Journal of Applied Psychology
2017, Vol. 102, No. 3, 375–388

0021-9010/17/$12.00 http://dx.doi.org/10.1037/apl0000114

100 Years of Occupational Safety Research: From Basic Protections and Work Analysis to a Multilevel View of Workplace Safety and Risk

David A. Hofmann
University of North Carolina at Chapel Hill

Michael J. Burke
Tulane University

Dov Zohar
Technion–Israel Institute of Technology, Haifa, Israel

Starting with initiatives dating back to the mid-1800s, we provide a high-level review of the key trends and developments in the application of applied psychology to the field of occupational safety. Factory laws, basic worker compensation, and research on accident proneness comprised much of the early work. Thus, early research and practice very much focused on the individual worker, the design of their work, and their basic protection. Gradually and over time, the focus began to navigate further into the organizational context. One of the early efforts to broaden beyond the individual worker was a significant focus on safety-related training during the middle of the 20th century. Toward the latter years of the 20th century and continuing the move from the individual worker to the broader organizational context, there was a significant increase in leadership and organizational climate (safety climate) research. Ultimately, this resulted in the development of a multilevel model of safety culture/climate. After discussing these trends, we identify key conclusions and opportunities for future research.

Keywords: safety, history, review, occupational health

The focus on occupational safety over the last 100 years has contributed significantly to saving thousands of lives. In the early 1900s, workplace deaths and injuries were quite common. For example, one early survey of workplace accidents reported that in Allegheny County Pennsylvania alone over 500 workers died per year with an additional estimated 1,500 serious nonfatal accidents (Eastman, 1910). Other statistics gathered about this same time estimated that between 18,000 and 23,000 workers died each year from workplace injuries (National Safety Council, 1998; see Corn & Corn, 1993).

Since that time, occupational safety has improved substantially. The National Safety Council reported that from 1933 to 1997 work related deaths declined 90% from 37 per 100,000 workers to four. This translates to a decline from 14,500 deaths to just over 5,000 despite the fact that the workforce increased from 39 million to 130 million (National Safety Council, 1998). Even with these improvements, however, occupational safety is still a significant concern. As recently as 2012, there were 4,930,000 workplace injuries requiring medical attention where these injuries had an estimated cost of over $198 billion dollars (National Safety Council, 2014).

This article was published Online First January 26, 2017.

David A. Hofmann, Kenan-Flagler Business School, University of North Carolina at Chapel Hill; Michael J. Burke, Freeman School of Business, Tulane University; Dov Zohar, William Davidson Faculty of Industrial Engineering and Management, Technion–Israel Institute of Technology, Haifa, Israel.

Correspondence concerning this article should be addressed to David A. Hofmann, Kenan-Flagler Business School, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-3490, E-mail: dhofmann@unc.edu

Clearly, the workplace has become safer. Technological improvements, work design changes, the use of personal protective equipment, and improvements in the broader safety culture of organizations have led to significant advances. That said, however, there are still too many incidents in the workplace. One recent report noted that in the United States approximately 150 workers die every day from hazardous working conditions—combining statistics from workplace accidents with occupational diseases (AFL-CIO, 2015). And hazardous working conditions are a particularly problematic issue in developing countries as evidenced by the 2013 *Rana* Plaza building collapse in Bangladesh killing 1,127 garment workers and injuring 2,500. Thus, there is still significant room for improvement on a worldwide basis.

At the outset, one must acknowledge that the field of occupational safety and health is quite broad spanning multiple disciplines and fields of study including, but not limited to, law, engineering, medicine, public health, business, and psychology. Given the breadth and depth of both legislation and research in occupational safety, we will not attempt full and complete coverage. Specifically, we have decided not to significantly address the accumulation of health risk over time, often referred to as occupational disease. We also have opted not to spend significant time reviewing research that has emerged from engineering psychology, human factors and person-technology interactions. Rather, we have targeted immediate safety behavior and the literature that speaks to the social/psychological predictors of this behavior. Thus, our review focuses on the key trends and developments related to occupational safety in the domain of applied psychology, human resource management and organizational behavior with just a passing mention of key developments in other areas. Within these domains, we have focused on historical trends and developments and conclude with key learnings and areas for future research.

The Introduction of Factory Law to the Mid-1900s: A Focus on Monotony, Industrial Fatigue, and Accident Proneness

Legislation on worker health and safety in the United Kingdom originated as a political response to social problems resulting from the Industrial Revolution and the associated poor working conditions in factories. The Factory Acts of 1833 and 1844 addressed specific working conditions for children (1833) and for women (1844). These acts established several basic protections such as limits on the number of hours worked, the securement of some class of machinery, and basic record keeping and inspections. Additional improvements were included in the Factory Acts of 1867, 1891, and 1895 along with advances in inspections of workplaces, requirements for accident reporting, and provisions for fire escape (see Eves, 2014).

Research efforts focused on the behavioral aspects of workplace safety also have their roots in the late 19th-century United Kingdom. During the late 1800s, a number of European researchers—including those in England, Belgium, France, and Italy—sought to understand the relation between "industrial fatigue" (i.e., overstrain or physical exhaustion resulting from excessive work) and worker efficiency including costs associated with accidents (Goldmark, 1912). One notable experiment on working hours by William Mather at Salford Ironworks in Manchester, England during 1893 to 1894 demonstrated that a 48-hr work week resulted in increased productivity in relation to the standard 53- or 54-hr work week (McIvor, 1987). Mather attributed the primary cause of the increased productivity to a reduction in worker fatigue. A subsequent study in Germany by Ernst Abbe, the owner of Zeiss Optical Works who introduced the 8-hr workday, confirmed Mather's hypothesis that productivity increased as excessive working hours were reduced. Later research carried out in the United Kingdom by the Health of Munitions Workers Committee (from 1915 to 1917) and its post-World War I successor, the Industrial Fatigue Research Board (1918-1947), further advanced our understanding of the relationship between worker fatigue and the occurrence of accidents.

During this broad time frame, management practices focused on simplifying and compartmentalizing work in a number of industries (Taylor, 1911). An outcome of these management practices was that work became highly repetitive, which led to research investigating workplace monotony (and boredom)—often examined in using both productivity- and safety-related consequences (Mayo, 1924).

Emerging Research in the United States and Europe

Beginning with Hugo Münsterberg (1913) in the United States, a considerable amount of research was devoted to studying monotony curves (i.e., daily production curves for repetitive work), individual susceptibility to monotony, drops in productivity, and increases in accidents. During the 1920s, both American and German psychologists noted the negative relation between general mental ability and monotony (Kornhauser, 1922). In addition, Thompson's (1929) research pointed to the role of emotional stability as an important factor in predicting susceptibility to monotony. In many respects, monotony was viewed at the time as a form of psychological exhaustion or burnout that could be predicted by individual difference measures, and a potential contributing factor to industrial fatigue.

Working from a personnel selection perspective, Münsterberg (1913) conducted a novel work simulation-based study of accident and injury prevention. Using the first low-fidelity work simulation—an apparatus consisting of moving cards designed to illicit the mental functioning of a motorman at the front of an electric streetcar. From this research, Munsterberg established standards for successfully completing the simulation and, in effect, the first personnel selection standards for worker safety. Münsterberg (1913) also described the development of a low-fidelity simulation for use in selecting shipping company workers for jobs where accidents were rare, but potentially catastrophic. This work simulation was designed to study the actions of individuals in complex situations and the types of mistakes they were prone to make.

Munsterberg's work ushered in research on the identification of accident-prone individuals where this wave of research spanned industries and continents (i.e., Europe & North America; Burnham, 2009). Following Munsterberg's lead, both general cognitive ability (e.g., Chambers, 1939) and more specific cognitive abilities (e.g., memory span, reaction time (RT); Forster, 1928; Moss & Allen, 1925) were incorporated into research aimed at identifying those who might be susceptible to accident involvement. Gradually, the psychological tests and work simulations—such as Viteles Motormen Selection Test—gained in terms of fidelity with the actual work (see Viteles, 1932). In addition, by studying accident records of thousands of workers with respect to work conditions and the control of personal factors (e.g., sickness), Greenwood and Woods (1919) concluded that the "genesis of multiple accidents . . . is an affair of personality . . ." (p. 10). Their research and that of the Industrial Fatigue Research Board in the United Kingdom foreshadowed decades of research on personality predictors of accidents.

As research on accident proneness progressed, a number of additional individual difference variables (e.g., vision, Stump, 1945) and situational variables (e.g., visual hazards, Guilbert, 1938) were examined. Among the individual difference variables, there was a growing interest and recognition in the emotional states of workers at the time of accidents and, more broadly, their general emotional maturity. Particularly, Hersey's (1932) detailed ethnographic research on workers involved in accidents was influential in identifying the role emotional states played in a worker's loss of situational awareness and resulting accident involvement. Tiffin (1947) summarized the psychological research to date on accident proneness and provided practical recommendations for its reduction. Later, summaries this line of research would be made by Shaw and Sichel (1971) and Visser, Pijl, Stolk, Neeleman, and Rosmalen (2007).

Although the research of applied psychologists in the early to mid-1900s attended to the role of individual differences, research and practice in other developing fields focused on how work conditions contributed to the occurrence of accidents, injuries, illness, and death. At the forefront of these efforts was the field research of Crystal Eastman (Eastman, 1910). Her research examined several industries and numerous individual cases of accident, injury and death, including detailed descriptions of the circumstances surrounding such incidents. It was the Pittsburg Survey that served as a model for the analysis of work conditions in relation to worker safety and health, and inspired thousands of related investigations over the next several decades. The Pittsburg Survey along with public awareness of poor work conditions, resulting from the accounts of Upton Sinclair (1906), led to one of the first workers compensation protection laws in the United States (i.e., the 1910 New York State law), but that act was shortly overturned in 1911.

