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How is safety climate formed? A meta-analysis of the antecedents of safety climate

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Abstract

The purpose of this meta-analysis was to provide a comprehensive quantitative review of research to date on the antecedents of psychological and organizational safety climate. Building upon and expanding Zohar's conceptual model, antecedents were organized into three broad categories: situational factors, interpersonal interactions, and personal factors. Data were gleaned from 136 primary studies to calculate effect sizes for 38 antecedents and the relative importance of each antecedent within the three categories. Antecedent effect sizes were generally homologous for psychological and organizational safety climate, with the strongest effect sizes for interpersonal interactions followed by organizational climate and leadership. The magnitude of the safety climate antecedent effect sizes tended to be stronger in health-care industry studies and varied inconsistently as a function of the industry-specific nature of the safety climate measure. This meta-analysis provides a much needed summary of the research to date in an effort to guide future research and practice on the development and improvement of safety climate in organizations.

Keywords

safety climate, antecedent, meta-analysis

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Workplace safety has received increasing attention from both researchers and practitioners. Workplace incidents result in millions of nonfatal injuries and illnesses, thousands of fatalities, and billions of dollars in costs in the U.S. alone (Liberty Mutual Research Institute for Safety, 2016; U.S. Bureau of Labor Statistics, 2015). Workplace incidents and injuries also result in 300,000 deaths annually and enormous economic losses worldwide (Takala et al., 2014). To reduce the possibility and the devastating effects of workplace incidents, it is essential to strengthen employees' perceptions of the enforcement of organizational safety policies and practices to improve employees' safety behavior and reduce safety hazards (Zohar, 2003). Indeed, multiple meta-analytic studies have shown that safety climate is a robust predictor of safety outcomes (e.g., Beus, Payne, Bergman, & Arthur, 2010; Christian, Bradley, Wallace, & Burke, 2009; Nahrgang, Morgeson, & Hofmann, 2011).

In contrast, the antecedents of safety climate are not well established. Given the need to develop and maintain a safe climate at work, it is critical to determine what contributes to safety climate in organizations. Managers and safety personnel frequently ask what can they do to enhance or improve, as well as maintain a good safety climate? These are important questions to answer to maximize safety in the workplace. Many empirical studies examined theoretical predictors of safety climate (e.g., Beus, Muñoz, & Arthur, 2015; Clarke, 2010). Researchers speculate that safety climate emerges as a result of interpersonal interactions among workgroup members (e.g., Zohar & Tenne-Gazit, 2008). Other studies have shown the importance of the influence of organizational leaders in shaping safety climate (e.g., Hofmann, Morgeson, & Gerras, 2003; Zohar & Luria, 2004). These studies have begun to shed light on what contributes to safety climate by identifying some specific predictors. In a model of the antecedents and consequences of organizational safety climate, Zohar (2011) proposed seven antecedents of safety climate including structural attributes, symbolic interaction, group and organization leadership, psychological work ownership, organizational commitment, job stress and burnout, and personality. Beyond those in Zohar's (2011) model, additional antecedents (e.g., job demands, job resources, coworker influence) have also been empirically examined and demonstrated to have unique effects on safety climate (Beus, Muñoz, & Arthur, 2015; Phipps, Malley, & Ashcroft, 2012). Correspondingly, a comprehensive quantitative review of the antecedents of psychological and organizational safety climate is needed to summarize our knowledge to date on the variables that contribute to safety climate.

Building on existing theories (e.g., Weick, 1995) and conceptual models of workplace safety and safety climate (e.g., Christian et al., 2009; Griffin & Neal, 2000; Zohar, 2011), we organize the antecedents of safety climate into three broad categories: (a) situational factors (e.g., job and organizational characteristics), (b) interpersonal interactions (e.g., leader–member exchange [LMX]), and (c) personal factors (e.g., Big Five personality traits, locus of control). We calculate and compare the effect sizes of antecedents within and across each category. We also conduct meta-analytic relative importance analyses (Tonidandel & LeBreton, 2011) and path analyses to reveal their relative proximity and contributions to safety climate. We then test two potential moderators of the relationship between safety climate and its antecedents: (1) the industry in which the study was conducted and (2) whether safety climate was assessed with a universal or industry-specific measure.

The present study contributes to the safety climate literature by providing a much-needed empirical summary and expansion of existing conceptual models. We examine and quantitatively summarize whether previously proposed antecedents are truly robust predictors. We use sensemaking theory and the attraction–selection–attrition (ASA) model to explain why these variables relate to safety climate and provide future research with an enriched and quantitatively validated theoretical framework. Compared to previous meta-analyses which focused on a specific type of safety climate antecedent (e.g., leadership styles; Clarke, 2013), the present meta-analysis includes a more comprehensive set of antecedents examined in the literature to date, revealing what has been examined and what needs additional research. Moreover, relative importance analyses reveal which antecedents have a stronger impact on safety climate and path analyses begin to illuminate the proximity of different antecedents to safety climate. In addition, an examination of moderators shows when antecedents are likely to have stronger relationships with safety climate and hence identifies important boundary conditions that need to be considered when developing safety climate interventions. In summary, our meta-analysis informs researchers about the validity of conceptual models to date, which predictors warrant more empirical attention, as well as other important variables (e.g., moderators) that play a role in the prediction of safety climate. Our findings also inform practitioners which levers to manipulate to have the greatest impact on safety climate in the workplace.

Safety climate and workplace safety

Safety climate has long been recognized as an important contributor to workplace safety (Zohar, 1980). It is typically conceptualized as a distal situation-related factor that influences safety behavior through safety knowledge and safety motivation (Christian et al., 2009; Neal & Griffin, 2004). This pattern of relationships depicted in models of workplace safety was supported by a previous meta-analytic review (Christian et al., 2009). Recently, in an integrative multilevel model of workplace safety, safety climate was depicted as a major distal situational factor that influences not only safety behaviors and unsafe events at the individual level but also norms of safety behaviors and incident rates at higher levels of the organization (Beus, McCord, & Zohar, 2016).

Focusing specifically on safety climate, Zohar (2011) proposed a conceptual model of the antecedents and consequences of safety climate. He identified seven constructs/categories of constructs as antecedents of safety climate, including situational factors such as structural attributes (e.g., organizational policies and practices) and leadership, interpersonal interactions such as symbolic social interactions, and personal factors such as personality traits (e.g., conscientiousness). To date, a wide variety of variables beyond those proposed by Zohar (2011) have been examined as antecedents of safety climate. As such, this meta-analytic review seeks to validate the antecedents in Zohar's (2011) model, identify additional antecedents not included in his model, and determine where additional research is needed.

Safety climate

Safety climate is inherently a multilevel construct. Zohar (2003) conceptualized safety climate at two levels: psychological safety climate at the individual level of analysis and organizational safety climate at a higher level of analysis. At the individual level, *psychological safety climate* describes *individual* perceptions of workplace safety norms, priorities, and expectations; that is, each psychological climate score represents one employee's personal perceptions of the enforcement of workplace safety. At a higher level of analysis (e.g., work groups, organizations), *organizational safety climate* refers to the *shared* perceptions of workplace safety norms, priorities, and expectations among employees within a work unit (Schneider, Ehrhart, & Macey, 2013; Zohar, 2003).

When safety climate is conceptualized as a unit-level construct (i.e., organizational safety climate), individual employee safety climate scores are combined to represent the aggregate which can be a work team, department, worksite, or an entire organization (Ostroff, Kinicki, & Tamkins, 2003). There are two distinct and important indicators of safety climate when aggregated across a larger unit: level and strength. *Organizational safety climate level* refers to the mean level of psychological safety climate ratings across individuals within a work unit (Lindell & Brandt, 2000; Zohar & Luria, 2005). Higher scores reflect that the group perceives the environment to be more (rather than less) safe. A high level of organizational safety climate can be interpreted as a collective, positive perception about safety norms, priorities, and expectations of what behaviors are rewarded or sanctioned.

Organizational safety climate strength represents the extent to which members of the unit agree about safety norms, priorities, and expectations (Bliese & Halverson, 1998; Schneider, Salvaggio, & Subirats, 2002). In other words, it measures the amount of consensus there is among the unit members. A higher level of safety climate strength reflects greater consensus among unit members. Although we are not aware of a theoretical model of the predictors of safety climate strength, researchers have examined potential antecedents.

In the current review, antecedents of psychological and organizational safety climate level and strength are examined. A comparison of the effect sizes reveals the extent to which the relationships are homologous across levels of analysis (cf. Beus, Payne, Arthur, & Muñoz, 2019). In a meta-analysis of safety climate outcomes, organizational safety climate had a slightly stronger effect on safety behavior than psychological safety climate (Christian et al., 2009). By conducting homology analyses, we contribute to the development of multilevel theories of safety climate and workplace safety (Chen, Bliese, & Mathieu, 2005).

Theoretical background

Two theoretical models explain how and why various antecedents contribute to climate perceptions: sensemaking theory (Weick, 1995; Zohar, 2011) and the ASA model (Schneider, 1987; Schneider, Goldstein, & Smith, 1995). Derived from a social information processing model (e.g., Brown, 2000; Salancik & Pfeffer, 1978; Weick, 1995), sensemaking is a series of ongoing, socially based cognitive processes in which employees construct plausible interpretations of complex and ambiguous situations and reduce uncertainty regarding an organization's values and goals. Specifically, the formation of job-relevant judgments or evaluations depend on how employees interpret the situation. Employees interpret information perceived in the social environment (e.g., organizational policies, supervisors' behaviors). By engaging in interpersonal interactions and inherently interpretative processes, employees make inferences about appropriate attitudes and behaviors that align with an organization's values, priorities, and policies, as well as behaviors that are rewarded or sanctioned. Employees continuously attempt to make sense of information, as well as safety-related events. Sensemaking is likely to shape individual and collective perceptions about safety norms, priorities, and expectations of desirable behaviors (González-Romá, Peiró, & Tordera, 2002). Collective perceptions result from exposure to similar work contexts and frequent interactions among employees who work in the same unit (Ostroff et al., 2003).

The ASA model is also relevant to the formation of safety climate (Schneider, 1987; Schneider et al., 1995). According to this model, organizational processes, structures, and cultures reflect the characteristics of the people in an organization (e.g., personality); and organizational climate is determined by the kinds of people who are attracted to, selected by, and retained within the organization (Schneider et al., 1995). The ASA model is especially useful in explaining how and why certain personality traits are linked to the formation of safety climate. People who are high in conscientiousness, for instance, are more likely to be responsible for their behavior and engage in activities aligned with safety principles such as

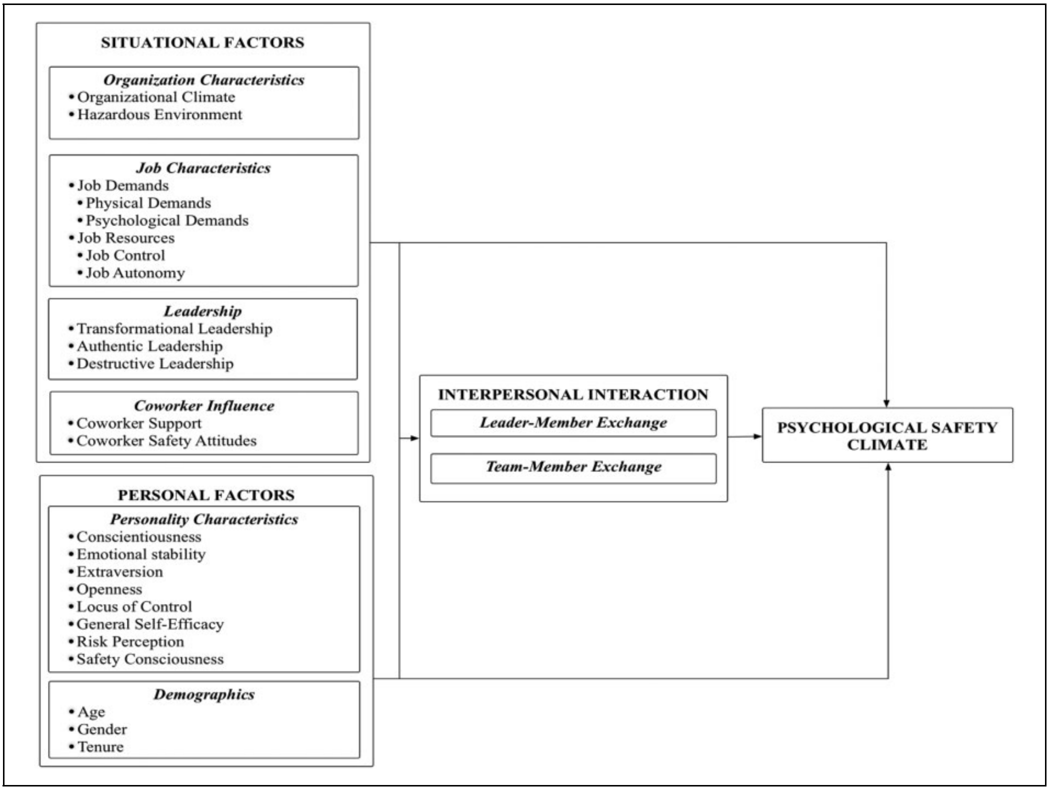

Figure 1. A conceptual model to summarize antecedents for psychological safety climate.

strictly following safety rules and maintaining high safety standards (Meyer, Dalal, & Bonaccio, 2009). When employees who adhere to safety procedures and priorities come together, they are likely to reinforce corresponding behaviors and correct each other's unsafe behaviors.

