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A Study of the Lagged Relationships Among Safety Climate, Safety Motivation, Safety Behavior, and Accidents at the Individual and Group Levels

Andrew Neal
University of Queensland

Mark A. Griffin
University of Sheffield

The authors measured perceptions of safety climate, motivation, and behavior at 2 time points and linked them to prior and subsequent levels of accidents over a 5-year period. A series of analyses examined the effects of top-down and bottom-up processes operating simultaneously over time. In terms of top-down effects, average levels of safety climate within groups at 1 point in time predicted subsequent changes in individual safety motivation. Individual safety motivation, in turn, was associated with subsequent changes in self-reported safety behavior. In terms of bottom-up effects, improvements in the average level of safety behavior within groups were associated with a subsequent reduction in accidents at the group level. The results contribute to an understanding of the factors influencing workplace safety and the levels and lags at which these effects operate.

Keywords: organizational climate, occupational safety, accidents, injuries, organizational behavior

Safety is a major concern for organizations, as it is a source of substantial direct and indirect costs. Traditionally, safety research has focused on identifying individual attributes, such as personality traits or attitudes, that are associated with accident proneness (Greenwood & Woods, 1919; Hansen, 1989; Shaw & Sichel, 1971; Sutherland & Cooper, 1991). However, major disasters, such as Piper Alpha and Chernobyl, have illustrated the importance of work climates and management practices as contributors to system failure (Reason, 1990). Consequently, increasing attention has been paid to the role of the work environment and management practices as determinants of safety in the workplace (Barling, Kelloway, & Iverson, 2003; Cox & Cheyne, 2000; Hayes, Perander, Smecko, & Trask, 1998; Parker, Axtell, & Turner, 2001). Much of this research has focused on the concept of safety climate.

The safety climate literature has examined the link between safety climate and safety outcomes, such as compliance with safe working practices and accidents. A large number of studies have demonstrated that perceptions of safety climate are positively correlated with self-reported safety behaviors and that both of these variables are negatively correlated with accidents (Griffin & Neal, 2000; Hayes et al., 1998; Hofmann & Stetzer, 1996; Neal, Griffin, & Hart, 2000; Rundmo, 1992). These findings are commonly taken to suggest that a poor safety climate produces a decrease in compliance with safety procedures and that this, in turn, causes an increase in accidents. However, most of this research has been cross-sectional. Reverse causality is, therefore, a possible explanation for some of these relationships. For example, accident involvement might bias an individual's perception of safety (Rundmo, 1997). Individuals who have accidents may feel less safe and, subsequently, report a poorer safety climate. In addition to the problem of reverse causality, relatively little is known about the mechanisms involved or the levels of analysis at which these effects operate.

In the current study we address these limitations by examining relationships among these constructs over a 5-year period. We place the concepts of safety climate and safety behavior into the broader theoretical context of work performance and examine the way safety motivation is linked to safety climate and safety behavior. In the following sections, we define these terms and present a model of the relationships among these constructs.

Climate, Motivation, and Behavior

The term *psychological climate* refers to individual perceptions of the work environment (L. A. James & James, 1989). When these perceptions are shared by members of a group or organization, they are referred to as *group* or *organizational* climate. Aspects of the work environment commonly assessed by climate measures include organizational policies, procedures, and practices (Reichers & Schneider, 1990). Specific types of climate reflect perceptions of different facets of the work environment, such as service (Schneider, White, & Paul, 1998), innovation (Anderson & West, 1998), and safety (Neal et al., 2000; Zohar, 1980, 2000). The term *perceived safety climate,* therefore, refers to individual perceptions of policies, procedures, and practices relat-

Andrew Neal, ARC Key Centre for Human Factors and Applied Cognitive Psychology, School of Psychology, University of Queensland, Brisbane, Queensland, Australia; Mark A. Griffin, Institute of Work Psychology, University of Sheffield, Sheffield, United Kingdom.

Portions of this research were completed while Mark A. Griffin was at the School of Management, Queensland University of Technology, Brisbane, Queensland, Australia, and the Australian Graduate School of Management, University of New South Wales, Sydney, New South Wales, Australia.