The day after the New York Court of Appeals overturned the 1910 law, 146 workers were killed in the 1911 Triangle Shirtwaist Factory fire in New York City—most trapped behind locked doors. This event, coupled with the work of Eastman and Sinclair, led to the passage of worker compensation and protection laws in several states and the improvement in work conditions as well as the implementation of safeguards to promote worker safety (see Stein, 1962). The first successful act was The Wisconsin Workers Compensation Act of 1911 that assured victims of workplace accidents or occupational illnesses just compensation regardless of fault. Although laws had been well-established in Germany since the late 1800s that provided assistance to workers who experienced accidental injury, it would not be until 1947 that all U.S. states would have comparable worker compensation protections for workplace injuries.

Efforts aimed at improving workplace safety also were spurred by the pioneering work of Alice Hamilton, known as the Illinois Survey, from 1910 to 1911. The Illinois Survey was the first comprehensive documentation of how workplace hazardous exposures led to occupational diseases (Hamilton, 1943). Hamilton's work provided the foundation for the fields of industrial hygiene, occupational medicine, and toxicology in the United States.

A More Holistic View of the Worker and Their Immediate Environment

As the 20th century continued to unfold, the field of occupational safety witnessed a movement beyond the measurement of specific individual differences and modification of particular aspects of the worker's environment (e.g., hours of work, rest pauses, exposures to workplace hazards) to an emphasis on studying the worker and the worker's environment as a whole. For instance, a number of U.S. companies established clinics that followed the "clinical method" for treating maladjusted workers (i.e., workers involved in multiple accidents). The clinical method was an individual case analysis of a worker's abilities, emotional characteristics, and work conditions (Shellow, 1930). These case analyses led to efforts to change aspects of the worker or the work environment in order to improve the worker's safety.

Notably, this more holistic focus on the worker and work environment also included consideration of the role of the workgroup and immediate supervisor in accident prevention (see Hersey, 1936). Because the immediate supervisor often had primary responsibility for worker preparation in regard to safety, supervisors in many industries were increasingly required to attend periodic safety conferences or classes focused on accident prevention. As Tiffin (1942) discussed, these conferences occurred alongside the establishment of training departments as branches of management within numerous industries in the late 1930s and early 1940s. Guidance for leaders or directors of safety training programs was provided in Faist and Newkirk's (1944) *Job Safety Training Manual* (see Rothe, 1947, for a review), where emphasis was placed on the role of job analysis in the design of safety training.

The Mid- to Late-1900s: Emphasis on Work Analysis and Worker Selection, Motivation, and Safety Training

During World War II, emphasis continued on evaluating individuals in a more holistic sense and, in addition, within simulated contexts for safety critical work. This point is evidenced by the development of the first assessment center in the U.S. devoted to personnel selection (Office of Strategic Services Assessment Staff, 1948). The Office of Strategic Services, the predecessor to the Central Intelligence Agency, used elaborate behavioral simulations, stress interviews, and tests to select intelligence agents. The use of assessment centers in the post-World War II era for selection purposes associated with safety-critical work and especially in regard to public safety (e.g., policing and firefighting to name just a few types of work) would be extensive.

Although several authors in the post-World War II era suggested or advocated for training individuals in simulations that incorporated the dangers of work (e.g., Heinrich, 1950), it was not until 1973 that the first experimental evaluation of accident simulation as a training method would be reported in the applied psychology literature (Rubinsky & Smith, 1973). In a series of experiments, Rubinsky and Smith found that training via an accident simulation for bench grinder work, in comparison to training by the use of written instructions and demonstrations, resulted in significantly fewer unsafe acts.

Another outgrowth of applied psychological research during World War II was the development of the work analysis procedure now known as the critical incident technique (Flanagan, 1954). Although initially used within personnel selection to develop selection tests for individual difference characteristics considered important for success in different types of work, it also was extensively used in the development of selection and training programs for safety-critical work. It continues to be used for accident analysis investigations such as those of the U.S.'s National Transportation Safety Board and the Health and Safety Executive (HSE) in the United Kingdom.

A Move Toward Engineering Psychology and Human Factors

As the post-World War II era progressed, other work analysis procedures were developed that included factors expected to impact worker safety (e.g., the pacing and scheduling of work, possibility of injury from exposure to hazards; see Wilson, Bennett, Gibson, & Alliger, 2012). In addition, considerable research from the 1950s on was devoted to the role of human factors in automated systems and designing equipment focused on both efficiency and the reduction of accidents and injuries (see Chapanis, 1965). This focus was, in large part, due to the growth in the number and complexity of machines in the 1950s and 1960s.

The study of individuals and groups in relation to such equipment became known as engineering psychology or ergonomics (Singleton, 1967)—both viewed as subfields of human factors.

Focusing on equipment design to achieve better fit with operator capabilities and limitations, this approach was used to increase human reliability and reduce system failure modes (Swain, 1964). Ergonomic research in Britain expanded its scope from accident prevention to operator health and occupational stress reduction (Singleton, 1967). In the late 1960s, systems theory was adopted in Europe and called *man-machine systems* and *system ergonomics* (Singleton, 1974).

One of the first human factors psychologists, Ross McFarland, showed how individual differences interacted with equipment design to affect driver responses and truck crashes (McFarland & Moore, 1957). McFarland's research along with that of Ralph Nader (a lawyer), John Gordon (an epidemiologist), and William Haddon (an engineer and public health physician) would become influential in developing accident analysis and injury research as an interdisciplinary science (see Waller, 1994). A related development in Europe in the mid-1900s was research on the epidemiological triangle model (see Swuste, van Gulijk, Zwaard, & Oostendorp, 2014). The goal of this model was attempting to control and reduce the intensity of unplanned energy transfer (accidents).

Another application of this model was suggested by a Dutch scientist who argued that accidents result from a coincidence in time and place of many factors rather than simple causal chains (Winsemius, 1965). According to this view, accidents arise due to production process disturbances such that reducing such disruptions should increase process safety. Other developments in the United States and beyond during this time period focused on system reliability and analytic techniques for identifying sources of disturbances in process flows (e.g., see Haynes, 1999; Kletz, 1999). Examples emerging out of Europe included Hazard and Operability Analysis (Kletz, 1999), and Quantitative Risk Assessment that the HSE in the United Kingdom had turned into government safety regulation (Haynes, 1999).

A more recent and important contribution from an engineering or ergonomics perspective is the work of Melamed and on the development of a comprehensive measure to assess adverse work and environmental conditions. Known as the Ergonomic Stress Inventory, it has been shown to predict occupational injuries over a 2-year period across thousands of workers in 21 factories and six industries (Melamed, Yekutieli, Froom, Krital-Boneh, & Ribak, 1999). Although an engineering approach has been dominant in the study of workers and work contexts in relation to the behavioral requirements of safe work, a notable and integrated behavioral approach to the study of safe work is the Safety Diagnosis Questionnaire, a standardized measure for assessing work context and work tasks, developed during the 1980s in Germany (see Hoyos & Ruppert, 1995).

A Continued Focus on Training and Introduction of "Behavior-Based Safety"

During the 1960s, Brethower and Rummler (1966) reported on an original study on safety training for supervisors that emphasized "positive reinforcement of correct lifting behavior." In comparison to just training supervisors, training coupled with supervisors' positive reinforcement of workers' correct lifting behavior was found to significantly reduce workers' back injuries. Subsequently, Komaki, Barwick, and Scott (1978) presented a more systematic investigation and application of the "behavior analysis approach" to improve worker safety in two food manufacturing plants. Substantial improvements in worker safety performance were observed along with a decline in the company's injury rate (see related work by Chhokar & Wallin, 1984; Komaki, Collins, & Penn, 1982; Komaki, Heinzmann, & Lawson, 1980). Work using positive feedback would eventually become recognized as Behavior-Based Safety, with applications of reinforcement theories found to be primarily effective in modifying more routine, task behaviors across different types of safety-related work at the individual and workgroup levels (see Geller, 2001; Sulzer-Azaroff & Austin, 2000).

Establishment of Government Agencies

Another important development in the late 1900s in many countries was the enactment of occupational safety legislation such as the Health and Safety at Work Act of 1974 in the United Kingdom and the Occupational Safety and Health Act of 1970 in the United States. These acts would be instrumental in the creation of agencies responsible for setting and enforcing workplace health and safety standards as well as conducting research—for example, the U.K.'s HSE, and in the United States, the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH).

The establishment of OSHA and the training standards it promulgated are landmarks in requiring employers to train employees in the safety and health aspects of their work. Notably, OSHA developed voluntary training guidelines that called for evaluating training program effectiveness as a critical component of the overall training process. As such, OSHA greatly expanded safety and health training program evaluation research, including a dramatic increase in safety training evaluation studies being reported in academic journals across subdisciplines in medicine, public health, psychology, and business, and for all types of safety-related work.

