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# A mediation model linking dispatcher leadership and work ownership with safety climate as predictors of truck driver safety performance

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ABSTRACT

The study was designed to test the effect of safety climate on safety behavior among lone employees whose work environment promotes individual rather than consensual or shared climate perceptions. The paper presents a mediation path model linking psychological (individual-level) safety climate antecedents and consequences as predictors of driving safety of long-haul truck drivers. Climate antecedents included dispatcher (distant) leadership and driver work ownership, two contextual attributes of lone work, whereas its proximal consequence included driving safety. Using a prospective design, safety outcomes, consisting of hard-braking frequency (i.e. traffic near-miss events) were collected six months after survey completion, using GPS-based truck deceleration data. Results supported the hypothesized model, indicating that distant leadership style and work ownership promote psychological safety climate perceptions, with subsequent prediction of hard-braking events mediated by driving safety. Theoretical and practical implications for studying safety climate among lone workers in general and professional drivers in particular are discussed.



## 1. Introduction

Safety climate research has offered consistent empirical support for its effect on diverse safety performance outcomes, ranging from self-reported to externally-observed safety behavior to objective injury data collected months or even years after climate measurement. This evidence was recently subjected to several meta-analytic studies, covering some two hundred published studies (Beus et al., 2010; Christian et al., 2009; Clarke, 2010; Nahrgang et al., 2011). Reported effect sizes for the climate-accidents/injuries relationship qualify safety climate and its proximal consequence, safety behavior, as the strongest predictors of organizational safety performance. For example, the largest meta-analytic study, covering 203 independent studies, estimated that safety climate accounts for 15.5% of accident/injury variance and 49.8% of unsafe behavior variance (Nahrgang et al., 2011). By comparison, whereas the mean corrected correlation between physical risks/hazards and accidents/injuries in that meta-analysis was estimated at 0.13, the corrected correlation between safety climate and accidents/injuries was nearly double, estimated at 0.24.

An examination of the studies included in these meta-analyses reveals that most studies were conducted in the manufacturing, construction and health-care industries. A common characteristic of companies in these industries is that their employees work in physical proximity, allowing frequent opportunities for experiencing and observing the effect of formal and informal policies and practices in addition to having daily opportunities for social interaction with co-workers, supervisors and higher-level leaders. As will be noted below, social interaction and personally experienced policies are known climate antecedents. By default, little is known about climate emergence in companies whose employees are geographically dispersed, spending their workdays away from home base. Given that lone working is becoming increasingly prevalent and that geographic dispersion is likely to restrict opportunities for social interaction and policy-related experiences, the purpose of this study is to test a conceptually adjusted model for safety climate and safety performance among lone workers, using long-haul truck drivers as exemplar.

One reason for choosing truck drivers relates to their exposure to high levels of physical risk, leading to elevated likelihood of road accidents. The U.S. Bureau of Labor Statistics' Census of Fatal Occupational Injuries (BLS, 2012) reported 396 fatalities in truck transportation in 2010 with a rate of 31.8 per 100,000 workers. This rate is ten times higher than the overall rate of 3.6 per 100,000 in-house workers, accounting for nearly 8.7% of all work-related fatalities in the U.S. The statistics of non-fatal injuries for truck

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drivers is similarly alarming, making this industry highly appropriate for studying safety climate emergence and its consequences among lone employees.

Despite the extensive evidence concerning predictive validity of safety climate and the need for improving traffic safety, there have been only a limited number of published studies addressing this issue among professional drivers. An examination of the available studies reveals, first, that they used (slightly modified) generic safety climate scales, designed largely for in-house employees and, second, that driving safety outcomes were measured mostly with self-reports collected concurrently with the climate surveys, resulting in weak research design.

The most recent study, offering an exception to the above qualifications, tested a model in which safety climate mediated the relationship between two generic climate dimensions (i.e. organizational-employee support and leader-employee relations) and road accident data collected after the climate survey (Wallace et al., 2006). The study was conducted with short-haul truck drivers whose work allows daily contact with both supervisor and co-workers located at the same local distribution or delivery center. Safety climate, measured with a scale developed for in-house employees (Zohar, 2000), mediated the effect of the generic climate dimensions on post-survey road accidents.

An earlier study used available data collected for a project focusing on truck delivery scheduling practices (Arboleda et al., 2003; Morrow and Crum, 2004). The authors used a new 4-item safety climate scale developed for this study, offering no psychometric data. Climate data were obtained from three drivers and dispatchers in each participating company, selected by its fleet safety manager. Climate scores were related to current self-reported fatigue, but not self-reported near-misses or accidents during the previous two years. These scores were also related to reported company policies and practices involving driver safety training, autonomy and participation.

