to downward counterfactuals (e.g., Krishnamurthy & Sivaraman, 2002; Morris & Moore, 2000; Roese, 1994). Both upward and downward counterfactuals were measured in the current study.

3.2. Functional theory of counterfactual thinking

According to the functional theory of counterfactual thinking, counterfactuals are a beneficial aspect of behavior regulation that may help future performance (Epstude & Roese, 2008; Roese & Epstude, 2017). This may occur via multiple mechanisms. Via the content-specific mechanism, counterfactuals impact behavior via a regulatory loop consisting of a negative event that elicits counterfactual information (i.e., the lesson learned or causal inferences made about a situation), which is incorporated into specific behavioral intentions, which in turn increases the likelihood of performing the corresponding behavior. For example, after contamination, glove-wearing counterfactuals strengthen glove-wearing intentions and lead to increased glove-wearing behavior. This process includes three important contingencies (Epstude & Roese, 2008; Roese & Epstude, 2017): (1) negative events activate counterfactuals (Gilovich, 1983), (2) counterfactuals strengthen behavioral intentions (Roese, 1994), and (3) behavioral intentions elicit corresponding behaviors (Ajzen, 1991). This regulatory loop maintains homeostasis by altering behaviors (Epstude & Roese, 2008; Roese & Epstude, 2017). In a workplace context, evidence of this pathway might be seen through increases in safety knowledge.

Additionally, counterfactuals can be beneficial via a content-neutral mechanism, which has broader or more diffuse impacts on behavior (Epstude & Roese, 2008; Roese & Epstude, 2017). Via this mechanism, engaging in counterfactual thinking can increase motivation and persistence towards improving future behavior and goal achievement more generally (Markman et al., 2008; Markman & McMullen, 2003). In this case, glove-wearing counterfactuals would both increase glove-wearing motivation but also increase motivation towards other positive safety-related behaviors in service of goal striving. In a workplace context, evidence of this pathway might be seen through increases in safety motivation. These two processes are not mutually exclusive and can occur simultaneously.

3.3. Functional counterfactual thinking in workplace health and safety

Workplace safety events are varied in nature, including both actual incidents as well as "near misses" (i.e., close calls in which a negative outcome almost occurred). Both types are expected to trigger counterfactual thoughts (Dillon & Tinsley, 2008). If a functional mechanism is activated, then these counterfactuals should also increase future corrective behaviors and reduce future workplace injuries and incidents.

Counterfactual research on health and safety is sparse. In terms of health behaviors, generating counterfactuals about unhealthy alcohol use decreased binge drinking intentions (Baek, Shen, & Reid, 2013) and HIV-positive men who generated counterfactuals about contracting HIV increased their safe-sex intentions (Epstude & Jonas, 2015), compared to participants who considered just the negative incident. These findings are noteworthy for two reasons. First, because Epstude and Jonas used an irreversible event (i.e., contracting HIV), therefore highlighting that counterfactuals can elicit generalizable insight (e.g., potential safe sex behaviors) which can be applied to an appropriate future situation (e.g., future sexual encounters). Second, because Baek and his colleagues found a decrease in negative behavior (lower incidents of binge drinking) as opposed to an increase in positive behavior (like alternating alcoholic drinks with non-alcoholic drinks), showing that counterfactuals can both reduce detrimental behaviors as well as increase beneficial behaviors.

Examining workplace safety behaviors, generating upward self-focused counterfactuals about a near miss flying incident increased pilots' intentions to perform incident-avoiding behaviors (Morris & Moore, 2000). Testing organizational incident remedies showed that generating counterfactuals increased the likelihood of proposing personal-behavior focused remedies, rather than environmental/organizational-focused ones (Morris, Moore, & Sim, 1999). These reflect that counterfactual thinking can sometimes promote adaptive learning and internal or self-focused rather than external or other-focused solutions. More importantly, in experimental laboratory studies, the counterfactual condition (in which participants describe the incident and then generate upward counterfactuals) is directly compared to a control condition (in which participants only describe the incident). Broadly speaking, compared to the control condition, the effect of upward counterfactuals on functional outcomes is a relatively robust phenomenon (Roese, 1994; Roese & Epstude, 2017; Sherif & Hovland, 1961). Thus, counterfactual-based learning from past negative experiences results in increased motivation and learning compared to just thinking about negative events themselves (Markman et al., 2008; Roese, 1994; Roese & Epstude, 2017).

