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Relationships Between Psychological Safety Climate Facets and Safety Behavior in the Rail Industry: A Dominance Analysis

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Abstract

The goals of this study were twofold: (1) to confirm a relationship between employee perceptions of psychological safety climate and safety behavior for a sample of workers in the rail industry, and (2) to explore the relative strengths of relationships between specific facets of safety climate and safety behavior. Non-management rail maintenance workers employed by a large North American railroad completed a survey (n = 421) regarding workplace safety perceptions and behaviors. Three facets of safety climate (management safety, coworker safety, and work-safety tension) were assessed as relating to individual workers' reported safety behavior. All three facets were significantly associated with safety behavior. Dominance analysis was used to assess the relative importance of each facet as related to the outcome, and work-safety tension evidenced the strongest relationship with safety behavior.

Keywords: safety climate, dominance analysis, transportation, rail

1. Introduction

Workplace safety is of paramount importance in the rail industry, where accidents involving the movement of people and goods can result in serious injury, lost time, delays in service, and even death. The U.S. Federal Railroad Administration (FRA) reported 5271 cases of injury and/or illness, including 17 fatalities, involving on-duty railroad workers in 2007 (FRA, 2008). The sheer number of employee injuries and fatalities may not be surprising; working on a railroad can be extremely dangerous. In fact, incident reports from the 1970s document well over 100 employee fatalities each year (FRA, 2008). Although the rail industry has made tremendous improvements in safety over the years with new reporting programs, investigation procedures, and safety initiatives (e.g., FRA, 2006), even low rates of incidence ought not be tolerated. Improving safety requires a continuous refinement of practices and a strong commitment to prevention, especially when the risk involves human life.

Currently, railroads rely almost exclusively on retrospective data, such as the aforementioned incidence rates, to gauge levels of organizational safety. Yet, increasingly, railroads are looking to adopt practices of other high reliability industries (i.e., industries with low rates of incidents, but potentially high associated costs; e.g., mining, nuclear power plants) and use leading indicators of safety to aid in identifying unsafe conditions before incidents occur (Flin et al., 2000). Safety climate is a prime example of a leading indicator of safety because it provides evidence of the psychosocial conditions that may encourage or discourage safe behavior.

The growing interest in safety climate is echoed in a recent research agenda released by the transportation sector council of the National Institute for Occupational Safety and

Health (NIOSH). In an attempt to better connect research with effective organizational practices and interventions, NIOSH recently restructured the National Occupational Research Agenda (NORA) into sector-based councils. The mission of these councils is to document sector-specific research needs and encourage collaborations among employers, employees, labor, academic institutions, and government agencies to meet those needs (NORA, 2009). In particular, the Transportation, Warehousing, and Utilities Sector Council has prioritized research developing techniques to measure attributes of organizational culture and climate, specifically to “help safety and health professionals identify changes in policies and practices that will improve safety performance” (NORA, 2009, p. 8). The current study addresses this call for research in multiple ways by: 1) documenting a relationship between safety climate and safety behavior in a sample of workers in the transportation sector; 2) evaluating the relative importance of three key facets of safety climate as related to safety behavior; and 3) disseminating research accomplished through a collaboration among multiple stakeholders in industry, government, and academia.

The subjects of this study, rail maintenance workers, represent a broad spectrum of job types. In addition to those individuals performing more traditional transportation-related duties, such as engineers and hostlers, the rail industry employs machinists, electrical workers, and sheet metal workers to repair and maintain its equipment. Safety compliance is essential in such a hazardous work environment because of the inherent risks associated with the management of large machinery. Mechanical workers, for example, must regularly maneuver underneath rail cars suspended inches above their heads. Failure to comply with safety standards for the proper use of jacks could result in the loss of stability of over one hundred tons of equipment. This and other unsafe behaviors may have devastating consequences.

Studies utilizing samples of workers from construction, manufacturing, and other modes of transportation, generally show that a positive safety climate is associated with greater compliance with safety standards (Goldenhar et al., 2003; Griffin & Neal, 2000; Prussia et al., 2003) and lower incidence of workplace accidents (Clarke, 2006b; Mattila et al., 1994; Morrow & Crum, 2004; Probst, 2004). Rail-specific safety climate research is sparse, but we expect that the relationship between safety climate and safety behavior will hold for rail maintenance workers, as it does for workers in similar industries. However, there are also noteworthy exceptions suggesting that this relationship is not always so straightforward. For instance, a recent study of workers in an industry much akin to the current sample, aircraft maintenance, found a relationship between safety climate and observed noncompliance with safety standards for only one out of two sites sampled (Neitzel et. al, 2008). This finding underscores the importance of continuing to study, and further to decompose, the relationship between safety climate and safety behavior.