In the current study, we adopted and extended Zohar's (2011) theoretical framework to organize the antecedents of safety climate into one of three broad categories: situational factors, interpersonal interactions, and personal factors. We propose all three categories as antecedents of psychological safety climate (Figure 1) and situational factors and interpersonal interactions as antecedents of organizational safety climate level and strength (Figure 2). Moreover, we propose that, for both psychological and organizational safety climate, interpersonal interactions are proximal antecedents, whereas personal and situational factors are distal antecedents. In the following sections, we refer back to sensemaking and the ASA model to explain why each antecedent is likely to shape safety climate. Specifically, the influence of personal factors on psychological safety climate is explained by sensemaking and the ASA model, and the influence of situational factors and interpersonal interactions on both psychological and organizational safety climate can be explained by sensemaking.

It is important to note that studying antecedents of any type of organizational climate is difficult as researchers are more likely to have access to an organization that is already established and the climate has already been developed or formed to a certain extent. This is

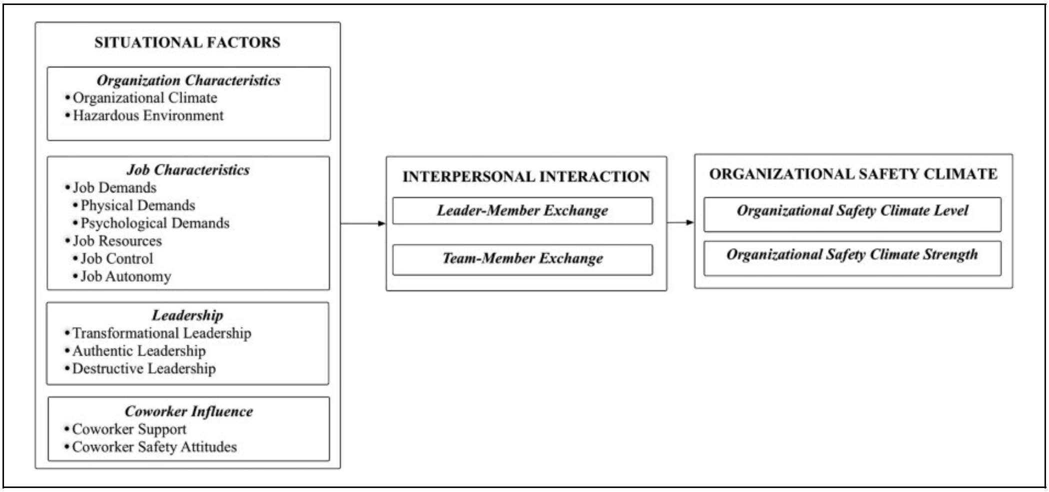

Figure 2. A conceptual model to summarize antecedents for organizational safety climate.

further illustrated by the predominant use of cross-sectional studies examining antecedents of safety climate. Thus, the antecedents and safety climate are typically measured at the same time, precluding the ability to establish temporal precedence. Likewise, our writing is guided by theory about the development and perpetuation of safety climate but reflects more conceptual rather than empirical patterns in the data. That said, the variables that contribute to the development of safety climate are also likely to change safety climate; thus, our study also identifies variables that can help to improve safety climate over time and would be important levers to move when designing a safety climate intervention.

Given the wide range of potential antecedents of safety climate, some variables are likely to have stronger effects than others in part because they are "closer" to climate than other variables. For example, personal factors are likely to be more distal to safety climate than situational factors. Evidence for proximity is demonstrated by the magnitude of the relationships, with distal antecedents having weaker relationships than proximal antecedents. Proximity of antecedents can also be shown through direct and indirect relationships, with distal antecedents having indirect relationships through mediating mechanisms rather than direct relationships with safety climate.

Situational factors as antecedents of psychological and organizational safety climate

We conceptualize situational factors as job and organizational characteristics, as well coworker and supervisor characteristics. Based on sensemaking theory, all of these characteristics are important external factors that shape both psychological and organizational safety climate (Zohar, 2011). Specifically, organizational characteristics include the broader organizational climate as well as safety-specific aspects such as the extent to which the environment is perceived to be hazardous. Job characteristics include job demands (e.g., psychological demands, physical demands) as well as job resources (e.g., job control, autonomy; Demerouti, Bakker, Nachreiner, & Schaufeli, 2001). Supervisor characteristics include leadership styles such as transformational leadership (Zohar & Tenne-Gazit, 2008), and coworker characteristics include coworkers' safety attitudes and coworker support.

Different from safety climate, organizational climate captures employees' perceptions of general organization-wide norms, priorities, routines, expectations, and rewards (Reichers & Schneider, 1990) and it encompasses a wide range of individual perceptions of the work environment (e.g., goal congruency, supportive leadership, empowerment, communication, professional growth). Its measurement focuses on global concepts of climate (Neal, Griffin, & Hart, 2000; e.g., "There is good communication between groups in this workplace"). Researchers have proposed that the organizational climate sends implicit and explicit messages to employees about the organization's values, norms, and priorities and thereby influences individual employees' psychological safety climate as well as the work unit's collective organizational safety climate (DeJoy, Schaffer, Wilson, Vandenberg, & Butts, 2004; Neal et al., 2000). Another aspect of the organization is how hazardous the physical environment is (noise, temperature, etc.), as well as the inherent danger of the work conducted in that environment (e.g., apprehending an armed suspect). Clearly, employees' perceptions of threats to their health and safety in their working environment are likely to influence safety climate (Cui, Fan, Fu, & Zhu, 2013).

Job characteristics such as job demands and resources also play a role in shaping safety climate at work (Phipps et al., 2012; Squires, Tourangeau, Laschinger, & Doran, 2010). For example, if employees are expected to complete a great number of tasks quickly and meet strict deadlines at any expense, they are likely to infer that safety is not a priority, diminishing safety climate (He et al., 2016). In contrast, if employees are expected to perform tasks only if their health and safety is not compromised, they are likely to feel the organization prioritizes their safety and well-being. These positive feelings may in turn promote the employee's psychological and organizational safety climate (Phipps et al., 2012).

It has long been said, "leaders create climate" (Lewin, Lippitt, & White, 1939). Supervisors reinforce safety behaviors by rewarding desirable behaviors and sanctioning undesirable ones, which in turn shape subordinates' perceptions and understanding of safety norms and values. Clarke's (2013) meta-analysis showed that transformational and active transactional leadership were positively related to psychological safety climate. Both leadership styles promote the perception that leaders value and prioritize safety in relation to other organizational goals. The current study extends Clarke's (2013) study by examining more leadership styles (e.g., authentic leadership) and behaviors. For instance, we included destructive leader behaviors such as abusive leadership, which is expected to diminish the emergence of safety climate (e.g., Krasikova, Green, & LeBreton, 2013).

Beyond the leader, coworkers are also likely to have an impact on safety climate by providing support and conveying their related attitudes (Watson, Scott, Bishop, & Turnbeaugh, 2005). Coworker support, which reflects coworkers' willingness to help, may influence safety climate by instilling an understanding that employees are not alone and can rely on their colleagues for help (Phipps et al., 2012). Safety climate is also likely to be influenced by coworkers' safety attitudes through interpersonal interactions. Coworkers' pro-safety attitudes and behaviors are likely to reinforce other employees' understanding and perceptions of safety norms and priorities (Watson et al., 2005). Likewise, at the unit level, high levels of within-unit support and sharing of safety attitudes will foster within-unit consensus or organizational safety climate strength (e.g., González-Romá et al., 2002).

Interpersonal interactions as antecedents of psychological and organizational safety climate

As illustrated in Figure 1, interpersonal interactions are likely to shape employees' perceptions of safety climate. Interpersonal interactions emphasize the quality of interpersonal relationships and exchanges between employees, whereas situational factors emphasize leaders and coworker behaviors. The importance of interpersonal interactions in shaping individuals' perceptions is also underscored by sensemaking theory (Brown, 2000; Weick, 1995). Accordingly, high-quality interpersonal interactions incentivize making sense of safety-related information (e.g., safety regulations, policies) and facilitate interpreting this information in the same way as others. As such, in the present study, we examined interpersonal interactions as a unique category of antecedents of safety climate. Many researchers have operationalized interpersonal interactions with measures of LMX and *team–member exchange* (TMX).

High-quality LMX involves frequent interaction, mutual trust, support, and formal and informal rewards between a supervisor and subordinates (Dienesch & Liden, 1986; Liden & Graen, 1980). Supervisors' behaviors, opinions, and interactions with subordinates provide important information about safety norms, goals, and priorities in the workplace. Employees are likely to obtain a better understanding of safety regulations and requirements when they have regular high-quality exchanges with their supervisors, who transmit safety policies down from upper management. Therefore, LMX is a key process responsible for shaping employees' perceptions of workplace safety. At the unit level, the high-quality exchanges promote the collective understanding of safety rules and expectations, thus fostering organizational safety climate.

TMX refers to an individual employee's perception of his or her exchange relationship with the work group as a whole (Seers, 1989). Like LMX, extensive and high-quality exchange relations with the work group can enhance employees' knowledge about safety norms, priorities, and discipline, which in turn strengthens safety climate (DeJoy et al., 2004; Shen, Tuuli, Xia, Koh, & Rowlinson, 2015; Zohar, Huang, Lee, & Robertson, 2014). Thus, TMX is also expected to relate to psychological and organizational safety climate.

Furthermore, both TMX and LMX are expected to foster a collective perception of safety climate through sensemaking as interpersonal interactions are the primary means through which organizational values, policies, and norms are transformed into a common experience and interpretation of the climate. High-quality social exchanges are expected to promote the convergence of interpretations about organizational events (e.g., injuries and incidents) and situational information (i.e., organizational safety climate strength; Zohar & Tenne-Gazit, 2008). Therefore, interpersonal interactions are conceptualized as antecedents of both organizational safety climate level and strength.

Personal factors as antecedents of psychological safety climate

In addition to situational characteristics and interpersonal interactions, personal factors are expected to play a nontrivial role in shaping psychological, but not organizational, safety climate (Beus, Dhanani, & McCord, 2015). Personal factors include employee personality traits and job attitudes. They are likely to determine whether employees are attracted to and stay within an organization, as well as how employees make sense of their work environments (Beus, Dhanani, & McCord et al., 2015; Schneider, 1987). Both the ASA model and sensemaking theory help to explain why and how personal factors influence psychological safety climate. In the present review, we examined the following antecedents as personal factors: four of the Big Five personality traits (conscientiousness, emotional stability, extraversion, and openness), locus of control, general self-efficacy, risk perception, and safety consciousness.

According to the ASA model, the emergence of safety climate depends on whether safety-conscious people are attracted to, selected by, and retained within the same organization (Schneider et al., 1995). Employees who are conscientious and have an internal locus of control tend to perceive a better safety climate at work, because they have more favorable attitudes toward organizational efforts and policies to improve safety and they perceive these efforts to be consistent with their own values (e.g., Beus, Dhanani, & McCord 2015). Moreover, employees who are extraverted, open to experience, and efficacious are inclined to proactively engage in activities aligned with safety policies and rules and interact with others to learn and advocate for safety principles and guidelines (Beus, Dhanani, & McCord, 2015; Newnam, Griffin, & Mason, 2008), thus they tend to have favorable views of safety climate. Safety consciousness, which reflects an individual's awareness of safety issues, prompts employees to proactively think about safety practices and enactments and thus is expected to positively relate to safety climate (Barling, Loughlin, & Kelloway, 2002; Kelloway, Mullen, & Francis, 2006).