3.4. Upward vs. Downward counterfactuals and safety behavior

The effect of counterfactuals on safety behaviors may depend on counterfactual direction. Upward counterfactuals could be interpreted as schemas or scripts for safe future actions (Roese, 1994). Consequently, focusing on better outcomes should increase the likelihood of safer workplace behaviors. Similarly, upward counterfactuals should heighten motivation towards improving future outcomes, pushing individuals to make more general safety improvements to better future situations. Moreover, upward counterfactuals may increase feelings of perceived control (Nasco & Marsh, 1999) and self-efficacy (Tal-Or et al., 2004), which can increase subsequent effort and persistence (Brown, Willis, & Prussia, 2000).

Downward counterfactuals can be functional when they assimilate to the worse alternative, as this may increase safety behaviors by virtue of not wanting to "re-experience" a similar situation. However, contrastive downward counterfactuals (e.g., feeling relief and satisfaction when contrasting the imagined worse alternative with the better actual outcome) are much more frequent and can inhibit counterfactual-based performance improvement (Markman & McMullen, 2003; McMullen & Markman, 2000). In fact, Dillon and Tinsley (2008) found that people were more likely to interpret near misses as successes or "events that almost happened" rather than failures "that could have happened." Therefore, positive behavioral effects from downward counterfactual thinking may hinge on the specific type of downward counterfactual thought. Nevertheless, given the extensive empirical support for the behavioral effects of upward counterfactual thinking (Krishnamurthy & Sivaraman,

2002; Morris & Moore, 2000; Roese, 1994), upward counterfactuals are expected to be more strongly related to safety behavior than downward counterfactuals.

Hypothesis 1. *Upward counterfactual thinking has a significantly stronger relationship with (a) safety compliance and (b) safety participation than downward counterfactual thinking.*

4. Safety knowledge and safety motivation as counterfactual pathways

Combining Neal and Griffin (2004) safety climate and safety behavior framework with the functional theory of counterfactual thinking (Epstude & Roese, 2008; Roese & Epstude, 2017) suggests both safety knowledge and safety motivation as potential mechanisms for the effect of counterfactuals on safety behavior.

4.1. Safety Knowledge.

Safety knowledge is defined as an employee's understanding of safety instructions and safety procedures (Probst & Brubaker, 2001). For example, a counterfactual inference about safety-related information (e.g., risks, value of protective equipment) could heighten behavioral intentions (e.g., plans to wear gloves before drawing blood), which should 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 2. *Upward counterfactual thinking has a significantly stronger relationship with safety knowledge than downward counterfactual thinking.*

Safety knowledge is one explanatory mechanism by which counterfactuals could enhance safety behavior. Mathematically, explanatory mechanisms are represented by a mediated relationship (Baron & Kenny, 1986) in which counterfactual thinking leads to higher levels of knowledge, which in turn is related to higher levels of safety behavior. Counterfactuals prompt individuals to contemplate alternative behaviors, situational factors, and outcomes, expanding the way they think about specific events. In addition, generating counterfactuals about a safety-related event might increase information-seeking efforts related to reducing incident reoccurrence (Coricelli & Rustichini, 2010; Summerville, 2011). As a result, employees are likely to generate new solutions to safety-related problems. Ideally, this newly acquired knowledge will lead to safer behavior in the future.

Hypothesis 3. *The relationships between upward counterfactual thinking and (a) safety compliance and (b) safety participation are mediated by safety knowledge.*

4.2. 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). For example, 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 increasing motivation (Markman et al., 2008). Thus, upward counterfactual thinking is proposed to have a stronger effect on safety motivation than downward counterfactual thinking.

Hypothesis 4. *Upward counterfactual thinking has a significantly stronger relationship with safety motivation than downward counterfactual thinking.*

Safety motivation is also proposed to mediate the effect of upward counterfactuals on safety behavior through increased goal striving. In other words, the reason why upward counterfactuals are related to safety behavior is because counterfactual thinking leads to higher levels of safety motivation, which in turn is expected to be positively related to safety behavior. In order to achieve their safety goals and improve future outcomes, employees should be motivated to identify and implement ways they could have avoided the original outcome and show greater persistence towards performance improvement (Markman et al., 2008; McMullen & Markman, 2000). Previous behaviors and events become reference points for future consideration and facilitate setting goals associated with more desirable (safer) outcomes (Epstude & Roese, 2011). Such goals serve as a strong motivator to initiate action to achieve the goal (Förster, Liberman, & Friedman, 2007).