Clarke (2006a) also notes that, although safety climate accounts for substantial variance in safety behaviors and accidents, there is considerable variation in the strengths of these relationships; possibly due to methodological differences between studies. One such difference commonly noted between studies of safety climate concerns how the construct is measured. For instance, studies investigating the factor structure of safety climate have often produced very different results (e.g., Brown & Holmes, 1986; Dedobbeleer & Béland, 1991; Zohar, 1980). Additionally, although most researchers agree that safety climate is a multidimensional construct, a number of studies still use a global indicator of safety climate when assessing its relationship to safety outcomes (e.g., Clarke, 2006b; DeJoy et al., 2004; Neal, Griffin, & Hart, 2000; Pousette, Larsson, & Törner, 2008). Cooper and Phillips (2004) argue that “the purpose of measuring safety climate is to provide opportunities for enquiry or change so as to improve safety performance” (p. 498), and a safety climate factor should only be viewed as key if it predicts safety-related outcomes. It is possible that the relative strength of the safety climate-safety behavior relationship is dependent on the particular facets selected to capture psychological safety climate; however, these differences are not often explicitly examined in the literature. This study explores a new direction in understanding and measuring safety climate by utilizing dominance analysis to examine the relative relationships between facets of safety climate and safety behavior.

1.1. Psychological Safety Climate

Psychological climate refers to an individual’s perception of his or her working environment, which arises from his or her cognitions and sense-making (James & James, 1989). Conceptualizations of climate can exist in a myriad of forms from general to specific (i.e., “climates for something;” Schneider & Reichers, 1983). Psychological *safety* climate is a specific type of climate defined as an employee’s perception of the value or priority of safety at his or her workplace (Griffin & Neal, 2000). As Zohar and Luria (2005) point out, organizational operations demand safety as well as productivity from employees. The formal policies and procedures instated by upper management, together with the actual practices of supervisors and coworkers in carrying out said policies and procedures, inform employees of the relative value of safety in light of other, competing demands (e.g., productivity, efficiency).

Psychological safety climate is a valuable addition to the safety literature in that it can help explain workers' safety behaviors. For instance, Larsson, Pousette, and Törner (2008) found construction workers' perceptions of psychological climate related both directly and indirectly to their safety behaviors. Shared perceptions of safety (group- or organizational-level climate) are also related to individuals' safety behaviors (e.g., Hofmann & Stetzer, 1996; Neal & Griffin, 2006; Zohar, 2000). Although both individual (psychological) and group/organizational climate are valuable in understanding safety behaviors, it is important to note that they are distinct concepts. When group or organizational climate is conceptualized, its measurement should refer to the group or organization; when psychological climate is conceptualized, it should measure individuals' perceptions. The current study examines psychological safety climate as it relates to individual behaviors. A positive climate for safety should motivate employees to engage in safety-conscious behaviors because workers will perceive that the effort expended to behave safely is important.

1.2. Facets of Psychological Safety Climate

As mentioned previously, existing literature on the construct of safety climate suggests disagreement concerning the number and nature of the facets that should be included in its conceptualization. Flin et al.'s (2000) review of the literature revealed significant variations in construct measurement between studies, with factor solutions ranging from two to 19, and marked differences in content, style, and item referents (e.g., coworkers, supervisors, upper-management). Research suggests that differences in culture (Vinodkumar & Bhasi, 2009), industry (Guldenmund, 2007), and/or job position (Findley et al., 2007) may partially account for the failure to replicate factor loadings across studies.

Despite the aforementioned discrepancies in the factor structure of the safety climate construct, we believe some sensible common themes have emerged, including facets which represent the three primary constituents of most workers' psychosocial environments: the hierarchical social environment (management safety), the lateral social environment (coworker safety), and the job itself (work-safety tension). We employ these three facets in the current study. These facets were represented in Zohar's (1980) original safety climate scale, were the highest loading factors of six explored by Díaz and Cabrera (1997), and map onto three factors of the Mueller, DaSilva, Townsend, and Tetrick (1999) four-factor model of safety climate. A fourth factor in the Mueller et al. model, labeled incentives, was not included in our study because subject matter experts from the participating organization determined that the incentives factor was not applicable to our target population. The three facets we examine are also common to other, more recent, studies of safety climate (Hofmann & Mark, 2006; Lu & Tsai, 2008; Zhou et al., 2008).