Sensemaking theory also suggests that employees observe and interpret organizational events through the filter of personal characteristics or psychological predispositions (Brown, 2000; Lewin et al., 1939). Individuals make sense of their environment and attribute meaning to organizational events in ways that are in accordance with personal characteristics (McCrae & Costa, 1999). For instance, Beus, Dhanani, and McCord (2015) speculated and found that people with lower emotional stability are more likely to notice potential risks and threats and thus interpret their climate as less safe; whereas those who are more emotionally stable are less likely to have such tendencies and correspondingly perceive a more favorable safety climate. Another personal antecedent that may influence psychological safety climate through sensemaking is risk perception, a person's assessment of hazards and potential for injury in a given situation (Sitkin & Pablo, 1992). Those who tend to perceive the environment as hazardous are also likely to interpret that there is a lack of safety norms and policies to protect them against injury and thereby perceive a less favorable safety climate (Weyman & Clarke, 2003).

Interpersonal interactions as proximal antecedents

As depicted in Figures 1 and 2, we propose interpersonal interactions are proximal antecedents and situational and personal factors are distal antecedents of safety climate. Situational factors influence safety climate through the formation of high-quality interpersonal interactions between supervisors and subordinates or among coworkers. Moreover, interpersonal interactions provide a means for safety attitudes and perceptions to be shared. Employees contribute to interpersonal interactions, which in turn influence safety climate. We propose that interpersonal interactions exert direct, stronger effects on both psychological and organizational safety climate compared to personal and situational factors. We also expect that interpersonal interactions will mediate the relationships between (a) situational factors and psychological safety climate, (b) situational factors and organizational safety climate, and (c) personal factors and psychological safety climate.

Relative importance of each category of antecedents

By examining a wide array of situational and personal antecedents, we are able to reveal the relative importance of each one to safety climate (Tonidandel & LeBreton, 2011). Although situational and personal factors are both conceptualized as distal antecedents of safety climate, we expect situational factors to have a stronger effect on safety climate than personal factors, because climate tends to be a function of the environment, more so than the person. Moreover, the individual variables within each of these two categories may also vary to the extent that they can contribute to safety climate. By comparing the relative importance of the antecedents, we extend conceptual models of safety climate antecedents. From a practical standpoint, information about the relative importance of each proposed antecedent is likely to help safety managers determine where to allocate resources to have the greatest impact on changing and maintaining safety climate.

Potential moderating variables

Industry

The magnitude of the relationships between each antecedent and safety climate may vary depending on the industry in which the work is conducted. Industries vary in hazards, emphasis on and enforcement of safety rules and norms, and therefore the potential for workplace injuries and accidents (U.S. Bureau of Labor Statistics, 2015). Industries also vary in interdependence or the extent to which employees are required to collaborate with others to complete their work, which has been shown to relate to workplace safety (Zohar & Tenne-Gazit, 2008). The primary industries that appear in the safety climate literature include health care, transportation, construction, manufacturing, and energy. Correspondingly, we examine industry as an exploratory moderator of the antecedent–safety climate relationship.

Specificity of the safety climate measure

Safety climate has been assessed with universal/ general measures as well as industry-specific measures. Universal measures of safety climate contain general items about the enforcement of safety rules that apply to any industry (e.g., Beus et al., 2019; Zohar & Luria, 2005). An example item reads, “my direct supervisor frequently talks about safety issues throughout the work week” (Zohar & Luria, 2005). In contrast, industry-specific measures consist of items that contain specific hazards, tasks, or contexts that are unique to the focal industry. An example safety climate item for the trucking industry reads, “my leader allows drivers to change their schedules when they are getting too tired” (Huang et al., 2013).

Compared to industry-specific measures, universal measures of safety climate permit safety climate scores and relationships with other variables to be compared or benchmarked across industries. However, universal safety climate measures may not reveal context-dependent norms, actions, and benchmarks (Zohar, 2011). In contrast, industry-specific measures elaborate on more contextualized information (e.g., referencing “masks, goggles, and gloves” rather than the generic “safety equipment”). Such information can facilitate respondent comprehension by reducing ambiguity of survey items, potentially leading to more accurate and meaningful responses (Keiser & Payne, 2018).

To date, the majority of research studies comparing industry-specific to universal safety climate measures have focused on safety climate–outcome relationships. For instance, Huang, Zohar, Robertson, and Lee (2012) found that the effect sizes of a trucking industry-specific measure were double that of the universal measure for both safe-driving behaviors and subsequent injuries. Recently, Keiser and Payne (2018) compared the predictive ability of five industry-specific safety climate measures to universal safety climate measures on a series of safety outcomes. They found in less-safety salient environments the industry-specific safety climate measure related more strongly to all six outcomes than the universal measure. These findings suggest that industry-specific measures may lead to stronger correlations for less dangerous industries. On the other hand, Jiang, Lavaysse, and Probst’s (2018) meta-analysis revealed that universal safety climate measures had stronger relationships with objective safety-related outcomes such as injuries and other adverse events, whereas industry-specific measures showed stronger relationships with subjective, self-report safety-related outcomes such as safety behaviors. We explore whether the strength of the relationships between antecedents and safety climate vary as a function of the specificity of the safety climate measure.

Method

Search for primary data

We used a three-fold approach to identify studies that contain useful information for our meta-analysis. First, we used Web of Science and PsycINFO to search for articles, dissertations, and theses containing the keywords *safety climate* in combination with other keywords such as *antecedent*, *determinant*, *predictor*, *organization*, *group*, *work*, *leader*, *coworker*, *team*, *personality*, and *injur**. All searches were limited to articles published in English since 1900. Next, we searched the Society for Industrial and Organizational Psychology and the Academy of Management conference programs available online. Finally, we contacted researchers who have published safety climate research in the past. These steps identified 420 studies to review for potential inclusion in our analysis.

To be included in the meta-analysis, an article had to meet all the following inclusion criteria. First, the study had to include an assessment of safety climate that was consistent with Zohar's (2011) definition of this construct: the shared perceptions of organizational norms, priorities, and expectations related to safety. Whereas some studies referred to the construct as "safety climate" or "safety culture," other studies used the terms "safety communication" or "management commitment to safety" which are conceptualized as dimensions of safety climate (Flinn, Mearns, O'Connor, & Bryden, 2000). Both broad assessments of safety climate and narrow (dimension-level) were included in the meta-analysis. We were guided by other reviews and meta-analyses when identifying appropriate operationalizations of the antecedent variables. For example, we consulted Bass (1985) and Bono and Judge (2004) for measures of transactional and transformational leadership. Second, the study had to include at least one variable that could be theorized as an antecedent of safety climate. We used Zohar's (2011) conceptual model of safety climate as an initial guide but we also considered any other variables that could be classified into one of the three categories: situational factors, interpersonal interactions, and personal factors. A list of these variables appears in Figure 1. Third, study data had to come from a sample of employed workers. Fourth, the studies had to contain the minimum statistics necessary for conducting a meta-analysis, that is, sample size and the effect sizes for the relations between the focal constructs. In situations when necessary information was missing, we tried to contact the authors for relevant information. Most (71%) of the articles were examined by the first author; the rest of the articles were examined by the second author and then double-checked by the first author to address disagreement if there was any. Ultimately, 130 articles with 136 studies contributed effect sizes to our meta-analyses.

Coding procedures

For each study, we coded the effect sizes, the sample size, and the internal consistency estimates (coefficient alphas) for the focal constructs. We also coded other information, including the measure used to assess the safety climate construct; whether safety climate was measured at the individual, group, or organizational level; whether the safety climate measure was industry-specific or universal; and the industry in which the study was conducted. The first two authors and one advanced undergraduate research assistant conducted the coding. Multiple steps were taken to reduce and control for potential errors due to coders (Orwin

& Vevea, 2009). Specifically, we made sure that all coders were familiar with the safety climate literature, a coding protocol was developed and pilot-tested with both safety- and non-safety-related papers, and all coders were trained to use the coding protocol prior to coding. The coders then each independently coded 10 articles (7% of the total number of articles). Due to the error-controlling procedures, the initial coding agreement was 100% across coders. Because of the high agreement among coders, it was decided that double-coding was not necessary. The coders met to discuss any questions or confusion that arose during the remainder of the coding process.

Meta-analytic calculations

Pearson's correlation (r) was chosen as the principal effect size. Other statistics (e.g., Cohen's d, t-statistics, means, and standard deviations) were converted into r using the formulas provided in Wilson and Lipsey (2001). In cases where more than one correlation was available for the same constructs (e.g., when effect sizes were reported for each dimension of a multidimensional construct; when the same variable was measured multiple times and results were reported separately for each time point; or when the same construct was obtained through different sources such as objective, self- or other-rating, and results were reported separately for each source), we followed the procedures and Formulas 13 and 18 from Ghiselli, Campbell, and Zedeck (1981) to combine multiple correlations into a composite correlation. Specifically, the calculation of the composite correlation takes into consideration the intercorrelations among the components that formed the composite. To calculate the composite correlation, we used the original intercorrelations reported in the study whenever such information was available; when the information was not obtainable, $r = .50$ (or $-.50$ for theoretically negative correlations) was inserted as a conservative estimate (Borenstein, Hedges, Higgins, & Rothstein, 2009).

We followed Schmidt and Hunter's (2016) methods for meta-analysis, adopting a random-effects model to estimate between-study variance. Each raw correlation was weighted by sample size and corrected for measurement error in both the antecedent and safety climate using the corresponding α coefficients reported in the study. In cases where the original α coefficients were not available or single-item measures were used, a mean reliability was imputed using the formulas developed by Raju, Burke, Normand, and Landis (1991). A 95% confidence interval (CI) around the effect size was reported with a narrower CI reflecting a more precise estimation of the meta-analytic correlation (Borenstein et al., 2009). We present multiple statistics, including I^2, Q-statistic (and the associated p-value), and a 90% credibility interval (CV) around the corrected correlation, to convey the magnitude of heterogeneity. We mainly rely on I^2 to determine the magnitude of heterogeneity because it is easy to interpret and less likely to be influenced by the number of studies in the meta-analysis (Borenstein et al., 2009). An I^2 larger than 75% was interpreted as a considerable amount of heterogeneity across effect sizes (Higgins, Thompson, Deeks, & Altman, 2003).

Schmidt and Hunter's (2015) subgroup meta-analysis procedure was used to compare the differences in magnitudes of effect sizes across levels of analyses. Specifically, effect sizes for the same antecedent but different levels of analyses were treated as different groups and quantitatively compared using Raju and Brand's (2003) Formulas 9 and 14.

Outlier analyses and publication bias

To ensure enough statistical power for the calculations, meta-analyses were conducted when there were more than three effect sizes ($k \geq 3$) for the corresponding relation. In addition, each pair of meta-analytic relations was examined for potential outliers. To check for potential publication bias, we first used the trim and fill method (Duval & Tweedie, 2000a, 2000b). Because its assumptions are based on effect size rather than significance, it provides a more conservative estimate of publication bias than other methods relying on significance tests (e.g., Egger's test; Borenstein et al., 2009). We used both the fixed-random and random-random approaches (Peters, Sutton, Jones, Abrams, & Rushton, 2007), which involves using fixed- or random-effect model to produce the original funnel, and then another random model to produce the new funnel with the filled effect sizes. The L_0 estimator was used to obtain the filled meta-analytic estimates and the corresponding 95% CI (Peter et al., 2007). The magnitude of potential publication bias is indicated by the percentage of absolute r change between the original and the filled r (Kepes, Banks, McDaniel, & Whetzel, 2012; Kepes & McDaniel, 2015). Consistent with previous research (e.g., Kepes et al., 2012; Kepes & McDaniel, 2015), we characterize the magnitude of publication bias as negligible if the percentage of change was smaller than 20%, moderate if it was between 20% and 40%, and large if it was larger than 40%. When r was rather small (e.g., $r \leq .10$), we used absolute differences of .02, .04, and .06 as the cutoff value for small, moderate, and large publication bias, respectively (List, Kepes, McDaniel, & MacDaniel, 2018).