Hypothesis 5. *The relationships between upward counterfactual thinking and (a) safety compliance and (b) safety participation are mediated by safety motivation.*

5. A potential Enhancer: Safety locus of control

Individual differences may influence how much counterfactuals elicit learning and motivation. One such factor is locus of control, or 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. 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). Importantly, counterfactual research has shown that event controllability is related to counterfactual-based learning, such that generating controllable counterfactuals leads to stronger behavioral intentions compared to generating uncontrollable counterfactuals (Girotto, Legrenzi, & Rizzo, 1991).

Safety locus of control is the extent to which one believes that safety-related events could be controlled personally or by external factors (Jones & Wuebker, 1985; 1993). Both general and safety locus of control have been examined in the safety literature. For example, Jones and Wuebker (1993) found that employees with an internal safety locus of control reported fewer occupational injuries than those with an external safety locus of control. General internal locus of control is positively associated with safety behavior and negatively associated with injuries and incidents (Christian et al., 2009).

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 triggered by negative events are expected to strengthen behavioral intentions and motivation towards improving future outcomes (Epstude & Roese, 2008). An internal safety locus of control is expected to enhance this relationship by influencing employees' intentions and motivation 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 be 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.

Hypothesis 6. *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.*

It is also possible that internal safety locus of control strengthens the indirect relationship between upward counterfactuals and safety compliance and participation by promoting knowledge acquisition and enhancing motivation. Specifically, employees with a strong internal locus of control should acquire more knowledge and have stronger safety motivation following upward counterfactuals than employees with a weak internal locus of control. Therefore, a pattern of moderated mediation between these variables is proposed. A conceptual model depicting the hypothesized relationships appears in Fig. 1. As depicted, the previously proposed mediated relationships in which counterfactual thinking is related to safety behavior because it results in higher levels of safety knowledge and motivation are even stronger when employees have a strong internal locus of control, rather than a weak internal locus of control.

Hypothesis 7. *Safety locus of control will moderate the strength of the mediated relationship between upward counterfactual thinking and (a) safety compliance and (b) safety participation via safety knowledge. Specifically, the mediated relationships will be stronger for individuals with a strong internal safety locus of control than individuals with weak internal safety locus of control.*

Hypothesis 8. *Safety locus of control will moderate the strength of the mediated relationship between upward counterfactual thinking and (a) safety compliance and (b) safety participation via safety motivation. Specifically, the mediated relationship will be stronger for individuals with a strong internal safety locus of control than individuals with a weak internal safety locus of control.*

6. Method

6.1. Participants and procedure

Healthcare employees and their supervisors were recruited from a hospital in Guizhou Province in China to participate in a study about workplace safety. Employees completed three online surveys with approximately one-month in between each administration. Across the three surveys, 295, 289, and 272 employees provided usable responses, resulting in 98%, 96%, and 91% response rates. The final sample consisted of 240 participants who responded to all three surveys with matched supervisor ratings. Among the respondents, 92 were nurses, 105 were doctors, and 43 chose not to respond to this question. The respondents were mostly (71.3%) male, ranging 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.

When designing the study, we contemplated various approaches. Hospital management had experience administering anonymous cross-sectional surveys to employees. However, these designs are criticized in the peer-reviewed literature for common method bias, so we were eager to conduct a more rigorous study. Hospital management had never (1) conducted multi-wave surveys that could be linked together, (2) attempted to link employee and supervisor surveys together, and (3) given researchers access to hospital records of injuries. They generously agreed to go outside their comfort zone by allowing us to expand the number of surveys administered to three and the number of people/sources providing data (i.e., employees and supervisors). They denied our request to access hospital records.

At Time 1, employees completed demographics, background information, perceived risk, safety climate, and safety locus of control measures. At Time 2, they completed upward/downward counterfactual and safety motivation measures. At Time 3, employees were asked to send their supervisors a link to complete a brief employee assessment. For each employee, supervisors provided ratings of 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 the translations preserve the original meaning. All surveys were administered online and linked over time and with supervisor ratings using employee identification numbers.

