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Can Teamwork Promote Safety in Organizations?

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Abstract

In this review, we conceptualize teamwork as the linchpin driving safety performance throughout an organization. Safety is promoted by teams through various mechanisms that interact in a complex and dynamic process. We press pause on this dynamic process to organize a discussion highlighting the critical role played by teamwork factors in the engagement of safe and unsafe behavior, identifying five team-level emergent states that enable effective teamwork and safety: psychological safety, team trust, collective efficacy, shared mental models, and situation awareness. Additionally, we consider foundational conditions that support team-driven safety, the development of safety culture, and the importance of team safety climate in shaping performance. We discuss leveraging teams to generate safety and identify directions for future research investigating the relationship between teamwork and safety. Overall, we submit that researchers and practitioners would benefit from taking a systems perspective of safety by integrating principles of team science to better understand and promote safety in organizations.

INTRODUCTION

In the 1970s, the airline industry was fairly new, growing in popularity, and suffering from high rates of preventable accidents. Standards for conduct on the flight deck were dictated largely by the pilot, and implications for the intricate systems managing safety were not yet fully understood. It became clear that this model was ineffective in December of 1978, when United Airlines Flight 173 ran out of fuel and went down just a few miles from its destination due to a series of miscommunications and poor coordination among the flight crew (NTSB 1979). This completely avoidable incident led to the development and implementation of crew resource management (CRM), a set of learning initiatives that teaches crews to work together effectively using teamwork (Cooke & Durso 2008, Helmreich & Foushee 1993). By 1985, the Federal Aviation Administration (FAA) mandated that CRM be implemented across all airlines, overhauling the pilot-centric culture of the industry and capitalizing on teamwork in the interest of promoting safety.

Formal investigations into the sources of safety incidents often reveal causes more complex than a single misstep or a lack of technical competence (e.g., Cooper et al. 1980, Fogarty 1988, Kohn et al. 1999). Whether it be the crash of a mechanically fit aircraft, friendly fire in the heat of combat, or a medical error in the operating room, when mistakes happen and lives are lost, the impact can galvanize large-scale efforts in search of answers. In the case of airline travel, the FAA and the National Aeronautics and Space Administration backed an extensive, multidisciplinary research effort that uncovered the critical impact of teamwork and developed CRM. They learned that when the stakes are high, safety depends on effective interdependent systems and people (i.e., teams), and herein lies the danger. Systems fail if any component lacks the necessary resources or conditions to function as designed, and then errors begin to cascade through fail-safes and, if left unmanaged, disaster ensues (Reason 1997, p. 9).

Four years after CRM was mandated by the FAA, United Flight 232 lost its aft engine about an hour into its planned route from Denver to Chicago with 296 passengers and crew members on board. Alerted by a loud explosion, the flight deck sprang into action for engine shutdown and then identified a loss of all hydraulics, rendering a safe landing virtually impossible (NTSB 1990). For the next half hour, the cockpit crew coordinated with the cabin crew and air traffic control to minimize the inevitable disaster at hand, guiding the aircraft with only engine thrusts. Leaving a trail of flames and debris, the plane crashed down on a Sioux City runway and snapped into pieces, sparing the lives of over half on board. Captain Al Haynes would later attribute their survival to a little bit of luck and the team skills gained from CRM (Haynes 1991).

By all means, United 232 should have resulted in a complete tragedy. No pilot had ever successfully landed a DC-10 without hydraulics, which allow for control of elevation; but with consummate teamwork (and a little luck), 185 souls survived. Acting individuals are often the last line of defense when errors occur, what Reason (1997, p. 12) terms the "sharp end" of organizational accidents. From the exterior, mechanical failure elicited the adverse events of both United 232 and United 173, but teamwork was the deciding factor that led to their distinct outcomes (Cooke & Durso 2008, p. 38). Many factors have the potential to influence safety outcomes in organizations; protocols, equipment, and the individual at the sharp end are only single components of a larger system. This highlights the importance of organizational psychology in looking beyond a narrow focus on safe and unsafe behaviors to understanding how team phenomena might impact those behaviors.

High-Reliability Organizations and Teams

Organizations that successfully operate in intrinsically hazardous conditions requiring a high degree of risk management and safety to achieve effectiveness have been referred to as

Table 1 Five principles of HROs

Principle	Description
1. Monitor all failures.	HROs understand that minor errors can be symptoms of larger problems. Being preoccupied with investigating sources of error and repairing the system is essential for reducing liabilities and latent errors.
2. Avoid simplifying the system.	Collapsing the details of an operation or chain of events involved in a failure or near miss allows for only general solutions to address surface-level issues. HROs are reluctant to simplify the complex systems in place, and they avoid generalizations by reviewing each situation with a new lens.
3. Evaluate operations-objectives link.	HROs are sensitive to how boots-on-the-ground operations achieve strategic objectives, but they understand that real-time operations are only a piece of the puzzle and unexpected events can still occur. The outcomes of each operation performed are used to gauge system functioning and experiences to learn from.
4. Commit to resilience.	In learning from their experiences, HROs can quickly regain steady state operations after adverse events. They do so by remaining dynamic, adapting, and maintaining a learning orientation in approaching and bouncing back from failures.
5. Trust frontline expertise.	In HROs, formal hierarchy does not translate directly to expertise knowledge or decision-making authority. Deferring to those with hands-on experience as the expert empowers employees to speak up on relevant issues and take charge of safety-relevant matters.

Abbreviation: HRO, high-reliability organization. Adapted from Weick & Sutcliffe (2015, pp. 7–15).

high-reliability organizations (HROs) (Roberts 1990). Researchers study HROs (including those in aviation, nuclear power, oil drilling, and the military) to understand how safety can be maintained in challenging and adverse conditions where the consequences of failure can be dire, and their findings lend insight to organizations striving toward high reliability. Weick & Sutcliffe (2015, pp. 7–15) suggest that what HROs do well is "mindful organizing," which can be encapsulated in five hallmarks (**Table 1**). The team level likely plays a critical role in mindful organizing, as the literature notes a key tendency in complex organizations to leverage teams as a means for achieving safety and effectiveness (Baker et al. 2006). This spotlights teamwork skills (e.g., cooperation, communication) as essential components of HROs that can make or break success.

Consider the events that unfolded aboard the *Deepwater Horizon* drilling rig in April 2010, when we witnessed one of America's greatest environmental disasters after an explosion claimed the lives of 11 crew members and emptied four million barrels of crude oil into the fragile ecosystem of the Gulf Coast. Subsequent investigations found that the accident could have been avoided had there been a shared understanding and proper communication among the system of teams involved in the decision-making process (Natl. Comm. BP Deepwater Horiz. Oil Spill Offshore Drill. 2011). This tragedy underscores the need to attend to the nontechnical aspects of effective performance, such as the teamwork involved in coordinating interdependent work, rather than focusing solely on the technical expertise required to get the job done. The oil and gas industry responded in time by gradually embedding teamwork into its safety management systems to support safety culture and a move toward high reliability (see Reader & O'Connor 2014).