Management safety, which refers to employees' perceptions of their supervisors' value of and commitment to safety, is the most-frequently referenced of all safety climate facets (Seo et al., 2004). This concept has been labeled *management attitudes toward safety* (Zohar, 1980), *management concern for employee well-being* (Brown & Holmes, 1986) and *management commitment to safety* (Dedobbeleer & Béland, 1991). Coworker safety describes the extent to which employees perceive their peers as valuing safety; it provides social cues for the types of behaviors regarding safety that are appropriate and expected within the organization. Coworker safety is analogous to *perceived effects of safe conduct on social status* (Zohar, 1980) and *coworker safety* (Hayes et al., 1998). Work-safety tension is the tension felt when working safely is perceived to be at odds with effectively performing one's job duties and meeting organizational standards for performance. Accompanying this is a belief that risk taking and accident occurrence is an inherent part of one's job. Work-safety tension is similar to the concepts of *job safety* (Hayes et al., 1998), *perceived effects of required work pace on safety* (Zohar, 1980), *employee risk perception* (Brown & Holmes, 1986), and *workers' involvement in safety* (Dedobbeleer & Béland, 1991). Through a review of the existing conceptualizations of safety climate we know that management safety, coworker safety, and work-safety tension provide cues regarding workplace norms that inform employees' perceptions of safety climate. Yet, as mentioned, the relative importance of each of these cues to worker safety behavior is unclear.

1.3. Safety Behavior

Griffin and Neal (2000) distinguished two categories of safety-related behaviors. *Safety compliant behaviors* describe "the core safety activities that need to be carried out by individuals to maintain workplace safety" (p. 349), whereas *safety participation behaviors* "may not directly contribute to workplace safety, but do help to develop an environment that supports safety" (p. 349). The behavioral outcome of interest in the current study, labeled *unsafe behavior*, maps on to Griffin and Neal's first category of safety behaviors. More specifically, it is a type of noncompliance indicating self-reported engagement in activities considered fundamentally 'unsafe' by employees and managers alike.

Habitual noncompliance with safety policies and procedures, like other pre-existing conditions, may be considered a root cause of accidents because it can make the entire work system more vulnerable to failure (Reason, 1990). Studies exploring safety behaviors and accidents support this idea, demonstrating a link between unsafe behavior and accident occurrence (Baysari et al., 2008; Hofmann & Stetzer, 1996; Neal & Griffin, 2006). In a study specific to the rail industry, Baysari et al. (2008) found that the majority of documented safety violations (i.e., noncompliance) were regularly occurring activities, “often going unnoticed or even tolerated by authority” (p. 1754). This suggests that workers may behave in ways that are not compliant with safety rules because such habits are overlooked by employees and managers, or that compliance is considered less important than doing what is necessary to get the job done. Thus, understanding which factors motivate unsafe behavior can provide opportunities for interventions to enforce safety, reduce noncompliance, and protect the work system from vulnerabilities.

1.4. Current Study & Hypotheses

First, we posit a relationship between employee perceptions of psychological safety climate and unsafe behavior. Corroborating previous research (e.g., Goldenhar et al., 2003; Griffin & Neal, 2000; Prussia et al., 2003), we expect that a positive safety climate will negatively relate to self-reported propensity to engage in unsafe behavior. Our hypothesis will be supported if management safety and coworker safety are negatively related to unsafe behavior, and work-safety tension is positively related to unsafe behavior.

H1: Positive perceptions of safety climate will be negatively related to reports of one’s own unsafe behavior.

Second, we examine the relative importance of three safety climate facets in relating to unsafe behavior. We expect management safety to demonstrate the strongest negative relationship with unsafe behavior because supervisors are the primary means through which the organization connects with its individual employees. When perceptions of management safety are low, employees perceive the organization as not valuing safety; therefore their motivation to engage in compliance behavior is also expected to be low. Managerial commitment to safety is also one of the most often-used safety climate facets in the literature (Flin et al., 2000; Zohar, 2003; Seo et al., 2004), and has been proposed as the facet most theoretically salient to the conceptual definition of safety climate (Zohar, 2003). It has also been found to be among the strongest predictors of accidents and safety compliance when examined in conjunction with job safety, coworker safety, and satisfaction with safety programs (Hayes et al., 1998).