A set of studies was conducted in Australia, using in-house government employees whose work includes occasional driving activities. One study, by Wills et al. (2005, 2006, 2009) used a generic safety climate scale, adding a number of items related to driving. Using self-reported driving behavior as outcome criterion, the climate factors of safety rules, safety communication and management commitment were related to self-reported distraction and traffic violations. Another study, using the same scale and a similar sample, reported a relationship between safety climate and self-reported fatigue and near misses experienced during the previous six months (Strahan et al., 2008). A third study used three items taken from a generic safety climate scale after being reworded to suit the driving context (Newman et al., 2008). Safety climate was related to self-reported safety motivation (i.e. investment of effort for driving safely), which was negatively related, in turn, to self-reported accidents in the previous six months. Given the scarcity of safety climate research in transportation, let alone its adjustment to the context of lone work, the current study was designed to test a conceptual model taking into account both lone working in general and truck driving in particular.

### *1.1. Conceptualization of climate in the context of lone working*

Currently, most climate scholars consider climate an emergent, group-level construct representing socially shared climate perceptions among members of organic work units. Organizational climate scores are, therefore, derived by aggregation of individual climate perceptions of group members, turning workgroups into the unit of analysis. At the same time, level of analysis issues pervaded climate research, starting with three essays distinguishing between individual- and unit-level climates, labeled as psychological and organizational climates (Glick, 1985; Hellriegel and Slocum, 1974; James and Jones, 1974). Subsequent literature reviews and meta-analytic studies concerning this distinction include those published by Carr et al. (2003), James et al. (2008) and Parker et al. (2003).

Decisions for aggregation of individual climate perceptions are typically made on the basis of two criteria: (a) theoretical justification for considering climate a group-level construct; and (b) statistical justification based on homogeneity or agreement statistics justifying aggregation of individual climate perceptions (Bliese, 2000; James et al., 1984; Kozlowski and Hattrup, 1992; Kozlowski and Klein, 2000). When these criteria are not met, climate ought to be operationalized at the individual level of analysis and labeled as psychological climate (see relevant literature reviews and meta-analytic studies by Carr et al., 2003; Clarke, 2010; Glick, 1985; Hellriegel and Slocum, 1974; James and Jones, 1974; James et al., 2008; Parker et al., 2003). Our contention is that this is the case for lone workers due to the fact that, by definition, they work on their own rather than being members of work teams or any other social collective. Practically speaking, although psychological and organizational climates include the same set of perception items, each referring to organization- and group-level safety practices as sub-scales, item aggregation determines whether the resultant climate score is considered an individual- or group-level variable, affecting the choice of requisite statistical models.

The argument that organizational climate is a theoretically meaningful construct only in the context of membership in natural (formal or informal) groups is based on a long-held proposition concerning climate etiology or emergence. This proposition states that similarity in climate perceptions emerges from symbolic social interaction among group members (Schneider and Reichers, 1983). Symbolic interaction or sense-making involves comparing bits of information and cues, discussing possible interpretations, and attempting to reach consensual interpretation of the meaning of events and practices at the workplace. As a result of such a process, over time, employee perceptions tend to converge, resulting in shared climate perceptions (Ashforth, 1985; Brown, 2000; Schneider and Reichers, 1983; Stryker, 2008; Weick, 1995, 2005).

Given symbolic social interaction as a proximal antecedent of organizational climate, an examination of the contextual attributes of lone working suggests they diminish or severely limit opportunities for such interaction. Lone working often entails performing the work at geographically remote locations coupled with high autonomy and job control (Bailey and Kurland, 2002; Gajendran and Harrison, 2007; Pinsonneault and Boisvert, 2001). Such attributes result in increasing job independence and, consequently, declining inter-dependence with other remote co-workers. Given that teams are defined by inter-dependence among individuals working toward a common goal (Kozlowski and Ilgen, 2006), this implies that, despite availability of electronic means for communication, many lone workers are literally working on their own. By default, therefore, they do not engage in social symbolic interaction.

Considering long-haul truck drivers as exemplar, drivers whose work is coordinated by the same dispatcher have little, if any, idea who their co-workers are, having had few opportunities for interacting with them. Given absence of symbolic interaction, the primary mechanism for emergence of shared climate perceptions, there is no theoretical justification for supposing within-group homogeneity or consensus in climate perceptions. Running alongside these arguments is the case of collective climate (Joyce and Slocum, 1984), a construct referring to the aggregation of individual climate perceptions based exclusively on its statistically demonstrated agreement, disregarding membership in natural groups such as work teams. Although this collective approach meets the second criterion (statistical justification) listed above, it fails to meet the first one (theoretical justification), leading critics to argue that “collective climates are meaningless unless climate similarity is rooted in some formal, or informally structured collectivity" (Payne, 1990, p. 78). This theory-based argument has led to abandonment of collective climate in organizational climate research.