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Correspondence concerning this article should be addressed to Andrew Neal, ARC Key Centre for Human Factors and Applied Cognitive Psychology, School of Psychology, University of Queensland, Brisbane QLD 4072, Australia. E-mail: andrew@psy.uq.edu.au

ing to safety in the workplace. *Group safety climate* refers to the shared perceptions of the group as a whole. Researchers can operationalize group safety climate by aggregating individual perceptions to the group level, using the direct consensus model (Chan, 1998).

Griffin and Neal (2000) argued that theories of work performance provide a useful basis for conceptualizing the link between safety climate and safety behavior. Drawing on Borman and Motowidlo's (1993) distinction between task and contextual performance, they differentiated two types of safety behavior: compliance and participation. *Safety compliance* refers to the core activities that individuals need to carry out to maintain workplace safety. These behaviors include adhering to standard work procedures and wearing personal protective equipment. *Safety participation* describes behaviors that do not directly contribute to an individual's personal safety but that do help to develop an environment that supports safety. These behaviors include activities such as participating in voluntary safety activities, helping coworkers with safety-related issues, and attending safety meetings.

Drawing on Campbell, McCloy, Oppler, and Sager's (1993) theory of performance, Griffin and Neal (2000) argued that perceived safety climate is an antecedent of safety behavior. They also proposed that safety motivation mediates the relationship between safety climate and safety behavior. The term *safety motivation* refers to an individual's willingness to exert effort to enact safety behaviors and the valence associated with those behaviors. Individuals should be motivated to comply with safe working practices and to participate in safety activities if they perceive that there is a positive safety climate in the workplace. Some evidence already exists to support this hypothesis. In one of the few longitudinal studies in the safety literature, Probst and Brubaker (2001) found that safety motivation had a lagged effect on safety compliance 6 months later.

There are a number of theoretical mechanisms that may be responsible for a link between perceived safety climate and safety motivation, including social exchange theory (Blau, 1964) and expectancy-valence theory (Vroom, 1964). Social exchange theory predicts that if employees perceive that the organization is concerned for their well-being, they will develop an implicit obligation to reciprocate by carrying out behaviors that benefit the organization. Evidence suggests that employees may reciprocate the positive experiences they have in an employment relationship by carrying out their core tasks at a high standard and by carrying out citizenship activities (Tsui, Pearce, Porter, & Tripoli, 1997). In the safety literature, Hofmann and Morgeson (1999) argued that when employees work in an environment in which safety is a concern, they reciprocate by complying with established safety procedures. Expectancy-valence theory predicts that employees will be motivated to comply with safety procedures and participate in safety activities if they believe that these behaviors will lead to valued outcomes. Zohar (2003) has argued that perceptions of safety climate reflect employees' beliefs about the priority of safety and that these perceptions inform behavior-outcome expectancies.

Recent studies of safety climate have focused on the effects of safety climate at the group level (Hofmann, Morgeson, & Gerras, 2003; Hofmann & Stetzer, 1996; Zohar, 2000, 2002). Levels of safety climate may vary among groups in the same organization because of differences in group processes. Supervisory practices, for example, may shape members' perceptions of organizational policies, practices, and procedures (Zohar & Luria, 2004). The arguments we have presented regarding the link between perceived safety climate and individual motivation also apply to the link between group safety climate and individual motivation. Zohar (2000) argued that group safety climate influences safety motivation, because it informs group members of desired role behaviors and thereby shapes the expectancy and valence associated with safe or unsafe behavior. A positive group safety climate may also signal that the supervisor is concerned for the welfare of group members and may generate an implicit obligation for members to reciprocate by carrying out safety activities (Hofmann & Morgeson, 1999). These arguments suggest that individuals who work in groups with a positive safety climate should be more motivated to engage in safety activities than individuals who work in groups with a negative safety climate. Individuals who are motivated to engage in safety behaviors should, in turn, be more likely to carry out those behaviors. Given that the direction of causation is assumed to be from climate to motivation and from motivation to behavior, we predict the following:

> *Hypothesis 1:* Group safety climate will exert a lagged effect on individual safety motivation.

> *Hypothesis 2:* Individual safety motivation will exert a lagged effect on individual safety compliance and safety participation.