Work-safety tension describes the level of inherent risk and conflict between productivity and safety an employee associates with the performance of his or her job. Employees who perceive the organization as valuing productivity over safety due to an unsafe job design or working environment may be less likely to enact safety behaviors because they are motivated to maximize productivity and rewards. Wills, Watson, and Biggs (2006) found that aspects of work-safety tension (labeled work pressures and safety rules) accounted for a significant proportion of variance in multiple safety-related driving behaviors, including self reports of distraction, traffic violations, and errors. Brown and Holmes (1986), and later Dedobbeleer and Béland (1991), also highlight the importance of work-safety tension in studies of production, and construction workers. Nonetheless, this facet is generally overshadowed by management safety in safety research. Despite having received less empirical attention to date, we believe this facet is potentially very important to railroad employees and expect work-safety tension to exhibit the second-strongest relationship with unsafe behavior.

Of these three facets, we expect the weakest relationship between coworker safety and unsafe behavior. Coworkers' attitudes toward safety are expected to influence safety behaviors because they provide cues as to what is socially acceptable in the organization.

Yet coworkers have less direct bearing on workers' jobs and rewards than do supervisors. It is also likely that, in a practical sense, job-related conflicts with working safely (i.e., work-safety tension) outweigh social factors in relating to safety behaviors. Additionally, coworkers' attitudes regarding safety presumably stem from their own perceptions of management's commitment to safety and work-safety tension, giving both of these facets the edge in importance over coworker safety.

A study by Hofmann and Mark (2006) also provides some empirical support for the hypothesized ordering of safety climate factors. The authors used the same three facets of safety climate (albeit using different labels: management attitudes, social standing, and job duties; representing management safety, coworker safety, and work-safety tension, respectively) to explore the relationships between safety climate and safety outcomes in a sample of nurses. Although the relative importance of each facet was not explicitly tested, an examination of the correlations among study variables reveals the same pattern of results as hypothesized in the current study; the facet relating to management safety was most strongly correlated with injuries and errors, followed by work-safety tension, and coworker safety evidenced the weakest relationship with injuries and errors.

H2: Management safety will be the dominant predictor of unsafe behavior.

H3: Work-safety tension will dominate coworker safety as a predictor of unsafe behavior, but will not dominate management safety.

H4: Coworker safety will demonstrate the weakest relationship with unsafe behavior of the three safety climate facets.

2. Method

2.1. Participants

Participants were mechanical workers employed by a large North American railroad. A total of 635 non-management employees from two different workshops (each specializing in the maintenance and repair of either rail cars or diesel locomotives) at each of three different locations were selected for participation. Of these, 421 returned completed surveys (66% response rate). Given that only 1% of the workforce was female, respondents did not report gender to preserve the anonymity of female respondents. The majority of the sample (92%) reported working between 30 and 50 hours per week. In addition, 65% reported working more than 20 years with the railroad and 68% of the sample was age 46 or older.

All workers in this organization belonged to the same union. Site administrators, who were also union members, asked employees to volunteer to complete an anonymous paper and pencil survey about safety during working hours. No individually identifying information was collected. Participants were asked to seal their surveys in unmarked envelopes and were given the option of either returning the surveys to the site administrator or mailing them directly to the researchers, who were not affiliated with the participants' employer.

2.2. Measures

Measures included in the current study were part of a larger survey administered in 2004 and 2007 measuring safety perceptions, behaviors, and attitudes. The safety climate facet scales and the items included in those scales were selected based on consideration of facets included in research of similar industries and consultation with subject matter experts in the organization. Factor analysis on the safety climate item responses were conducted using the baseline (2004) survey data. Results of this work indicated that management safety, coworker safety, and work-safety tension were distinct factors. Select items were removed from each facet scale based on low factor loadings and revised scales were used in the follow-up (2007) survey. Data from the 2007 survey were used to test our hypotheses.

2.2.1. Management Safety

Eleven items were used to measure perceptions of management safety. Ten items were taken from the 21-item measure of management attitudes toward safety (Zohar, 1980, as reported in Mueller et al., 1999), and one item was included to address resource needs (D. A. Hofmann, personal communication, August 12, 2004). A sample item is, "Our management acts quickly to correct safety issues." Participants were asked to respond using a five-point Likert scale ranging from (1) *strongly disagree* to (5) *strongly agree*. Coefficient alpha was .93.

2.2.2. Coworker Safety

Five items were used to assess coworker safety, taken from Zohar's (1980) six-item effect of safe behavior on social status scale as reported by Mueller et al. (1999). Participants were asked to indicate agreement to items such as, "Workers who work safely try to emphasize it and make sure others appreciate it" using a five-point Likert scale. Coefficient alpha was .88.