### *1.2. Dispatcher–driver relationship as antecedent of safety climate perceptions*

Reviews and meta-analytic studies of the safety climate literature identify leadership as a climate antecedent (Clarke, 2010; Nahrgang et al., 2008; Zohar, 2011). Given that climate research has focused on in-house employees, the leadership–climate relationship has been explained as a social learning process in which group members repeatedly observe and exchange information with their leader as a means for interpreting the organizational environment (Dragoni, 2005). Verbal exchanges with the leader inform members regarding the kinds of behavior that are valued and supported at the workplace, constituting the target or referent of climate perceptions (Ashforth, 1985; Zohar, 2011). When leader's messages and practices remain stable and consistent across situations, they offer employees a common source of information, promoting shared climate perceptions.

Arguably, however, geographic dispersion of lone workers is expected to weaken (though not eliminate) the leadership-climate relationship due to a number of reasons. Physical remoteness turns immediate supervisors and more senior managers into distant leaders. The concept of leadership distance has been construed as a joint function of physical distance, interaction frequency and psychosocial disparity between leader and members (Antonakis and Atwater, 2002; Napier and Ferris, 1993). Long-haul truck drivers have limited opportunity for face-to-face or electronic interaction with their dispatchers, whose offices are often located away from truck routes (safety rules in most trucking companies forbid phone conversations while driving). The resulting sparseness of leader-member interaction limits opportunities for social learning, reducing the leader's impact on members' climate perceptions. Such reduction is augmented by psychosocial disparity, due to the fact that dispatchers in trucking companies are often more educated than drivers, yet have no truck-driving experience.

An additional factor concerns the findings of several literature reviews and meta-analytic studies, indicating that distributed work arrangements increase the level of autonomy, responsibility, work-scheduling potential, and job-related control (Bailey and Kurland, 2002; Gajendran and Harrison, 2007; Pinsonneault and Boisvert, 2001). Such empowerment implies, by default, lesser social influence capability on behalf of distant leaders, resulting in a weaker leadership–climate relationship.

At the same time, however, this relationship is expected to prevail due to the fact that distant leaders continue to inform remote employees regarding organizational policies and practices as well as offer contingent outcomes indicative of the kinds of behavior that are rewarded or supported. For example, dispatchers of long-haul truck drivers can offer contingent consequences for safe driver behavior such as over-the-phone approval or favorable work assignments, highlighting the priority of safety in the context of competing demands such as on-time delivery. Considering that the priority of safety in the context of competing operational demands constitutes the core referent of safety climate perceptions (Zohar, 2010, 2011), distant leadership is hypothesized to serve as a (weakened) antecedent of driver safety climate perceptions.

### *1.3. Distant leadership and climate perceptions variability*

In addition to resulting in a weaker leadership–climate relationship, distant leadership is expected also to give rise to greater variability of climate perceptions, ensuing from the documented effect of leadership distance on increased differentiation in leader–member relationships. Considering that relational leadership theory posits within-group variation in terms of the quality of leader–member relationships (Uhl-Bien, 2006), distant leadership was shown to result in greater variation, known as leader–member exchange (LMX) differentiation (Henderson et al., 2009). Although there is no acceptable explanation for such an effect (Graen and Scandura, 1987), the resulting differentiation in quality of dyadic leader–member exchanges is likely to increase variability of individual climate perceptions.

This line of arguments was empirically tested by Ford and Seers (2006), using generic team climate as outcome variable. Results indicated that LMX differentiation, promoted by leadership distance, was negatively related to homogeneity scores of climate perceptions, suggesting psychological climate as the appropriate level of analysis. When work involves heightened physical risks, leaders have been shown to exhibit greater commitment to the protection or prioritization of physical welfare for members with whom they have higher-quality relationships (Gonzalez-Roma et al., 2002; Hofmann et al., 2003; Kozlowski and Doherty, 1989). Consequently, individual safety climate perceptions are likely to exhibit corresponding within-group variability, turning into psychological climate perceptions. When these arguments are coupled with scarceness of opportunities for social interaction among drivers reporting to the same dispatcher, this reinforces the abovementioned argument that the leadership–climate relationship ought to be tested at the individual level of analysis, leading to the following hypothesis:

**Hypothesis 1.** Dispatcher leadership will be positively related to lone worker psychological safety climate perceptions.