We also performed Egger, Smith, Schneider, and Minder's (1997) regression tests to test for publication bias. A nonzero regression intercept would indicate asymmetry of the funnel plot, thus indicating potential publication bias. To ensure enough statistical power, publication bias analyses were only conducted on antecedents with $k \geq 10$ (Kepes et al., 2012; Sterne, Egger, & Moher, 2008). We conducted Egger's test and the trim and fill analyses with the "Metafor" R package (Viechtbauer, 2010), and results are presented in Online Appendix B. Note that this package uses different formulas to calculate r compared to the formulas used by Schmidt and Hunter (2016). As such, the original r in Online Appendix B may be different from the main effect results we presented in Table 1.

Relative importance analyses

Relative importance analyses identify the unique contribution each antecedent has on the outcome, above and beyond the other antecedents (Johnson & LeBreton, 2004; Tonidandel & LeBreton, 2011). This statistical approach identifies the unique variance in safety climate explained by each of the antecedents. To perform path analyses, three meta-analytic correlation matrices were constructed: the first matrix (see Table A1 in Online Appendix A) consists of the intercorrelations between the situational antecedents and psychological safety climate, the second matrix (see Table A2 in Online Appendix A) contains intercorrelations between personal antecedents and psychological safety climate, and the third matrix contains intercorrelations between TMX and LMX ($\rho = .21, k = 8, N = 1847$), TMX and psychological safety climate, and LMX and psychological safety climate. For intercorrelations between the situational and personal antecedents, we used weighted correlations from existing meta-analyses (e.g., Van der Linden, Te Nijenhuis, & Bakker, 2010). When we were unable to locate an effect size, we used MetaBUS (Bosco, Uggerslev, & Steel, 2017). MetaBUS is an online resource that contains effect sizes between thousands of psychological constructs that appear in applied psychology and human resource management journals (http://metabus.org/). Effect sizes were corrected for unreliability in both the predictor and the criterion based on our artifact distribution.

Path analysis

To test interpersonal interactions as a mediator of the relationships between distal antecedents and psychological safety climate,[1] we

Table 1. Meta-analytic summary of antecedents of psychological safety climate.

Variable	N	k	r	SD_r	ρ	SD_ρ	% var.	CV_L	CV_U	CI_L	CI_U	I^2	Q	Q_p
Situational factors														
Organizational characteristics														
Organizational climate	32,694	22	.52	.08	.58	.10	3.18	.41	.76	.54	.63	92.63	349.38	.00
Hazardous environment	3,462	6	−.29	.24	−.34	.27	2.60	−.78	.10	−.56	−.12	96.36	245.02	.00
Job characteristics														
Job demands	24,116	30	−.20	.14	−.23	.16	5.65	−.49	.03	−.29	−.17	93.66	540.57	.00
Physical demands	12,892	15	−.18	.12	−.21	.13	8.96	−.42	.00	−.27	−.14	85.77	128.92	.00
Psychological demands	2,524	9	−.25	.15	−.29	.16	13.20	−.55	−.03	−.40	−.18	83.76	110.83	.00
Job resources	13,023	10	.29	.10	.35	.12	5.77	.15	.55	.27	.43	92.21	165.45	.00
Job control	5,321	4	.36	.10	.44	.12	5.20	.24	.64	.32	.56	92.34	73.55	.00
Job autonomy	6,550	4	.26	.04	.32	.04	31.96	.24	.39	.26	.37	22.64	13.37	.00
Leadership	12,350	36	.39	.17	.48	.21	5.89	.13	.83	.41	.55	92.82	508.27	.00
Transformational leadership	7,471	22	.36	.14	.44	.17	10.38	.17	.71	.37	.51	88.71	196.11	.00
Transactional leadership	2,792	6	.51	.14	.67	.17	4.81	.39	.95	.53	.81	91.81	94.94	.00
Authentic leadership	1,295	4	.38	.18	.44	.19	6.39	.12	.76	.24	.64	92.31	54.07	.00
Destructive leadership	792	4	−.23	.27	−.26	.31	5.03	−.76	.25	−.56	.05	93.64	64.44	.00
Coworker influence	15,509	9	.31	.13	.37	.16	2.05	.10	.64	.26	.47	96.8	327.91	.00
Coworker safety attitudes	1,941	4	.43	.10	.55	.13	10.38	.33	.77	.41	.69	85.79	31.02	.00
Coworker support	13,568	5	.29	.13	.34	.15	1.50	.09	.58	.20	.47	97.76	257.13	.00
Interpersonal interactions	13,400	21	.61	.14	.70	.15	4.14	.45	.95	.63	.77	96.51	650.93	.00
Leader-member exchange	5,731	7	.66	.12	.73	.11	6.21	.55	.92	.65	.82	95.77	243.5	.00
Team-member exchange	7,669	14	.57	.14	.68	.17	3.55	.39	.96	.58	.77	95.67	345.61	.00
Personal factors														
Personality characteristics														
Conscientiousness	2,852	6	.20	.11	.23	.12	15.45	.03	.42	.12	.33	84.05	39.44	.00
Extraversion	695	4	.17	.18	.19	.19	16.15	−.12	.50	−.01	.40	80.52	24.93	.00
Emotional stability	1,205	4	.21	.10	.24	.09	35.23	.10	.39	.13	.35	65.94	12.81	0.01
Openness	666	3	.12	.13	.14	.14	22.11	−.09	.36	−.04	.31	70.28	10.95	.00
Internal locus of control	2,717	7	.21	.10	.25	.11	19.84	.06	.43	.16	.34	77.31	31.36	.00
General self-efficacy	1,586	5	.22	.14	.25	.15	13.23	.00	.49	.11	.39	84.85	35.66	.00
Risk perception	2,375	7	−.02	.24	−.02	.26	4.73	−.45	.41	−.22	.18	94.41	131.27	.00
Safety consciousness	496	3	.57	.07	.80	.09	36.36	.66	.94	.68	.92	49.48	5.94	.05

(continued)

Table 1. (continued)

Variable	N	k	r	SD_r	ρ	SD_ρ	% var.	CV_L	CV_U	CI_L	CI_U	I^2	Q	Q_p
Demographics														
Age	14,210	20	.00	.05	.00	.04	56.98	−.06	.06	−.02	.03	38.68	35.54	.01
Sex[a]	12,321	13	.05	.14	.05	.15	4.90	−.20	.30	−.03	.13	93.43	256.94	.00
Organizational tenure	3,971	7	−.06	.05	−.06	.03	73.00	−.11	−.02	−.10	−.02	25.73	10.18	.12

Note. N = sample size (i.e., number of individuals); k = the number of independent effect sizes included in each analysis; r = sample-weighted mean uncorrected correlation; SD_r = standard deviation of uncorrected correlations; ρ = sample-weighted mean corrected correlation; SD_ρ = standard deviation of the mean corrected correlation; % var. = the percentage of variance of the uncorrected correlation accounted for by sampling and measurement error; 90% CV = 90% credibility interval; 95% CI = 95% confidence interval; I^2 = the ratio of true heterogeneity to total variance across the observed effect estimates; Q = Q-statistic for heterogeneity; Q_p = p-value of Q-statistic based on a central χ^2 distribution with ($k-1$) degrees of freedom.
[a]Male = 0, female = 1.

conducted a meta-analytic path analysis in Mplus 7.1 (Muthén & Muthén, 1998–2011). An exemplar path analysis was conducted including psychological safety climate and situational antecedents that showed larger weights in the relative importance analyses. For the path analysis, a meta-analytic correlation matrix was first constructed, which includes intercorrelations between selected situational antecedents with the larger relative weights, interpersonal interactions constructs, and psychological safety climate. Personal antecedents were not included because (a) they only explained a small proportion of variance (R^2 = 0.12, as compared to R^2 = 0.43 contributed by the situational factors in total) in psychological safety climate; and (b) we could not obtain enough effect sizes to calculate meta-analytic correlations between personal factors and situational factors or between personal factors and interpersonal interactions. As suggested by previous research (Landis, 2013), the harmonic mean of all sample sizes (*N*) associated with the correlations in the matrix was used for the path analysis (Viswesvaran & Ones, 1995), which was 2,109. Model fit was evaluated based on the χ^2 index (χ^2 statistic), comparative fit index (CFI), root-mean-square error of approximation (RMSEA), and standardized root-mean-square residual (SRMR).

Moderator analysis

To test for the effects of potential moderators, the magnitudes of the meta-analytic effect sizes were compared when they were categorized into different moderator groups. Raju and Brand's (2003) formulas were used to compare and test for the significance of difference between groups. We examined two moderators: (1) industry and (2) specificity of the safety climate measure. Specifically, we coded whether the data were collected within the health-care industry or not. We also coded whether safety climate was measured using industry-specific measures or universal measures. Notably, given only a handful of studies have examined antecedents of organizational safety climate, moderation analyses were limited to the antecedents of psychological safety climate.

Results

Psychological safety climate

Table 1 presents the meta-analytic results for the relationships proposed with psychological safety climate. The antecedents are organized into the three categories: situational factors, interpersonal interactions, and personal factors.

Situational factors. With respect to organizational characteristics, organizational climate (r_c = .58) and hazardous environment (r_c = −.34) exhibited strong, moderate relationships with psychological safety climate, respectively. The 95% CI for these relationships excluded zero.

With regard to job characteristics, job demands (r_c = −.23) and job resources (r_c = .35) exhibited moderate corrected correlations with psychological safety climate. Within the category of job demands, psychological demands (r_c = −.29) and physical demands (r_c = −.21) yielded moderate corrected correlations with psychological safety climate. Within the category of job resources, job control (r_c = .44) and job autonomy (r_c = .32) yielded moderate to strong corrected correlations with psychological safety climate. The 95% CI excluded zero for all of these relationships.

Leadership appears to have a sizable relationship with psychological safety climate. Overall leadership demonstrated a moderate relationship with psychological safety climate (r_c = .48). The corrected effect sizes for transformational, transactional, and authentic leadership were .44, .67, and .44, respectively. The effect size for destructive leadership was small (r_c = −.26) and the CI included zero. Compared to overall leadership (r_c = .48), coworker influence (r_c = .37) had a weaker, yet substantial, relationship with psychological

Table 2. Meta-analytic summary of organizational safety climate level and strength.

Variable	N	k	r	SD_r	ρ	SD_ρ	% var.	CV_L	CV_U	CI_L	CI_U	I^2	Q	Q_p
Organizational safety climate level														
Organizational climate	543	5	.51	.14	.59	.18	15.19	.30	.89	.42	.76	69.98	18.46	.00
Hazardous environment	164	3	.28	.08	.32	.00	—	—	—	.21	.42	.00	1.3	0.52
Job demands	367	6	−.20	.07	−.23	—	—	—	—	−.16	−.29	.00	2.11	0.83
Leadership	695	5	.36	.08	.45	.06	63.47	.34	.55	.35	.54	7.47	5.57	0.23
Interpersonal interactions	430	4	.53	.38	.62	.12	28.40	.42	.82	.48	.76	63.91	12.11	0.01
Organizational safety climate strength														
Safety climate level	933	6	.34	.06	.35	—	100	—	—	.30	.41	.00	4.76	0.45
Leadership	524	4	.25	.13	.28	.11	35.48	.47	.09	.14	.42	41.11	9.37	0.02
Interpersonal interactions	524	4	.15	.08	.16	.01	98.27	.14	.18	.08	.25	.00	3.75	0.29

Note. N = sample size (i.e., number of groups); k = the number of independent effect sizes included in each analysis; r = sample-weighted mean uncorrected correlation; SD_r = standard deviation of uncorrected correlations; ρ = sample-weighted mean corrected correlation; SD_ρ = standard deviation of the mean corrected correlation; % var. = the percentage of variance of the uncorrected correlation accounted for by sampling and measurement error; 90% CV= 90% credibility interval around; 95% CI = 95% confidence interval around; I^2 = the ratio of true heterogeneity to total variance across the observed effect estimates; Q = Q-statistic for heterogeneity; Q_p = p-value of Q-statistic based on a central χ^2 distribution with ($k-1$) degrees of freedom.

safety climate, and coworker safety attitudes (r_c = .55) had a stronger effect than coworker support (r_c = .34).

Interpersonal interactions. Overall, interpersonal interactions constructs showed strong relationships with psychological safety climate (r_c = .70). Both LMX (r_c = .73) and TMX (r_c = .68) exhibited strong relationships with psychological safety climate.

Personal factors. For personality characteristics, safety consciousness (r_c = .80) demonstrated a strong relationship with psychological safety climate. The corrected correlations were small to moderate for locus of control (r_c = .25), general self-efficacy (r_c = .25), emotional stability (r_c = .24), and conscientiousness (r_c = .23). Extraversion, openness, and risk perception were not meaningfully related to psychological safety climate, as the 95% CI included zero for these relationships.