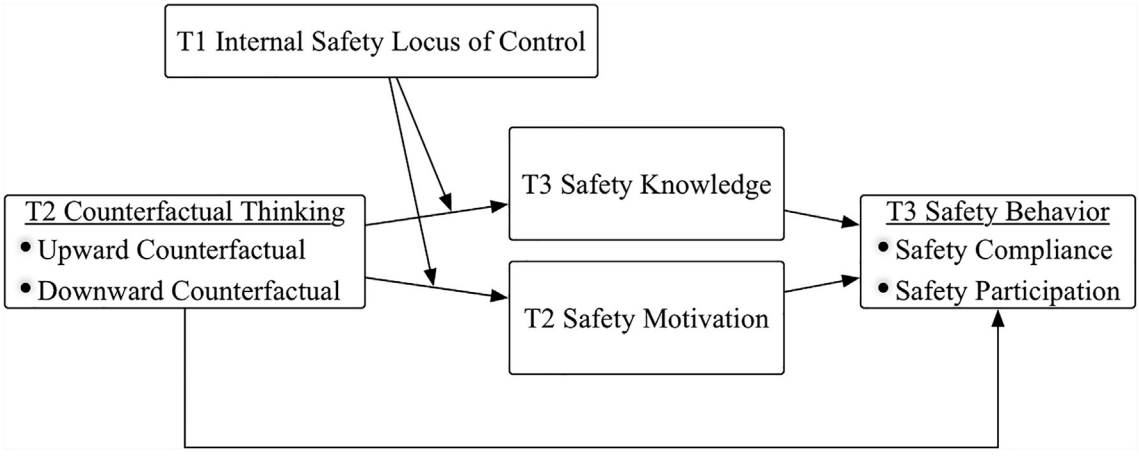

Fig. 1. The conceptual model of the hypothesized relationships.

7. Measures

All items in this study were rated on a 5-point agreement scale except counterfactual thinking which was rated on a 5-point frequency scale (1 = "Never"; 5 = "Very Often"). All of the items administered appear in the Appendix. Internal consistency reliabilities for these scales are reported on the diagonal of Table 1. Further, age, sex, organizational tenure, perceived risk, and safety climate were controlled for when testing the proposed hypotheses; however, the results were very similar with and without the control variables. In order to keep the survey length manageable, we chose abbreviated measures and sometimes administered fewer items than originally proposed in the previously validated measures.

7.1. Perceived Risk.

Perceived risk was measured with two items from Jermier, Gaines, and McIntosh (1989). An example item for perceived risk was: *"I encounter personally hazardous situations on the job."*

7.2. Safety Climate.

Safety climate was measured with Beus, Payne, Arthur, and Muñoz (2019) shortened 8-item safety climate measure. This scale assesses employees' safety climate perceptions at the individual level, rather than the aggregate level. An example item reads: "*My supervisor is committed to improving safety.*"

7.3. Safety internal locus of Control.

Jones and Wuebker (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. An example item for internal safety locus of control was "*Industrial accidents are due to employee carelessness.*" One item that reads "Most of my accidental injuries are preventable" was not administered, as we felt it was only appropriate if they have personally experienced a safety-related injury at work.

7.4. Counterfactual Thinking.

Counterfactuals were assessed using the counterfactual thinking for negative event scale (Rye, Cahoon, Ali, & Daftary, 2008), which included three upward counterfactual and three downward counterfactual items. Participants were asked to think of a safety-related event that occurred in the hospital in the past month and rate the frequency with which they experienced specific thoughts related to that event. We defined a safety-related event as any type of error, mistake, incident, accident, or deviation, regardless of whether or not it resulted in patient harm (detailed instructions appear in the Appendix). We chose not to ask employees to write down the specific safety-related event as this would have required more time and effort from each respondent and we were concerned they would not have been comfortable sharing such detailed, sensitive information. Example items for upward and downward counterfactuals about safety-related events they recalled, 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."*

7.5. Safety Motivation.

Safety motivation was measured using six items adapted from Neal et al. (2000). Three items assessed individuals' motivation to improve patients' safety and three items measured individuals' motivation to improve workgroup safety. An example item reads: *"I am driven to improve workgroup safety."*

7.6. Safety Knowledge.

Safety knowledge was measured with three items from Griffin and Neal (2000) (e.g., *"This employee knows how to perform the job in a safe manner"*).

7.7. Safety Behavior.

Safety behavior was measured using Griffin and Neal (2000) two dimensional measure with four items for each dimension: compliance (e.g., *"This employee uses all the necessary safety equipment to do the job"*) and participation (e.g., *"This employee promotes the safety program within the organization"*).

8. Results

8.1. Confirmatory factor analysis

Table 1 presents descriptive statistics and correlations among the variables. To check for independence of all the constructs included in this study, we tested the fit of a seven-factor model (i.e., two types of counterfactual thinking, safety locus of control, and four safety-related variables) using Confirmatory Factor Analysis. This analysis was performed using Mplus 7.4 software

Table 1
Descriptive Statistics and Correlations among the Variables.