Poor teamwork was also a culprit in the accidental shoot down of a civilian aircraft by the USS *Vincennes* in 1988, which led the US government to invest in training programs to improve teamwork competencies in the armed forces, such as the Navy's Aircrew Coordination Training (Collyer & Malecki 1998). The Office of Naval Research backed large research projects, such as the Tactical Decision-Making Under Stress program, to better understand teamwork and prevent such disasters from reoccurring (Cannon-Bowers & Salas 1998). Similar efforts were undertaken

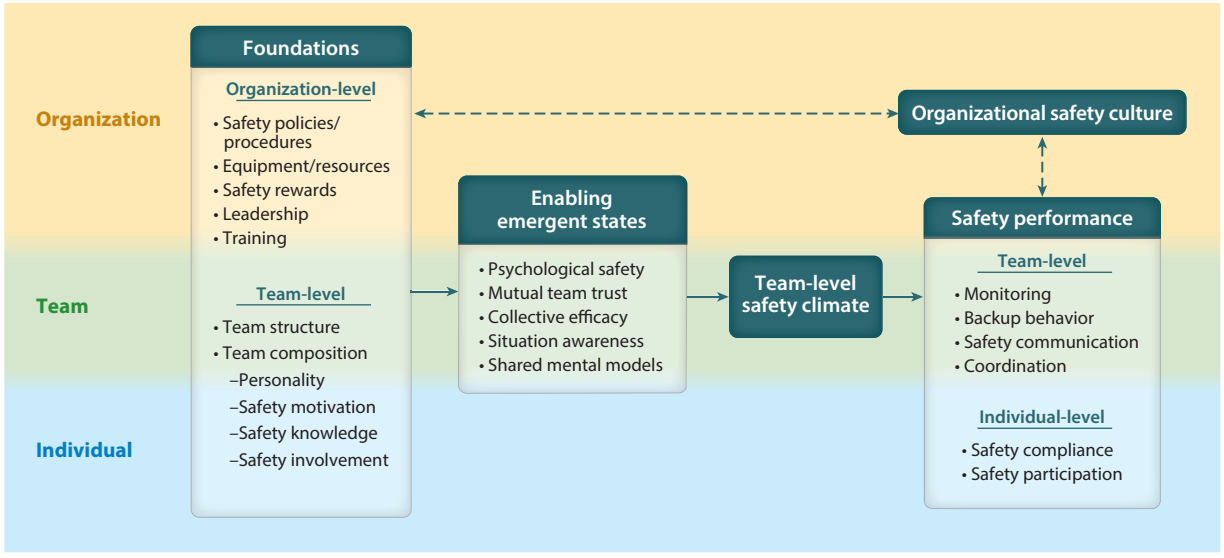

Figure 1

A multilevel framework of the organizational, team, and individual-level factors driving safety via teams.

in the health-care industry. Although health-care organizations may not operate in personally hazardous environments like traditional HROs, attempts to achieve high-reliability status are prevalent in the industry (e.g., Pronovost et al. 2006, Wilson et al. 2005). The HRO movement in health care is predicated on the grave magnitude of medical errors first unveiled in the Institute of Medicine's groundbreaking report *To Err Is Human* (Kohn et al. 1999). This report urged scientists to consider the entire system of factors impacting patient safety, which led to major discoveries implicating the critical role of teamwork in fostering organizational effectiveness in health care (Alonso et al. 2006).

The overwhelming evidence suggests that safety is generated through team performance and that safety cannot exist when teams fail under pressure. This effectively positions teamwork as a mediating mechanism that acts as the linchpin driving safety across organizations. From this perspective, we examine the body of literature on teams and safety with three overarching goals: (*a*) to reconceptualize the way researchers think about safety by highlighting the large and decisive role played by teamwork; (*b*) to provide a selective review that unpacks the complex relationship between teamwork and safety, revealing how and why they are connected; and (*c*) to operationalize the findings of current progress by considering the context of leveraging teams to improve safety in organizations. In doing so, we outline the various pathways through which safety emerges in organizations and assess scholarly progress on the influence of teams in this process. We integrate this information in a multilevel framework that serves to organize our discussion and illustrates how teams generate safety (**Figure 1**).

An Organizing Framework for Teamwork and Safety

Teamwork is a complex behavioral phenomenon that involves many factors (Mathieu et al. 2019). Moreover, organizations are complex social systems with many moving parts that can impact teamwork as well as safety. The role played by each part can vary depending on the perspective with which researchers approach studying organizations—in short, there are far more endogenous

variables fueling organizational performance than there are exogenous, independent sources of influence. Rather than make assertions regarding the temporal order of effects, we acknowledge the complexities that exist while suspending the process in **Figure 1** (like those before us, e.g., Ilgen et al. 2005) to bring perspective to the impact of teams on safety.

We contribute this framework not to hypothesize unexplored relationships but to synthesize current knowledge in a parsimonious manner and depict the story told by the literature about teams and safety, specifically how safety is generated through effective teamwork. With this framework, we can pause the dynamic process and its interactive elements so that a useful discussion around them can be organized. In doing so, we define key emergent states that transpire as the team interacts, which shape the team safety climate and enable safety performance across the organization. We also highlight the foundational components that influence both teamwork and safety, and we discuss how relationships among the factors in this process may contribute to safety culture over time.

Team safety climate: a team's collective perceptions about safety, which provide context for and shape the team's engagement in safety performance behaviors

Safety compliance: core activities employees engage in to maintain their own workplace safety

Safety participation: activities employees engage in that contribute to the overall safety of the organization

SAFETY IN ORGANIZATIONS

At the most basic level, safety is a state that exists when employees think, feel, and act in a safe manner. In other words, safe performance (and unsafe performance) is ultimately enacted by the employee and reflected in measures of safety or safety outcomes (e.g., accidents, errors, injuries, near misses). Safety can also exist at the team level when employees work together to carry out safe teamwork. This is different because it depends on not only whether each individual is safe but also how effectively individuals interact as a team to be safe. To wit, we term safety as a multilevel phenomenon that emerges in part from safety performance at individual and team levels.

Individual-Level Safety Performance

Foundational theories of work performance differentiate between two broad types of performance: Task performance is directly related to core job duties and goal pursuit (e.g., piloting an aircraft), and contextual performance impacts work objectives indirectly (e.g., extrarole behaviors such as a pilot helping the cabin crew) (Borman & Motowidlo 1993). In parallel with this notion, teams researchers recognize that total performance is the product of both taskwork (i.e., task performance) and teamwork (i.e., contextual performance) (McIntyre & Salas 1995). Without effective task performance, contextual performance would have a minimal effect on outcomes; without contextual performance, task performance may not be as effective and outcomes may suffer (Borman & Motowidlo 1993). Neal & Griffin's (2002) model of individual safety performance adopts a similar perspective in differentiating between safety compliance and safety participation.

Safety compliance describes the core activities employees engage in to maintain workplace safety, such as driving the speed limit or wearing a hard hat (Neal & Griffin 2002). Safety compliance is driven by several organization-level factors including the policies and procedures in place and the equipment provided. These artifacts provide employees with direction on how to engage in safe behavior and the resources to do so. Compliance also relies on employee knowledge of these policies and procedures for safety as well as skills for using equipment in a safe manner. For this reason, most organizations provide some degree of safety training during the onboarding process. The underlying culture and existing climate of the work context also play a key role in the engagement of safety compliance (Neal et al. 2000). We discuss organizational culture and climate further in a later section. Briefly, organizational culture is a lasting phenomenon that establishes assumptions about the way things are in the organization (Schein 1984), and climate is more transient in nature and reflects employee attitudes and perceptions about organizational values (Zohar

& Luria 2005). If employees believe safety is valued by the organization, their positive beliefs may create and encourage behavioral norms for safety compliance.

Climate and culture also have implications for the contextual type of safety performance, known as safety participation. Safety participation describes activities employees engage in that contribute to the overall safety of the organization rather than the safety of the self in a given moment, such as reminding coworkers to use handrails or participating in a voluntary workshop to learn a new safety technique (Neal & Griffin 2002). Safety participation is enabled by safety-related knowledge and motivation (Neal et al. 2000). The interpersonal nature of safety participation is particularly relevant for theorizing the critical connection between individual safety performance and the social influence of team phenomena. Notably, safety participation focuses on the aspects of performance that benefit others rather than the self and potentially signals to others group norms for safety performance. Thus, individual safety participation may lend itself to team-level safety performance through interpersonally geared team behaviors such as mutual performance monitoring and backup behavior.