2.2.3. Work-Safety Tension

Work-safety tension was measured with five items. Two items were taken from Zohar's (1980) effect of work pace on safety scale, two items concerning worker involvement in safety were drawn from Hofmann and Stetzer (1998, adapted from Dedobbeleer & Béland, 1991), and one item was included regarding job interference with safety (D. A. Hofmann, personal communication, August 12, 2004). An example item is, "My job duties often interfere with my ability to act as safely as I would like." Participants were asked to indicate agreement using a five-point Likert scale. Coefficient alpha was .85.

2.2.4. Unsafe Behavior

Unsafe behavior was assessed using six items from Hofmann and Stetzer (1996). The National Health and Safety Representatives from the participants' union and a Safety Specialist on a policy committee from the participating organization were asked to choose items from the original 29-item scale that were most relevant to the current sample of workers. The six highest-ranked items were included in the current study. Participants were asked to indicate the frequency with which they had personally engaged in the behavior described by each item (e.g., "Not wearing fall protection for a job that had a risk for a fall."). Participants responded using a five-point scale ranging from (1) *never* to (5) *more than once a week*. Coefficient alpha was .70.

3. Results

To confirm the integrity of the measurement model using the current dataset, a confirmatory factor analysis of safety climate items (management safety, coworker safety, work-safety tension) was conducted using structural equation modeling. All items loaded significantly on their respective latent variables and the measurement model demonstrated adequate fit [$\chi^2(186) = 669.3$, $p < .05$; CFI = .92; RMSEA = .07]. In order to check the discriminant validity between the three facets, the model was also run as a single latent model (safety climate) with indicators as all items from the management safety, coworker safety and work-safety tension subscales. The single factor model demonstrated significantly worse fit [$\chi^2(189) = 2123.3$, $p < .05$; CFI = .61; RMSEA = .16] than the three-factor model; therefore the three latent factor model was retained.

Means, standard deviations and scale score intercorrelations for all study variables are reported in Table 1. Management and coworker safety means were modestly high and the work-safety tension mean was modestly low, indicating generally positive safety climate perceptions. Note that high scores on work-safety tension are indicative of poor safety climate.

Respondents' work shift was considered as a possible control variable, because work shift has been found to be an important factor in perceptions of injury risk (Huang et al., 2007); however, we found that the pattern of results was the same whether the effects of shift were statistically controlled or not. Likewise, we considered work site as a possible control variable for our analyses because there were small site differences in mean perceptions of psychological safety climate. However, invariance between the groups in the dependent variable, unsafe behavior, led us to believe this was unnecessary (Allison, 1999). As anticipated, results of analyses that included work site as a control variable did not differ from the results obtained without controlling for work site. Therefore, for the sake of parsimony, we omitted work shift and work site from the analyses presented in this paper. Finally, we considered age and tenure as potential covariates; however, our sample's homogeneity in age and tenure made their inclusion in the analyses irrelevant.

3.1. Analytical Approach

Hypothesis 1 was tested using hierarchical regression analysis. Hypotheses 2-4 were tested using dominance analysis to determine the relative importance of the three facets of safety climate in relating to unsafe behavior (Azen & Budescu, 2003; Budescu, 1993; Budescu & Azen, 2004). Dominance analysis assesses the importance of each predictor relative to other predictors by calculating the change in R^2 from a series of regression equations. The analysis decomposes the total R^2 value into the partial, direct, and total effect components of all possible combinations of predictor variables (LeBreton et al., 2004). The direct effect average reflects the independent contribution of each of the three predictors to R^2. The partial effects show the contribution of the remaining predictors after one other predictor is already accounted for in the model (i.e., conditional on subsets of predictors). The total effect average (i.e., conditional on all other predictors) represents the additional contribution of each predictor to the total R^2 after controlling for all other variables. The C statistic, which is an average of the direct, total, and partial effects of the individual variables, is interpreted as a quantitative measure of general dominance by indicating the overall average contribution of each predictor in the model.

In order to establish a level of confidence that one predictor is consistently dominant over another in subset model pairings, a bootstrapping procedure was conducted using the Dominance Probability SAS Macro described in Azen and Budescu (2003). The bootstrapping procedure provides a measure of confidence (i.e., reproducibility) that indicates the chance of reproducing the sample result over 1000 bootstrap samples (Azen & Budescu, 2003). The dominance value listed in Table 4, sample D_{ij}, signifies whether one variable generally dominates another in the current sample and can be one of three reference points: 1 (X_i dominates X_j), 0.5 (dominance cannot be established between X_i and X_j), or 0 (X_j dominates X_i). The reproducibility score indicates the probability of reproducing the sample results. Thus when the sample $D_{ij} = 1$, higher reproducibility scores indicate more reliable evidence that X_i dominates X_j. We used a reproducibility cutoff of 95% or above, similar to a 95% confidence interval, to conclude that one variable reliability dominates another as a predictor of the associated outcome.