Variable	*M*	*SD*	# of items	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	33.40	7.69	1	–												
2. Sex	1.71	0.45	1	0.02	–											
3. Tenure	8.53	8.39	1	0.85	0.05	–										
4. Occupation	1.47	0.50	1	−0.02	0.34	0.22	–									
5. Perceived risk	3.18	1.04	2	−0.01	−0.02	−0.02	−0.01	(0.74)								
6. Safety climate	3.88	0.65	8	−0.02	0.13	0.00	0.10	−0.11	(0.92)							
7. UCFT	3.19	0.89	3	−0.05	−0.12	−0.09	0.01	0.15	−0.05	(0.88)						
8. DCFT	2.99	0.88	3	−0.08	−0.16	−0.11	−0.10	0.20	−0.03	0.78	(0.90)					
9. ILOC	3.54	0.68	5	0.08	−0.02	0.09	0.15	0.03	0.21	0.07	0.09	(0.86)				
10. Safety motivation	4.32	0.54	6	−0.10	−0.03	−0.15	−0.05	−0.02	0.31	0.11	0.07	0.13	(0.96)			
11. Safety knowledge	4.24	0.66	3	−0.09	0.13	−0.12	−0.10	−0.01	−0.02	0.21	0.11	0.00	0.04	(0.94)		
12. Safety compliance	4.03	0.57	4	−0.09	0.16	−0.14	−0.10	−0.06	0.01	0.21	0.11	−0.02	0.09	0.89	(0.92)	
13. Safety participation	3.91	0.67	4	−0.07	0.13	−0.12	−0.07	0.01	−0.01	0.15	0.02	−0.05	0.07	0.83	0.85	(0.94)

Note. $N = 240$; Sex: 1 = female, 2 = male; Occupation: 1 = doctor, 2 = nurse; UCFT = upward counterfactual thinking; DCFT = downward counterfactual thinking; ILOC = internal safety locus of control; Internal consistency reliabilities (coefficient alphas) are shown in parentheses on the diagonal; Correlations > 0.13 are statistically significant at * $p < .05$; (two-tailed).

(Muthén & Muthén, 1998–2012). Model fit was assessed with the χ^2 statistic, the comparative fit index (CFI), Tucker-Lewis index (TLI), the standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA). Based on recommendations by Hu and Bentler (1999), the following cut-offs were used to indicate adequate model fit: CFI and TLI $\geq$ 0.95 and SRMR and RMSEA $\leq$ 0.05. Several fit indices were examined to interpret the fit of the model. Although the chi-square test was significant (χ^2 (251) = 434.26, $p < .001$), other fit indices indicated that the seven-factor model showed an excellent fit to the data (Comparative Fit Index [CFI] = 0.97; Tucker-Lewis Index [TLI] = 0.96; Root Mean Square Error of Approximation [RMSEA] = 0.05 (90% CI [0.046,0.064]); Standardized Root Mean Square Residual [SRMSR] = 0.04).

9. Main effects and moderation

We used multiple regression to test the effect of upward counterfactuals on safety knowledge, motivation, and behavior, as well as safety locus of control as a moderator. Results showed that upward counterfactuals were positively related to safety knowledge ($\beta = 0.22$, $p < .01$), safety compliance ($\beta = 0.23$, $p < .01$), and safety participation ($\beta = 0.16$, $p < .05$). However, upward counterfactuals were not significantly related to safety motivation (see Table 2).

Steiger's z test examined whether upward counterfactuals had a stronger relationship with four safety outcomes than downward counterfactuals (Hoerger, 2013; Steiger, 1980). The results indicated that the relationships between upward counterfactuals and safety compliance and participation were stronger than the relationships between downward counterfactuals and safety compliance and participation ($z = 2.36$, $p < .05$; $z = 3.03$, $p < .05$). Therefore, Hypotheses 1a and 1b were supported. In addition, upward counterfactuals were more strongly related to safety knowledge than downward counterfactuals ($z = 2.36$, $p < .05$), but revealed no difference from downward counterfactuals in relation with safety motivation ($z = 1.17$, $p > .05$). Thus, Hypothesis 2 was supported and Hypothesis 4 was not supported.

Next, we tested the extent to which internal safety locus of control moderated the relationships between upward counterfactuals, safety knowledge, and motivation. These effects were not significant ($\beta = 0.05$, $p > .05$; $\beta = 0.03$, $p > .05$, respectively). Thus, Hypothesis 6 was not supported.

9.1. Mediation

The indirect effects of safety knowledge and motivation were estimated using a SPSS macro (Preacher & Hayes, 2004). 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). Results indicated that safety knowledge had an indirect effect on the relationships between upward counterfactuals and safety compliance (95% bootstrap CI = 0.05 to 0.37) and safety participation (95% bootstrap CI = 0.05 to 0.33), supporting Hypothesis 3 (see Table 3). However, the results did not support an indirect effect of upward counterfactuals on safety behavior through safety motivation. Thus, Hypothesis 5 was not supported.