Accidents

Analyses of major accidents and disasters (e.g., Reason, 1990) provide a basis for generating predictions regarding the levels at which the relationship between accidents and behavior or climate may be observed and the time lags involved. Accidents are low-frequency events and are typically triggered by unintentional errors, such as slips, lapses, or mistakes. They are generally made possible by preexisting hazards or pathogens that have made the system vulnerable to failure (Reason, 1990). These hazardous conditions are typically caused by unsafe behaviors carried out by other people. Noncompliance with safety procedures and refusal to participate in activities that enhance the safety of other people, therefore, may not directly affect the person who fails to carry out these behaviors but can create the conditions that make it more likely that someone else will be injured later on. Groups that have a greater proportion of members who fail to carry out safety behaviors should consequently accumulate a greater number of pathogens over time.

These arguments suggest that a link between safety behavior and accidents should be observed at the group level rather than the individual level. Furthermore, this effect is likely to be lagged. A change in the overall level of compliance and participation in a group should take time to produce changes in the accident rate for that group, because of the preexisting pathogens that have accumulated over time. Finally, although group safety climate might also be a predictor of accidents (Hofmann & Stetzer, 1996; Zohar, 2000), Neal and Griffin (2004) have argued that this relationship is mediated by safety behavior. The effects of safety behavior should, therefore, be stronger than the effects of safety climate, as safety behavior is the more proximal predictor. As is typically the case in multilevel research, the power to detect effects at the group level is weaker than at the individual level in our study. This is compounded by the problem that effect sizes decrease as the relationship between variables becomes more distal, because of the number of links in the causal chain, competing causes, and other random factors (Shrout & Bolger, 2002). For this reason, our hypothesis focuses on the most proximal predictor.

> *Hypothesis 3:* Safety behavior in work groups will be associated with a subsequent reduction in accidents at the group level of analysis.

Method

Participants and Procedure

The study was carried out in an Australian hospital employing over 700 staff. There was a range of safety issues that were of concern to these staff, including manual handling injuries, needle-stick injuries, exposure to infectious or poisonous agents, and bullying or harassment. All employees were surveyed in 1996 (Year 1), 1997 (Year 2), and 1999 (Year 4). In 1996, employees completed a measure of dispositional negative affectivity that we used to control for potential common method variance. In 1997 and 1999, participants responded to items concerning safety climate, motivation, and behavior. Four hundred thirty staff completed the first survey (a 61% response rate), 490 staff completed the second survey (a 52% response rate), and 301 staff completed the third survey (a 46% response rate).

All three surveys were completed by a longitudinal sample of 135 employees. This longitudinal sample was the focus for hypotheses tested at the individual level of analysis. There were no significant differences on any of the climate, motivation, or behavior measures between the final longitudinal sample and those who were present in only one or two of the measurement waves. Of the 135 employees in the longitudinal sample, 90% were female, and the respondents had a mean age of 42.7 years (SD = 9.51) in 1999. The main occupational category was nursing (61%), with other categories of employee including administration (26%), technical support (10%), social work (2%), and medical (1%).

Employees were located in 39 work groups, and these groups were the focus of hypotheses tested at the group level of analysis. Groups ranged from 6 employees to 70 employees. We excluded groups with more than 30 employees, because it is possible that there would be very little interaction among members in large groups. This resulted in a final sample of 33 groups, with a mean size of 12.1 employees. The average number of respondents per group was 4.1. The relatively low within-group response rate is a consequence of attrition over the course of the study. Although the within-group response rate is low, our analyses show high levels of agreement within groups. Under these conditions, we expect the within-group estimates of climate to be reliable even when we use a sample of group members.

Measures

Individual ratings of safety climate, safety motivation, and safety behavior were assessed with items from Neal et al. (2000). All items were measured on a 5-point rating scale ranging from 1 *(strongly disagree)* to 5 *(strongly agree),* and the items are reported in the Appendix. For safety climate, three items assessed the degree to which safety was valued by the organization (αs = .95 in Year 2 and .94 in Year 4). Safety motivation was assessed by three items that measured the extent to which individuals viewed safety as an important part of their work life (αs = .92 in Year 2 and .85 in Year 4).