Organizational safety climate level and strength

Table 2 presents the results of antecedents of organizational safety climate level and strength, organized into the two categories: situational factors and interpersonal interactions constructs. A relatively small number of studies examined antecedents of organizational safety climate level and strength.

Situational factors. Organizational climate (r_c = .59) and leadership (r_c = .45) demonstrated strong relationships with organizational safety climate level. Hazardous environment (r_c = .32) and job demands (r_c = −.23) exhibited moderate corrected correlations with

Table 3. Comparison of meta-analytic results between antecedents of psychological and organizational safety climate.

Variable	Psychological safety climate, ρ (k)	Organizational safety climate, ρ (k)	Organizational safety climate strength, ρ (k)
Organizational climate	.58 (22)	.59 (5)	
Hazardous environment	−.34 (6)	.32 (3)	
Job demands	−.23 (30)	−.23 (6)	
Leadership	.48 (36)	.45 (5)	.28 (4)
Interpersonal interactions	.70 (21)	.62 (4)	.16 (4)

Note. We conducted Raju and Brand's (2003) z-test to test the significance of the difference between the meta-analytic effect sizes for psychological and organizational safety climate and found none of the pairings to be significant.

organizational safety climate level. Group size (i.e., the number of employees in the work unit) was found to have a weak negative relationship with organizational safety climate level ($r_c = -.09$). Leadership was found to be moderately related to organizational safety climate strength ($r_c = .28$). The 95% CI excluded zero for all of these relationships.

Interpersonal interactions. Interpersonal interactions constructs demonstrated a strong relationship with organizational safety climate level ($r_c = .62$) and a much weaker relationship with organizational safety climate strength ($r_c = .16$). The 95% CI excluded zero for both of these relationships.

Table 3 displays the meta-analytic effect sizes across levels of analysis. We performed *z*-tests adapted by Raju and Brand (2003) to test the significance of the difference between these effect sizes. The *z*-tests indicated no meaningful differences between the effect sizes for psychological and organizational safety climate. Thus, the effects of the antecedents on safety climate were generally homologous across levels of analysis. These results also indicate that, at both the individual- and unit-level, interpersonal interactions, which encompass both LMX and TMX, have stronger relationships with safety climate than situational factors and therefore are more proximal to safety climate than situational factors.

Table 4. Relative importance of situational and personal factors in predicting psychological safety climate.

Variable	R^2	$\%R^2$
Situational factors		
Organizational climate	.18	40.79
Hazardous environment	.07	16.93
Job demands	.01	2.59
Job resources	.03	7.84
Leadership	.09	21.09
Coworker influence	.05	10.76
Total R^2	.43	
Personal factors		
Conscientiousness	.02	19.13
Extraversion	.01	11.99
Emotional stability	.02	18.98
Openness	.00	4.18
Locus of control	.04	29.68
General self-efficacy	.02	16.04
Total R^2	.12	
Interpersonal interactions		
TMX	.38	45.72
LMX	.45	54.28
Total R^2	.82	

Note. LMX = leader–member exchange; TMX = team−member exchange.

Relative importance analyses

Results for relative importance analyses are presented in Table 4. Collectively, situational factors accounted for 43.46% of the variance of safety climate. Specifically, organizational climate contributed the largest proportion to this

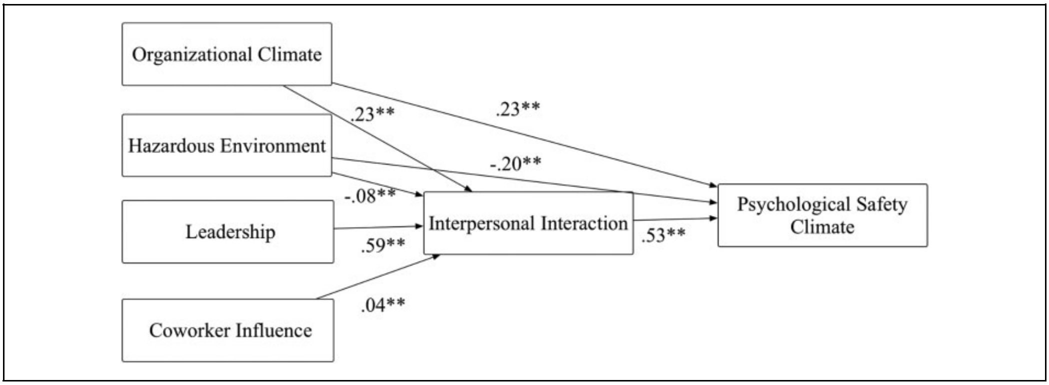

Figure 3. An exemplar path model.
Note. *p < .05; ** p < .01 (two-tailed).

percentage, accounting for 40.79% of the explained variance (R^2 = .18). The second strongest contributor was leadership, which accounted for 21.09% of the explained variance (R^2 = .09), followed by hazardous environment at 16.93% (R^2 = .07), coworker influence at 10.76% (R^2 = .05), job resources 7.84% (R^2 = .03), and job demands 2.59% (R^2 = .01).

Personal factors collectively accounted for 12.42% of the explained variance in safety climate. Specifically, the largest contributor to this percentage was trait locus of control, accounting for 29.68% of the explained variance (R^2 = .04). The next strongest contributor was conscientiousness, which accounted for 19.13% of the explained variance (R^2 = .02), followed by emotional stability at 18.98% (R^2 = .02), general self-efficacy at 16.04% (R^2 = .02), extraversion 11.99% (R^2 = .01), and openness to experience 4.18% (R^2 = .00).

Collectively, interpersonal interactions constructs accounted for 82% of the variance in safety climate. Specifically, 45.72% of the explained variance was contributed by TMX (R^2 = .38), and 54.28% of the explained variance was contributed by LMX (R^2 = .45).

Path analyses

To determine whether interpersonal interactions fully or partially mediate the situational factors–psychological safety climate relationship, we tested two nested models, sequentially. First, a full-mediation model (Model 1) was tested, where the antecedents were leadership, coworker influence, organizational climate, and hazardous environment and the mediator was interpersonal interactions. Although the path coefficients were significant, this model (Model 1) fit the data poorly, $\chi^2(4) = 412.85$, $p < .01$; CFI = .89; Tucker-Lewis index (TLI) = .76; RMSEA = .22; SRMR = .06. Then, a partial mediation model (Model 2) was tested by freeing the direct paths between organizational climate, hazardous environment, and psychological safety climate according to the modification indices. This model showed satisfactory fit to the data, $\chi^2(2) = 45.52$, $p < .01$; CFI = .99; TLI = .95; RMSEA = .08; SRMR= .01.[2] As shown in Figure 3 and Table 5, the direct and indirect effects of organizational climate and hazardous environment through interpersonal interactions were significant, providing support for partial mediation. Additionally, only the indirect effects of leadership and coworker influence through interpersonal interactions were significant, providing support for full mediation.

Moderator analyses

Industry. Although we intended to look at each industry separately, there were an insufficient

Table 5. Direct, indirect, and total effects of situational factors for psychological safety climate.

Variable	Direct effects	Indirect effects	Total effects
Organizational climate	.23	.12	.35
Hazardous environment	−.20	−.04	−.25
Leadership	—	.31	.31
Coworker influence	—	.02	.02

Note. All computations were conducted by imputing the harmonic mean for the sample size ($N = 2{,}109$).

number of studies within many of the industry categories (e.g., manufacturing, transportation). The health-care industry had the largest number of studies, so the only comparison we could make was to contrast health-care to non-health-care studies (see Table 6). With one exception (coworker influence .32 vs. .40), *z*-tests indicated antecedents had stronger relationships with psychological safety climate in the health-care industry. Leadership (.54 vs. .39), job demands (−.28 vs. −.14), organizational climate (.73 vs. .57), and interpersonal interactions (.82 vs. .68) had significantly larger relationships with psychological safety climate in the health-care industry compared to non-health-care industries.

Specificity of the safety climate measure. Relationships between psychological safety climate and its potential antecedents may be affected by whether the safety climate measure industry-specific. As displayed in Table 7, the relationship between job resources (.27 vs. .13) and hazardous environment (−.36 vs. −.18) with psychological safety climate was larger when a universal safety climate measure was used. In contrast, the relationships between job demands (−.13 vs. −.23) and interpersonal interactions (.63 vs. .79) with psychological safety climate were larger when an industry-specific safety climate measure was used. Thus, the specificity of the safety climate measure appears to matter, but the nature of its impact is inconsistent across antecedents.

Tests for publication bias

As shown in Online Appendix B,[3] results from Egger's test did not show a non-zero intercept for any of the examined antecedents. Similarly, the trim and fill method indicated that, for most antecedents, the meta-analytic estimations only had small to moderate differences before and after the trim-and-fill analyses, suggesting minimal concerns about the potential for publication bias. Two antecedents had large differences before and after the trim-and-fill analyses: physical demands and sex. For both of these variables, however, the potential for large publication biases did not alter the substantive conclusion regarding the magnitude or direction of the effect. As such, we conclude that extensive publication biases did not appear to meaningfully impact our results or conclusions.

Discussion

This meta-analysis provides a comprehensive, quantitative review of safety climate antecedents to date. Extending Clarke's (2013) meta-analysis on transformational and transactional leadership, we meta-analytically examined a wider set of safety climate antecedents. In doing so, we extend Zohar's (2011) conceptual model of safety climate by including more safety climate antecedents established in the literature (e.g., job characteristics, coworker influence) and provide a comprehensive, quantitative integration of this research to advance our understanding of safety climate. Consistent with the propositions derived from this expanded theoretical framework, results showed that psychological safety climate was related to antecedents that reflect situational factors (e.g., leadership), interpersonal interactions (e.g., LMX and TMX), and personal factors (e.g., conscientiousness). Within the categories, the magnitude of the effect sizes

Table 6. Results for moderator analyses.

Moderator	N	k	r	SD_r	ρ	SD_ρ	% var.	CV_L	CV_U	CI_L	CI_U	I^2	Q	Q_p	z
Industry															
Organizational climate															9.41**
Health care	2,090	9	.61	.16	.73	.25	3.04	.32	1.15	.56	.90	91.07	105.11	.00	
Non-health care	30,604	13	.52	.06	.57	.07	4.14	.45	.70	.53	.62	93.55	236.02	.00	
Job demands															−8.74**
Health care	15,813	12	−.24	.09	−.28	.15	3.93	−.52	−.04	−.36	−.19	94.53	290.18	.00	
Non-health care	8,303	18	−.12	.11	−.14	.15	11.42	−.38	.10	−.21	−.07	87.46	167.77	.00	
Job resources															1.12
Health care	1,987	3	.34	.16	.39	.17	5.42	.11	.68	.19	.60	96.82	103.17	.00	
Non-health care	11,036	7	.29	.06	.37	.08	10.70	.24	.50	.30	.43	81.39	52.62	.00	
Leadership															7.77**
Health care	7,389	16	.43	.09	.54	.15	8.46	.29	.78	.46	.61	88.29	140.63	.00	
Non-health care	4,961	20	.32	.16	.39	.26	5.74	−.04	.81	.27	.50	93.36	303.06	.00	
Coworker influence															−4.64**
Health care	7,090	2	.27	.09	.32	.10	2.79	.16	.48	.19	.46	92.78	62.34	.00	
Non-health care	8,419	7	.34	.16	.40	.19	2.08	.08	.72	.26	.55	96.82	253.68	.00	
Interpersonal interactions															9.03**
Health care	1,918	5	.70	.18	.82	.19	2.00	.51	1.12	.65	.98	96.85	168.91	.00	
Non-health care	11,482	16	.59	.13	.68	.14	5.35	.46	.90	.61	.75	96.15	461.68	.00	

Note. N = sample size (i.e., number of individuals); k = the number of independent effect sizes included in each analysis; r = sample-weighted mean uncorrected correlation; SD_r = standard deviation of uncorrected correlations; ρ = sample-weighted mean corrected correlation; SD_ρ = standard deviation of the mean corrected correlation; % var. = the percentage of variance of the uncorrected correlation accounted for by sampling and measurement error; 90% CV= 90% credibility interval around; 95% CI = 95% confidence interval around; I^2 = the ratio of true heterogeneity to total variance across the observed effect estimates; Q = Q-statistic for heterogeneity; Q_p = p-value of Q-statistic based on a central χ^2 distribution with ($k-1$) degrees of freedom; z = z-test adopted from Raju and Brand (2003) to test the significance of the difference between the meta-analytic effect sizes.
**p < .01 (two-tailed).