9.2. Moderated mediation

Hypotheses 7 and 8 were tested using Preacher et al. (2007) moderated mediation approach. Prior to analyses, all continuous variables were standardized and moderators were operationalized at the mean, one standard deviation above the mean, and one standard deviation below the mean. The bootstrap method was used to examine the conditional indirect effect of upward counterfactuals on safety compliance through safety knowledge at three levels of safety locus of control (see Table 4). The results showed that two of the three conditional indirect effects were positive and significantly different from zero, as these bootstrap CIs did not contain zero. Thus, Hypothesis 7a was supported, such that the indirect and positive effect of upward counterfactuals on safety compliance through safety knowledge was observed when levels of internal safety locus of control were moderate to high, but not when internal safety locus of control was low.

Analyses on safety participation yielded similar results. The results showed that two of the three conditional indirect effects were positive and significantly different from zero, as these

Table 2
Regression Results for Hypotheses 3, 5, and 6

	Safety motivation	Safety knowledge	Safety compliance		Safety participation	
			Without mediators	With mediators	Without mediators	With mediators
Age	0.12	0.06	0.13	0.08	0.14	0.09
Sex	−0.04	0.17**	0.20**	0.05	0.17*	0.03
Tenure	−0.24*	−0.16	−0.24*	−0.10	−0.24	−0.10
Perceived risk	−0.01	−0.05	−0.09	−0.05	−0.02	0.03
Safety climate	0.30***	−0.04	−0.01	0.01	−0.02	−0.00
UCFT	0.09	0.22**	0.23***	0.02	0.16*	−0.04
ILOC	0.06	0.01				
UCFT*ILOC	0.05	0.03				
Safety motivation				0.05		0.03
Safety knowledge				0.87***		0.82***
R^2	0.14	0.09	0.11	0.80	0.07	0.69
F (df)	4.89*** (8; 231)	2.82** (8; 231)	4.73*** (6; 233)	113.54*** (8; 231)	2.71* (6; 233)	63.49*** (8; 231)

Note. $N = 240$; Sex: 1 = female, 2 = male; UCFT = upward counterfactual thinking; ILOC = internal safety locus of control. Standardized (β) regression coefficients are reported for each variable. *$p < .05$, ** $p < .01$, *** $p < .001$.

Table 3
Simple Mediation Results

Predictor	Mediator	Outcome	Indirect Effect	Boot SE	LL95%CI	UL95%CI
Upward CFT	Safety knowledge	Safety compliance	0.19	0.08	0.05	0.37
Upward CFT	Safety motivation	Safety compliance	0.01	0.01	0.00	0.02
Upward CFT	Safety knowledge	Safety participation	0.18	0.07	0.05	0.33
Upward CFT	Safety motivation	Safety participation	0.00	0.01	0.00	0.02

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

Table 4
Moderated Mediation Results for Upward Counterfactual across Levels of Safety Internal Locus of Control

Outcome	Mediator	Safety LOC	Conditional indirect effect	Boot SE	LL95%CI	UL95%CI
Safety compliance	Safety knowledge	−1*SD*	0.14	0.10	−0.03	0.36
		M	0.18	0.08	0.03	0.36
		+1*SD*	0.21	0.09	0.05	0.42
Safety compliance	Safety motivation	−1*SD*	0.00	0.01	−0.02	0.02
		M	0.00	0.01	0.00	0.02
		+1*SD*	0.01	0.01	0.00	0.03
Safety participation	Safety knowledge	−1*SD*	0.14	0.09	−0.03	0.33
		M	0.17	0.08	0.03	0.33
		+1*SD*	0.20	0.09	0.05	0.39
Safety participation	Safety motivation	−1SD	0.00	0.01	−0.01	0.02
		M	0.03	0.05	−0.02	0.02
		+1SD	0.06	0.07	0.00	0.03

Note. $N = 240$; LOC = internal locus of control; SE = standard error; LL = lower level; CI = confidence interval; UL = upper level.

bootstrap CIs did not contain zero. Thus, Hypothesis 7b was supported, such that the indirect and positive effect of upward counterfactuals on safety participation through safety knowledge was observed when levels of internal safety locus of control were moderate to high, but not when internal safety locus of control was low.