Two components of safety behavior were assessed: safety compliance and safety participation. Each safety component was assessed by three items. An example item for safety compliance is, "I use all the necessary safety equipment to do my job" (αs = .93 in Year 2 and .92 in Year 4); an example item for safety participation is, "I promote the safety program within the organization" (αs = .89 in Year 2 and .86 in Year 4).

Psychometric properties of the individual perception items were assessed with confirmatory factor analysis. We estimated an eight-factor model comprising the four constructs repeated across the 2 years. The confirmatory factor analysis model provided a good fit to the data, $\chi^2(212, N = 194) = 373.93$, $p > .05$, goodness-of-fit index = .87, nonnormed fit index = .95, comparative fix index = .96, root-mean-square error of approximation = .05. The factor loadings are reported in Table 1. Correlations between the factors ranged from .08 ($p > .05$) for the correlation between safety compliance in Year 2 and safety motivation in Year 4 to .68 ($p < .001$) for the correlation between safety motivation in Year 2 and safety compliance in Year 2.

Negative affectivity. We included a measure of dispositional negative affectivity as a control for common method variance among self-report measures (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). We assessed negative affectivity using the Neuroticism scale of the NEO Five Factor Inventory (Costa & McCrae, 1989). The scale comprises 12 items that ask respondents how they would generally describe themselves. Responses were recorded on a 5-point scale ranging from 1 *(strongly disagree)* to 5 *(strongly agree).*

Accidents. The number of injuries within each work group was extracted from the hospital's injury database for the years 1996 (Year 1) to 2000 (Year 5). By government regulation, all accidents resulting in a lost-time injury were recorded in this database, which was maintained by the hospital's safety manager. The most common forms of injuries were strains and sprains (68.5%), followed by bruises (10.3%) and fractures (4.3%).

Table 1
Correlations Between Self-Report Measures (N = 135)

Year and measure	*M*	*SD*	1	2	3	4	5	6	7	8	9
Year 1 (1996)											
1. Negative affectivity	2.52	0.67	—								
Year 2 (1997)											
2. Safety climate	3.80	0.77	−.15	—							
3. Safety motivation	4.59	0.53	−.07	.49***	—						
4. Safety compliance	4.48	0.63	−.09	.50***	.71***	—					
5. Safety participation	3.93	0.89	−.13	.56***	.48***	.57***	—				
Year 4 (1999)											
6. Safety climate	3.62	0.89	−.14	.58***	.32***	.31***	.29**	—			
7. Safety motivation	4.55	0.55	−.30**	.27**	.31***	.21*	.32***	.56***	—		
8. Safety compliance	4.44	0.62	−.14	.27**	.26**	.31***	.32***	.48***	.79***	—	
9. Safety participation	3.80	0.91	−.16	.34***	.44***	.46***	.67***	.66***	.65***	.64***	—

* $p < .05$. ** $p < .01$. *** $p < .001$.

Aggregation Procedures

Before aggregating perceptions of safety climate to the group level, we assessed the group-level properties of the measure. The mean $r_{WG(J)}$ value (L. R. James, Demaree, & Wolf, 1984) for group safety climate was .83 (SD = .15) in Year 2 and .78 (SD = .18) in Year 4, representing adequate levels of agreement. We assessed the between-groups variance using one-way analyses of variance. The F values and intraclass correlation, ICC(1), values for safety climate were $F(32, 134) = 1.44$, $p < .10$, ICC(1) = 5.1%, in Year 2, and $F(32, 134) = 1.07$, $p > .05$, ICC(1) = 2.2%, in Year 4. Although these values were not below the .05 level of statistical significance, George (1990) argued that one would not expect to find large differences when the groups belong to the same organization and that, in these cases, an F ratio greater than 1.00 is sufficient to justify examining relationships at the aggregate level.

When testing the prediction of accidents (Hypothesis 3), we also needed to aggregate the behavior measure to the group level. Accidents were recorded at the group level, and it is necessary for predictors to be aggregated to the same level of analysis as the dependent variable. For these group-level analyses, we combined the measures of safety compliance and safety participation to create an indicator of the mean level of safety behavior within each group. The reason for combining the two scales was that they were highly correlated at the group level ($r = .91$, $p < .001$, in Year 2; $r = .92$, $p < .001$, in Year 4). The mean $r_{WG(J)}$ value for overall safety behavior was .91 in 1997 and .92 in 1999. The F values for the behavior measure were greater than 1.00: $F(32, 134) = 1.60$, $p < .05$, ICC(1) = 4.1%, for Year 2; $F(32, 134) = 1.05$, $p > .05$, ICC(1) = 2.0%, for Year 4.