Team-Level Safety Performance

At the team level, safety performance consists of teamwork processes that represent how teams work together as a unit to foster safety. We highlight key team behavioral processes of monitoring and backup behavior, safety communication, and team coordination.

Monitoring and backup behavior. Mutual performance monitoring involves team members tracking progress toward goals, internal systems, and external conditions that could be meaningful for their objectives (Marks et al. 2001). Teams that adequately engage in mutual performance monitoring collect information from the external and internal environments and disperse it to ensure all members are updated with information necessary for goal achievement, as well as to provide timely feedback regarding mission progress and hazardous conditions that may materialize into threats (Wilson et al. 2005). Such feedback can help teams self-adjust by understanding how team functioning and the environment might be impacting objectives. Ludwig & Goomas (2009) studied operations in distribution centers and found that team performance improved when forklift drivers were given updates and feedback on their progress completing goals.

Members of safe teams may monitor each other's performance to ensure they are all abiding by policies and procedures put in place to maintain safety but also to engage in extrarole behaviors such as providing assistance or backup when teammates are overloaded with task demands (Wilson et al. 2005). Backup behavior can be carried out in a variety of ways, including through providing verbal feedback, assisting, task sharing, or taking any other action instrumental in alleviating a teammate's duties (Marks et al. 2001). Team members that engage in backup behavior help each other perform taskwork when the team is under stress, fostering team care and their capacity to engage in safe behaviors. Having the capacity to utilize held safety knowledge and skills, along with the motivation to do so, is key for safety participation (see Neal et al. 2000).

Safety communication. Team information exchange is a core driver of both team behavioral processes and subsequent performance outcomes (Marlow et al. 2018). Communication is a core component underlying many of the functions detailed in **Figure 1**. Effective communication allows team members to share knowledge about their environment and tasks in a timely manner, generate shared situational awareness, and coordinate with ease. Without effective communication, key pieces of information may go unattended, potentially leading to unsafe conditions and little awareness of environmental hazards.

Research in health care links effective team communication to improved patient outcomes (Leonard et al. 2004). In one study, communication failures during intraoperative phases and handoffs were associated with major complications and increased patient mortality, such that improved patient outcomes were more likely when teams engaged in high levels of information sharing (Mazzocco et al. 2009). Considering the specific content of information exchanged, sharing information related to safety can impact the way individuals learn from past mistakes and lead to improved safety performance. Hofmann & Stetzer (1998) found that safety communication, which is the act of exchanging safety-related information with others in the organization, can influence how employees interpret information surrounding an adverse event.

Research on safety communication is especially prevalent in the construction industry. Through qualitative interviews with construction team members and social network analysis, researchers found that the frequent (i.e., at least weekly) formal and informal safety communication differentiated crews with high accident rates from those with low accident rates (Alsamadani et al. 2013). Those studying efforts to train construction supervisors to improve crew safety communication found that intervention groups yielded noticeable increases in safety communication and attention to safety (Kines et al. 2010). Interestingly, data from union construction workers reveal a negative relationship between safety communication and chronic pain experienced at work, although findings show potential influence from an unaccounted-for group-level variable moderating the strength of this relationship, potentially implicating team-level characteristics (Cigularov et al. 2010). One of these characteristics might be psychological safety, or the team's shared perception of freedom to speak up. A study of railway workers revealed that employees feel more comfortable communicating safety concerns with supervisors when they have greater leader-member exchange relationships, leaders with positive safety attitudes, and fewer job demands interfering with safety efforts (Kath et al. 2010). Feeling free to engage in safety communication plays a potentially great role on safety performance.

Psychological safety: a shared belief that the team is safe for interpersonal risk taking and that speaking up will not lead to retribution

Shared mental models: a team's common cognitive representations of task requirements, procedures, or role responsibilities

Team coordination. Team coordination involves the management of behavior, team interdependencies, and sequencing of planned tasks. Coordination is critical for team effectiveness, particularly when success depends on numerous contributions by all group members and when teams are highly interdependent (Kozlowski & Bell 2003). Research demonstrates that coordination is developed through shared mental models (SMMs) of situations and team member roles, and it can even occur without explicit verbal communication (Guastello & Guastello 1998). Well-coordinated teams carry out tasks efficiently and effectively, drawing from SMMs around the behaviors that will generate the safest outcomes for the team, making few to no errors (Salas et al. 2009). A study of motor racing pit crews names team coordination as a key contributor of safe team performance (Catchpole et al. 2010).

An interesting stream of research finds that effective teams can adapt their coordination to maintain safe and successful performance as environmental demands shift. High-performing cockpit crews exhibit more succinct and balanced explicit coordination patterns of heedful behavior than poor-performing teams; these involve monitoring the environment for informational cues and effectively sharing that information across the team (Grote et al. 2010). In other words, teams with a shared sense of awareness may be better at coordinating interdependent tasking to produce safe outcomes when demands fluctuate. For instance, if a team member fails to communicate a potential hazard, the team will have to rely on other members to assess the situation and identify hazards, causing inefficiencies from double work and tighter time pressure in strategizing and managing tasks. Research in health care echoes the importance of coordination to safety, where observations of anesthesia teams handling emergencies revealed that greater adaptive coordination in the form of task management behaviors led to better performance outcomes with patient safety implications (Burtscher et al. 2010).

Summary

In safety-critical organizations, safe performance is ultimately carried out by individual employees and, more often than not, individuals in teams (Wilson et al. 2005). The behaviors indicating safe team performance discussed throughout this section are essentially effective teamwork behaviors, but team behavior is only part of the equation. Behaviors are shaped by many factors, including attitudes and perceptions that enable effective teamwork and foundational characteristics of the organization that support safe performance. Next, we discuss the emergent states that represent collective attitudes and perceptions at the team level.

Collective efficacy: the extent to which team members believe they can perform their tasks effectively in working toward their objectives

TEAM EMERGENT STATES THAT ENABLE SAFETY

As individuals come together to perform as a team, various psychological states emerge consisting of their shared attitudes and perceptions. These emergent states form and constantly evolve with each interaction and exert influence over the way teams carry out their work (Marks et al. 2001). Thus, emergent states are mediating mechanisms that link inputs of team performance to outcomes (Ilgen et al. 2005). We present five team emergent states thought to drive effective safety performance based on findings in the literature: (*a*) psychological safety, (*b*) mutual trust, (*c*) collective efficacy, (*d*) situation awareness, and (*e*) SMMs.

Psychological Safety

Psychological safety is a shared belief that the team is safe for interpersonal risk taking and that speaking up will not lead to punishment, embarrassment, or retribution (Edmondson 1999). In psychologically safe teams, members feel empowered to use their voice to inform their leader or other team members that a mistake has been made or to suggest new ideas to improve an existing approach. In teams with low psychological safety, members feel discouraged from participation and unwilling to speak up, even when they have vital information that might help during crises. Meta-analyses show that psychological safety enhances engagement, task performance, satisfaction, and commitment (Frazier et al. 2017).

The benefits of psychological safety are grounded in organizational learning theory (see Edmondson 1999, Liu et al. 2014). Psychological safety is likely critical for high-stakes teams (i.e., where the consequences of failure are catastrophic) to promote team learning and improve the knowledge, skills, and attitudes (KSAs) surrounding safety. Team members avoid reporting errors when psychological safety is low, effectively eliminating opportunities to learn from their mistakes (Edmondson 1999). Moreover, teams with high levels of psychological safety may enable members to engage in safety communication by speaking up when a teammate performs a task in an unsafe manner. Likewise, they may feel more comfortable pushing others to develop a more safety-minded approach to carrying out taskwork. Leroy and colleagues (2012) studied nursing teams and found that team leaders who admit their mistakes can improve the team's compliance with safety protocols and psychological safety to report errors.