A comprehensive quantitative investigation of 95 quasi-experimental safety training studies, conducted from the passage of the Occupational Safety and Health Act to 2003, indicated that as the training method required more active participation on behalf of the trainee, workers demonstrated greater knowledge acquisition, and experienced fewer accidents, illnesses, and injuries (Burke et al., 2006; although see Robson et al., 2010). More recently, a meta-analysis of 113 safety training studies published between 1971 and 2008 found support for an expected interaction between the level of worker involvement in safety training and hazardous event/exposure severity in the acquisition of safety knowledge and promotion of safe work behavior (Burke et al., 2011). Burke et al. (2011) found that high trainee involvement (e.g., through hands on or simulation training) was more effective than less trainee involvement (e.g., in lecture- or computer-based instruction) when hazardous event/exposure severity was high, whereas higher and lesser modes of trainee involvement had comparable levels of effectiveness when hazardous event/exposure severity was low. This research clarified where and why greater trainee involvement in the learning process was beneficial and pointed to the motivational implications of developing a sense of "dread" for trainees in high hazardous event/event severity situations. In addition, other cumulative assessments of the efficacy of training focused on specific levels of analysis or other occupations/

industries (e.g., Crew Resource Management Training, see Salas, Burke, Bowers, & Wilson, 2001; Tompa et al., 2009) have reported similar findings.

A considerable amount of research and practice continued throughout the 20th century and into the 21st century on not only proximal, knowledge, and motivational determinants of safe work behavior, but also on more distal individual difference determinants such as biodata, personality, cognitive abilities, perceptions of work and the work environment, and both physical abilities and physiological characteristics (for narrative reviews, see Burke & Signal, 2010; Lawton & Parker, 1998). In particular, Beus, Dhanani, and McCord (2015) found that among broad personality traits, agreeableness and conscientiousness had the strongest relationships with safety-related behavior. At the facet-specific level, Beus et al. found that sensation seeking, impulsiveness, altruism, and anger were meaningfully associated with safety-related behavior, with only sensation seeking having a stronger relationship than its parent trait (extraversion).

From a practice perspective, the most notable application was the selection system for airport security screeners at the Transportation Security Administration in the aftermath of 9–11 (Kolmstetter, 2003).

As the 20th century and the Cold War came to an end, the primary mission of the U.S. Department of Energy changed from plutonium production for nuclear weaponry to nuclear waste cleanup. Beginning in the early 1990s, this change called for the training of tens of thousands of workers across a wide range of occupations in hazardous waste cleanup. An early product of this effort was confirmation of a general four-factor model of worker safety performance and a measure (the General Safety-Performance Scale [GSS]) for use in evaluating worker safety training and job performance across jobs and occupational fields (Burke, Sarpy, Tesluk, & Smith-Crowe, 2002). The factors of the GSS are using personal protective equipment, engaging in work practices to reduce risk, communicating safety and health information, and exercising employee rights and responsibilities. In comparison to measures of the general concepts of safety compliance and safety participation that were originally introduced under the labels of "carefulness" and "initiatives" by Andriessen (1978), the GSS has been used somewhat less frequently in the field of applied psychology. Yet, the safety performance model underlying the GSS is widely applied in the fields of public health and occupational medicine, and the measure has served as the basis of evaluation efforts within a number of regional and national safety and health initiatives (e.g., Sarpy, Rabito, & Burke, 2015).

Over the first 100 years or so of research on occupational safety, a few conclusions can be rendered. First, we now have a better understanding of what and to what degree broad and facet-specific personality characteristics predict safe work behavior. Second, we now have more conclusive evidence on where, why, and how to foster the development of worker knowledge and skill to promote safety work behavior, especially where hazardous event/exposure severity is high. Third, work analysis procedures and safety performance measures have been developed, which provide sound bases for the development and evaluation of human resource programs across all types of safety-related work. Finally, we know where and how to apply feedback/reinforcement principles to promote safe work behavior.

The Late 1900s to Early 21st Century: Broadening the Focus on Teams, Multilevel Issues, and Cultural Influences

Although research published in this journal continued to focus on individual determinants of safety performance, work injuries, and accidents to some extent (e.g., Barling, Kelloway, & Iverson, 2003; Barrett & Thornton, 1968; Barrett, Thornton, & Cabe, 1969; Davids & Mahoney, 1957; Frone, 1998; Hansen, 1989; Kahneman, Ben-Ishai, & Lotan, 1973; Parker, 1953), the final stages of the 20th century (1980s and 1990s) saw a continued expansion focused on the surrounding team, leaders and broader organization. These efforts ushered in a more multilevel and systems view of safety where the broader dynamics of behavior occurring "in" the organization became a more salient aspect of the research and thinking. This change was evident in both the research of applied psychology as well as workplace safety models developed and used by various federal agencies such as OSHA and NIOSH (e.g., see Colligan & Cohen, 2004). An early and significant recognition of the broader organizational context was the introduction of safety climate research.

Introduction of Safety Climate

Safety climate originated with the publication of Zohar's (1980) original paper where he defined the concept, offered a measurement scale, and empirically tested its predictive validity. Building on the distinction between generic and specific ("climate for something") organizational climates (Schneider, 1975), Zohar's work on safety climate was one of the first applications of a facet-specific climate (Reichers & Schneider, 1990). A few years after the emergence of safety climate, the 1986 Chernobyl investigation report cited "poor safety culture" as the primary cause underlying the disaster. Since these two "defining moments" in the mid-1980s, safety climate research has grown exponentially (Huang, Chen, & Grosch, 2010) and a recent literature review found that safety climate accounted for the largest number of facet-specific organizational climate publications (Kuenzi & Schminke, 2009).

Zohar (1980) described *safety climate* as "shared employee perceptions about the relative importance of safe conduct in their occupational behavior" (Zohar, 1980, p. 96). Key terms in this definition emphasize that it is a shared, agreed upon cognition regarding the relative importance or priority of acting safely versus meeting other competing demands such productivity or cost cutting. These safety climate perceptions emerge through ongoing social interaction in which employees share personal experiences informing the extent to which management cares and invests in their protection (as opposed to cost cutting or productivity).

Examples of these social interactions would be the many "micro-decisions" that are made every day in safety sensitive environments such as deciding to use the correct personal protective equipment or how new employees are socialized with respect to safety. These microdecisions often occur when competing goals butt-up against one other and supervisors, team leaders, and/or more experienced employees make decisions about which strategic priority takes precedence (e.g., use a make-shift replacement part or wait two days for the correct part to arrive).

Over time, these microdecisions and other actions or nonactions by management with respect to safety will lead employees to develop gestalt perceptions regarding the relative priority of safety (Zohar & Hofmann, 2012). Obviously, one key component of a strong safety climate is local management support as these individuals often hold the decision rights for many of the microdecisions discussed above. In fact, a recent meta-analysis comparing the effect size of different safety climate dimensions indicated that perceived management commitment offered the strongest prediction of work injuries (Beus, Payne, Bergman, & Arthur, 2010).

More broadly, a series of meta-analyses of more than 200 safety climate studies have consistently found it to be a robust predictor of safety performance across industries and countries (Beus et al., 2010; Christian, Bradley, Wallace, & Burke, 2009; Clarke, 2010; Nahrgang, Morgeson, & Hofmann, 2011). Although difficult to draw firm conclusions given the observational nature of most of the studies, one meta-analysis found the effect size of safety climate exceeded that of unprotected risks and hazards, the hallmark of engineering-based safety management (Nahrgang et al., 2011). This suggests that shared social cognitions may play a greater role in safety performance than traditional safety management approaches and has led to the adoption of safety climate and culture as the "third age of safety" (Hale & Hovden, 1998).

Multilevel View of Safety Climate

Although originally conceived at the organizational-level, the introduction of the multilevel paradigm in organizational behavior research has led to concordant changes in the conceptualization of safety climate (Kozlowski & Klein, 2000). When viewed through this lens, employees perceive their work environment from a multilevel perspective such that they are simultaneously members of a work group/subunit and a larger organizational entity (e.g., division, region, or company).

A multilevel climate model was tested in a study involving 36 companies and 401 work groups (Zohar & Luria, 2005). Consistent with the model, the measurement of safety climate referenced both organizational and group-level subscales. The results demonstrated global alignment between organizational and subunit safety climate and that the relationship between organizational-level climate and individual safety outcomes was fully mediated by subunit climate. More interestingly, however, the results also revealed considerable group-level variance within the different organizations resulting from local managerial discretion. The amount of variability observed was predicted by variables that put a limit on subunit leader discretion such as the strength of organizational-level climate and the degree of formalization within the organization. As these organizational variables increased, thereby limiting managerial discretion, the variance in between-groups climate variance decreased as did within group variability.

Although not investigating a full multilevel model using multiple organizations and multiple work groups within each organization, other research has adopted a multilevel perspective such that climate antecedents, moderators, mediators, or outcome variables were measured at different levels of analysis than climate itself. For example, in several studies Hofmann and colleagues linked subunit climate with both group-level and individual variables to predict individual outcomes such as unsafe behavior, accidents, safety role definitions, and safety-related citizenship behavior (Hofmann & Stetzer, 1996, 1998; Hofmann, Morgeson, & Gerras, 2003).

Other studies have tested the relationship between organizational-level foundational climates (e.g., climates for organizational support) and group-level safety climate (Wallace, Popp, & Mondore, 2006). The results suggested that broader foundational (general) climate dimensions are related to more specific safety climate dimensions (see also Hofmann & Morgeson, 1999). In addition, a number of studies have documented the moderating effect of organizational or business unit-level safety climate on relationships between individual difference variables as well as relationships between group-level variables (e.g., Jiang, Yu, Li, & Li, 2010; Smith-Crowe, Burke, & Landis, 2003). These studies indicate that a positive safety climate enhances the effect of interventions designed to promote safe work behavior and reduce accidents and injuries at multiple levels. Related, Neal and Griffin (2006) investigated safety climate, individual-level safety motivation, safety behavior, and workplace injuries. Once again, the results supported the multilevel perspective of safety climate suggesting that this view of safety climate is robust to different companies, industries, individual research paradigms, and geographic regions of the world where the research occurs. In addition to these studies, it also should be mentioned that some very recent work has investigated within person variation in safety behaviors and activity over time opening up yet another level of analysis (e.g., Dai, Milkman, Hofmann, & Staats, 2015).