Results

Climate, Motivation, and Behavior

Correlations between all individual measures and with group safety climate are reported in Table 2. The table shows that the zero-order relationships between the same constructs across two waves were all significant, indicating that there was some level of stability in each of the constructs over time. Correlations ranged from .31 for safety motivation to .67 for safety participation from Year 2 to Year 4.

To test whether group safety climate exerted a lagged effect on individual safety motivation and behavior, we ran a series of multilevel analyses, using MLwin (Goldstein et al., 1998). We ran separate analyses using individual motivation, compliance, and participation at Year 4 as dependent variables. In Step 1, we entered the individual control measure of negative affectivity from Time 1 and the group measure of safety climate from Year 2.

Table 3 shows that negative affectivity in Year 1 was significantly and negatively related to safety motivation in Year 4. Negative affectivity was not a significant predictor of either safety compliance or safety participation. Group safety climate in Year 2 was a significant positive predictor of safety motivation and safety participation in Year 4 after we controlled for negative affectivity in Step 1. Group safety climate was not a significant predictor of subsequent safety compliance in Step 1.

In Step 2, we entered the individual measures of safety motivation, compliance, and participation. Table 3 shows that group safety climate in Year 2 was positively associated with subsequent levels of safety motivation after we controlled for all individual measures. This result supports Hypothesis 1 and provides strong evidence for a lagged effect of group safety climate on subsequent individual safety motivation. The inclusion of safety motivation in Year 2 as a predictor of safety motivation in Year 4 means that we found the lagged effect of group safety climate after controlling for prior levels of safety motivation.

Hypothesis 2 proposed that individual safety motivation in Year 2 would display a lagged effect on individual safety compliance and individual safety participation. This hypothesis is supported for safety participation but not for safety compliance. The results show that individuals with high levels of safety motivation in Year 2 were more likely to show an increase in safety participation when assessed 2 years later.

Contrary to expectations, neither group safety climate nor safety motivation in Year 2 was related to safety compliance in Year 4 after we controlled for safety compliance in Year 2. Therefore, Hypothesis 2 is only partially supported. Table 3 also shows that safety participation in Year 2 was associated with a subsequent change in safety motivation and safety compliance. This result was not expected.

Accidents

Correlations among the aggregate measures from Year 1 to Year 5 are shown in Table 2. We examined the lagged effects of aggregate safety climate and safety behavior on accidents in a Poisson regression analysis by controlling for group size and for prior levels of accidents, climate, and behavior. We used Poisson regression to test Hypothesis 3 because our dependent variable was a count measure with a Poisson-like distribution. We controlled for group size, prior accidents, climate, and behavior to eliminate potential suppressor effects.[1] As can be seen in Table 2, the zero-order correlations between aggregate behavior and subsequent accidents were not statistically significant. However, these correlations do not take account of the correlations between accidents over time and the relationship between group size and accidents. For example, if accidents are positively correlated with safety behavior in the same year and with accidents in the subsequent year, then this correlation will suppress the negative relationship between safety behavior and subsequent accidents.

The results of the Poisson regression analysis are presented in Table 4. This table shows the effects of safety behavior and aggregate safety climate on accidents. As expected, safety behavior in Year 4 was significantly negatively related to accidents in Year 5. This result supports Hypothesis 3. The right-hand side of Table 4 shows the results for safety behavior in Year 2. In this case, the results were not statistically significant, although they were in the expected direction, with safety behavior in Year 2 negatively related to accidents in Year 3. We note that this analysis could not control for prior levels of safety behavior. Overall, then, the results of the Poisson regression show partial support for Hypothesis 3. As expected, the observed effects of aggregate safety climate were weaker than the effects of aggregate safety behavior. Although the effects of aggregate safety climate were in the same direction as the effects of aggregate safety behavior, they were not significant. This is consistent with Shrout and Bolger's

[1] We carried out an additional analysis controlling for whether the work group was involved with technical equipment or direct patient contact or whether the work group was involved in administrative functions. Adding this additional control variable did not change the pattern of results, but it did cause an increase in the standard error of estimates. Given the small sample size and the need to maintain adequate degrees of freedom, we did not include this control variable in the final analysis.