### *1.4. Work ownership as antecedent of psychological safety climate*

The literature on lone work indicates that in addition to curtailing opportunities for social (symbolic) interaction with co-workers and distant leaders, resulting in the abovementioned shift in climate's level of analysis, the context of lone work has a number of other consequences promoting the emergence of (psychological) work ownership. Work ownership is an occupational condition in which one feels as though an aspect of one's work has become part of, or an extension of the self, i.e. becoming "mine" or "ours" (Belk, 1988; Pierce et al., 2001, 2003). In this case, one might come to (psychologically) own tools or equipment, work processes or products, or an organizational entity (e.g. "I feel this truck is part of me;" "Being on the road has become who I am"). A series of studies by Pierce and colleagues identified the following contextual antecedents of work ownership: low work routinization; high autonomy or controllability; task meaningfulness or significance; high skill variety; and task feedback (O'Driscoll et al., 2006; Pierce et al., 2001, 2003; Pierce et al., 2009; Van Dyne and Pierce, 2004).

Meta-analysis of 46 studies focusing on telecommuting and distributed (office) work arrangements (Gajendran and Harrison, 2007), coupled with a literature review (Bailey and Kurland, 2002), identified practically equivalent contextual features characterizing lone work, i.e., high perceived autonomy, work scheduling potential, and job-related control. Another literature review concluded that geographic separation or lone working increases opportunities for skill development and technical expertise, participation in decision making, acquisition of intimate knowledge of tasks, and increased sense of responsibility (Pinsonneault and Boisvert, 2001). Given such convergence, it can be deduced that lone work is likely to promote emergence of work ownership, although its specific or actual level is likely to depend on individual variation in psychological needs for autonomy and power or control

(McClelland, 1951), as well as personal growth (Belk, 1988; Marsh, 2006).

Work ownership has been shown to promote role-enhancing behaviors such as increased responsibility, technical knowledge and expertise, citizenship behavior, and protective or defensive behavior toward owned objects (Avey et al., 2009; O'Driscoll et al., 2006; Pierce et al., 2009). Based on social exchange theory (Blau, 1964; Cropanzano and Mitchell, 2005), such ownership-driven role behaviors are likely to be reciprocated by dispatcher practices, offering drivers greater opportunity for protecting their (psychologically) owned objects even at the cost of other competing demands such as on-time delivery. Such leader–driver exchanges will result in higher safety climate perceptions, turning ownership into a safety climate antecedent. Given individual variation in ownership level among drivers, coupled with distant leadership and resultant differentiation in quality of leader–member relationships, we expect work ownership to affect individual climate perceptions, suggesting the following hypothesis:

**Hypothesis 2.** Work ownership will be positively related to lone worker psychological safety climate perceptions.

### *1.5. Psychological safety climate, safety behavior and near-miss events*

Psychological safety climate as a facet-specific construct concerns employee perceptions targeting the safety aspect of their work environment. Consequently, it is expected to predict only congruent outcomes (Schneider et al., 2000, 2011), i.e. safety behavior and occupational injury or its proxy (near-miss events). The expected safety climate–behavior relationship is based on extrinsic and intrinsic motivation supplied by safety climate perceptions and work ownership. Granted that climate perceptions concern the kinds of role behavior likely to be supported and rewarded (Schneider and Reichers, 1983), they inform employees of the extent to which safe performance will be supported and rewarded in the context of competing demands such as on-time delivery or delivery costs. Reiterating our arguments, due to the effect of relational leadership differentiation resulting from distant leadership, some drivers are likely to receive more contingent safety-related responses from their dispatcher than others, resulting in within-group climate variability, leading to emergence of psychological, rather than shared climate perceptions. Ownership-induced safety climate is expected to provide intrinsic motivation for safe behavior due to the desire for protecting and maintaining the integrity of owned objects defining one's self, offering an incremental effect on safety behavior.

Finally, the distal outcome concerning near misses is assumed to be mediated by safety behavior, based on the argument that safer conduct reduces the overall likelihood of adverse events or near-misses, acting as proxy for actual accidents (Glendon et al., 2006). Such mediation has been supported in recent meta-analyses of the safety climate–safety outcomes relationship (Beus et al., 2010; Christian et al., 2009; Nahrgang et al., 2011). Furthermore, such outcomes have also been supported in a meta-analysis using 51 studies in which safety climate was measured with non-aggregated scores, constituting psychological safety climate (Clarke, 2010). These data and the arguments discussed above lead to the following hypotheses:

**Hypothesis 3.** Psychological safety climate perceptions will be positively related to safety behavior.

**Hypothesis 4.** Psychological safety climate perceptions will be negatively related to near-miss events.

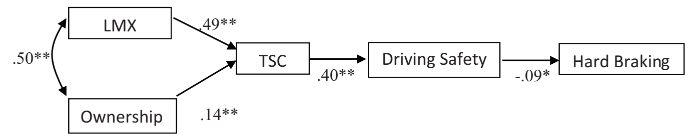


**Fig. 1.** An integrative path model of safety climate for long-haul truck drivers as lone workers. *Notes:* TSC-trucking safety climate, statistics are non-standardized path coefficients. $^*p < .05$. $^{**}p < .01$.