Mutual Trust

It is important to note that psychological safety is distinct from mutual trust in teams. Psychological safety is about feeling like teammates will not pass judgment onto each other, and team trust is a feeling of assurance about being able to rely on each other (Edmondson 2003). Research on nuclear power facilities in Spain found that employees who trust one another engage in more team learning and have higher levels of both safety compliance and safety participation (Ayenew et al. 2015).

De Jong & Elfring (2010) found that team trust improves team performance partially by mitigating process losses through increased levels of team monitoring. Recall that monitoring allows team members to recognize when their teammates need assistance; team trust is thought to facilitate this process by enhancing perceptions of helping behavior as supportive rather than controlling (Salas et al. 2005). As it relates to safety performance, monitoring facilitated by team trust may allow noncompliance to be detected and thus avoided. This may also improve coordination processes by allowing team members to be aware of each other's actions and the team's progress. Team trust has been described as a basis for team success and survival (West & Sacramento 2012), as well as a key indicator of performance in swift-starting action teams (i.e., teams with limited familiarity tasked with managing emergency situations) (Wildman et al. 2012). This could indicate the potential influence of trust in enabling teams to coordinate in high-pressure contexts and HROs.

The argument might be made that team trust can harm safety by reducing the detection of potential threats, or that the effect on safety is quadratic (see Burt et al. 2009). More specifically, high levels of trust may lead to team members becoming too comfortable and less safe, whereas low trust might lead them to avoid the collaboration necessary to be safe. Recent meta-analyses find that, overall, team trust has a positive relationship with team effectiveness (Breuer et al. 2016). Moreover, these analyses revealed that team trust facilitates collaboration and coordination processes that lead to effectiveness through its positive effect on interpersonal risk-taking behaviors (e.g., asking for help, discussing conflict). These findings further illustrate the relatedness of psychological safety and team trust. Although distinct, they may facilitate the same processes that lead to team effectiveness and safety. For instance, employees may be more likely to engage in safety communication when they have mutual trust in each other's intentions to be supportive, as well as feel psychologically safe enough to speak up without sacrificing their reputations.

Research on driving performance found that trust and team potency mediated the relationship between trust in the team leader and subsequent performance (Schaubroeck et al. 2011). Moreover, affect-based trust (i.e., feelings of interpersonal concern) was more related to psychological safety, while cognition-based trust (i.e., feelings of dependability) was more related to team potency. These findings imply that having a team leader whose interpersonal intentions are trusted can enhance feelings of safety in speaking up about concerns (e.g., safety communication), and a leader who is trusted as competent and dependable can improve the team's collective sense of efficacy in accomplishing its mission (i.e., team potency), another important driver of safety. Ideally, team leaders should have both the affect- and cognition-based trust of their teams to support both psychological safety and team potency.

Collective Efficacy

A team's level of collective efficacy defines the extent to which members believe their team is capable of performing its tasks effectively toward its objectives (Bandura 1997). Although collective efficacy is a strong predictor of performance across most teams, it is particularly important in highly interdependent teams, such as those that operate in extreme performance contexts where safety is a top priority (Gully et al. 2002, Katz-Navon & Erez 2005, Stajkovic et al. 2009). Collective efficacy is also a key predictor of team learning, as it predicts learning behavior even when controlling for psychological safety (Edmondson 1999).

Collective efficacy has critical implications for both effective communication and coordination in health-care teams (see Salas et al. 2008). Researchers have argued that shared beliefs about the team's efficacy serve to motivate collaboration and commitment and that a team without collective efficacy may not be as energized to work together through the challenges it may face (Bandura

1997, Le Blanc et al. 2010). We suggest that there is also reason to investigate the potential implications of collective safety efficacy, or the team's perceived ability to maintain safe operations while accomplishing task objectives. Safe teams may have a sense of collective agency, where teammates believe in the power and ability of the team to take safe actions, independent of each member's individual self-efficacy. There may be instances where the team feels capable of performing its tasks but also uses unsafe means to do so (e.g., using workarounds to deal with faulty protection gear, carrying unsafe loads to meet strict production goals). Assessing collective safety efficacy may reveal underlying issues with the design of the work that impact safety, which would not be captured with existing collective efficacy measures. Moreover, researchers might investigate antecedents of safety efficacy beliefs: Do these perceptions match the team's actual capabilities? Are they based on past experience or blind optimism? Are they cultivated in the same ways as collective efficacy?

Situation Awareness

Perhaps the most prominent model of situation awareness is Endsley's (1995) three-level model, which involves perceptions of elements in the environment (level 1), comprehension of the current situation (level 2), and prediction of future status (level 3). At the individual level, situation awareness involves the intersection of an individual and the immediate environment. Team-level situation awareness is more complex, describing not only the cognitive processes underlying individual situation awareness but also other essential processes such as coordination and communication of status with other team members (Salas et al. 2007). Team situation awareness involves an understanding of all that can impact the team and its performance, which provides information that can inform decision making. Theory underlying situation awareness is grounded in studies of aviation and the military, as well as other complex environments where the detection and prevention of errors are paramount (see Leaver et al. 2018).

Errors may occur at any of the three levels of situation awareness, but a review of the literature on offshore drilling crews found that most errors occur at the perceptual level (followed by comprehension and then prediction) (Sneddon et al. 2006). Errors at the perceptual level of situation awareness involve missing important cues in the internal or external environment that are meaningful for the team's performance. For example, in cardiac resuscitation teams, attentional tunneling due to high workload and stress levels can prevent team members from recognizing deficiencies in CPR performance (e.g., incorrect rate and depth of compressions) that adversely impact patient outcomes (Hunziker et al. 2011). In general aviation, aircrews operating under unfavorable meteorological conditions (i.e., flying at night, in poor weather, or in other conditions that can disrupt visual cues) should rely on data from their primary instruments but instead may choose to continue using unreliable visual cues to judge distances, a pattern of behavior that has caused fatal accidents (Wiegmann et al. 2005).

Both Brady et al. (2013) and Edbrooke-Childs et al. (2018) describe implementing systems to reduce situation awareness failures in detecting patient risk factors by utilizing team huddles specifically to exchange safety-relevant information. These researchers concluded that team huddles reduced instances of unrecognized clinical deterioration in patients. Although situation awareness was not measured directly in either study, the relationship between enhanced safety communication and the detection of hazards supports the relevance of situation awareness to effective teamwork and safety performance. Qualitative analyses of interviews with emergency response teams also reveal linkages between poor information exchange and ineffective situation awareness among agencies (Waring et al. 2018). Furthermore, the idea of shared situation awareness among agencies may have implications for SMMs about each other's roles and responsibilities.

Shared Mental Models

SMMs describe a team's common cognitive representations of task requirements, procedures, and role responsibilities (Cannon-Bowers et al. 1993). As teams pursue their goals, they must maintain a shared understanding of their objectives and strategies, each teammate's roles, team norms, and the status of their resources. Shared and accurate mental models elicit team coordination and compatible decision making, and they are linked to team behavioral processes, motivational states, and successful performance (DeChurch & Mesmer-Magnus 2010). Inconsistencies in mental models within and between teams can lead to confusion and errors stemming from poor coordination of work (Salas et al. 2009).