Table 2
Correlation Between Aggregated Measures (N = 33)

Measure	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Accidents Year 1	0.50	0.83	—									
2. Safety climate Year 2	3.63	0.53	.16	—								
3. Safety behavior Year 2	4.15	0.41	.02	.64***	—							
4. Accidents Year 2	0.32	0.73	.13	.02	.01	—						
5. Accidents Year 3	0.21	0.48	.34*	−.03	−.15	.33*	—					
6. Safety climate Year 4	3.50	0.48	.05	.32*	.23	−.06	.09	—				
7. Safety behavior Year 4	4.01	0.42	−.16	.22	.62***	−.17	−.04	.52**	—			
8. Accidents Year 4	0.38	0.61	.33*	.23	.16	.12	.03	.46**	.14	—		
9. Accidents Year 5	0.21	0.54	.24	.33*	.20	−.02	−.17	.14	−.19	.50***	—	
10. Group size	12.15	8.04	.25	.20	.10	.56***	.31*	−.07	−.22	.39**	.37**	—

* $p < .05$. ** $p < .01$. *** $p < .001$.

(2002) argument that the power to detect effects decreases as the relationship between the predictor and criterion becomes more distal.

To test for reverse causation, we ran an additional set of ordinary least squares regression analyses using safety behavior in Year 4 as the dependent variable and prior safety behavior, prior accident rates, and group size as the predictors. Prior accident rates were not negatively related to safety behavior in Year 4. In fact, the trend (although nonsignificant) was positive. Accidents in Year 3 were positively related to safety behavior in Year 4 after we controlled for prior levels of safety behavior ($\beta = .25$, $p < .10$). These results suggest that reverse causation is not an explanation for our findings.

Discussion

Longitudinal studies of safety perceptions and accidents are rare. The current study spans a 5-year period during which safety perceptions were measured on two occasions, accidents on five occasions, and personality on one initial occasion. No previous study has measured perceptions of safety climate, motivation, and behavior at two time points and linked them to prior and subsequent levels of accidents.

The design of this study provides a unique opportunity to establish the direction of causal relationships, and the levels at which these effects operate. The key lagged relationships that we investigated were from (a) group safety climate to individual safety motivation, (b) individual safety motivation to individual behavior, and (c) aggregated behavior to group accident rates. The study, therefore, examines both top-down and bottom-up processes operating dynamically over time. However, no single analytic procedure can test a conceptual model that incorporates both top-down and bottom-up processes operating simultaneously (Griffin, 1997). Therefore, we examined the top-down and bottom-up effects in separate analyses. Together, these analyses examine a longitudinal multilevel process that has not been tested in previous studies of safety.

We found support for key aspects of each lagged relationship over a 2-year period after controlling for previous levels of each measure and controlling for levels of individual negative affectivity. As predicted by our model, individuals who belonged to groups with a positive safety climate in Year 2 reported an increase in their safety motivation in Year 4. Furthermore, individual safety motivation in Year 2 was associated with positive changes in individual safety participation. The results suggest that when employees believe safety is important, they are more likely to carry out activities that do not necessarily contribute to their own safety but that do help to make the broader work environment safer.

These findings make an important contribution to the safety literature by showing that relationships between group safety climate and individual safety motivation and between individual

Table 3
Prediction of Individual Motivation, Compliance, and Participation by Group Safety Climate