Leaders and Safety

As noted above, investigations in the safety climate domain have offered much support for Kurt Lewin's proposition that "leaders create climate" (Lewin, Lippitt, & White, 1939). The connection between leaders and climate has been explained using both group- and organizational-level mechanisms. First, at the group level, there often is a social learning process that occurs whereby group members repeatedly observe the kinds of behavior likely to be recognized or rewarded by their supervisor (Dragoni, 2005). Second, there is a gate-keeping and sense-making process in which leaders communicate and interpret organizational priorities to group members. This communicative and interpretative process has been called informing behavior (Gonzalez-Roma, Peiro, & Tordera, 2002), or *mediation behavior* (Kozlowski & Doherty, 1989), and the fact that it is being offered by the local leader promotes socially shared climate perceptions among group members (i.e., group-level climate).

Another group-level mechanism that has received significant research support is the leadership qualities of frontline supervisors. In fact, general attributes for local leaders—for example, high quality leader–member exchanges and transformational leadership—have been shown to predict increased safety performance when working in high risk environments. This relationship holds both for climate level (Barling, Loughlin, & Kelloway, 2002; Gonzalez-Roma et al., 2002; Hofmann & Morgeson, 1999; Hofmann et al., 2003; Zohar & Luria, 2004), as well as climate strength referring to the extent of agreement or consensus between members' climate perceptions (Gonzalez-Roma, Peiro, & Tordera, 2002; Zohar & Tenne-Gazit, 2008).

At the organizational-level, structural attributes of the work environment can help to inform workers about the relative prioritization of certain role behaviors. For example, Kozlowski and Hults (1987) investigated the relationship between standardization, centralization, specialization, and reward procedures and the climate for technical updating among R&D engineers. Given that such structural attributes are determined by senior management, they offer an organization-level explanation for the leadership–climate relationship. A second way in which climate can be impacted by organizational-level processes is through the managerial practices and decisions that are perceived by employees to reside outside the control of lower-level managerial authority. Pertinent examples include investment in costly monitoring equipment, immediacy of correcting physical hazards (even if costly), or adjusting production schedules due to absenteeism (Zohar & Luria, 2005). The final organizational-level process focuses on the observed consistency across situations and among subunits. A strong degree of consistency is indicative of reduced leniency in policy implementation, which, in turn, informs employees about senior management priorities and their commitment to these priorities throughout the organization. In sum, all of these mechanisms—both at the group- and organizational-level—help to provide employees a gestalt perception regarding the kinds of behavior that is expected, valued, rewarded and supported.

Teams and Safety

Reviews of the work team literature have identified a number of foundational group-level process and characteristics that positively predict performance (Salas et al., 2008; Stewart, 2006). Although these reviews and meta-analyses support the effect of team processes on generic performance outcomes, similar results have been reported for safety outcomes in a more recent meta-analysis (Clarke, 2010). Additional support for these conclusions comes from two studies testing the relationship between high-performance work systems and safety outcomes (Zacharatos, Barling, & Iverson, 2005). High-performance work systems are an organization-level construct describing a cluster of human resource management practices emphasizing, among other things, group cohesion, members' sense of belongingness, and information sharing. This bundle of practices has been shown to account for 33% of the variance in injury rates across organizations. In addition, a recent literature review of the teamwork-safety relationship led to similar conclusions suggesting that member-member and member-supervisor cooperation and communication, as well as team cohesion is consistently related to safety performance in high risk environments (Turner & Parker, 2003).

Culture and Safety

Given the conceptual overlap—and often ambiguity—between organizational culture and climate, a number of integrative models have been proposed although none have been empirically validated to date (Ostroff, Kinicki, & Muhammad, 2012; Schneider, Ehrhart, & Macey, 2011; Zohar & Hofmann, 2012). In the context of safety research, there potentially is even greater conceptual ambiguity given the lack of a clear and agreed upon definition of safety culture, and where the definitions that have been put forth do not make reference to broader, more general aspects of organizational culture. In addition, many measures of safety culture use items and scales which resemble safety climate measures. This has led many authors to use the two constructs interchangeably. We believe this situation is unfortunate and would like to suggest that any study of safety culture should be integrated with and connected to the broader, more general organizational culture as well as the models and research within this domain such as Schein's (2004) organizational culture model and the competing values framework to organizational culture (see Quinn & McGrath, 1985; Schneider, Ehrhart, & Macey, 2013).

When considering the more general integration of culture and climate, one such model suggested by Zohar and Hofmann (2012) proposes that organizational climate acts as a social–cognitive mechanism for resolving or coping with such complexity. As noted above, climate perceptions are targeted at surface-level artifacts (policies, procedures, and practices) indicative of the kinds of behavior likely to be recognized and rewarded. Such perceptions help employees make sense of their environment by using expected (social, financial) rewards for different types of role behavior (e.g., safety, productivity, or cost reduction) as the pertinent metric. For example, if safety behavior is expected to result in fewer or smaller rewards than on-time delivery or cost-cutting behaviors, a poor safety climate will emerge. Over time the perception that schedule or cost consistently takes priority over safety helps to inform employees that the company's core values prioritize profitability over the formally espoused value of employee safety.

According to this model, the various facet-specific climates enacted on the frontlines of organizations constitute a key mechanism allowing employees to interpret deep and surface-level layers of culture. In other words, even though it is difficult to identify deep-level cultural elements from any specific surface-level feature, this model proposes that observing the interaction and prioritization of multiple surface-level features over time can help employees gain a gestalt perception regarding what is truly valued, expected, supported, and rewarded (enacted values). For example, if employees consistently see production, schedule, and cost prioritized over safety, then the interaction among these climate dimensions, and the relative prioritization emerging out of these interactions, can enable climate to serve as a bottom-up lens through which to understand the deeper-level elements of organizational culture.

There is virtually no research specifically linking broader organizational cultural dimensions to more specific safety culture dimensions and safety outcomes. Although general attributes of the work group (e.g., leader–member exchange) and the organization (Perceived Organizational Support) have between linked to safety outcomes (Hofmann & Morgeson, 1999; Hofmann et al., 2003), there has not to our knowledge been research linking validated measures of organizational culture with safety outcomes. That notwithstanding, however, it could be argued that the deep-level elements of a clan culture (i.e., a culture characterized by collaboration, trust, and open communication) may promote higher safety climate and safety performance than a market culture (i.e., characterized by competition and meritocracy). Similar arguments could be made with regard to having superior safety climate and performance under a hierarchy culture, stemming largely from safety compliance. These and other similar questions have yet to be answered, and we encourage others to take up the task.

Related, even though safety researchers have argued for a single, higher-order factor as underlying workers' safety climate perceptions (see Griffin & Neal, 2000; Neal & Griffin, 2004), the broader work climate literature would suggest that multiple higher-order factors likely underlie employees' safety climate perceptions (Ostroff & Shulte, 2014). That is, to the extent that organizationally espoused values reflect concern for the well-being of multiple stakeholders and organizational practices reinforce these values, then employees would be expected to cognitively appraise aspects of their work environment (in a hierarchical manner) with respect to the impact of work environment characteristics on personal well-being as well as with respect to the well-being of other relevant stakeholder groups. A multiple stakeholder conceptualization of safety climate holds promise for guiding a broader measurement of safety climate relative to the constituent groups and may enhance our understanding of the effects of safety-related work contexts on safety outcomes. This point is important as safety contexts, perhaps more so than any other type of work environment, have the potential to affect well-being, in the broadest psychological and physical sense, of employees, their families, customers/clients, suppliers, and the public.

Another shortcoming in the literature is the relative lack of research in regard to national cultural taxonomies and characteristics (see Hofstede, 2001; House, Hanges, Javidan, Dorfman, & Gupta, 2004), such as uncertainty avoidance and power distance. These characteristics would be expected to underlie aspects of the political economy of nations and states that, in turn, would be expected to influence workplace safety and the efficacy of organizational safety interventions (see Burke & Signal, 2010). The few studies that have been conducted have largely examined bivariate associations, at the country level of analysis, between national cultural characteristics, aggregated safety climate perceptions, and accident and injury rates (e.g., see Håvold, 2007; Infortunio, 2006; Gyekye & Salminen, 2005). An exception, from a person–situation interaction perspective, is the work of Burke, Chan-Serafin, Salvador, Smith, and Sarpy (2008). Using data from 68 organizations embedded within 14 nations, they found support for the hypothesized moderating effect of uncertainty avoidance on the transfer of safety training with regard to reducing accidents and injuries. As a whole, improvements could be made in research directed at understanding the processes by which national cultural characteristics affect workplace safety, and within a more complete multilevel perspective.