10. Discussion

The current study extends workplace safety research by examining the role of counterfactual thinking on workplace safety behavior. This study contributes three new insights to the workplace safety literature. First, upward counterfactuals had a significant effect on safety compliance and safety participation. Based on the correlations in Table 1, downward counterfactuals did not have a significant effect on safety compliance and safety participation. Second, safety knowledge operated as a mediating mechanism between upward counterfactuals and safety compliance, as well as safety participation. Third, the internal safety locus of control amplified the effects of counterfactuals on safety behavior through safety knowledge.

11. 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 organizational psychology and behavior 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 to negative outcomes are more likely to engage in safe behavior in the future. This result highlights the role of one specific cognitive process when predicting workplace safety behavior. 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 organizational psychology (e.g., Morris & Moore, 2000), 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, consistent with the cognitive mechanisms identified in the functional theory of counterfactual thinking (Epstude & Roese, 2008; Roese & Epstude, 2017), safety knowledge served as an explanatory mechanism for the relationship between upward counterfactual thinking and safety compliance, as well as safety participation. In other words, upward counterfactual thinking had an indirect effect on both obligatory and discretionary behavior through safety knowledge. Also, consistent with the previous cross-sectional research on safety-related counterfactual thinking on self-reported learning (Morris & Moore, 2000), upward counterfactual thinking may facilitate safety behavior by fostering individuals' learning about safety practices.

Unexpectedly, safety motivation was not an explanatory mechanism for the relationship between upward counterfactuals and safety behaviors. This unanticipated result might be due to the broad time period over which participants were instructed to reflect when responding to the safety motivation items. However, this same time period was used in the safety knowledge measure. Theoretically, safety motivation should be heightened immediately following and in response to counterfactual thinking and likely declines over time. Future research could utilize an experience sampling method in which counterfactual thinking and motivation could be assessed simultaneously.

Finally, counterfactual thinking had stronger effects on safety behavior for individuals with an internal safety locus of control. These results begin to reveal the importance of individual differences for the functional theory of counterfactual thinking. Since nurses in our sample had significantly higher levels of internal safety locus of control than doctors (as displayed in the correlation matrix in Table 1), this pattern of relationships may be even stronger for them. Further research is needed to determine if these differences in internal safety locus of control are dispositional or situational.

12. Practical implications

The current research has several practical implications for workplace safety improvements. First, it provides initial evidence for the relationship between counterfactuals and safety behavior, suggesting that counterfactual training may be a useful workplace safety intervention (cf. Dillon & Tinsley, 2008). Such training should highlight the distinction between and consequences of upward and downward counterfactuals. Managers could also encourage their employees to engage in upward counterfactuals 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 learn from their own or others' experiences.

Moreover, the finding that safety knowledge plays a central role in explaining the effects of counterfactuals on safety behavior also suggests that experience-based learning is critical to behavioral improvement. Therefore, organizations could use learning potential as an employee selection criterion and create a climate that

promotes learning and personal growth, encouraging individuals to obtain knowledge and develop skills 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.

Furthermore, our results showed that individuals with a high internal safety locus of control appear to benefit more (in terms of two forms of safety behavior: compliance and participation) from upward counterfactual thoughts than individuals with a low internal locus of control. Recruiters could identify people who are prone to perceive events as personally controllable in selection procedures, as this trait could maximize individuals' learning from past negative experiences. Alternatively or in addition, incident/near miss investigators could emphasize aspects of negative events that were within the employee's control and what they personally could have done differently or this information could be emphasized in an after action review/debrief.

13. Limitations and future research directions

Despite collecting data from two sources at three different time periods and thereby avoiding issues of same-source bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), this study has some limitations. First, because specific information about the safety-related events was not collected, details surrounding the event (e.g., whether it was a near miss, incident, or injury) are unknown. Recognizing the demands of open-ended survey items and culturally-related apprehensions, this was an intentional decision to not probe the respondents with such personal experiences. Dillon and Tinsley (2008) noted that whether a near miss is considered an event that *almost* happened or one that *could have* happened influences the resulting counterfactual's functionality, such that those interpreted as almost happened induce counterfactual-based learning but those interpreted as could have happened may not (Kahneman & Varey, 1990). Additionally, it is unknown whether the negative event under consideration was something the individual experienced themselves, observed, or simply heard about. Although it is possible that the degree of counterfactual-based learning may vary from these different types of negative events, it is important to note that research has shown counterfactual-based learning from each of these event types (Morris & Moore, 2000; Roese, 1994; Walker et al., 2016). It is also likely that event severity relates to counterfactual generation. Future studies should gather more information about the negative safety-related event, which would allow for a more nuanced examination of the event (e.g., differentiating near misses from injuries). Future research should consider such event characteristics and explore how they influence counterfactual-based processes.