**Hypothesis 5.** Safety behavior will mediate the relationship between psychological safety climate perceptions and near-miss events.

Fig. 1 presents the conceptual model discussed above and tested in this study. Numbers represent non-standardized path coefficients identified during data analysis to be described below.

## 2. Method

### *2.1. Participants and procedures*

Participants were long-haul truck drivers from a large national trucking company in the U.S. They were recruited by an announcement that appeared on the computer screen during a seasonal re-training program. Using a web-based survey, 3578 questionnaires were retained for analysis, representing a response rate of 51%. Mean age of participants was 46.7 (S.D. = 10.0) with an average tenure as a professional truck driver of 13.5 years (S.D. = 9.4). Drivers had been working for the company 5.1 years (S.D. = 5.8) on average. Percentage of female truckers was 3%. Practically all participants worked alone during delivery runs, having only sporadic and remote exchanges with their dispatcher.

Mean age of dispatchers was lower than that of drivers, i.e. 34.5 (S.D. = 8.6), accompanied by absence of truck-driving experience. On the other hand, 87% of dispatchers had a college degree. Average driver-to-dispatcher ratio was 1:40 (S.D. = 7.88). Given that an optimal span of control varies from 1:6 for complex work to 1:30 for routine or repetitive work (Davis, 1951), our data imply a large span of control. One implication of a large span of control is reduction in frequency of leader-member interaction, augmenting the effects of leader distance (Judge and Ferris, 1993; Ouchi and Dowling, 1974; Udell, 1967). The major roles of dispatchers included scheduling and assigning trips and coordinating pick-up or delivery issues. Dispatcher exchanges with truck drivers were largely done using in-vehicle communication devices allowing text messaging and radio exchanges or by cell-phone. Given that drivers in this company were not allowed to communicate or speak on the phone while driving, such exchanges were limited to rest stops, reducing their frequency. Furthermore, most drivers had sparse face-to-face exchanges with their dispatcher, if any (i.e. some drivers had never met their supervisor).

Using a prospective design, we collected hard-braking data over a period of six months, starting six months after survey completion. Hard-braking incidents represent a major category of traffic near-miss events. Data were collected from Internet-connected onboard computers, using an algorithm that defines hard-braking events based on deceleration per unit distance. Congruent with common practices of large companies in this industry, trucks were equipped with electronic devices limiting truck speed to 63 miles per hour. Such speed limit controls the effect of over-speeding on hard-braking frequency. Driver ID was used to link and match this information with individual driver safety-climate perceptions as well as direct dispatcher. Once this was done, a new set of identification numbers was assigned, replacing driver ID numbers to ensure the confidentiality of survey participants. The near-miss variable was obtained for 3207 drivers, constituting the final sample.

**Table 1**
Descriptive statistics, Cronbach's $\alpha$ and inter-correlations among model variables.

| | Mean (S.D.) | LMX | Ownership | TSC | Driving safety | Hard braking |
|---|---|---|---|---|---|---|
| LMX | 3.54 (.89) | (.86) | | | | |
| Ownership | 3.31 (.87) | .51** | (.75) | | | |
| TSC | 4.05 (.65) | .74** | .52** | (.95) | | |
| Driving safety | 4.40 (.59) | .29** | .25** | .45** | (.65) | |
| Hard braking | 1.42 (2.20) | −.02[a] | .01[a] | −.02[a] | −.04[a] | – |

*Notes*: TSC, Trucking Safety Climate. Diagonal values within parentheses are internal consistency statistics (Cronbach's $\alpha$).
** $p < .01$.
[a] Hard braking variable is a Poisson-distributed count variable and caution is needed in interpreting its correlation with other normally-distributed continuous variables (i.e. a zero-inflated Poisson log-link generalized linear model must be used for testing its relationship with the other variables).

### 2.2. Measures

*Trucking safety climate* (*TSC*) was measured with a new, industry-specific scale of 40 items (a detailed description of this scale development and its psychometric properties can be found in Huang et al., 2013). Scale items refer to company policies and procedures and dispatcher practices, accompanied by a 5-point scale ranging from strongly disagree (1) to strongly agree (5). The TSC scale is based on two sub-dimensions referring to company policies and practices (e.g. Company cares more about my safety than on-time delivery; Company turns a blind eye when a supervisor bends some safety rules) and dispatcher practices (e.g. Dispatchers are strict about driving safely even when we are tired or stressed; Dispatcher pushes me to keep driving even when I call in to say I feel too sick or tired). Previous research has indicated that safety climate scales are often characterized by a single higher-order factor inducing the lower-order ones (e.g. Griffin and Neal, 2000; James et al., 2008; Johnson, 2007; Zohar and Luria, 2005). Given the parsimony in theoretical modeling of such a factorial structure, we conducted confirmatory factor analysis (CFA), resulting in the following fit indexes: $\chi^2$ ($df$) = 13,172.61 (739), CFI = .97, and RMSEA = .069 (90% confidence interval = .068, .070), supporting this model's goodness of fit (Browne and Cudeck, 1993; Hair et al., 1998; Hu and Bentler, 1999). Given such results, the remainder of our analysis used a single TSC score. Cronbach's alpha reliability coefficient for scale items was $\alpha$ = .96.