	Safety motivation Year 4			Safety compliance Year 4			Safety participation Year 4		
Step and variable	Parameter	*SE*	Ratio	Parameter	*SE*	Ratio	Parameter	*SE*	Ratio
Step 1									
Group safety climate Year 2 (β_{1j})	0.48	0.18	2.67**	0.13	0.19	0.68	0.57	0.28	2.04*
Individual negative affectivity Year 1 (β_{2ij})	−0.19	0.07	−2.71**	−0.11	0.08	−1.34	−0.17	0.11	−1.55
Step 2									
Group safety climate Year 2 (β_{1j})	0.37	0.16	2.32*	0.03	0.19	0.16	0.31	0.24	1.29
Individual negative affectivity Year 1 (β_{2ij})	−0.16	0.06	−2.67**	−0.10	0.08	−1.25	−0.13	0.09	−1.44
Individual safety motivation Year 2 (β_{3ij})	0.30	0.11	2.73**	0.01	0.13	0.08	0.28	0.14	2.00*
Individual safety compliance Year 2 (β_{4ij})	−0.14	0.10	−1.40	0.14	0.12	1.17	−0.19	0.15	−1.27
Individual safety participation Year 2 (β_{5ij})	0.16	0.06	2.67**	0.13	0.06	2.17*	0.58	0.08	7.25***

Note. In the subscripts to β, the first numeric subscript is a sequential identifier for each predictor, the subscript i indicates that the measure varies across individuals, and the subscript j indicates that the measure varies across groups.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4
Prediction of Group Accident Rates by Group Size, Previous Accidents, and Safety Behavior (N = 33)

Variable	Predicting accidents Year 5			Predicting accidents Year 3		
	Parameter	*SE*	Ratio	Parameter	*SE*	Ratio
Safety behavior						
Safety behavior 1 year past	−3.06	1.62	−1.89*	−1.32	1.17	−1.12
Safety behavior 3 years past	7.05	4.34	1.62			
Accidents 1 year past	1.76	0.67	2.60**	0.78	0.22	3.61***
Accidents 2 years past	0.48	0.22	2.20*	0.66	0.33	2.02*
Safety climate						
Safety climate 1 year past	−1.28	0.98	−1.31	−0.39	1.08	−0.36
Safety climate 3 years past	3.02	1.84	1.64			
Accidents 1 year past	1.90	0.64	2.97**	0.66	0.18	3.65***
Accidents 2 years past	0.54	0.26	2.06*	0.63	0.34	1.84

* $p < .05$. ** $p < .01$. *** $p < .001$.

safety motivation and individual safety participation can be observed with lags of up to 2 years. These results suggest that safety climate and safety motivation can have important and lasting effects. The current study, therefore, provides stronger evidence regarding the direction of causation and the mechanisms that are involved than previous studies within this field.

Contrary to our hypotheses, safety motivation in Year 2 was not associated with subsequent changes in safety compliance. This result fails to replicate Probst and Brubaker (2001), who did find such an effect. One reason for the different results could be that the measures of safety motivation used in these two studies assess different aspects of the construct. The items used by Probst and Brubaker (2001) assessed extrinsic motivators for compliance, such as the rewards and punishments handed out by supervisors. Our measure assessed the intrinsic value of safety and did not focus specifically on compliance. It is possible that extrinsic motivators, such as rewards and punishment, may be more important determinants of changes in compliance than the intrinsic value that individuals place on safety. The results of our study are consistent with Motowidlo, Borman, and Schmit's (1997) argument that motivation is a stronger determinant of contextual performance than task performance, because contextual behaviors are more discretionary.

Unexpectedly, the results also suggest that there is a reciprocal relationship between safety motivation and safety participation over time. It appears that the act of participating in safety activities can lead to a further increase in safety motivation. This finding makes a contribution to the organizational behavior literature, as it suggests that carrying out behaviors that benefit the organization has positive motivational consequences. One explanation may be that individuals who carry out discretionary activities, such as participating in safety activities, receive positive reward and encouragement, which motivates them to carry out further activities. Merely complying with safety requirements is unlikely to generate reward or encouragement, which may explain why compliance did not have the same effect on motivation.

In summary, the results show that self-reports of safety compliance and safety participation are empirically distinct at the individual level of analysis and are differentially related to safety motivation over time. This is important because, as Burke, Sarpy, Tesluk, and Smith-Crowe (2002) have argued, the vast majority of studies have treated safety behavior as a unidimensional construct. Researchers have long suggested that more attention be paid to the dimensionality of the criterion domain (Austin & Villanova, 1992). Although substantial progress has been made in understanding the dimensionality of job performance, much less progress has been made in understanding the dimensionality of safety behavior.