Lessons Learned and Areas for Additional Research

After 100 years of research into occupational safety, we believe that several conclusions can be drawn and these are summarized in Table 1. Clearly, as we suggest in Table 1, much progress has been made and the workplace has become significantly safer. We also

Table 1
Key Learnings From Occupational Safety Research

Conclusion	Summary
1. Strong trend of improvement over time	Tracing from the earliest research on occupational safety to the present day, the workplace has become increasingly safe. Early work on work design and individual behavior helped form the foundation for engineering psychology (human factors) and behavioral safety both of which continue to make significant contributions to safe work today. The formation of the National Institute for Occupational Safety and Health, other government initiatives, safety training, and the relatively recent focus on safety culture have helped to improve safety at work.
2. Individual differences do predict safety at work	Although initial efforts at identifying an "accident prone" personality were inconsistent and inconclusive (e.g., Visser, Pijl, Stolk, Neeleman, & Rosmalen, 2007), recent research has found consistent relationships between personality and safety-related behavior. Notably, Beus, Dhanani, and McCord (2015) found that agreeableness and conscientiousness were negatively associated with unsafe behavior (see also Clarke & Robertson, 2005), and that sensation seeking is positively and more strongly related to unsafe behavior than its parent trait (i.e., extraversion). Although recent research has demonstrated consistent relationships, this research also indicates that safety climate perceptions are often a more important predictor of safety-related behavior than personality.
3. Importance of frontline supervisors	Starting with the early safety research (Hersey, 1936), to training research (Brethower & Rummler, 1966; Faist & Newkirk, 1944), to more recent work on leadership and safety climate (Hofmann et al., 2003; Zohar, 2002a, 2002b), the role of the immediate supervisor has been identified to be a key influence on safety outcomes. It is in the "micro-decisions" made by these frontline managers and the degree to which day-in and day-out they reinforce and signal the importance of safety where the "rubber meets the road" so to speak with respect to safety.
4. Safety training works	There is substantial research documenting the efficacy of safety training. Reviews have found that individual training efforts improve safety behaviors and reduce accidents (Burke et al., 2006). Supervisor training also positively impacts the safety outcomes of individual workers (e.g., Zohar, 2002a). As the job context becomes more complex with more severe hazardous event/exposure, worker involvement in the training becomes more critical (Burke et al., 2011). Thus, for those jobs where safety is particularly critical, workers should receive highly engaging training that simulates the situations they will face on the job. At the same time, their supervisors should receive training on how to reinforce positive safety behaviors and establish a positive safety culture on their unit (Zohar, 2002a).
5. Safety climate and culture are critically important	Since the introduction of the concept (Zohar, 1980), research has demonstrated the critical role the social context plays in safety-related outcomes. Recent research has found support for a multilevel model of safety climate (Zohar & Luria, 2005) as well as the critical role that leaders and fellow team members play in enacting a strong safety climate (Beus et al., 2010; Turner & Parker, 2003). Interventions also have been shown to positively impact safety climate as well as related safety behaviors (Zohar, 2002b; Zohar & Polachek, 2014).

know that some individual differences are consistently and significantly related to safety at work, but that the social context (e.g., climate) is often a more powerful predictor of safety behavior and related outcomes such as accidents and injuries. Substantial evidence has accumulated documenting the effectiveness of safety training and investigating several moderators of this effectiveness. Over the last 25 years, the importance of safety climate has been well established concluding with support for a multilevel model. Within both the training and safety climate literature, the importance of frontline leaders and fellow team members' behavior on individual worker safety behavior also has been well documented. Integrating literatures beyond the scope of our review suggests a systems view is (perhaps obviously) necessary. Appropriate work design, the availability of resources such as relevant equipment, providing training, and building a strongly reinforcing social climate are all required to effectively manage safety at work.

Beyond the conclusions in Table 1, several other areas of convergence should be noted. One has to do with the measurement of safety outcomes. Burke et al. (2002), for example, developed a four-factor model of safety outcomes which has been widely used in public health and other applied fields to evaluate interventions. Another widely used outcome distinction is between safety compliance and safety participation, labels proposed by Griffin and Neal (2000). They defined *safety compliance* as behaviors associated with safe work practices (e.g., using safe procedures for handling hazardous materials), whereas *safety participation* focused on behaviors supporting the overall safety of the organization (e.g., volunteering for safety-related tasks).

On the predictor side of the equation, worker safety training is one of the most researched areas in occupational safety with hundreds of studies reported in the literature. Although safety training is recognized as having meaningful behavioral, health, and economic impacts; a number of unanswered questions remain about the efficacy of these interventions at the individual, workgroup, and business unit levels of analysis. Among several areas where future research would be informative are investigations of the applicability and efficacy of immersive virtual reality training for individuals and "in situ" simulation training for workgroups, studies on how training interventions might contribute to the reduction of racial/ethnic disparities in safety and health outcomes, and examinations concerning the role of language and literacy considerations in the conduct, transfer, and evaluation of training (Burke & Sockbeson, 2015).

As noted above, safety climate/culture also has received a great deal of attention. That said, however, both across the research literature and practitioner organizations, no consistent measure of safety climate has emerged. After a comprehensive review of the literature, Beus et al. (2010) concluded that the most frequently occurring dimension was management commitment to safety. Beyond that, other measures that seemed to reoccur with some frequency that aligned well with the conceptual definition of safety climate where the priority of safety, perceptions of safety policies, practices, and procedures; safety training, safety communication, and employee involvement in safety activities (see Beus et al., 2010).

Similarly, different industry groups have developed their own measures of safety climate (sometimes called safety culture). The Agency for Healthcare Research and Quality has developed a standard instrument that is available for health care organizations to use (Agency for Healthcare Research and Quality, 2015). Although not specifying specific measurement items, a number of different industry and/or government agencies have developed policy statements on the various dimensions comprising safety climate/culture (e.g., Institute of Nuclear Power Operations and Bureau of Safety and Environmental Enforcement). Again, there is a fair bit of agreement on the various dimensions, but there has not been a standard set of dimensions or measurement items identified (National Research Council, 2015, Chapter 6).

The measurement notwithstanding, safety climate research has clearly established a strong and consistent relationship between employee perceptions of the emphasis on safety and safety outcomes (Beus et al., 2010; Christian et al., 2009; Nahrgang et al., 2011). But there are several other conclusions that can be drawn from this research. One such conclusion is that there is significant variability on the frontlines and across frontline supervisors. For example, a number of safety climate studies have been conducted in industries and with companies where safety is a core value and heavily emphasized. Yet, even with this emphasis, when frontline teams are surveyed, there is still significant variability in both safety climate perceptions and safety outcomes. Even though Zohar's multilevel model of safety climate has demonstrated that top management support for safety can reduce this frontline discretion, there often seems to be significant frontline variability. Relatedly, we believe that although safety climate has been shown to significantly predict many safety-related outcomes, much of this research involves relationships occurring concurrently or in rather short proximity. What is less known, in our opinion, is how to create a sustained, ongoing, year-over-year focus on safety such that it becomes embedded in the DNA of the organization. More work should be done on how organizations build this type of safety culture, one where it is truly embedded in the core operating assumptions and does not fade or drift in the background over time, where time here is operationalized in years or decades.

Another conclusion is that the research on safety climate has evolved rather naturally to include a more "organization," or systems view of safety. It has transitioned from safety climate being perceived as primarily an organizational-level construct to it being imbedded in a full multilevel, more systems focused model (Zohar & Luria, 2005). Yet, even though the safety literature within applied psychology has been moving in the direction of a broader, more organizational perspective, this research has largely focused on unsafe behavior, accidents, injuries and other similar outcomes. Thus, there still remains a significant gap in viewing the safety space in its totality from a systems perspective. This gap, in particular, was emphasized over a decade ago in the Institute of Medicine (1999) report, which emphasized that medical errors are caused by faulty systems and processes that lead people to make mistakes or fail to prevent them. Importantly, this gap comprises the difference between what we would term "personal" safety versus operational or process safety. Traditional safety research, like that published over the years in this journal and reviewed here, has focused primarily on personal safety (unsafe behavior, injuries, accidents and so forth).

Over the last 20 years, however, there has been an increasing recognition and discussion concerning process or operational safety—particularly in comparison to personal safety. The Baker Commission's (U.S. Chemical Safety and Hazard Investigation Board, 2007) investigation of British Petroleum's Texas City accident clearly emphasized the distinction between process and personal safety and concluded that indicators of personal safety do not necessarily provide evidence of process safety. The Baker Commission report continued that Process Safety Management applies "management principles and analytical tools to prevent major accidents rather than focusing on worker occupational health and safety issues, such as fall protection and personal protective equipment" (p. 19; see also CCPS, 1992). Hopkins (2007) made a similar distinction when he noted that process safety hazards arise from the processing activities and involve the escape of toxic substances, fires, explosions, or the like. Personal safety hazards, on the other hand, impact individuals and might involve falls, trips, pinching of hands and fingers, electrocutions, vehicle accidents, and similar individual accidents and injuries (Hopkins, 2007).

Even though the indicators of process and personal safety are distinct, we believe that the findings in the two literatures do have the potential to inform one another more than they have to date. Of course, this is not very difficult goal to achieve, given the literatures are virtually independent of each other. To illustrate the lack of integration of these two bodies of research, neither Reason's (1990) work on organizational accidents, the Baker Report investigating Texas City (U.S. Chemical Safety and Hazard Investigation Board, 2007), Weick and Suttcliffe's book on managing he unexpected (Weick & Suttcliffe, 2001), or the edited volume on the Columbia Disaster (Starbuck & Farjoun, 2005) mention much if any of the existing research on safety climate. This is despite the fact that one of main issues identified in the Columbia Accident Investigation Board report (Columbia Accident Investigation Board, 2003) was the ongoing safety culture of the organization. Furthermore, interventions subsequent to the accident used an organizational and safety survey that at least in part directly focused on safety climate (BST Solutions, 2005). Similarly, it is rare that the research on safety climate and culture significantly draws on work more focused on process safety (e.g., high reliability organizations; Weick & Sutcliffe, 2001; Weick et al., 1999; resilience engineering; Hollnagel, Woods, & Leveson, 2006).