Burtscher & Manser (2012) systematically reviewed the literature on mental models and safety performance, providing that mental models have a strong positive impact on safety performance across a number of types of teams including command and control teams, negotiation teams, business and service teams, and action teams. In a study of air traffic controllers, Smith-Jentsch and colleagues (2005) demonstrated that SMMs of goal interdependencies and cue-strategy associations interacted to predict reported safety incidents. Interestingly, they found that units with high SMMs of goal interdependencies but inconsistent ideas about cue-strategy associations had the greatest amount of safety incidents. Variety in cue-strategy associations means that the controllers would respond differently (i.e., adopt different strategies) in the same high-risk situation, which can be interpreted as controllers lacking clear protocols for crises. A lack of clear protocols can create conditions promoting task or process conflict among multiple controllers responding to a crisis when time is limited.

SMMs are also critical for safe teamwork in health care, as quality patient care can rely on a number of interdependent specialists and teams that should take a consistent approach to treatment (Baker et al. 2006). When mental models are not shared or there are variations in team members' perceptions, examinations of their knowledge structures can be used to localize the source of confusion and opportunities for improvement. SMMs can be examined in several ways, including interviews, direct observations, and self-reported perceptions of team knowledge or individual knowledge content or structure (e.g., associations between concepts) aggregated to the team level to assess indices such as accuracy and sharedness (see Wildman et al. 2014). Emerging research on mental models among nursing units suggests that nurses directly providing care and their managers may have different ideas of executive leaders' influence on patient safety, revealing the potentially critical role of nursing managers to act as an informational link between executive-level efforts to improve safety and frontline nurses (Weaver et al. 2017).

Research finds that early SMMs in a team's life cycle may predict future team effectiveness via the impact of team learning as the team becomes accustomed to working together toward its objectives (Santos et al. 2015). Using a firefighting simulation, researchers discovered the central role of task-based SMMs on team strategy adaptation patterns in response to fluctuating task demands. Specifically, teams with highly shared construals may draw the same interpretations of the changing situation, leading them to recognize the need to adapt quicker and respond more effectively than those with inconsistent SMMs (Uitdewilligen et al. 2018). Future research might look closer at the behaviors that facilitate strategy selection and adaptation stemming from SMMs to clarify the specific team processes impacting safety outcomes.

Summary

Organizational research has made much progress identifying the sources that impact safety performance. We believe the evidence is strong for each of the emergent states discussed in this section for promoting safety by supporting effective teamwork. We note that effective team performance

is the product of both teamwork and taskwork, and the relationship between the two is critical (McIntyre & Salas 1995). Teamwork skill alone can achieve little safety without precise and effective task performance, just as technical skill alone is insufficient for collaborative work. In our next section, we discuss the foundational elements required for safe teamwork and taskwork.

FOUNDATIONS OF TEAMWORK AND SAFETY

The factors discussed so far are essential for safety to emerge in organizations, particularly from effective teamwork. Safe and effective teamwork, as well as safe individual performance, cannot exist without conditions that are conducive to these efforts. There are fundamental characteristics of the organization and the team that can either support or hinder the engagement in safety performance.

Organization-Level Foundations

Some of the most basic contributors to safety at the organizational level are the resources and equipment provided by the organization. Safety outcomes are jeopardized when the necessary equipment required to carry out safe performance is not available or well maintained. Equipment and resources for safety are a prerequisite for safety, but they are not sufficient in isolation. For example, an organization may have proper safety equipment, but if employees lack the knowledge, skills, or motivation to use the equipment to carry out tasks, its presence lacks practical utility. Thus, other organizational variables such as training and leadership are integral to ensuring that safety equipment and resources are used appropriately. The same can be said for organizational policies and procedures for safety—without adequate conditions, policies and procedures lack utility.

Policies and procedures for safety are also important for shaping performance. Safety policies can outline the organization's strategic safety goals and the means by which these goals should be achieved, and safety procedures indicate the specific actions employees and leaders can take to meet these goals (Zohar & Luria 2005). Policies and procedures can be thought of as a bedrock for safety performance, but employee perceptions of these safety policies and procedures may be just as important for implementation. For example, if employees misinterpret or do not adequately understand a policy, it may serve little use and become ignored. Moreover, safety can still exist in the absence of compliance to policies. Research in health care shows that leaders who admit their violations against policies and procedures may actually improve reports of treatment errors (Leroy et al. 2012). Safety incident reporting is paramount for ensuring employees learn from the errors they make and make changes to improve safety performance (Reason 1997).

Programs to reward safe performance also have implications for safety performance. Distributing safety rewards provides a means for leaders to incentivize safe behavior with recognition or tangible rewards, such as emphasizing collegiality in performance evaluations and compensation reviews, which might motivate backup behavior, or providing positive feedback and visible awards for making safe choices. Leadership can also contribute to safety performance through its impact on psychological safety. Team leaders can create psychologically safe environments by modeling behavior, such as by sharing ideas openly and admitting their own mistakes (see Leroy et al. 2012). Leaders can set the tone for acceptance by welcoming and responding to feedback respectfully, creating an environment that discourages incivility, and fostering a team-first mind-set (Nembhard & Edmondson 2006, Walumbwa & Schaubroeck 2009). Specifically, inclusive and transformational leadership styles, which emphasize a leader's ability to inspire and support followers, have been identified as antecedents to psychological safety (Frazier et al. 2017). In a study of nuclear power plants, team leaders' empowering behaviors, including setting high performance standards and

encouraging group members to express ideas and suggestions, generated safety compliance and participation while also reducing risky behaviors (Martínez-Córcoles et al. 2013). Leaders play a similar role in improving safety in health care by cultivating safety norms that can improve patient care and reduce litigation and complaints (Firth-Cozens 2001).

Leaders serve as representatives of the larger organization and can signal what is valued by top management. When employees perceive their organizational environment as supportive, they may be more motivated to perform safely (Wen Lim et al. 2018). Zacharatos et al. (2005) studied high-performance work systems and found that trust in management partially explained relationships between individual differences in safety orientation to injuries and near misses. Mullen & Kelloway (2009) explored the impact of safety-specific transformational leadership in health care by having leaders participate in either a training workshop or a control workshop and then assessed post-training effects on leaders and their subordinates. Ultimately, they found that safety leadership training significantly improved transformational leadership and the safety climate. This research also highlights the benefits of training beyond technical expertise to promote safety.

The importance of training for both employees and leaders is well documented in the literature (Hofmann et al. 2017). The efficacy of safety training in particular is high across a variety of methods, but the most engaging interventions (e.g., those involving behavioral modeling, extended practice, and dialogue) tend to elicit the greatest reduction in accidents, illness, and injuries (Burke et al. 2006). Safety training lays the foundation for employees to gain the KSAs necessary to engage in safe behavior; however, training rarely works in isolation. Well-maintained equipment and clear-cut safety policies must be in place to support the transfer of learned content on the job, as well as supportive leaders and an environment that allows for opportunities to practice (Blume et al. 2010).

Team-Level Foundations

There are several characteristics of teams, and individuals within those teams, that can impact teamwork and engagement in safety performance. These considerations fall into one of two categories: team compositional variables or team structural variables.

Team composition. Team composition variables represent individual-level variables aggregated to create team-level phenomena. Here, we discuss personality, safety knowledge and motivation, and safety involvement. The mix of these individual characteristics has important implications for the team that can impact safety.

Personality. Meta-analyses exploring relationships between personality and measures of safe and unsafe behavior show that personality traits are important for safety outcomes. For example, agreeableness and conscientiousness are negatively related to unsafe behavior, and refined analyses also point to sensation seeking as a notably strong negative correlate (Beus et al. 2015, Clarke & Robertson 2005). Indeed, personality explains incremental variance in safety behavior beyond stronger predictors (e.g., safety climate; Hofmann et al. 2017), and organizations looking to compose safe teams could benefit from considering personality and optimal combinations of team member traits. More research is needed to understand the interactive compositional effects of team personality on safety performance, as current work focuses primarily on personality at the individual level. Using novel methods to explore the potential impact of team personality profiles may lead to new discoveries regarding the implications on safety (e.g., Hoch & Dulebohn 2017).