*Leadership* was measured with six items taken from the LMX-7 scale (Graen and Uhl-Bien, 1995). Items were followed by a 5-point rating scale ranging from strongly disagree (1) to strongly agree (5). Some words were modified to fit the context of the trucking industry. Solid psychometric properties of the LMX-7 scale are well documented in a meta-analytic study comparing different versions of LMX measurement scales (Gerstner and Day, 1997). Sample items are: My dispatcher understands my problems and needs well enough; and My working relationship with my dispatcher is effective. Choice of LMX over the Multifactor Leadership Questionnaire (Bass and Avolio, 1997) was based on its suitability for measuring informal exchanges between distant leaders and drivers, coupled with the fact that leadership scores measured with the two scales are strongly correlated (Howell and Hall-Merenda, 1999; Wang et al., 2005). Cronbach's alpha reliability coefficient for the six items of the scale was .86.

*Work ownership* was measured with five items using the same 5-point Likert scale as the previous variables (1 = strongly disagree; 5 = strongly agree). Items were taken from the psychological work ownership scale (Van Dyne and Pierce, 2004), adjusting the wordings of some items to better fit a trucking context. Sample items include: Drivers feel as if they own their cargo; and I feel a very high degree of personal ownership for this truck, like it's mine. Cronbach's alpha reliability among the items was .76.

*Driving safety* was measured with a new scale adapted from Huang et al. (2005) and using information collected during driver interviews associated with development of the TSC scale. Six behaviorally anchored items of the driving safety scale refer to frequent safety shortcuts among truck drivers. Item wording was designed to minimize social desirability bias. Sample items include: I sometimes find myself in a difficult situation without having a way out; I always use the log book legally; and When I am tired or rushed, I sometimes skip the daily vehicle inspection. Items were accompanied by the same 5-point rating scale (1 = strongly disagree to 5 = strongly agree). Alpha reliability among scale items was .75.

*Hard-braking frequency* was measured using a searchable electronic file maintained by the participating company. Data were collected six months after completion of the climate survey over a period covering the following six months. Hard-braking constitutes a count variable which does not follow normal distribution (45.5% of participants had no record of hard-braking during the six months). Therefore, zero-inflated Poisson log-link generalized linear modeling was used to test the hypothesized path model in which hard-braking serves as the final outcome or dependent variable.

## 3. Results

### 3.1. Data analysis procedure

Path analysis was conducted to test the series of hypothesized direct and indirect effects, using M-plus version 6.0 software

**Table 2**
Direct and indirect effect testing of the hypothesized model relationships.

| Path | Standardized coefficient (S.E.) | Indirect effect (S.E.) | Sobel $z$ | 20,000 Bootstrapping 95% C.I. |
|---|---|---|---|---|
| *Direct effects* | | | | |
| LMX → TSC | .49 (.01)** | – | – | – |
| Ownership → TSC | .14 (.01)** | – | – | – |
| TSC → driving safety | .40 (.02)** | – | – | – |
| Driving safety → hard braking | −.09 (.05)* | – | – | – |
| *Indirect effects* | | | | |
| LMX → TSC → driving safety | – | .20 (.01) | 18.38 | [.18, .22]** |
| Ownership → TSC → driving safety | – | .06 (.01) | 10.92 | [.05, .07]** |
| TSC → driving safety → hard braking | – | −.04 (.02) | −1.97 | $[-.07, -.01 \times 10^{-1}]$* |

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

(Muthén and Muthén, 2006). To test the mediation hypothesis, in addition to the Sobel test (1982), parametric residual bootstrapping was used to calculate the confidence intervals of the indirect effect estimates (Pituch et al., 2006). The indirect effect estimates were replicated 20,000 times based on Monte Carlo simulation by using *R* open-source program. Results were rank ordered to test statistical significance. Range of the middle 95% of the replicated values forms the 95% confidence interval and, if it does not include zero, it indicates statistical significance.