3.2. Hypothesis Testing

As seen in Table 1, all three facets of psychological safety climate were significantly correlated with unsafe behavior, as expected. The three safety climate measures accounted for 18% of the variance in unsafe behavior ($R^2 = .18$; $F (3, 396) = 26.7$, $p < .01$), supporting Hypothesis 1 (see Table 2).

A summary of the combined effects (direct, partial, and total effects) and proportion of R^2 accounted for by each facet relative to the full model are reported in Table 3. Note that the C statistic is expressed in R^2 units, and the proportion of total variance explained is listed in the last line of Table 3. Contrary to Hypotheses 2 and 3, the results indicate that work-safety tension (C = .13; 73% of the total variance explained by all three facets) is most strongly related to unsafe behavior, relative to both management (C = .03; 19%) and coworker safety (C = .01; 8%). However, Hypothesis 4 was supported: coworker safety had the weakest relationship with unsafe behavior of the three facets measured.

The outcomes of the bootstrapping procedure testing the reliability of the sample results are shown in Table 4. The model predicting unsafe behavior suggests that work-safety tension reliably dominates both management safety and coworker safety (reproducibility = 99%). On the other hand, management safety did not reliably dominate coworker safety in relating to unsafe behavior (reproducibility = 8%).

4. Discussion

We first proposed that employees' perceptions of safety climate would significantly relate to their propensity to engage in safety compliance behavior, thereby replicating relationships found in similar industries (e.g., Goldenhar et al., 2003; Griffin & Neal, 2000; Prussia et al., 2003). In general, we expected to find that more positive perceptions of safety climate would be associated with fewer reported instances of unsafe behavior (H1). Hypothesis 1 was fully supported, demonstrating that, in general, perceptions of safety climate are significantly associated with the safety compliance behavior of railroad workers in this sample.

We also sought to determine if there were relative differences in the strength of relationships between safety climate facets and unsafe behavior. Contrary to our hypotheses, the results of a dominance analysis indicated that work-safety tension demonstrated the strongest association with unsafe behavior, dominating both management safety and coworker safety. Furthermore, although perceptions of management safety tended to have a stronger association with unsafe behavior than did perceptions of coworker safety, management safety did not reliably dominate coworker safety as a predictor of unsafe behavior in this study.

Our results suggest that psychological perceptions of work-safety tension are more strongly related to safety behavior than perceptions of management or coworker commitment to safety. This is somewhat surprising, particularly given previous findings linking management safety to safety behaviors and accidents (e.g., Hayes et al., 1998), the focus on the management safety climate facet in the safety literature, and the relationship between management safety and safety outcomes as observed by Hofmann and Mark (2006). On the other hand, our results correspond with a previous study in which perceptions of safety rules (an aspect of work-safety tension) demonstrated a stronger overall relationship with, and accounted for more unique variance in, safety-related driving behaviors than other facets of safety climate, including management commitment to safety (Wills, Watson, and Biggs, 2006). We speculate that work-safety tension may be of distinct relative importance because, above and beyond management and coworkers' valuing of safety, it indicates an employee's perception of the inherent level of tolerance for risk in the work environment and, as a result, the extent of his or her ability to perform the job safely.

Zohar (2008) suggests that proper measurement of safety climate entails capturing perceptions regarding policies and procedures indicative of the true priority of safety. Work-safety tension may be more indicative of *individual* perceptions of the true priority of safety than other facets of safety climate because it reflects individual interpretations of the importance of safety when faced with competing operational demands. Work-safety tension may also reflect workers' perceptions of how they are truly expected to perform their job. Although managers may speak of the importance of safety, if workers perceive that the work environment or job duties do not allow for safe working, managers' attitudes may come across as insincere. Alternatively, workers may feel that managers value safety, yet that they don't truly understand "what it takes" in terms of unsafe behaviors needed to get the job done.