Table 7. Results for moderator analyses.

Moderator	N	k	r	SD_r	ρ	SD_ρ	% var.	CV_L	CV_U	CI_L	CI_U	I^2	Q	Q_p	z
Universal vs. industry-specific SC scale															
Organizational climate															1.44
Universal SC	21,531	15	.53	.08	.59	.09	4.78	.45	.73	.55	.64	92.37	235.47	.00	
Industry-specific SC	11,163	7	.51	.07	.57	.13	1.78	.36	.79	.48	.67	76.67	104.16	.00	
Hazardous environment															−2.86**
Universal SC	3,089	4	−.31	.25	−.36	.28	1.70	−.82	.10	−.63	−.09	97.22	236.75	.00	
Industry-specific SC	373	2	−.14	.17	−.18	.04	83.07	−.24	−.11	−.30	−.05	4.54	2.22	.14	
Job demands															8.01**
Universal SC	21,140	20	−.11	.11	−.13	.09	13.22	.02	−.28	−.17	−.09	90.58	250.22	.00	
Industry-specific SC	2,976	10	−.19	.30	−.23	.17	12.72	.05	−.50	−.34	−.12	96.02	268.13	.00	
Job resources															4.46**
Universal SC	10,424	3	.22	.05	.27	.14	1.63	.51	.04	.11	.44	89.02	33.88	.00	
Industry-specific SC	2,599	7	.11	.21	.13	.07	43.85	.24	.02	.06	.19	92.96	112.26	.00	
Leadership															−1.74
Universal SC	4,357	14	.38	.1	.46	.12	18.08	.26	.65	.39	.52	76.88	61.89	.00	
Industry-specific SC	7,993	22	.39	.2	.49	.25	4.19	.08	.9	.38	.60	94.96	448.22	.00	
Interpersonal interactions															−12.88**
Universal SC	7,319	13	.53	.12	.63	.12	8.85	.44	.82	.56	.69	89.56	133.9	.00	
Industry-specific SC	6,081	8	.70	.16	.79	.14	2.80	.55	1.00	.69	.89	97.15	390.38	.00	

Note. N = sample size (i.e., number of individuals); k = the number of independent effect sizes included in each analysis; r = sample-weighted mean uncorrected correlation; SD_r = standard deviation of uncorrected correlations; ρ = sample-weighted mean corrected correlation; SD_ρ = standard deviation of the mean corrected correlation; % var. = the percentage of variance of the uncorrected correlation accounted for by sampling and measurement error; 90% CV= 90% credibility interval around; 95% CI = 95% confidence interval around; I^2 = the ratio of true heterogeneity to total variance across the observed effect estimates; Q = Q-statistic for heterogeneity; Q_p = p-value of Q-statistic based on a central χ^2 distribution with (k−1) degrees of freedom; z = z-test adopted from Raju and Brand (2003) to test the significance of the difference between the meta-analytic effect sizes; SC = safety climate.
**p < .01 (two-tailed).

varied, indicating that some factors have stronger influences on psychological safety climate than others. Overall, interpersonal interactions and situational factors had much stronger associations with psychological safety climate than personal factors. Moreover, a path analysis substantiated that interpersonal interactions mediate the impact of situational factors on psychological safety climate. Additionally, effect sizes tended to be stronger in the health-care industry compared to the non-health-care industries and appear to vary inconsistently when psychological safety climate was measured with an industry-specific measure compared to a universal one.

Antecedent effect sizes were generally homologous across the psychological and organizational safety climate levels of analysis. At the organizational level, both situational factors and interpersonal interactions constructs were associated with organizational safety climate level and strength. Effect sizes for organizational climate strength were much weaker than effect sizes for organizational climate level; however, there have been many more studies of organizational safety climate level than strength. Taken together, this study provides a holistic and current quantitative summary of the effects of variables that are theorized to contribute to and shape safety climate.

Theoretical implications

To develop a comprehensive model integrating antecedents of safety climate and theoretical processes through which safety climate is believed to emerge, we started with Zohar's (2011) conceptual model of organizational safety climate and added variables to it based on the extent research literature. Expanding on the constructs/categories of constructs originally identified by Zohar (2011) as antecedents of organizational safety climate (e.g., group and organization leadership, social interactions), we organized the antecedents into three categories: situational (e.g., organizational climate), interpersonal interactions (e.g., TMX), and personal factors (e.g., personality). We expand the number of safety climate antecedents by adding variables to each category (e.g., job demands and resources). Moreover, situational and personal factors were proposed to impact safety climate through more proximal processes (i.e., interpersonal interactions). Of importance, this modified framework begins to reveal the process by which safety climate emerges. We gathered all the empirical studies that examined at least one variable conceptualized as an antecedent of safety climate and either psychological or organizational safety climate in the multidisciplinary workplace safety research literature. We meta-analytically validated this expanded theoretical framework, providing the first systematic effort to test a theoretical model of safety climate antecedents. The findings were generally congruent with theory and our expectations.

Our meta-analysis replicated Clarke's (2013) meta-analysis demonstrating the importance of functional leadership styles and behaviors to safety climate. Our findings suggest that employees parse information derived from the situational environment (e.g., job requirements, supervisors' and coworkers' attitudes and behaviors) and engage in interpersonal interactions to gain knowledge and make inferences about appropriate behaviors endorsed by organizations. Personal characteristics also appear to play an important role in this sensemaking process, as they determine the personal lens through which employees look at and interpret the environment (Beus, Dhanani, & McCord, 2015).

Of particular significance, our findings revealed the relative importance of the various factors to the sensemaking process. Among the situational factors, organizational characteristics yielded stronger effects and contributed a larger amount of variance to psychological safety climate than job characteristics. Thus, employees' perceptions of workplace safety were influenced more by organizational than job factors. Also, leadership-related variables had slightly stronger effects than coworker-related variables. These findings echoed previous propositions that people at higher levels of the hierarchy represent the interests, goals, and values of the organization (McFadden, Stock, & Gowen, 2015). Leaders are more likely to be perceived as role models whose exemplary behaviors empower followers to behave in congruence with organizational values and principles (e.g., Walumbwa & Hartnell, 2011). These findings are also consistent with previous findings that showed the strong influence that leaders can have on organizational climate (Lewin et al., 1939).

Sensemaking theory is by far the most frequently used framework to explain the development and formation of organizational climate (Zohar, 2011; Zohar & Luria, 2005). Additionally, data that contributed to this study were consistent with the notion of "people make the place" put forth by the ASA model (Schneider, 1987; Schneider et al., 1995; Schneider, González-Romá, Ostroff, & West, 2017). Specifically, meta-analytic results showed that antecedents reflecting person-related factors, such as conscientiousness, locus of control, and self-efficacy, had moderate relationships with psychological safety climate. Given the importance of personal factors in shaping safety climate (Beus, Dhanani, & McCord, 2015), our findings further revealed that focusing on personal characteristics of employees may be a promising area for future safety climate research. Moreover, our results showed that personal antecedents influenced safety climate by virtue of interpersonal interactions, which is consistent with the sense-making process. Thus, the empirical evidence supporting the influence of personal factors on safety climate is consistent with both the ASA and the sensemaking processes.

Furthermore, this meta-analysis contributes to the multilevel theory of safety climate by examining safety climate at two levels of analysis (Chen et al., 2005; Zohar, 2008). Meta-analytic results were generally homologous between psychological and organizational safety climate level. Specifically, like psychological safety climate, organizational characteristics, job characteristics, leadership, and interpersonal interactions were found to be moderately or strongly correlated with organizational safety climate level. The only exception was the hazardous environment, which was positively related to organizational safety climate level but negatively related to psychological safety climate. Theoretically, a hazardous environment is a more safety-salient environment in which it is even more important to enforce safety policies and procedures. Thus, a hazardous environment should be negatively related to safety climate. The mixed results may reflect that some safety climate measures are contaminated with assessments of inherent risk on the job (Beus et al., 2010).

For organizational safety climate strength, consistent with our theorizing, interpersonal interactions and leadership are likely to promote the consensus of safety climate perceptions among unit members. Given the limited number of studies examining antecedents of safety climate strength, we note that these results should be interpreted with caution. More research is clearly needed to examine the factors that influence the within-unit agreement of safety climate perceptions.

We proposed that relationships between safety climate and its antecedents may be altered by the industry and the specificity of safety climate measure. Due to the distribution of studies across industries, we were only able to compare health-care to non-health-care studies. Overall, antecedents tended to have stronger relationships with psychological safety climate in health-care studies. This may be a function of the importance of interpersonal interactions in health-care settings (Gilson, 2003; Zohar & Tenne-Gazit, 2008). In the health-care industry, interpersonal interactions take place between employees as well as with patients. Thus, these behaviors are emphasized and encouraged to ensure and promote trust among health-care workers and to improve health-care quality (Gilson, 2003).

Whether safety climate was assessed with an industry-specific measure or a universal measure also seemed to have an influence on the safety climate antecedent effect sizes. Results indicated that job demands and interpersonal interactions constructs showed stronger effects with industry-specific than universal safety climate measures, whereas job resources and a hazardous work environment showed stronger effects with universal rather than industry-specific safety climate measures. These results add to the inconsistent findings comparing industry-specific and universal measures of safety climate (Jiang et al., 2018; Keiser & Payne, 2018). Additional research is needed recognizing that most safety climate measures are a combination of industry-specific and universal items; thus, this differentiation may be better operationalized on a continuum.

Practical implications

Our findings suggest that situational factors and interpersonal interactions are important when it comes to shaping safety climate at both the individual and the organizational levels. By revealing key factors that enhance or hinder safety climate at work, these results provide guidance to practitioners and managers on the design of safety climate interventions. For instance, our results strongly support efforts to promote safety-related interpersonal interactions. Moreover, managers can encourage knowledge sharing about safety-oriented experiences, which reinforces safety norms and priorities (e.g., Zohar & Polachek, 2014). In addition, our results showed that positive leadership styles had a strong positive relationship with safety climate, suggesting that managers/supervisors play an important role in the level of safety climate. This is not surprising as they are the primary communicators and enforcers of safety policies and procedures. Correspondingly, it appears worthwhile to hone supervisors' safety-oriented leadership skills. In fact, multiple safety climate interventions have been targeted at first-line supervisors (e.g., Zohar, 2002).

Furthermore, given that job characteristics and organizational climate are important predictors of safety climate, it is advisable for managers to monitor and improve them. They can do this by reducing psychological and physical demands, increasing job control, and creating a supportive and trusting environment. It might also be fruitful to develop leadership training programs to coach leaders on how to build a positive organizational climate, effectively implement safety policies, provide support and resources to their employees, and encourage safety communication to maximally reduce risk and hazards in the work environment (Kelloway & Barling, 2010; Mullen & Kelloway, 2009).

This study also showed that the effects of personal factors on safety climate are not negligible. Consistent with previous research (Beus, Dhanani, & McCord, 2015), the present study revealed that conscientiousness and locus of control covary with psychological safety climate at work and extraversion and openness to experience have nontrivial relationships with safety climate. However, compared to situational factors and interpersonal factors, personal factors are less important antecedents of safety climate as they associated with safety climate to a lesser extent.

Limitations and future research directions

Although this study has meaningfully contributed to the safety literature, there are several limitations worth noting. First, as with all meta-analyses, our meta-analytic findings are limited to the primary studies we were able to gather. Most of the primary studies we found adopted a concurrent design. We were unable to meta-analyze the longitudinal effects of these antecedents, primarily due to a lack of longitudinal studies in the literature. We should also note that, although we used the term "antecedents" based on theory, primary study designs rarely established temporal precedence or constant conjunction, thus causality cannot be inferred from our meta-analytic results. To truly measure predictors of safety climate, researchers would need to measure the predictors first and have access to the rare opportunity of observing the creation of a climate within a new organization. Alternatively, many organizations merge or are acquired by another organization and must transition from two organizational climates into one. Such events present a unique opportunity to study the development of a new climate, largely influenced by the legacy climates.

Second, our review also revealed that relatively few cross-level studies have been conducted in the literature. For instance, situational factors should shape safety climate through a multilevel mechanism, where higher level elements such as organizational characteristics influence individual perceptions. In reviewing the current literature, however, we found that a limited number of studies have examined the influence of safety climate antecedents (e.g., organizational climate, leadership) using a multilevel approach. Thus, more research is needed to examine the emergence of safety climate with a cross-level design to uncover how higher level factors impact individual-level factors, which in turn influence psychological safety climate. It may also be interesting to examine whether and how a preexisting organizational safety climate influences the psychological safety climate of newcomers to the organization.