Second, counterfactually-driven affect and experiential learning was not directly measured. However, previous research has shown that the upward (but not downward) counterfactual items used in this study correlated positively with negative affective measures (i.e., depression, rumination, pessimism; Rye et al., 2008). Nevertheless, future research using real-time assessment should examine the nature and intensity of the affect, specific experiential learning, and how they relate to other variables. To better understand the mechanisms underlying the relationship between counterfactual thinking and safety-related behaviors and outcomes, multiple mediators should be assessed simultaneously. For instance, counterfactual thinking may heighten awareness of and respect for workplace risks. Accounting for additional relevant variables will also likely increase the magnitude of the correlations and percent of variance accounted for; however, even small relationships can have practical value when predicting workplace safety behavior.

Third, safety in the workplace is complex and any given study is unlikely to capture all relevant variables. Nevertheless, it is important to contextualize our findings and accumulate knowledge relative to other known predictors. Thus, it is important to further determine the nomological network for safety behavior in the workplace and embed counterfactual thinking within this. Thus future research should include leadership (Mullen & Kelloway, 2009), organizational accountability (Morris & Moore, 2000), among other known predictors, and test the incremental validity of counterfactual thinking above and beyond these known predictors. It would also be good to obtain more distinct assessments of the mediators and dependent variables, given their strong intercorrelations in this study.

To further our understanding of the moderating effects of individual differences on functional counterfactual thinking, future research should expand the types of individual differences assessed. For instance, personality traits and self-efficacy might influence how counterfactuals impact safety knowledge, motivation, and behavior. Additionally, situational factors might also enhance functional counterfactual effects. Correspondingly, a more sophisticated moderated mediation model that incorporates these variables could be tested (cf. Smith-Crowe, Burke, & Landis, 2003). Finally, research should attempt to replicate the current findings by collecting data in different industries to determine the generalizability of the results.

14. Conclusion

This study is the first empirical study demonstrating the influence of counterfactual thinking on workplace safety behavior. Specifically, upward counterfactuals (thinking about how things could have been better) were positively associated with safety compliance and participation. This type of thinking had a stronger influence on safety knowledge and behavior than downward counterfactuals (thinking about how things could have been worse). Moreover, evidence supported safety knowledge as a mechanism explaining the relationship between upward counterfactuals and safety behavior. In addition, safety locus of control enhanced the effect of upward counterfactuals on safety behavior by amplifying the impact of upward counterfactuals on safety knowledge. This study provides a foundation from which future research can build to advance our understanding of how cognitive processes influence workplace safety behavior.

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Appendix:. Study measures

Time 1

Perceived Risk (Jermier et al., 1989)

1. I encounter personally hazardous situations on the job.
2. The nature of the work that I do and/or the environment I work in is physically dangerous.

Safety Climate (Beus et al., 2019)

1. My supervisor is committed to improving safety.
2. My supervisor places a strong emphasis on workplace safety.
3. Safety issues are openly discussed between my supervisor and my workgroup.
4. My supervisor ensures employees have adequate safety training.
5. My co-workers are committed to safety improvement.
6. Unsafe conditions are promptly corrected in my work area.
7. My supervisor encourages employees to become involved in safety matters.
8. My supervisor praises safe work behavior.

Internal Safety Locus of Control (Jones & Wuebker, 1985)

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.

Time 2

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.

1 = Never; 2 = Rarely; 3 = Sometimes; 4 = Often; 5 = Very Often

Counterfactual Thinking (Rye et al., 2008)

1. I think about how much better things could have been. (upward)
2. I cannot stop thinking about how I wish things would have turned out. (upward)
3. Although the bad situation was nobody's fault, I think about how things could have turned out better. (upward)
4. I think about how much worse things could have been. (downward)
5. I count my blessings when I think about how much worse things could have been. (downward)
6. Although what happened was negative, it clearly could have been a lot worse. (downward).

Safety motivation (Griffin & Neal, 2000)

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

Time 3

Safety Knowledge (Neal et al., 2000; modified for completion by the supervisor)

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 Compliance (Griffin & Neal, 2000; modified for completion by the supervisor)

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 (Griffin & Neal, 2000; modified for completion by the supervisor)

1. This employee promotes the safety program within the organization.
2. This employee puts in extra effort to improve the safety of the workplace.
3. This employee helps others when we are working under risky or hazardous conditions.
4. This employee voluntarily carries out tasks or activities that help to improve workplace safety.