Descriptive statistics and correlations between study variables are provided in Table 1, using an individual level of analysis ($n = 3841$). As can be seen in this table, correlations between study variables were mostly of a medium strength, indicating that potential indirect effects had to be properly controlled when testing individual paths in the mediation model. Fig. 1 presents the conceptual model tested in this study. Numbers represent non-standardized path coefficients identified during data analysis to be discussed below. Table 2 provides detailed description of path coefficients appearing in Fig. 1.

### 3.2. Testing the mediation model

The path coefficient from LMX to trucking safety climate (TSC) was .49 ($SE = .01$, $p < .01$), after controlling for the effect of Ownership. Furthermore, due to the fact that drivers were associated with different dispatchers in each company, this analysis was conducted after controlling for possible group variance by using group-mean centering of TSC scores (Bliese and Hanges, 2004). The significant path coefficient between LMX and TSC supports Hypothesis 1. Similarly, the path coefficient from Ownership to TSC was .14 ($SE = .01$, $p < .01$), after controlling for LMX and group-mean centering of TSC, supports Hypothesis 2. Findings also supported Hypothesis 3 concerning the relationship between TSC and driving safety, resulting in a path coefficient of .40 ($SE = .02$, $p < .01$). Hypothesis 4, specifying a direct effect of safety climate on hard-braking frequency, was not supported. The path coefficient for TSC → hard-braking was −.01 ($SE = .04$, $p = .81$). To keep the path model parsimonious, the non-significant direct effect path was omitted from our path model (Fig. 1).

Despite the non-significant direct effect from TSC to hard-braking, safety climate perceptions showed negative and statistically significant indirect effects on hard-braking via safety behavior (driving safety). This situation of non-significant direct effect of $X$ (safety climate) on $Y$ (hard-braking) can take place even though $X \rightarrow M$ (driving safety) and $M \rightarrow Y$ paths are substantial (Kenny et al., 1998). Safety behavior predicted hard-braking with a path coefficient of −.09 ($SE = .05$, $p < .05$). Using the coefficient obtained while testing Hypothesis 3, the indirect effect coefficient of TSC → *driving safety* → hard-braking path was calculated. This coefficient was −.04 ($SE = .02$, Sobel's $z = -1.97$, 95% bootstrapped confidence interval = −.07, −.001, $p < .05$). Both the Sobel's $z$ value and 95% bootstrapped confidence interval denote the indirect effect is statistically significant, supporting Hypothesis 5. In summary, our findings support the entire mediation path model, except for the direct effect of TSC on hard-braking frequency.

## 4. Discussion

This study tested a mediation path model linking dispatcher leadership and work ownership as antecedents of psychological safety climate perceptions and two primary consequences among truck drivers, i.e. driving safety and hard-braking events. Corresponding with the wealth of evidence regarding leadership as a safety climate antecedent, quality of dispatcher–driver relationships was positively related to safety climate perceptions, despite reduced interaction opportunities characterizing distant leadership. Work ownership, promoted by increased autonomy and control over work characterizing lone working, offered incremental prediction of safety climate perceptions over that accounted for by LMX. Safety climate perceptions, in turn, predicted driving safety behavior, which predicted the frequency of subsequent hard-braking events, measured six months after survey administration.

One contribution of this study concerns the expansion of safety climate research in the context of lone working. As noted in the meta-analyses and literature reviews of lone working discussed above (Bailey and Kurland, 2002; Gajendran and Harrison, 2007; Pinsonneault and Boisvert, 2001), most research on lone workers has focused on distributed office work, subsumed largely under the title of telecommuting. This has excluded major occupational categories of lone workers whose work is characterized by physical risk, such as repair technicians, utility-line workers, agriculture laborers, or delivery personnel. Our sample of long-haul truck drivers represents the latter category, offering an opportunity to study a large occupational group of lone workers whose annual safety records indicate exposure to substantial physical risks. The fact that our trucking safety climate scale predicted (self-reported) driving safety and, more impressively, hard-braking events that took place six months after survey delivery, offers an important contribution to lone-work safety research in general and truck-driving safety in particular.

A related contribution of this study concerns the effect of distant leadership on employee safety performance. Our data indicate that, despite expected reduction in leader social influence on remote workers, distant leaders can maintain their influence on safety climate perceptions and role behavior in their work group. Given that leadership distance is related to LMX differentiation (i.e. within-group LMX variance between different leader-member dyads; see: Henderson et al., 2009), our data indicate that high-LMX exchanges promote more positive safety climate perceptions, leading to safer driving behavior and reduced frequency of hard-braking. These data expand the traditional view in traffic safety research, suggesting that rather than putting the onus of responsibility (and blame) on driver shoulders, fleet managers or supervisory personnel ought to be included in safety improvement efforts.