Third, a relatively few number of primary studies existing in the literature limits our ability to provide a more comprehensive meta-analytic examination of the antecedents of organizational safety climate level and strength. We therefore urge safety researchers to measure safety climate at a higher level of analysis and examine the variables that contribute to organizational safety climate level and strength. More empirical studies at higher levels of analyses could also extend our comparison of the magnitude of effect sizes across levels of analysis. Such examinations will contribute to our understanding of the formation of safety climate across levels of the organizational hierarchy (Chen et al., 2005). As such, more multilevel safety climate research is needed to distinguish the precursors of safety climate level and strength and shed light on the homology of our findings at different levels of analyses.

Finally, given the relationship between personal characteristics and safety climate at the individual level, it would be interesting to see if aggregations of these characteristics are related to organizational safety climate (Chen et al., 2005; Klein & Kozlowski, 2000). Despite Zohar's (2011) illustration of personality influencing organizational safety climate, research is nearly silent on the associations between the collective personality and organizational safety climate. Extant research and theories postulate that the collection of personality traits or other individual attributes can impact group-level patterns of perceptions, interpretations, or behaviors (Ashforth, 1985). Specifically, based on the ASA model, organizational safety climate could be determined by collective personality traits possessed by a group of similar individuals who are attracted to and employed with the organization (Schneider et al., 1995). Also, through considerable workplace interactions among group members, teams can develop dominant or pervasive personalities that may affect shared perceptions or interpretations of organizational events. Future research should test whether a group-level manifestation of personality traits (e.g., the mean level of openness for the members of a work group) affects shared perceptions or interpretations of organizational safety norms and priorities (i.e., organizational safety climate).

Conclusion

In summary, we provide a much needed systematic and up-to-date quantitative review of the research on antecedents of psychological and organizational safety climate. We reveal robust relationships with variables like leadership style and interpersonal interactions which can inform safety climate interventions. We also identify variables like perceived hazardous environment and organizational climate that warrant further research attention. By synthesizing this research in one place, we provide a succinct resource for researchers and practitioners concerned about developing and maintaining safe workplaces.

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Supplemental material

Supplemental material for this article is available online.

Notes

1. We were not able to obtain enough effect sizes to calculate meta-analytic correlations among the antecedents at the unit-level which meant we could not conduct a path analysis for organizational safety climate.
2. Two alternative models were tested; however, both of them had unsatisfactory fit to the data. One model portrayed situational factors as mediating mechanisms between interpersonal interactions and safety climate: χ^2 (6) = 384.530, $p < .001$; comparative fit index [CFI] = .93; TLI = .82; root-mean-square error of approximation [RMSEA] = .17 (90% confidence interval [CI: .16, .19]); standardized root-mean-square residual [SRMR] = .07. The other model proposed safety climate influences situational factors, which in turn impacts interpersonal interactions: χ^2 (6) = 686.912, p < .001; CFI = .87; TLI = .67; RMSEA = .23 (90% CI [.21,.25]); SRMR = .10.
3. Although the "Metafor" R package utilizes different formulas to calculate *r* compared to the formulas adopted by Schmidt and Hunter (2016), the results for the original *r* in Online Appendix B were similar to the main effect results presented in Table 1.

References

Ashforth, B. E. (1985). Climate formation: Issues and extensions. *Academy of Management Review*, *10*, 837–847. doi:10.5465/AMR.1985.4279106

Barling, J., Loughlin, C., & Kelloway, E. K. (2002). Development and test of a model linking safety-specific transformational leadership and occupational safety. *Journal of Applied Psychology*, *87*, 488. doi:10.1037//0021-9010.87.3.488

Bass, B. M. (1985). *Leadership and performance beyond expectations*. New York, NY: Free Press.

Beus, J. M., Dhanani, L. Y., & McCord, M. A. (2015). A meta-analysis of personality and workplace safety: Addressing unanswered questions. *Journal of Applied Psychology*, *100*, 481–498. doi:10.1037/a0037916

Beus, J. M., McCord, M. A., & Zohar, D. (2016). Workplace safety: A review and research synthesis. *Organizational Psychology Review*, *6*, 352–381. doi:10.1177/2041386615626243

Beus, J. M., Muñoz, G. J., & Arthur, W. (2015). Personality as a multilevel predictor of climate: An examination in the domain of workplace safety. *Group & Organization Management*, *40*, 625–656. doi:10.1177/1059601115576597

Beus, J. M., Payne, S. C., Arthur, W., Jr., & Muñoz, G. J. (2019). The development and validation of a cross-industry safety climate measure: Resolving conceptual and operational issues. *Journal of*

Management, *45*, 1987–2013. doi:10.1177/0149206317745596

Beus, J. M., Payne, S. C., Bergman, M. E., & Arthur, W. E., Jr. (2010). Safety climate and injuries: An examination of theoretical and empirical relationships. *Journal of Applied Psychology*, *95*, 713–727. doi:10.1037/a0019164

Bliese, P. D., & Halverson, R. R. (1998). Group size and measures of group-level properties: An examination of eta-squared and ICC values. *Journal of Management*, *24*, 157–172. doi:10.1177/014920639802400202

Bono, J. E., & Judge, T. A. (2004). Personality and transformational and transactional leadership: A meta-analysis. *Journal of Applied Psychology*, *89*, 901–910. doi:10.1037/0021-9010.89.5.901

Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. Chicago, IL: John Wiley & Sons.

Bosco, F. A., Uggerslev, K. L., & Steel, P. (2017). MetaBUS as a vehicle for facilitating meta-analysis. *Human Resource Management Review*, *27*, 237–254. doi:10.1016/j.hrmr.2016.09.013

Brown, A. D. (2000). Making sense of inquiry sensemaking. *Journal of Management Studies*, *37*, 45–75. doi:10.1111/1467-6486.00172

Chen, G., Bliese, P. D., & Mathieu, J. E. (2005). Conceptual framework and statistical procedures for delineating and testing multilevel theories of Homology. *Organizational Research Methods*, *8*, 375–409. doi:10.1177/1094428105280056

Christian, M. S., Bradley, J. C., Wallace, J. C., & Burke, M. J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology*, *94*, 1103–1127. doi:10.1037/a0016172

Clarke, S. (2010). An integrative model of safety climate: Linking psychological climate and work attitudes to individual safety outcomes using meta-analysis. *Journal of Occupational and Organizational Psychology*, *83*, 553–578. doi:10.1348/096317909x452122

Clarke, S. (2013). Safety leadership: A meta-analytic review of transformational and transactional leadership styles as antecedents of safety behaviours. *Journal of Occupational and Organizational Psychology*, *86*, 22–49. doi:10.1111/j.2044-8325.2012.02064.x/full

Cui, L., Fan, D., Fu, G., & Zhu, C. J. (2013). An integrative model of organizational safety behavior. *Journal of Safety Research*, *45*, 37–46. doi:10.1016/j.jsr.2013.01.001

Demerouti, E., Bakker, A. B., Nachreiner, F., & Schaufeli, W. B. (2001). The job demands-resources model of burnout. *Journal of Applied Psychology*, *86*, 499–512. doi:10.1037//0021-9010.86.3.499

DeJoy, D. M., Schaffer, B. S., Wilson, M. G., Vandenberg, R. J., & Butts, M. M. (2004). Creating safer workplaces: Assessing the determinants and role of safety climate. *Journal of Safety Research*, *35*, 81–90. doi:10.1016/j.jsr.2003.09.018

Dienesch, R. M., & Liden, R. C. (1986). Leader-member exchange model of leadership: A critique and further development. *Academy of Management Review*, *11*, 618–634. doi:10.5465/AMR.1986.4306242

Duval, S. J., & Tweedie, R. L. (2000a). Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics*, *56*, 455–463.

Duval, S. J., & Tweedie, R. L. (2000b). A nonparametric "trim and fill" method of accounting for publication bias in meta-analysis. *Journal of the American Statistical Association*, *95*, 89–98. doi:10.1080/01621459.2000.10473905

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *British Medical Journal*, *315*, 629–634. doi:10.1136/bmj.315.7109.629

Flinn, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: Identifying the common features. *Safety Science*, *34*, 177–192. doi:10.1016/S0925-7535(00)00012-6

Ghiselli, E. E., Campbell, J. P., & Zedeck, S. (1981). *Measurement theory for the behavioral sciences*. San Francisco, CA: W.H. Freeman. doi:10.1016/S0277-9536(02)00142-9

Gilson, L. (2003). Trust and the development of health care as a social institution. *Social Science & Medicine*, *56*, 1453–1468. doi:10.1016/s0277-9536(02)00142-9

González-Romá, V., Peiró, J. M., & Tordera, N. (2002). An examination of the antecedents and moderator influences of climate strength. *Journal of Applied Psychology*, *87*, 465–473. doi: 10.1037/0021-9010.87.3.465

Griffin, M. A., & Neal, A. (2000). Perceptions of safety at work: A framework for linking safety climate to safety performance, knowledge, and motivation. *Journal of Occupational Health Psychology*, *5*, 347–358. doi:10.1037fl1076-8998.5.3.347

He, Q., Dong, S., Rose, T., Li, H., Yin, Q., & Cao, D. (2016). Systematic impact of institutional pressures on safety climate in the construction industry. *Accident Analysis & Prevention*, *93*, 230–239. doi:10.1016/j.aap.2015.11.034

Higgins, J. P. T., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analysis. *British Medical Journal*, *327*, 557–560.

Hofmann, D. A., Morgeson, F. P., & Gerras, S. J. (2003). Climate as a moderator of the relationship between leader-member exchange and content specific citizenship: Safety climate as an exemplar. *Journal of Applied Psychology*, *88*, 170–178. doi:10.1037/0021-9010.88.1.170

Huang, Y., Zohar, D., Robertson, M. M., Garabet, A., Lee, J., & Murphy, L. A. (2013). Development and validation of safety climate scales for lone workers using truck drivers as exemplar - transport research international documentation. *Transportation Research Part F: Traffic Psychology and Behaviour*, *17*, 5–19. doi:10.1016/j.trf.2012.08.011

Huang, Y. H., Zohar, D., Robertson, D., & Lee, J. (2012). *Development and validation of safety climate scales for the trucking industry*. Hopkinton, MA: LM Research Institute for Safety. doi: 10.1016/j.aap.2013.09.005

Jiang, L., Lavaysse, L. M., & Probst, T. M. (2018). Safety climate and safety outcomes: A meta-analytic comparison of universal vs. industry-specific safety climate predictive validity. *Work & Stress*, *33*, 41–57. doi:10.1080/02678373.2018.1457737

Johnson, J. W., & LeBreton, J. M. (2004). History and use of relative importance indices in organizational research. *Organizational Research Methods*, *7*, 238–257. doi:10.1177/1094428104266510

Keiser, N. L., & Payne, S. C. (2018). Safety climate measurement: An empirical test of context-specific vs. general assessments. *Journal of Business and Psychology*, *33*, 479–494. doi:10.1007/s10869-017-9504-y

Kelloway, E. K., & Barling, J. (2010). Leadership development as an intervention in occupational health psychology. *Work & Stress*, *24*, 260–279. doi:10.1080/02678373.2010.518441

Kelloway, E. K., Mullen, J., & Francis, L. (2006). Divergent effects of transformational and passive leadership on employee safety. *Journal of Occupational Health Psychology*, *11*, 76–86. doi: 10.1037/1076-8998.11.1.76

Kepes, S., Banks, G. C., McDaniel, M., & Whetzel, D. L. (2012). Publication bias in the organizational sciences. *Organizational Research Methods*, *15*, 624–662. doi:10.1177/1094428112452760

Kepes, S., & McDaniel, M. A. (2015). The validity of conscientiousness is overestimated in the prediction of job performance. *PLoS One*, *10*, *e0141468*. doi:10.1371/journal.pone.0141468

Klein, K. J., & Kozlowski, S. W. J. (2000). From micro to meso: Critical steps in conceptualizing and conducting multilevel research. *Organizational Research Methods*, *3*, 211–236. doi: 10.1177/109442810033001

Krasikova, D. V., Green, S. G., & LeBreton, J. M. (2013). Destructive leadership: A theoretical review, integration, and future research agenda. *Journal of Management*, *39*, 1308–1338. doi: 10.1177/0149206312471388.