At the group level, changes in self-reported safety behavior were associated with a subsequent reduction in accidents. With respect to methodology, this finding is important, because it shows that the self-report measures of safety behavior used in the current study have predictive validity. In terms of theory, this is one of the few studies to examine the relationship between changes in behavior and changes in accidents. The results show that a relationship can be detected at the group level of analysis and suggest that the direction of causation is from behavior to accidents. This represents a bottom-up process, as behavior is an individual-level construct. As predicted by a resident pathogen account (Reason, 1990), groups that are composed of individuals who engage in safety behaviors experience a subsequent reduction in accident rates, presumably because these behaviors make the work environment less hazardous. Furthermore, our results rule out reverse causation as an explanation for this relationship. In fact, there is some evidence that accidents positively increase subsequent levels of safety behavior.

Limitations

There are several limitations of this study that readers need to consider when interpreting the results. First, the measures of climate, motivation, and behavior were collected from the same individuals. The relationships among these variables may, therefore, be confounded by common method variance. As Podsakoff et al. (2003) recommended, we minimized the effects of common method variance by temporally separating the collection of predictor and criterion information, evaluating the validity of our criterion measures by collecting objective measures of accidents, and controlling for stable differences in negative affectivity. Of course, it is possible that, by using negative affectivity as a control variable, we might have masked true relationships. Negative affectivity (neuroticism) could be a meaningful source of stability in perceptions of climate and behavior over time. By controlling for negative affectivity, the current study provides a conservative test of the levels of stability and the determinants of change in climate, motivation, and behavior.

A second limitation that readers need to consider is the sample size at the group level of analysis and the number of accidents recorded over the 4-year period. The power of this study to detect effects at the group level of analysis was limited. With 33 work groups, we only had sufficient power to detect large effect sizes. The power of the analyses might have been further restricted by the low base rate of accidents. For this reason, nonsignificant results in the current study need to be treated with caution.

A third limitation is the nature of the safety climate measure that we used. The measure assessed individual perceptions of policies, practices, and procedures relating to safety and did not specifically focus on attributes of the group (e.g., supervisory practices). This might have reduced the sensitivity of the measure to differences in climate at the group level. A final limitation relates to the representativeness of the sample. As with any longitudinal study, attrition is a problem. The final sample may overrepresent highly committed employees.

Conclusion

The results of the current study add to the growing body of literature examining the impact of the work environment on employee safety. The findings clarify the direction of the relationships among safety-related constructs and the levels at which these effects operate. Furthermore, the results provide new insights into the role of motivation in workplace safety and the dimensionality of safety behavior. These results support the claim that when individuals perceive that there is a safe working climate, they will reciprocate by allocating effort to discretionary safety activities. This supports the arguments being made by many in the field that organizations attempting to improve safety should focus on changing the work environment to motivate people to actively participate in safety activities, rather than simply blaming and punishing individuals who fail to comply with standard work procedures. However, the results suggest that it takes time for a change in employee behavior to result in a reduction in the accident rate. Changing the work environment may be more difficult and time consuming than punishing or retraining the individual. However, in the long run, this change might be more effective.

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Appendix

Factor Loadings for Items Assessing Safety Climate, Motivation, and Behavior

Variable and item	Year 2	Year 4
Safety climate		
1. Management places a strong emphasis on workplace health and safety	.93	.91
2. Safety is given a high priority by management	.95	.97
3. Management considers safety to be important	.95	.93
Safety motivation		
1. I feel that it is worthwhile to put in effort to maintain or improve my personal safety	.84	.68
2. I feel that it is important to maintain safety at all times	.96	.87
3. I believe that it is important to reduce the risk of accidents and incidents in the workplace	.92	.89
Safety compliance		
1. I use all the necessary safety equipment to do my job	.78	.91
2. I use the correct safety procedures for carrying out my job	.89	.94
3. I ensure the highest levels of safety when I carry out my job	.92	.87
Safety participation		
1. I promote the safety program within the organization	.85	.80
2. I put in extra effort to improve the safety of the workplace	.95	.95
3. I voluntarily carry out tasks or activities that help to improve workplace safety	.70	.71

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