Our data, supporting dispatcher leadership and work ownership as predictors of safety climate perceptions and driving safety offer some new ideas regarding the management of lone employees. One relevant idea implies that, rather than trying to increase work formalization to compensate for diminishing control due to geographic dispersion of employees, company policies and supervisory practices should encourage increased employee autonomy, higher skill variety, greater task meaningfulness and intimate task knowledge, leading to development of greater work ownership.

A methodological contribution of this study concerns the development and validation of a new safety climate scale designed for truck drivers. The new scale follows Zohar and colleagues' ideas about theoretical attributes of organizational climate items (Zohar, 2010, 2011; Zohar and Hofmann, 2012). Such a strategy is noteworthy given repeated concerns over conceptual ambiguity characterizing organizational climate research at large and safety climate in particular (Ostroff et al., 2013; Schneider et al., 2011). Our trucking safety climate scale follows a number of attributes differentiating climate from other perception-based variables, such as assessment of priorities among competing demands (e.g. safety vs. on-time delivery), alignment between words and deeds, or internal consistency among formal policies and informal practices. The fact that our theory-based scale predicted objective safety outcomes measured six months later offers empirical justification for our scale development strategy.

A related methodological note concerns the study of safety climate in the context of traffic safety. As noted above, our search of the traffic safety literature identified only a small number of climate-related studies, most of which used adjusted generic safety climate scales designed for in-house employees, coupled with a cross-sectional design using self-reported accidents over the previous year (e.g. Newman et al., 2008; Strahan et al., 2008; Wills et al., 2005, 2006, 2009). Both attributes compromise theoretical and methodological strengths, introducing possible reverse causality (Beus et al., 2010). Given this state of affairs, the present study offers the advantage of using an industry-specific climate scale accounting for the unique attributes of professional driving, coupled with a prospective design ruling out reverse causality.

### 4.1. Study strengths and limitations

The strengths of this study relate to conceptual and methodological issues. First, this study expands safety climate theory, offering work ownership as an additional antecedent variable for this construct. Work ownership was shown in this study to act as a substitute for symbolic social interaction among employees, having been considered a necessary condition for climate emergence. Second, development of the trucking safety climate scale was guided by conceptual attributes focusing on the discriminant validity of climate vs. other perception-based constructs in organizational behavior research. Such an approach, as noted above, ought to reduce conceptual ambiguity that has afflicted climate research over the years (Schneider et al., 2011). Third, the use of a prospective design in which outcome criteria are collected after completion of the climate survey, coupled with the use of objective outcome data, offers methodological strengths in testing the predictive validity of safety climate in the context of lone working.

Weaknesses of this study relate largely to three issues. First, the conceptual model refers to lone working as a discrete variable (i.e. in-house vs. lone work), whereas in reality there are intermediate positions between the two poles of this variable. In the context of truck driving, a better test of the conceptual model would have included a sample of both short- and long-haul trucking companies, representing variation in opportunities for social-symbolic interaction among drivers. In the former case, we would have expected the emergence of *shared* climate perceptions among drivers operating from the same distribution center, as reported by Wallace et al. (2006), by contrast with *individual-level* climate perceptions as reported in the present study.

Second, the conceptual model integrates work ownership in the nomological network of organizational climate, using it as an additional antecedent of safety climate perceptions. Given its key role, our model must be expanded to include specific factors responsible for the emergence and ensuing level of psychological work ownership. In particular, there is a need for including formal and informal policies and practices as well as individual differences in personality and motive profiles likely to affect the level of work ownership among workers. A case in point concerns high-performance work systems in which human-resource management policies are designed to promote task autonomy and employee participation among in-house employees. Such policies were shown to promote better safety climate and safety behavior (Zacharatos et al., 2005) inasmuch they were shown in our study to promote work ownership. An expanded model will serve the literatures of organizational safety climate, work ownership, and lone working. We hope the present work will stimulate further research along these lines.

Third, although safety outcomes were measured six months after survey completion, all of the predictor variables, being included in the same survey, were measured concurrently. Consequently, although it is possible to infer causality regarding the behavior-outcome relationship (i.e. the last path in our conceptual model), the same is not true regarding the other paths in the model. At the same time however, given robust meta-analytic support for the leadership (LMX) → safety climate → safety behavior path (Beus et al., 2010; Christian et al., 2009; Clarke, 2010; Nahrgang et al., 2011), it is possible to justify our model while acknowledging that a longitudinal measurement of our predictor variables would have offered better empirical testing of this model.

In conclusion, the current paper presents a mediation path model linking the effects of safety climate perceptions on driving safety and near-miss events of long-haul truck drivers. Results supported the model that leader–member relationships and driver work ownership were safety-climate antecedents, with climate perceptions mediating its effects on safety behavior and hard-braking frequency. These results expand the nomological network of the organizational climate construct as well as suggesting that safety performance depends on management personnel as much as it does on front-line employees.

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