Safety Knowledge and Motivation. Safety knowledge involves an understanding of the procedures necessary for effectively carrying out safe behaviors and implications for performance

outcomes, and safety motivation is the willingness to actually enact these behaviors and the positive or negative valence associated with doing so (Neal & Griffin 2006). Thus, safety knowledge and motivation go hand in hand because safety motivation requires some degree of knowledge of what it means to be safe. Vinodkumar & Bhasi (2010) studied manufacturing organizations and found that safety knowledge and motivation linked safety management practices (e.g., training) to safety performance. Moreover, meta-analyses show that safety knowledge and motivation have significantly positive relationships with safety performance, stronger than personality, job attitudes, and situational factors (Christian et al. 2009).

As one can imagine, motivation to be safe has important implications for actually engaging in safe behavior—we are more likely to behave accordingly when a threat is imminent. Furthermore, research shows that when employees are motivated, their engagement expands beyond safety compliance to active safety participation as employees begin to show consideration for the safety of their team and the organization as a whole (Neal & Griffin 2006). An interesting question is why employees may have safety motivation beyond imminent threat. Wen Lim et al. (2018) found safety communication to be one of the strongest predictors of intrinsic safety motivation in a Malaysian sample of construction workers, which led to greater safety participation and safety compliance. Research on work-related driving found that safety motivation was predicted by fleet manager safety values, driver attitudes toward safety, and driver self-efficacy; and it also found that safety motivation held a positive relationship with self-reported driving crashes (Newnam et al. 2008). Probst & Brubaker (2001) studied food-processing plants and found that employees reporting feelings of low job security were generally less motivated to perform safely and tended to exhibit less safety compliance than others, which further led to increased rates of accidents and on-the-job injuries.

Safety motivation has been studied primarily at the individual level, but we expect that teams have an enhanced ability to promote safety motivation. While organizations and leaders can improve safety knowledge and motivation by leveraging training and rewards for safety, teams might improve motivation through interpersonal processes and social influence. For example, in teams where members feel a strong sense of cohesion, members may have a greater desire to engage in safety-related backup behavior to help those under pressure or falling behind. They may also be motivated to engage in safety performance to protect their fellow teammates. In other words, team members may set aside their personal dislike of a particular safety policy in favor of compliance because their actions could create unsafe conditions for their fellow teammates. In the *Deepwater Horizon* explosion, the victims were not necessarily the actors who made the unsafe decisions leading up to the disaster. Being responsible for the safety of others is a powerful motivator that we believe is especially prevalent for teams. Researchers should work to better understand the motivational aspects of team members' having each other's backs and the impact on safety outcomes.

Safety Involvement. Related to motivation is the level of involvement employees have in contributing to safety-related decisions. Employee perceptions of safety involvement (or, more specifically, of their opportunities to be involved) are especially strong indicators of organizational safety climate (Beus et al. 2019). Lending employees a voice on safety-related matters may lead to feelings of ownership of safety outcomes and a greater understanding of how their actions impact the safety of the overall organization, supporting principles of HROs (see Weick & Sutcliffe 2015). This could be especially important for teams, as researchers find perceived coworker support fully mediates the relationship between perceived organizational support for safety and employee safety communication regarding fixing unsafe conditions (Tucker et al. 2008). These findings suggest that teammates may provide avenues for safety involvement by encouraging each other to act on safety issues.

Team structure. Characteristics of the team's objective and tasks can also impact safety performance. Tasks are considered more complex when the required skills, interdependence, and number of different actions increase (Wood 1986). Vashdi et al. (2013) studied surgical teams and found that adverse event occurrences increased with the complexity of surgeries, even when controlling for the patient's condition. They found that practicing post-action team debriefs in prior surgeries significantly reduced adverse events in less complex surgeries, but, interestingly, no significant effect of debriefing was found at higher levels of task complexity. This might indicate that task complexity has safety implications for team behavior that benefit less from debriefs. In the study reported by Vashdi et al. (2013), it could be that complex surgeries are seen as unique or special circumstances where lessons learned from debriefs of past cases do not easily apply to the current situation or that the cognitive demands required by complex tasks do not allow for the benefits of past debriefs to carry over as much as in less complex tasks. Perceived task complexity might also have implications for the degree of vigilance employees feel is required in a given situation. There is much room for researchers to clarify the impact of task complexity on teamwork and safety outcomes.

Organizational changes also have the potential to put stress on team functioning to impact safety. For instance, if an organization undergoes downsizing or restructuring, teams may have to adapt to working harder or longer with fewer people and a broader scope of work. Research from simulations of patient air transport in the military show that task saturation stemming from structural adjustments may be mitigated by effective teamwork (Davis et al. 2014). We know little about how such organizational changes impacting team structure or composition may influence safety because the literature currently lacks longitudinal insight to these areas (Bell et al. 2018). In a study of hockey teams, Stuart (2017) found that when a key player is injured, team interaction patterns can differ to the extent that overall interactions within the team and with other players are reduced. Organizational researchers should work to better understand the longitudinal impact of team structural dynamics on safety.

Summary

In effect, these foundations serve as prerequisites to the emergence of safety. Organizations with a supportive foundation have the tools necessary to carry out functions that elicit safety performance and safe outcomes. As individuals in these organizations come together to work in teams, psychological states emerge that support safe and effective teamwork. Research suggests that over time, these aspects combine to create experiences that shape the climate in which employees operate, forming underlying assumptions about what is valued and to be expected in the organization; with stability and consistency over an extended period of time, organizational culture is formed (Denison 1996, Schein 1984, Schneider et al. 2017). Climate and culture play an important role in whether employees engage in safe behavior; thus, the discussion of their influence is necessary in this review of teamwork and safety.

ORGANIZATIONAL CULTURE AND CLIMATE

Climate can be thought of generally as a "summary perception derived from a body of interconnected experiences" or specifically toward a particular organizational phenomenon (e.g., safety climate, justice climate) (Schneider et al. 2017, p. 468). The significance of the word summary is actually twofold, as climate refers to a summary of all employees' summary perceptions. To wit, safety climate would be the summary perception of safety-related experiences, measured by the attitudes and perceptions of a collective toward safety at a given point in time. Organizational

culture is a more enduring construct that evolves gradually and concerns deep-seated assumptions about what is valued and why, reflected in behavioral norms and artifacts (Denison 1996). Assumptions, values, norms, and artifacts related to safety constitute safety culture.

Organizational safety culture: safety norms, values, and assumptions held by employees

Organizational Safety Culture

Culture is more difficult to directly observe and assess than climate, which authors have argued is a contributing factor to the frequent conflation between the similar yet distinct concepts of culture and climate (see Mearns & Flin 1999). Because culture and climate share many of the same characteristics and are interdependent to a degree, some researchers might use climate measures to investigate a culture-based argument, explicitly or implicitly referring to them as interchangeable. The most important aspect of their distinction might be the transient nature of climate in comparison to culture. For instance, observing a colleague neglect to wash his or her hands before returning to work may yield negative perceptions of the safety climate, but this behavior would not necessarily impact the more engrained, positive organizational safety culture that existed long before the incident occurred. In the same light, a new supervisor who encourages making safe choices might improve perceptions of a team's safety climate, but employees may still prioritize efficiency over safety and fail to develop underlying values for safe behavior that are characteristic of safety culture. It takes time to build culture, but climate is more malleable and may eventually give rise to culture change; thus, climate research has strong ties to the culture literature (Denison 1996).