The relative importance of work-safety tension in relating to unsafe behaviors has implications for workplace intervention. First, the presence of high levels of work-safety tension may indicate that line workers should be consulted regarding safety issues and included in safety intervention design and implementation. As Dedobbeleer and Béland (1991) suggest, safety climate could be effectively improved through the implementation of a participatory approach to safety, which would afford workers an opportunity to share their perceptions of safety issues and help design solutions to safety problems. Secondly, high levels of work-safety tension in an organization may indicate a general need for increased bottom-up communication. Whereas high levels of management safety likely indicate adequate top-down communication about the importance of safety, perceptions that the job/environment is inherently unsafe indicate a possible disconnect between line workers and management on job design and work environment safety issues. Interventions to increase bottom-up communication, such as involving workers in safety meetings (Dedobbeleer & Béland, 1991) may be critical to the cultivation of a positive safety climate.

Our results may also afford an alternate interpretation of the somewhat equivocal findings of a recent safety climate meta-analysis (Clarke, 2006a). Our findings suggest that the observed variability in relationships between safety climate and safety behavior could be due to differences in the facets used to measure safety climate. It is likely that there is added value to measuring multiple facets of safety climate (rather than a single measure of overall safety climate) because different facets of psychological safety climate dominate others in relating to safety behavior. For instance, had we only measured management commitment to safety, the most commonly used facet of safety climate (Flin et al., 2000), our results would have suggested a relatively weaker overall relationship between safety climate and safety behavior within the current sample.

The results of our study provide an impetus for discussing changes in how we think about measuring safety climate. We should move beyond focusing on factor structure to discovering which facets maximize the relationship between safety climate and safety performance in different industries. Clearly, measures of safety climate can be useful as leading indicators of safety-related behaviors. However, safety climate research may need to reconsider whether management attitudes regarding safety represent the theoretical and empirical core of safety climate (Zohar, 2008).

4.1. Limitations and Future Directions

The self-report data used in this study may lead to concern regarding the potential for common method bias. Although we recognize this possibility, we note three pieces of evidence suggesting that the impact of common method bias is limited in this study. First, research indicates that a frequent symptom of common method variance is the presence of uniformly high relationships among variables (Doty & Glick, 1998; Kline, Sulsky, & Rever-Moriyama, 2000; Spector, 2006). The correlations between our study variables and other attitudinal measures included in the survey evidenced substantial range: from .65 (between management safety and perceptions of supervisor fairness) to .02 (between work-safety tension and perceptions of interactional justice). Second, the overall magnitude of the relationship we found between safety climate and unsafe behavior is similar to that reported in Clarke's (2006a) meta-analysis (18% variance accounted for by safety climate in our study, as compared to 22% variance in the meta-analysis). Third, we used Harman's single-factor test and conducted a principle components analysis on all 27 study items. Results indicate the presence of four components that uniquely represent the four study variables and 60% of the overall variance (eigenvalues ranging from 1.77 to 8.10). The absence of a general factor accounting for most of the variance suggests that common method variance is unlikely to be a problem (Podsakoff, MacKenzie, Lee, & Podsakoff 2003). It should also be noted that, because the likelihood of obtaining more than one factor increases with increasing numbers of variables, the low number of variables in our study means this is a more conservative test. Despite the evidence we present suggesting common method variance may not be a problem with our study, we do not wish to minimize the possibility that it may exist and we suggest that future studies should seek to replicate our findings using multiple data sources (e.g., self-report, coworker, and management observations).

Another methodological limitation is the use of a cross-sectional design, as it prevents us from asserting the causal direction of the observed relationships. Nevertheless, longitudinal studies of safety climate and safety behavior have provided evidence that the proposed direction of these relationships is appropriate (e.g., Cooper & Phillips, 2004, Johnson, 2007; Pousette et al., 2008).

We also believe it prudent to note that safety climate has been studied and found to be salient to safety behaviors at both the individual level (psychological climate) and the group level (organizational safety climate). The focus of the current study was on psychological safety climate and its relationship with individual unsafe behaviors. Although organizational safety climate was not a component of the current study, we recognize that broader, shared understandings of the safety climate in a work group or department may operate in tandem with individual-level concepts such as psychological safety climate. The relationships between facets of safety climate and safety behavior may function differently when examined at the group-level and should be investigated in the future in order to draw inferences about shared climate.

The current study examined a single form of safety behavior: noncompliance, measured as workers' reports of performing unsafe behaviors. Future studies should also consider how different classes of safety behaviors relate to the various facets of safety climate, such as participation behavior (cf., Griffin and Neal, 2000). Behaviors that support a safe working environment (e.g., participation in safety committees, briefings, or other activities) may relate differently to management, coworker, and work-safety tension facets of safety climate.