Landis, R. S. (2013). Successfully combining meta-analysis and structural equation modeling: Recommendations and strategies. *Journal of Business and Psychology*, *28*, 251–261. doi:10.1007/s10869-013-9285-x

Lewin, K., Lippitt, R., & White, R. K. (1939). Patterns of aggressive behavior in experimentally created "Social Climates". *The Journal of Social*

Psychology, *10*, 269–299. doi:10.1080/00224545.1939.9713366

Liberty Mutual Research Institute for Safety. (2016). *Workplace safety index in 2013*. Retrieved from https://www.libertymutualgroup.com/about-lm/research-institute/communications/workplace-safety-index.

Liden, R. C., & Graen, G. (1980). Generalizability of the vertical dyad linkage model of leadership. *Academy of Management Journal*, *23*, 451–465. doi:10.2307/255511

Lindell, M. K., & Brandt, C. J. (2000). Climate quality and climate consensus as mediators of the relationship between organizational antecedents and outcomes. *Journal of Applied Psychology*, *85*, 331–348. doi:10.1037//0021-9010.85.3.331

List, S. K., Kepes, S., McDaniel, M. A., & MacDaniel, X. (2018, August). *Assessing the trustworthiness of our cumulative knowledge in learning, behavior, and performance*. Paper presented at the Academy of Management conference, Chicago, IL.

McCrae, R. R., & Costa, P. T., Jr. (1999). A five-factor theory of personality. In L. A. Lawrence & O. P. John (Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 139–153). New York, NY: Guilford Press.

McFadden, K. L., Stock, G. N., & Gowen III, C. R. (2015). Leadership, safety climate, and continuous quality improvement: Impact on process quality and patient safety. *Health Care Management Review*, *40*, 24–34. doi:10.1097/HMR.0000000000000006

Meyer, R. D., Dalal, R. S., & Bonaccio, S. (2009). A meta-analytic investigation into the moderating effects of situational strength on the conscientiousness-performance relationship. *Journal of Organizational Behavior*, *30*, 1077–1102. doi:10.1002/job.60

Mullen, J. E., & Kelloway, E. K. (2009). Safety leadership: A longitudinal study of the effects of transformational leadership on safety outcomes. *Journal of Occupational and Organizational Psychology*, *82*, 253–272. doi:10.1348/096317908X325313

Muthén, L. K., & Muthén, B. O. (1998-2011). *Mplus user's guide* (6th ed.). Los Angeles, CA: Muthén & Muthén.

Nahrgang, J. D., Morgeson, F. P., & Hofmann, D. A. (2011). Safety at work: A meta-analytic investigation of the link between job demands, job resources, burnout, engagement, and safety outcomes. *Journal of Applied Psychology*, *96*, 71–94. doi:10.1037/a0021484

Neal, A., & Griffin, M. A. (2004). Safety climate and safety at work. In J. Barling & M. R. Frone (Eds.), *The psychology of workplace safety* (pp. 15–34). Washington, DC: American Psychological Association. Retrieved from http://psycnet.apa.org/psycinfo/2003-88217-002

Neal, A., Griffin, M., & Hart, P. (2000). The impact of organizational climate on safety climate and individual behavior. *Safety Science*, *34*, 99–109. doi:10.1016/s0925-7535(00)00008-4

Newnam, S., Griffin, M. A., & Mason, C. (2008). Safety in work vehicles: A multilevel study linking safety values and individual predictors to work-related driving crashes. *Journal of Applied Psychology*, *93*, 632–644. doi:10.1037/0021-9010.93.3.632

Orwin, R. G., & Vevea, J. L. (2009). Evaluating coding decisions. In H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.), *The handbook of research synthesis and meta-analysis* (pp. 177–203). New York, NY: Russell Sage Foundation.

Ostroff, C., Kinicki, A. J., & Tamkins, M. M. (2003). Organizational culture and climate. In W. C. Borman & D. R. Ilgen (Eds.), *Handbook of psychology: Industrial and organizational psychology* (pp. 565–593). New York, NY: John Wiley. doi:10.1002/0471264385.wei1222

Peters, J. L., Sutton, A. J., Jones, D. R., Abrams, K. R., & Rushton, L. (2007). Performance of the trim and fill method in the presence of publication bias and between-study heterogeneity. *Statistics in Medicine*, *26*, 4544–4562. doi:10.1002/sim.2889

Phipps, D. L., Malley, C., & Ashcroft, D. M. (2012). Job characteristics and safety climate: The role of effort-reward and demand-control-support models. *Journal of Occupational Health Psychology*, *17*, 279–289. doi:10.1037/a0028675

Raju, N. S., & Brand, P. A. (2003). Determining the significance of correlations corrected for unreliability and range restriction. *Applied Psychological Measurement*, *27*, 52–71. doi:10.1177/0146621602239476

Raju, N. S., Burke, M. J., Normand, J., & Landis, G. M. (1991). A new meta-analytic approach. *Journal of Applied Psychology*, *76*, 432–446. doi:10.1037//0021-9010.76.3.432

Reichers, A. E., & Schneider, B. (1990). Climate and culture: An evolution of constructs. In B. Schneider (Ed.), *Organizational climate and culture* (pp. 5–39). San Francisco, CA: Jossey-Bass.

Salancik, G. R., & Pfeffer, J. (1978). A social information processing approach to job attitudes and task design. *Administrative Science Quarterly*, *23*, 224–253. doi:10.2307/2392563

Schmidt, F., & Hunter, J. (2015). *Methods of meta-analysis*. London: SAGE.

Schmidt, F. L., & Hunter, J. E. (2016). *Methods of meta-analysis: Correcting error and bias in research findings* (3rd ed.). Thousand Oaks, CA: Sage.

Schneider, B. (1987). The people make the place. *Personnel Psychology*, *40*, 437–453. doi:10.1111/j.1744-6570.1987.tb00609.x

Schneider, B., Ehrhart, M. G., & Macey, W. H. (2013). Organizational climate and culture. *Annual Review of Psychology*, *64*, 361–388. doi:10.1146/annurev-psych-113011-143809

Schneider, B., Goldstein, H. W., & Smith, D. B. (1995). The ASA framework: An update. *Personnel Psychology*, *48*, 747–773. doi:10.1111/j.1744-6570.1995.tb01780.x

Schneider, B., Gonzáles-Romá, V., Ostroff, C., & West, M. A. (2017). Organizational climate and culture: Reflections on the history of the constructs in JAP. *Journal of Applied Psychology*, *102*, 468–482. doi:10.1037/apl0000090

Schneider, B., Salvaggio, A. N., & Subirats, M. (2002). Climate strength: A new direction for climate research. *Journal of Applied Psychology*, *87*, 220–229. doi:10.1037//0021-9010.87.2.220

Seers, A. (1989). Team-member exchange quality: A new construct for role-making research. *Organizational Behavior and Human Decision Processes*, *43*, 118–135. doi:10.1016/0749-5978(89)90060-5

Shen, Y., Tuuli, M. M., Xia, B., Koh, T. Y., & Rowlinson, S. (2015). Toward a model for forming psychological safety climate in construction project management. *International Journal of Project Management*, *33*, 223–235. doi:10.1016/j.ijproman.2014.04.009

Sitkin, S. B., & Pablo, A. L. (1992). Reconceptualizing the determinants of risk behavior. *The Academy of Management Review*, *17*, 9–38. doi:10.5465/amr.1992.4279564

Squires, M., Tourangeau, A., Laschinger, H. K. S., & Doran, D. (2010). The link between leadership and safety outcomes in hospitals. *Journal of Nursing Management*, *18*, 914–925. doi:10.1111/j.1365-2834.2010.01181.x

Sterne, J. A. C., Egger, M., & Moher, D. (2008). Addressing reporting biases. In J. P. T. Higgins & G. Sally (Eds.), *Cochrane handbook for systematic reviews of interventions* (pp. 297–333). West Sussex, UK: Wiley-Blackwell.

Takala, J., Hämäläinen, P., Saarela, K. L., Yun, L. Y., Manickam, K., Jin, T. W. . . . Lin, G. S. (2014). Global estimates of the burden of injury and illness at work in 2012. *Journal of Occupational and Environmental Hygiene*, *11*, 326–337. doi:10.1080/15459624.2013.863131

Tonidandel, S., & LeBreton, J. M. (2011). Relative importance analysis: A useful supplement to regression analysis. *Journal of Business and Psychology*, *26*, 1–9. doi:10.1007/s10869-010-9204-3

U.S. Bureau of Labor Statistics. (2015). *Workplace injuries and illnesses in 2014*. Retrieved from http://www.bls.gov/news.release/osh.nr0.htm

Van der Linden, D., Te Nijenhuis, J., & Bakker, A. B. (2010). The general factor of personality: A meta-analysis of Big Five intercorrelations and a criterion-related validity study. *Journal of Research in Personality*, *44*, 315–327. doi:10.1016/j.jrp.2010.03.003

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*, *36*, 1–48. Retrieved from http://www.jstatsoft.org/v36/i03/

Viswesvaran, C., & Ones, D. S. (1995). Theory testing: Combining psychometric meta-analysis and structural equations modeling. *Personnel Psychology*, *48*, 865–885. doi:10.1111/j.1744-6570.1995.tb01784.x

Walumbwa, F. O., & Hartnell, C. A. (2011). Understanding transformational leadership-employee performance links: The role of relational identification and self-efficacy. *Journal of Occupational and Organizational Psychology*, *84*, 153–172. doi:10.1348/096317910X485818

Watson, G. W., Scott, D., Bishop, J., & Turnbeaugh, T. (2005). Dimensions of interpersonal relationships and safety in the steel industry. *Journal of Business and Psychology*, *19*, 303–318. doi:10.1007/s10869-004-2230-2

Weick, K. E. (1995). *Sensemaking in organizations*. London, UK: Sage.

Weyman, A. K., & Clarke, D. D. (2003). Investigating the influence of organizational role on perceptions of risk in deep coal mines. *Journal of Applied Psychology*, *88*, 404–412. doi:10.1037/0021-9010.88.3.404

Wilson, D. B., & Lipsey, M. W. (2001). *Practical meta-analysis*. Thousand Oaks, CA: Sage.

Zohar, D. (1980). Safety climate in industrial organizations: Theoretical and applied implications. *Journal of Applied Psychology*, *65*, 96–102. doi:10.1037/0021-9010.65.1.96

Zohar, D. (2002). Modifying supervisory practices to improve subunit safety: A leadership-based intervention model. *Journal of Applied Psychology*, *87*, 156–163. doi:10.1037/0021-9010.87.1.156

Zohar, D. (2003). Safety climate: Conceptual and measurement issues. In J. C. Quick & L. E Tetrick (Ed.), *Handbook of occupational health psychology* (pp. 123–142). Washington, DC: American Psychological Association. doi:10.1037/10474-006

Zohar, D. (2008). Safety climate and beyond: A multilevel multi-climate framework. *Safety Science*, *46*, 376–387. doi:10.1016/j.ssci.2007.03.006

Zohar, D. (2011). Safety climate: Conceptualization, measurement, and improvement. In J. C. Quick & L. E. Tetrick (Eds.), *Handbook of occupational health psychology* (2nd ed., pp. 141–164). Washington, DC: American Psychological Association. doi:10.1037/10474-006

Zohar, D., Huang, Y. H., Lee, J., & Robertson, M. (2014). A mediation model linking dispatcher leadership and work ownership with safety climate as predictors of truck driver safety performance. *Accident Analysis & Prevention*, *62*, 17–25. doi:10.1016/j.aap.2013.09.005

Zohar, D., & Luria, G. (2004). Climate as a social-cognitive construction of a supervisory safety practices: Scripts as a proxy of behavior patterns. *Journal of Applied Psychology*, *89*, 322–333. doi:10.1037/0021-9010.89.2.322

Zohar, D., & Luria, G. (2005). A multilevel model of safety climate: Cross-level relationships between organization and group-level climates. *Journal of Applied Psychology*, *90*, 616–628. doi:10.1037/0021-9010.90.4.616

Zohar, D., & Polachek, T. (2014). Discourse-based intervention for modifying supervisory communication as leverage for safety climate and performance improvement: A randomized field study. *Journal of Applied Psychology*, *99*, 113–124. doi:10.1037/a0034096

Zohar, D., & Tenne-Gazit, O. (2008). Transformational leadership and group interaction as climate antecedents: A social network analysis. *Journal of Applied Psychology*, *93*, 744–757.doi:10.1037/0021-9010.93.4.744.

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