A recent multidisciplinary review of safety culture research highlights the various factors thought to enable safety norms, values, and assumptions to become adopted and enacted by employees (Bisbey et al. 2019a). Key organizational factors mentioned were policies and resources for safety, as well as a demonstrated commitment and prioritization of safety by leaders. When executive leadership shows commitment to safety above other objectives (e.g., profit), the trickle-down effect on unit-level leadership relays to employees that safety should be the priority, encouraging the adoption of safety-related behavior from leaders (Brown et al. 2005, Hofmann & Morgeson 1999). Moreover, in addition to giving clear guidelines for carrying out safe operations, the signals sent by formal policies may encourage employees to comply with the safety values held by the organization (see Connelly et al. 2011).

Team-Level Safety Climate

Indeed, organizational safety policies and management styles that support safety culture are important, but ultimately, the influence on employee safety performance may boil down to the proximal climate at the group level. Team safety climate refers to team members' collective perceptions about safety, and it provides context for and shapes their engagement in safety performance. Leaders and mission statements may espouse safety values or codify safety behavior in policies and protocols, but safety climate defines the extent to which employees actually value safety (Zohar & Luria 2005). The collective attitudes and perceptions that form safety climate create a figurative lens through which work and the organization are experienced. For example, team members in a positive safety climate might perceive a compliance officer as a reflection of the organization's dedication to safety, while those in a negative safety climate might view a compliance officer as a means to avoid potential litigation. Consequently, safety climate has a substantial positive influence on safety performance (Griffin & Neal 2000, Hofmann & Stetzer 1998). Meta-analytic findings indicate that organizational safety climate explains 18% of the variance in employee safety performance (Clarke 2006, p. 322), and others found this positive relationship to be fully mediated by

team-level climate (Zohar & Luria 2005). Research also demonstrates the impact of team safety climate on safety communication and team learning. Hofmann & Stetzer (1998) studied utility workers and found that team safety climate influences the way accidents are interpreted and that workers with a stronger safety climate are more likely to feel comfortable communicating with their supervisors about safety and discussing their mistakes than those in teams with a poor safety climate.

Climate is inherently a multilevel phenomenon (Kozlowski & Klein 2000). Not only do organizational factors, including safety culture, influence individual perceptions of safety climate and subsequent performance, but individual-level factors also stimulate emergent processes influencing team and organizational outcomes contributing to climate. The multilevel nature of this phenomenon fixes teams as a central hub for promoting safety. The top-down effects of safety climate are particularly well documented in the literature, with empirical tests emphasizing the pivotal role that teams play in creating safe organizations by influencing individual safety performance (Zohar & Luria 2005). Neal & Griffin (2006) conducted a longitudinal study of hospital employees and found that enhanced team safety climate improves individual safety motivation and engagement in safe behavior.

The literature also details the emergent, bottom-up ways in which individuals build and maintain the collective climate. For instance, a strong safety climate is contingent upon individual safety knowledge and motivation (Neal et al. 2000). Employees come to work with various levels of safety-related knowledge, skill proficiencies for safe behavior, and attitudes about safety. As employees enter a team environment, the interplay of their safety-related KSAs contributes to the team safety climate, such that the team is influenced by its individual members as much as the members are influenced by collective team phenomena. For example, if a team member finds success in eschewing formal safety policies for speed, others may develop attitudes and perceptions that efficiency is valued over safety. Furthermore, if too many team members lack positive attitudes and perceptions toward formal safety policies, a poor safety climate may develop and propagate ineffective norms throughout the organization and impact safety culture in the long term. Teams have tremendous influence over safety climate and culture, and their role as a central hub for promoting safety should continue to be capitalized on in research and practice.

Summary

Overall, climate both is shaped by top-down influences of the organization and emerges bottom-up from the characteristics of the team. Essentially, team safety climate acts as a perspective lens that provides context for employees' priorities and engagement in safety performance. Further, the assumptions and norms afforded by culture shape employee expectations of right and wrong, and they color the nature of their reality at work. The development of safety culture is a major objective of many organizations, particularly in health care. We present a simplified illustration in **Figure 2** to show distinctions among the components in **Figure 1** in the development of safety culture over time.

Figure 2 demonstrates how the accumulation of experiences, consisting of iterative performance cycles, generates and shapes safety culture. This depiction embraces the complexity of the processes impacting safety culture over time while outlining the roles of key contributors. In summary, safety culture can be thought of as shaped over time by norms in the way people perform (i.e., safety performance), what they typically feel and think (i.e., emergent states), what they perceive is valued (i.e., safety climate), and fundamental characteristics of the organization itself (i.e., foundations). Notably, safety culture may not necessarily develop in a positive, linear fashion. Instead, other phenomena (e.g., stemming from a change in leadership, cuts to safety management

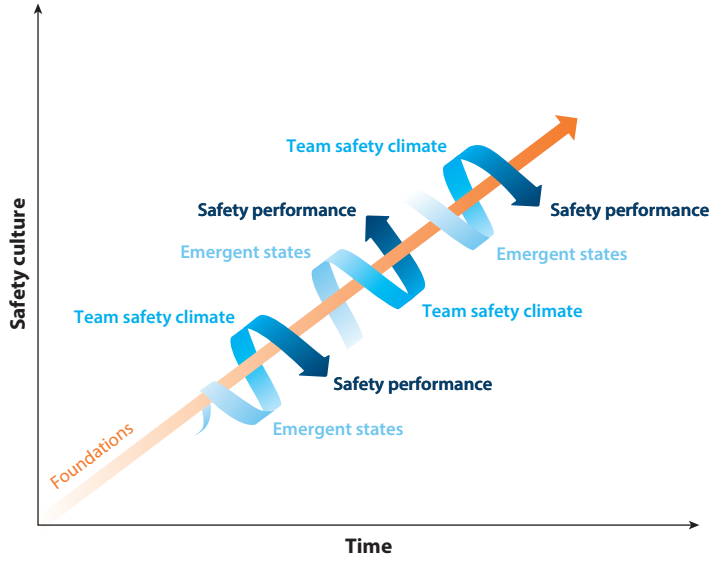

Figure 2

The emergence of safety culture over time as a function of team emergent states, safety climate, and safety performance.

programs, poor selection practices) can create lasting negative changes that may halt its development or deteriorate safety culture over time. Thus, it is crucial for employees at all levels to possess a sustained commitment to and deference for safe operations that endure throughout time and organizational changes in order to continue the upward spiral of safety culture development.

LEVERAGING TEAMS TO IMPROVE SAFETY

It is clear that teams play an essential role in driving safety across organizations when we press pause on the dynamic process to consider all that research has uncovered in each topic area; however, operationalizing what we have learned and applying it to real-world organizations requires us to unpause and consider the complex interactions between factors in the context of where the work is performed. Fortunately, teams researchers have made it a habit to study teams in their natural environments. Many practically useful tools and solutions for improving safety have been developed over the years with the help of psychologists in human factors, engineering, education, the military, and aviation (Bisbey et al. 2019b). Drawing upon this research, we take a deeper dive into the real-world influences on teams and safety, as well as the contextual roles teams play in safety management.

Teams in Context: Safety and Risk Management

Although occupational safety is important to some degree in every organization, safety considerations are especially critical for those organizations in which high-risk work is performed (e.g., HROs). Teams are employed for high-risk work because they have more resources to adapt, be flexible, and solve problems than individuals alone; thus, the more risk is prevalent in a given environment, the more likely it is for teams to play a critical role in safety. What exactly does a high-risk context or an HRO look like, and how do teams operating in these contexts actually

experience work? High-risk conditions can be atypical in many ways from traditional environments and have serious consequences for errors (Bell et al. 2016). Consequences might involve life-or-death situations, compromised safety of the team or others, or the potential to cause an adverse event that jeopardizes the well-being of the organization or society at large (Hannah et al. 2009).