We believe this lack of integration and cross-fertilization has been a missed opportunity and presents an area where future research could help us gain a true understanding of how to manage the full range of safety issues in organizations. One effort that starts to move toward this integration is Vogus, Sutcliffe, and Weick's (2010) recent paper focused on safety culture in health care. The authors propose three specific activities—enabling, enacting, and elaborating—that help create a positive safety culture. Within each of these phases, there is work both from a process safety and more personal-safety focused perspective that help inform the way in which these three activities could be enacted.

Having a well-developed picture of managing the full spectrum of safety—both personal and process safety—could help facilitate the extension of findings from this body of work to other industries. For example, there has been an increasing focus on risk management culture within the financial services industry (see, e.g., Ashby, Palermo, & Power, 2012). Similar to the safety world, risk management in this domain would seem to involve a culture that ensures and reinforces compliance to know standards and processes (akin to personal safety) as well as a consideration of the broader reliability of the system (process safety).

Conclusions

Looking across 100+ years of research on occupational safety suggests great progress has been made. The workplace has become dramatically safer with respect to personal safety seeing a significant reduction in accidents, injuries, and fatalities over time. As work continues to become more complex, however, there is a need to develop a more comprehensive and integrated model integrating personal safety, process safety and total worker health (National Institute for Occupational Safety and Health, 2015). We believe that better tying together these areas of research is a needed future direction. It is not until this more integrated picture is formed that both academics and practitioners will be able to understand and build a comprehensive safety and health culture within organizations. Another avenue for future research is exploring the extent to which findings in occupational safety can be extrapolated to other industries where there is a combination of local compliance and broader process/risk management issues involved. We have seen these models navigate into health care (e.g., Vogus et al., 2010) and there are discussions occurring within the financial services industry that seem to parallel much of the safety research that has been done.

Although much progress has been made, there are still too many workplace injuries, fatalities, and occurrences of occupational disease. So even within the domain of occupational safety there is much work to be done. It is important to continue this work—particularly when one looks beyond the statistics to consider the people impacted by occupational incidents and disease. Even though it is easy to view aggregate statistics and each additional data point as one more observation in a database, we should not lose sight of what each of these individual data points represent—particularly those representing serious disabling injuries and death. We ask that you not lose sight of this fact as you read this review and conclude, like we have, there is still much work to do on this front.

References

AFL-CIO. (2015). *Death on the job: The toll of neglect*. Washington, DC: AFL-CIO Safety and Health Department.

Agency for Healthcare Research and Quality. (2015). *Surveys on Patient Safety Culture*. Rockville, MD: Author. http://www.ahrq.gov/professionals/quality-patient-safety/patientsafetyculture/index.html

Andriessen, J. H. T. H. (1978). Safe behavior and safety motivation. *Journal of Occupational Accidents, 1,* 363–376. http://dx.doi.org/10.1016/0376-6349(78)90006-8

Ashby, S., Palermo, T., & Power, M. (2012). *Risk culture in financial organisations: An interim report*. London, UK: Centre for Analysis of Risk and Regulation, The London School of Economics and Political Science.

Barling, J., Kelloway, E. K., & Iverson, R. D. (2003). High-quality work, job satisfaction, and occupational injuries. *Journal of Applied Psychology, 88,* 276–283. http://dx.doi.org/10.1037/0021-9010.88.2.276

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,* 488–496. http://dx.doi.org/10.1037/0021-9010.87.3.488

Barrett, G. V., & Thornton, C. L. (1968). Relationship between perceptual style and driver reaction to an emergency situation. *Journal of Applied Psychology, 52,* 169–176. http://dx.doi.org/10.1037/h0025658

Barrett, G. V., Thornton, C. L., & Cabe, P. A. (1969). Relation between embedded figures test performance and simulator behavior. *Journal of Applied Psychology, 53,* 253–254. http://dx.doi.org/10.1037/h0027416

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. http://dx.doi.org/10.1037/a0037916

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

Brethower, D. M., & Rummler, G. A. (1966). For improved work performance: Accentuate the positive. *Personnel, 43,* 40–49.

Burke, M. J., Chan-Serafin, S., Salvador, R., Smith, A., & Sarpy, S. A. (2008). The role of national culture and organizational climate in safety training effectiveness. *European Journal of Work and Organizational Psychology, 17,* 133–152. http://dx.doi.org/10.1080/13594320701307503

Burke, M. J., Salvador, R., Smith-Crowe, K., Chan-Serafin, S., Smith, A., & Sonesh, S. (2011). The dread factor: How workplace hazards and training influence learning and performance. *Journal of Applied Psychology, 96,* 46–70. http://dx.doi.org/10.1037/a0021838

Burke, M. J., Sarpy, S. A., Smith-Crowe, K., Chan-Serafin, S., Salvador, R. O., & Islam, G. (2006). Relative effectiveness of worker safety and health training methods. *American Journal of Public Health, 96,* 315–324. http://dx.doi.org/10.2105/AJPH.2004.059840

Burke, M. J., Sarpy, S. A., Tesluk, P. E., & Smith-Crowe, K. (2002). General safety performance: A test of a grounded theoretical model. *Personnel Psychology, 55,* 429–457. http://dx.doi.org/10.1111/j.1744-6570.2002.tb00116.x

Burke, M. J., & Signal, S. (2010). Workplace safety: A multilevel, interdisciplinary perspective. In J. J. Martocchio, H. Liao, & A. Joshi (Eds.), *Research in personnel and human resource management* (pp. 1–47). Bingely, United Kingdom: Emerald Group Publishing Limited.

Burke, M. J., & Sockbeson, C. E. S. (2015). Safety training. In S. Clarke, T. Probst, F. Guldenmund, & J. Passmore (Eds.), *The Wiley-Blackwell handbook of the psychology of occupational safety and workplace health. West Sussex,* UK: Wiley Limited. http://dx.doi.org/10.1002/9781118979013.ch15

Burnham, J. (2009). *Accident prone: A history of technology, psychology, and misfits of the machine age*. Chicago, IL: University of Chicago Press. http://dx.doi.org/10.7208/chicago/9780226081199.001.0001

Chambers, E. G. (1939). A preliminary inquiry into the part played by character and temperament in accident causation. *Journal of Mental Science, 85,* 115–118.

Chapanis, A. (1965). *Man-machine systems*. Belmont, CA: Wadsworth Publishing Company.

Chhokar, J. S., & Wallin, J. A. (1984). A field study of the effect of feedback frequency on performance. *Journal of Applied Psychology, 69,* 524–530. http://dx.doi.org/10.1037/0021-9010.69.3.524

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. http://dx.doi.org/10.1037/a0016172

Clarke, S. (2010). An integrative model of safety climate: Linking psychological climate to individual safety outcomes using meta-analysis. *Journal of Occupational and Organizational Psychology, 83,* 553–578. http://dx.doi.org/10.1348/096317909X452122

Clarke, S., & Robertson, I. T. (2005). A meta-analytic review of the Big Five personality factors and accident involvement in occupational and non-occupational settings. *Journal of Occupational and Organizational Psychology, 78,* 355–376.

Colligan, M. J., & Cohen, A. (2004). The role of training in promoting workplace safety and health. In J. Barling & M. R. Frone (Eds.), *The psychology of workplace safety* (pp. 223–248). Washington, DC: American Psychological Association. http://dx.doi.org/10.1037/10662-011

Columbia Accident Investigation Board. (2003). *Report Vol. 1*. Retrieved from http://spaceflight.nasa.gov/shuttle/archives/sts-107/investigation/CAIB_medres_full.pdf

Corn, M., & Corn, J. K. (1993). The United States experience with regulation of health and safety: 1970–1989. *Health Care in the Changing Economic and Social Environment, 7,* 225–238.

Dai, H., Milkman, K. L., Hofmann, D. A., & Staats, B. R. (2015). The impact of time at work and time off from work on rule compliance: The case of hand hygiene in health care. *Journal of Applied Psychology, 100,* 846–862. http://dx.doi.org/10.1037/a0038067

Davids, A., & Mahoney, J. T. (1957). Personality dynamics and accident proneness in an industrial setting. *Journal of Applied Psychology, 41,* 303–306. http://dx.doi.org/10.1037/h0047608

Dragoni, L. (2005). Understanding the emergence of state goal orientation in organizational work groups: The role of leadership and multilevel climate perceptions. *Journal of Applied Psychology, 90,* 1084–1095. http://dx.doi.org/10.1037/0021-9010.90.6.1084

Eastman, C. (1910). *Work accidents and the law*. New York, NY: Survey Associates, Inc.

Eves, D. (2014). *Two steps forward, one step back: A brief history of the origins, development and implementation of health and safety low in the United Kingdom*. Birmingham, UK: The Royal Society for the Prevention of Accidents, National Occupational Safety and Health Committee.

Faist, K. L., & Newkirk, S. M. (1944). *Job safety training manual*. New York, NY: National Foremen's Institute.

Flanagan, J. C. (1954). The critical incident technique. *Psychological Bulletin, 51,* 327–358. http://dx.doi.org/10.1037/h0061470

Forster, W. A. (1928). Test for drivers. *The Personnel Journal, 7,* 161–171.

Frone, M. R. (1998). Predictors of work injuries among employed adolescents. *Journal of Applied Psychology, 83,* 565–576. http://dx.doi.org/10.1037/0021-9010.83.4.565

Geller, E. S. (2001). Behavior-based safety in industry: Realizing the large-scale potential of psychology to promote human welfare. *Applied & Preventive Psychology, 10,* 87–105.

Goldmark, J. (1912). *Fatigue and efficiency: A study in industry*. New York, NY: Charities Publication Committee.

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. http://dx.doi.org/10.1037/0021-9010.87.3.465

Greenwood, M., & Woods, H. H. (1919). *The incidence of industrial accidents up individuals with special references to multiple accidents* (Industrial Fatigue Research Board, Medical Research Committee, Report 4). London, UK: Her Majesty's Stationery Office.