The fact that our data were collected from workers in a single industry can be considered both a strength and a limitation. This study presents an investigation of safety climate in an under-researched industry, as well as answers a national call for sector-specific research (9, 2008). We also avoided capitalizing on site-specific relationships by sampling from multiple worksites across multiple locations. However, we do acknowledge that previous research suggests the potential for industry-dependent results (e.g., Cooper & Phillips, 2004; Coyle et al., 1995). Consequently, additional studies investigating the current research questions within multiple industries are required in order to determine the extent to which our findings generalize across different contexts.

4.2. Conclusions

Understanding employees' safety behavior is of particular value to the rail industry because the occurrence of work-related illness and accidents can prove quite costly in terms of the potential for loss of equipment, man-hours, and even human life. Confirming an expected relationship between safety climate and safety behavior is a first step toward justifying the use of safety climate perceptions as a leading indicator of safety conditions in the rail industry. Yet evidence of a relationship between safety climate and safety behavior provides only a vague understanding of how such a relationship may be translated into a proactive intervention. Determining the relative degree to which facets of safety climate are associated with safety behavior can offer guidance for tailoring interventions to improve workplace safety. The results of this study suggest that work-safety tension is most strongly associated with unsafe behavior when compared with management and coworker facets of safety climate. Future investigations of safety climate should place greater emphasis on identifying which facets of safety climate are most salient to safety behavior within different industries and at various levels of analysis. In addition, we suggest that safety interventions that focus on reducing work-safety tension may be particularly effective at increasing safety compliance. For instance, utilizing a participatory approach to clarify the priority of safety in the organization, encouraging bottom-up communication about safety, and empowering workers to suggest and make changes to their job design to better carry out job duties without compromising safety may all be worthwhile interventions for mitigating work-safety tension.

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Table 1

Means, Standard Deviations, Number of Items, Reliabilities, and Intercorrelations

	Scale	M	SD	# Items	1	2	3	4
1	Management Safety	3.26	0.79	11	(.93)			
2	Coworker Safety	3.75	0.72	5	.47**	(.89)		
3	Work-Safety Tension	2.17	0.81	5	-.26**	-.22*	(.84)	
4	Unsafe Behavior	1.53	0.62	6	-.25**	-.17*	.38**	(.70)

Note. Sample N = 421. Correlations appear below the diagonal, and coefficient alphas are presented in parentheses along the diagonal.

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

Table 2

Regression of Safety Climate on Unsafe Behavior

	Unsafe Behavior		
Independent Variables	β	Total R^2	F
Management Safety	-.11*		
Coworker Safety	-.05		
Work-Safety Tension	.36**	.18	26.7**

* $p < .05$, ** $p < .01$

Table 3

Dominance Matrix of Safety Climate on Unsafe Behavior

		Additional Contribution of:		
Subset Model	R^2	X1 (Mgmt)	X2 (Coworker)	X3 (Tension)
Direct effect average		0.059	0.035	0.155
X1	0.059		0.007	0.116
X2	0.035	0.032		0.127
X3	0.155	0.021	0.006	
Partial effect average		0.026	0.007	0.121
X1, X2	0.066			0.110
X1, X3	0.176		0.001	
X2, X3	0.161	0.015		
Total effect average		0.015	0.001	0.110
X1, X2, X3	0.176			
Overall average (C)		0.033	0.014	0.129
% of total var. explained		19%	8%	73%

Note. The predictors are management safety (X1), coworker safety (X2), and work-safety tension (X3).The column labeled R^2 represents the variance in the outcome explained by the model appearing in the corresponding row. Columns labeled Xi contain the additional contributions to the explained variance gained by adding the column variable (Xi) to the row model. Blank cells indicate that data are not applicable. N = 421.

Table 4

Results of Bootstrapping for Predictors of Unsafe Behavior: D_{ij} Values in the Sample and Their Means, Standard Errors, Probabilities, and Reproducibility

				General Dominance				
i	*j*	Sample D_{ij}	$M(D_{ij}^{a})$	$SE(D_{ij})$	P_{ij}^{b}	P_{ji}^{c}	P_{noij}^{d}	Reproducibility
X1	X2	1	0.0830	0.276	0.083	0.917	0.000	0.083
X3	X1	1	0.9990	0.032	0.999	0.001	0.000	0.999
X3	X2	1	0.9940	0.077	0.994	0.006	0.000	0.994

Note. The predictors are management safety (X1), coworker safety (X2), and work-safety tension (X3). N = 421.

[a] $D_{ij} = 1 - D_{ji}$. [b] $P_{ij} = Pr(D_{ij} = 1)$. [c] $P_{ji} = Pr(D_{ij} = 0)$. [d] $P_{noij} = Pr(D_{ij} = 0.5)$.