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. http://dx.doi.org/10.1037/1076-8998.5.3.347

Guilbert, H. (1938). No one enters this plant without goggles. *Factory Management and Maintenance, 96,* 83–85.

Gyekye, S. A., & Salminen, S. (2005). Responsibility assignment at the workplace: A Finnish and Ghanaian perspective. *Scandinavian Journal of Psychology, 46,* 43–48. http://dx.doi.org/10.1111/j.1467-9450.2005.00433.x

Hale, A. R., & Hovden, J. (1998). Management and culture: The third age of safety. A review of approaches to organizational aspects of safety, health and environment. In A. M. Feyer & A. Williamson (Eds.), *Occupational injury: Risk, prevention and intervention* (pp. 129–165). London, UK: Taylor & Francis. http://dx.doi.org/10.1201/9780203212493.ch11

Hamilton, A. (1943). *Exploring the dangerous trades: The autobiography of Alice Hamilton*. Boston, MA: Little, Brown, and Company.

Hansen, C. P. (1989). A causal model of the relationship among accidents, biodata, personality, and cognitive factors. *Journal of Applied Psychology, 74,* 81–90. http://dx.doi.org/10.1037/0021-9010.74.1.81

Håvold, J. I. (2007). National cultures and safety orientation: A study of seafarers working for Norwegian shipping companies. *Work & Stress, 21,* 173–195. http://dx.doi.org/10.1080/02678370701424594

Haynes, M. R. (1999). The evolution of probabilistic risk assessment in the nuclear industry. *Transactions of the Institution of Chemical Engineers, 77,* 117–142.

Heinrich, H. W. (1950). *Industrial accident prevention*. New York, NY: McGraw-Hill.

Hersey, R. (1932). *Worker's emotions in shop and home*. Philadelphia, PA: University of Pennsylvania Press.

Hersey, R. (1936). Emotional factors in accidents. *Personnel Journal, 15,* 59–65.

Hofmann, D. A., & Morgeson, F. P. (1999). Safety-related behavior as a social exchange: The role of perceived organizational support and leader-member exchange. *Journal of Applied Psychology, 84,* 286–296. http://dx.doi.org/10.1037/0021-9010.84.2.286

Hofmann, D. A., & Morgeson, F. P. (2003). The role of leadership in safety. In J. Barling & M. Frone (Eds.), *The psychology of workplace safety* (pp. 159–180). Washington, DC: American Psychological Association.

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 behavior: Safety climate as an exemplar. *Journal of Applied Psychology, 88,* 170–178. http://dx.doi.org/10.1037/0021-9010.88.1.170

Hofmann, D. A., & Stetzer, A. (1996). A cross-level investigation of factors influencing unsafe behaviors and accidents. *Personnel Psychology, 49,* 307–339. http://dx.doi.org/10.1111/j.1744-6570.1996.tb01802.x

Hofmann, D. A., & Stetzer, A. (1998). The role of safety climate and communication in accident interpretation: Implications for learning from negative events. *Academy of Management Journal, 41,* 644–657.

Hofstede, G. H. (2001). *Culture's consequences: Comparing values, behaviors, institutions and organizations across nations*. Thousand Oaks, CA: Sage.

Hollnagel, E., Woods, D. D., & Leveson, N. (2006). *Resilience engineering: Concepts and precepts*. Aldershot, UK: Ashgate.

Hopkins, A. (2007). *Thinking about process safety indicators* (Working Paper 53). Canberra, Australia: National Research Centre for OHS Regulation, The Australian National Unversity.

House, R. J., Hanges, P. J., Javidan, M., Dorfman, P. W., & Gupta, V. (2004). *Culture, leadership, and organizations: The GLOBE study of 62 societies*. Thousand Oaks, CA: Sage.

Hoyos, G. C., & Ruppert, F. (1995). Safety diagnosis industrial work settings: The Safety Diagnosis Questionnaire. *Journal of Safety Research, 26,* 107–117. http://dx.doi.org/10.1016/0022-4375(95)00004-A

Huang, Y. H., Chen, P. Y., & Grosch, J. W. (2010). Safety climate: New developments in conceptualization, theory, and research. *Accident Analysis and Prevention, 42,* 1421–1422. http://dx.doi.org/10.1016/j.aap.2009.12.007

Infortunio, F. A. (2006). An exploration of the correlations between fatal accident rates across nations and the cultural dimensions of power distance, uncertainty avoidance, individuality, and masculinity. *Dissertation Abstracts International, Section A: Humanities and Social Sciences, 67,* 1809.

Institute of Medicine. (1999). *To err is human: Building a safer health system*. Washington, DC: National Academy Press.

Jiang, L., Yu, G., Li, Y., & Li, F. (2010). Perceived colleagues' safety knowledge/behavior and safety performance: Safety climate as a moderator in a multilevel study. *Accident Analysis and Prevention, 42,* 1468–1476. http://dx.doi.org/10.1016/j.aap.2009.08.017

Kahneman, D., Ben-Ishai, R., & Lotan, M. (1973). Relation of a test of attention to road accidents. *Journal of Applied Psychology, 58,* 113–115. http://dx.doi.org/10.1037/h0035426

Kletz, T. A. (1999). The origins and history of loss prevention. *Transactions of the Institution of Chemical Engineers, 77,* 109–116.

Kolmstetter, E. (2003). I-Os making an impact: TSA transportation security screener skill standards, selection system, and hiring process. *The Industrial-Organizational Psychologist, 40,* 39–46.

Komaki, J., Barwick, K. D., & Scott, L. R. (1978). A behavioral approach to occupational safety: Pinpointing and reinforcing safe performance in a food manufacturing plant. *Journal of Applied Psychology, 63,* 434–445. http://dx.doi.org/10.1037/0021-9010.63.4.434

Komaki, J., Collins, R. L., & Penn, P. (1982). The role of performance antecedents and consequences in work motivation. *Journal of Applied Psychology, 67,* 334–340. http://dx.doi.org/10.1037/0021-9010.67.3.334

Komaki, J., Heinzmann, A. T., & Lawson, L. (1980). Effect of training and feedback: Component analysis of a behavioral safety program. *Journal of Applied Psychology, 65,* 261–270. http://dx.doi.org/10.1037/0021-9010.65.3.261

Kornhauser, A. W. (1922). The psychology of vocational selection. *Psychological Bulletin, 19,* 192–229. http://dx.doi.org/10.1037/h0065566

Kozlowski, S. W., & Doherty, M. L. (1989). Integration of climate and leadership: Examination of a neglected issue. *Journal of Applied Psychology, 74,* 546–553. http://dx.doi.org/10.1037/0021-9010.74.4.546

Kozlowski, S. W., & Hults, B. M. (1987). An exploration of climates for technical upgrading and performance. *Personnel Psychology, 40,* 539–563. http://dx.doi.org/10.1111/j.1744-6570.1987.tb00614.x

Kozlowski, S. W., & Klein, K. J. (2000). A multilevel approach to theory and research in organizations: Contextual, temporal, and emergent processes. In K. J. Kline & S. W. Kozlowski (Eds.), *Multilevel theory, research, and methods in organizations* (pp. 3–90). San Francisco, CA: Jossey-Bass.

Kuenzi, M., & Schminke, M. (2009). Assembling fragments into a lens: A review, critique, and proposed research agenda for the organizational work climate literature. *Journal of Management, 35,* 634–717. http://dx.doi.org/10.1177/0149206308330559

Lawton, R., & Parker, D. (1998). Individual differences in accident liability: A review and integrative approach. *Human Factors, 40,* 655–671. http://dx.doi.org/10.1518/001872098779649292

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. http://dx.doi.org/10.1080/00224545.1939.9713366

Mayo, E. (1924). Basis of industrial psychology. *Bulletin of the Taylor Society, 9,* 249–259.

McFarland, R. A., & Moore, R. C. (1957). Human factors in highway safety; a review and evaluation. *The New England Journal of Medicine, 256,* 792–799. http://dx.doi.org/10.1056/NEJM195704252561706

McIvor, A. J. (1987). Employers, the government, and industrial fatigue in Britain, 1890–1918. *British Journal of Industrial Medicine, 44,* 724–732.

Melamed, S., Yekutieli, D., Froom, P., Kristal-Boneh, E., & Ribak, J. (1999). Adverse work and environmental conditions predict occupational injuries. The Israeli Cardiovascular Occupational Risk Factors Determination in Israel (CORDIS) Study. *American Journal of Epidemiology, 150,* 18–26. http://dx.doi.org/10.1093/oxfordjournals.aje.a009913

Moss, F. A., & Allen, H. H. (1925). The personal equation in automobile driving. *Journal of the Society of Automotive Engineers, 16,* 415–420.

Münsterberg, H. (1913). *Psychology and industrial efficiency*. Boston, MA: Houghton Mifflin Company. http://dx.doi.org/10.1037/10855-000

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. http://dx.doi.org/10.1037/a0021484

National Institute for Occupational Safety and Health. (2015). *Total worker health initiative*. Retrieved from http://www.cdc.gov/niosh/TWH/totalhealth.html

National Research Council. (2015). *Offshore oil and gas industry safety culture*. Washington, DC: National Academy Press.

National Safety Council. (1998). *Accident facts*. Itasca, IL: Author.

National Safety Council. (2014). *Injury facts*. Itasca, IL: Author.

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. http://dx.doi.org/10.1037/10662-002

Neal, A., & Griffin, M. A. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. *Journal of Applied Psychology, 91,* 946–953. http://dx.doi.org/10.1037/0021-9010.91.4.946

Office of Strategic Services Assessment Staff. (1948). *Assessment of men: Selection of personnel for the Office of Strategic Services*. New York, NY: Rinehart. http://dx.doi.org/10.1037/11118-000

Ostroff, C., Kinicki, A. J., & Muhammad, R. S. (2012). Organizational culture and climate. In N. Schmitt & S. Highhouse (Eds.), *Handbook of psychology: Vol. 12. Industrial and organizational psychology* (pp. 643–676). New York, NY: Wiley.

Ostroff, C., & Shulte, M. (2014). A configurial approach to the study of organizational culture and climate. In B. Schneider & K. Barbera (Eds.), *The Oxford handbook of organizational climate and culture* (pp. 532–552). New York, NY: Oxford University Press.

Parker, J. W. (1953). Psychological and personal history data related to accident records of commercial truck drivers. *Journal of Applied Psychology, 37,* 317–320. http://dx.doi.org/10.1037/h0053612

Quinn, R. E., & McGrath, M. R. (1985). The transformation of organizational culture: A competing values perspective. In P. J. Frost, L. F. Moore, M. R. Louis, C. C. Lundberg, & J. Martin (Eds.), *Organizational culture* (pp. 315–344). Beverly Hills, CA: Sage.

Reason, J. (1990). *Human error*. New York, NY: Cambridge University Press.

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.

Robson, L., Stephenson, C., Schulte, P., Amick, B., Chan, S., Bielecky, A., . . . Grubb, P. (2010). *A systematic review of the effectiveness of training and education for the protection of workers* (DHHS/NIOSH Publication No. 2010–127). Toronto, Ontario, Canada: Institute for Work and Health; Cincinnati, OH: National Institute for Occupational Safety and Health.

Rothe, H. F. (1947). Review of Job Safety Training Manual. *Journal of Applied Psychology, 31,* 101–102. http://dx.doi.org/10.1037/h0052035

Rubinsky, S., & Smith, N. (1973). Safety training by accident stimulation. *Journal of Applied Psychology, 57,* 68–73. http://dx.doi.org/10.1037/h0034199

Salas, E., Burke, C. S., Bowers, C. A., & Wilson, K. A. (2001). Team training in the skies: Does crew resource management (CRM) training work? *Human Factors, 43,* 641–674. http://dx.doi.org/10.1518/001872001775870386

Salas, E., DiazGranados, D., Klein, C., Burke, C. S., Stagl, K. C., Goodwin, G. F., & Halpin, S. M. (2008). Does team training improve team performance? A meta-analysis. *Human Factors, 50,* 903–933. http://dx.doi.org/10.1518/001872008X375009

Sarpy, S. A., Rabito, F. E., & Burke, M. J. (2015). *Evaluation of disaster worker training: Influence of worker race and ethnicity on safety performance in oil spill clean-up efforts*. Paper presented at the 11th Annual International Work, Stress, and Health Conference, Atlanta, GA.

Schein, E. H. (2004). *Organizational culture and leadership* (3rd ed.). San Francisco, CA: Jossey-Bass.

Schneider, B. (1975). Organizational climates: An essay. *Personnel Psychology, 28,* 447–479. http://dx.doi.org/10.1111/j.1744-6570.1975.tb01386.x

Schneider, B., Ehrhart, M. G., & Macey, W. H. (2011). Perspectives on organizational climate and culture. In S. Zedeck (Ed.), *Handbook of industrial and organizational psychology* (Vol. 1, pp. 373–414). Washington, DC: American Psychological Association.

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

Shaw, I., & Sichel, H. (1971). *Accident proneness*. Elmsford, NY: Pergamon Press.

Shellow, S. M. (1930). The accident clinic, how it functions, and what it accomplishes. *Personnel Journal, 9,* 203–215.

Sinclair, U. (1906). *The jungle*. New York, NY: Doubleday, Jabber, & Company.

Singleton, W. T. (1967). Ergonomics in systems design. *Ergonomics, 10,* 541–548. http://dx.doi.org/10.1080/00140136708930908

Singleton, W. T. (1974). *Man machine systems*. London, UK: Penguin Books.

Smith-Crowe, K., Burke, M. J., & Landis, R. S. (2003). Organizational climate as a moderator of safety knowledge–safety performance relationships. *Journal of Organizational Behavior, 24,* 861–876. http://dx.doi.org/10.1002/job.217

Solutions, B. S. T. (2005). *Interim assessment of the NASA culture change effort*. Retrieved from http://www.nasa.gov/pdf/108679main_BST_culture_Feb05.pdf

Starbuck, W., & Farjoun, M. (2005). *Organization at the limit: Lessons from the Columbia disaster*. Malden, MA: Wiley-Blackwell.

Stein, L. (1962). *The Triangle fire*. Ithaca, NY: Cornell University Press.

Stewart, G. L. (2006). A meta-analytic review of relationships between team design features and team performance. *Journal of Management, 32,* 29–55. http://dx.doi.org/10.1177/0149206305277792

Stump, N. F. (1945). A statistical study of visual functions and industrial safety. *Journal of Applied Psychology, 29,* 467–470. http://dx.doi.org/10.1037/h0061249

Sulzer-Azaroff, B., & Austin, J. (2000). Does BBS work? Behavior-based safety and injury reduction: A survey of the evidence. *Professional Safety, 45,* 19–24.

Swain, A. D. (1964). Some problems in the measurement of human performance in man-machine systems. *Human Factors, 6,* 687–700.

Swuste, P., van Gulijk, C., Zwaard, W., & Oostendorp, Y. (2014). Occupational safety theories, models and metaphors in the three decades since World War II, in the United States, Britain, and the Netherlands: A literature review. *Safety Science, 62,* 16–27. http://dx.doi.org/10.1016/j.ssci.2013.07.015

Taylor, F. W. (1911). *The principles of scientific management*. New York, NY: Norton & Co.

Thompson, L. A. (1929). Measuring susceptibility to monotony. *Personnel Journal, 8,* 172–196.

Tiffin, J. (1942). *Industrial psychology*. New York, NY: Prentice Hall, Inc. http://dx.doi.org/10.1037/11230-000

Tiffin, J. (1947). *Industrial psychology* (2nd ed.). New York, NY: Prentice Hall, Inc.

Tompa, E., Dolinschi, R., de Oliveira, C., & Irvin, E. (2009). A systematic review of occupational health and safety interventions with economic analyses. *JOEM, 51,* 1004–1023.

Turner, N., & Parker, S. K. (2003). The effect of teamwork on safety processes and outcomes. In J. Barling & M. R. Frone (Eds.), *The psychology of workplace safety* (pp. 35–62). Washington, DC: American Psychological Association.

U.S. Chemical Safety and Hazard Investigation Board. (2007). *Investigation report: Refinery explosion and fire* (Report No 2005–04-I-TX). Washington, DC: Author.

Visser, E., Pijl, Y. J., Stolk, R. P., Neeleman, J., & Rosmalen, J. G. M. (2007). Accident proneness, does it exist? A review and meta-analysis. *Accident Analysis and Prevention, 39,* 556–564. http://dx.doi.org/10.1016/j.aap.2006.09.012

Viteles, M. S. (1932). Psychology and industry. In P. S. Achilles (Ed.), *Psychology at work* (pp. 144–198). New York, NY: Whittlesey House.

Vogus, T. J., Sutcliffe, K. M., & Weick, K. E. (2010). Doing no harm: Enabling, enacting, and elaborating a culture of safety in health care. *The Academy of Management Perspectives, 24,* 60–77.

Wallace, J. C., Popp, E., & Mondore, S. (2006). Safety climate as a mediator between foundation climates and occupational accidents: A group-level investigation. *Journal of Applied Psychology, 91,* 681–688. http://dx.doi.org/10.1037/0021-9010.91.3.681

Waller, J. A. (1994). Reflections on a half century of injury control. *American Journal of Public Health, 84,* 664–670. http://dx.doi.org/10.2105/AJPH.84.4.664

Weick, K. E., & Sutcliffe, K. M. (2001). *Managing the unexpected: Resilient performance in an age of uncertainty*. San Francisco, CA: Jossey-Bass.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (1999). Organizing for high reliability: Processes of collective mindfulness. In B. M. Staw & L. L. Cummings (Eds.), *Research in organizational behavior* (Vol. 21, pp. 81–123). Greenwich, CT: JAI Press.

Wilson, M. A., Bennett, W., Gibson, S. G., & Alliger, G. M. (2012). *The handbook of work analysis: Methods, applications, and science of work measurement in organizations*. New York, NY: Routledge.

Winsemius, W. (1965). Some ergonomic aspects of safety. *Ergonomics, 8,* 151–162. http://dx.doi.org/10.1080/00140136508930787

Zacharatos, A., Barling, J., & Iverson, R. D. (2005). High-performance work systems and occupational safety. *Journal of Applied Psychology, 90,* 77–93. http://dx.doi.org/10.1037/0021-9010.90.1.77

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

Zohar, D. (2002a). The effects of leadership dimensions, safety climate, and assigned priorities on minor injuries in work groups. *Journal of Organizational Behavior, 23,* 75–92.

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

Zohar, D., & Hofmann, D. A. (2012). Organizational culture and climate. In S. W. J. Kozlowski (Ed.), *The Oxford handbook of organizational psychology* (Vol. 1, pp. 643–666). New York, NY: Oxford University Press.

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

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. http://dx.doi.org/10.1037/0021-9010.93.4.744

Received June 20, 2015
Revision received March 1, 2016
Accepted March 15, 2016 ■