Teams in high-risk contexts are often confronted with unsafe conditions that require them to shift between normal, day-to-day operations and emergency procedures. Many of these teams have limited experience with one another before working together (e.g., surgical teams, aviation crews, emergency response teams). Wildman et al. (2012) suggest team trust is particularly important for maintaining coordinated teamwork when teams must quickly form and then perform, noting that 73% of errors on the flight deck occur when the cockpit crew has never met before (NTSB 1994). In addition to variability in team familiarity prior to performance, the potential for adversity to occur as well as the severity of the potential danger can also vary. Accordingly, researchers are recognizing the fundamental importance of context and calling for more consideration of contextual features to understand the full spectrum of implications (Humphrey & Aime 2014, Johns 2006). Consider how an astronaut crew spends all of its time in the risk-laden context of outer space, often encountering novel problems in uncharted territory, and how a paramedic team primarily operates in a safe environment until an emergency takes place and encounters relatively similar problems on a regular basis. This juxtaposition highlights the stark differences that can exist between safety-critical contexts—differences that have implications for successful team composition, training, and safety. Future research into the nuances between and within different safety-critical contexts will lead to interesting findings for teams managing safety. For instance, how might hypothesized relationships with safety change based on team familiarity or expectancy to work together again, the typical base rate and characteristics of high-risk incidents, levels of engagement in down time between performance episodes, or the degree of danger and scope of impact in the event of failure?

Teams in safety-critical contexts might also engage in certain team behaviors to mitigate accidents and prevent danger. Risk management behaviors might include identifying and troubleshooting problems, as well as assessing and responding to threats to safety and goal attainment. These topics align with behavior-based safety approaches to managing risk (Geller 2005), which are somewhat unexplored (at least specifically) by teams researchers. We know that teams with high SMMs tend to detect problems quicker than others, which affords them more time to respond effectively (Uitdewilligen et al. 2018). We also know that problem detection and sensemaking may become more accurate as team members gain more domain experience (Cellier et al. 1997, Klein et al. 2005), which may lead to more effective risk management behaviors. As teams engage to mitigate accidents or unanticipated events, coordination of their efforts becomes critical and is often complicated by time pressure. Future research should expand on the criterion space of safety performance to better understand the specific behaviors teams engage in to mitigate and respond to disaster. For example, Gorman et al. (2017) found that adaptive coordination behaviors can be successfully trained with perturbation training, where the demands for coordination fluctuation experienced on the job is matched to coordination demands in the training environment. This novel approach opens the door to exciting research questions for training in HROs, in which teams regularly encounter unanticipated and nonroutine situations that have extreme safety consequences. For instance, how can we optimize synthetic task environments to uncover a greater understanding of how to train employees for unavoidable and unpredictable shifts in demands, how can we train not only for responding to unexpected problems but also for proactively preparing for such events by managing time and other resources effectively, and how should these systems be evaluated?

Team training: a set of learning initiatives designed to target and improve specific teamwork competencies

Technical skills training: a set of learning initiatives designed to enhance job performance by targeting technical knowledge and skills

Moving beyond the focus on frontline teams physically carrying out safe operations and responding to critical incidents, it is also worth considering the role teams play in managing safety and change initiatives more broadly. Teams often undergo regular formal training to proactively manage safety as well as reactively in initiatives deployed to counter negative trends in safety performance or to address specific root causes of critical events. In other words, the responsibility of organizational learning and improvement is often held by teams, both formally and informally.

Safety in complex organizations is frequently couched in terms of continuous learning or improvement processes where new risks are identified and solutions to mitigate future risk are developed, implemented, and evaluated locally within an organization. The teams tasked with this work frequently draw members from across departmental, professional, and geographic boundaries within the organization (Weaver et al. 2014). Although far fewer empirical studies exist on the impact of safety-improvement team functioning than on the impact of frontline team functioning, the dynamics of these cross-functional and multidisciplinary teams will clearly impact how risks are identified, safety practices implemented, and safety knowledge distributed within organizations (Edmondson & Harvey 2018). The general framework outlined in **Figure 1** and detailed above applies to these safety-improvement teams as well. For example, there has been a great deal of focus in health care on how to best compose and structure safety-improvement teams operationally (Pronovost & Marsteller 2014). The importance of learning and continuous improvement teams to safety will likely increase in the future as the nature of work grows in complexity and safety requires adaptive functioning and not just adherence to existing policies and procedures.

Countermeasures: Improving Safety Through Team Interventions

The framework in **Figure 1** gives insight into the concepts that may be targeted in safety initiatives. For instance, employees may need a refresher course to ensure everyone has a foundational knowledge of safety practices, new selection procedures might be created to compose teams with optimal personality profiles that enhance safety, or health-care organizations may initiate quality improvement projects that incorporate rewards for patient safety outcomes. However, the devil is in the details for designing and implementing these countermeasures in at least two key ways. First, the state of the science may be limited in providing specific guidance for countermeasure deployment. For example, exactly how often do safety skills and knowledge need to be refreshed, and what is an acceptable mix of personalities on a safe team? Second, each countermeasure needs to fit within a complex set of safety practices and compete for space in the overarching safety management system (Grote 2012). These systems are resource constrained, and frequently the introduction of new initiatives is viewed in zero-sum terms (e.g., a new training program equates to less staff time in revenue-generating activities or additional cuts to other programs). One of the most effective ways to promote safety might be by addressing the factors that impact safety performance at the team level: teamwork skills. Here, the devil is in the details as well, as researchers and professionals from different industries work to mature a context-appropriate set of primary teamwork skills to implement (Gregory et al. 2019).

Teamwork skills can be developed through team training and development interventions. Team training is a set of learning initiatives designed to target and improve specific teamwork competencies, in contrast to technical skills training, which is designed to improve task performance by targeting technical knowledge and skills (Salas et al. 2008). Targeting team development to improve safety is not a novel idea. One of the greatest achievements of teams research has been the development of the science of team training deployed specifically to address safety issues, which is grounded in compelling evidence for its effectiveness at improving teamwork and safety across industries (Bisbey et al. 2019b). The federal mandate of CRM demonstrates the impact

team training made on the commercial airline industry. Statistics published by the Flight Safety Foundation show that fatal airliner accidents have decreased each decade since the mandate (Flight Saf. Found. 2019). After this directive, the team-training trend continued to permeate across other high-stakes industries as CRM became effectively adopted in maritime, offshore drilling, and energy manufacturing (Havinga et al. 2017).

Health-care teams also benefit from team training (Weaver et al. 2010). Safety is a top concern in medicine, with many quality improvement interventions focusing on improving care delivery and patient outcomes. Arguably, patient safety is not an issue for quality improvement interventions to address but rather is best suited for organizational psychologists. The Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) program was created with the help of psychologists to improve patient safety in health care by targeting and developing team competencies of situation monitoring, mutual support, communication, and leadership (King et al. 2008). TeamSTEPPS has since been adapted to find success in other contexts (e.g., education; Benishek et al. 2016). A meta-analysis of medical team training by Hughes et al. (2016) suggests that patients treated by health-care professionals who underwent team training may have a better chance at surviving, demonstrating statistical significance in lower mortality rates with team training. Without a doubt, team training works when designed and deployed appropriately, but we currently know very little about how it might be implemented in multiteam systems (MTSs), or systems of interdependent teams (Shuffler et al. 2015). This issue is not exclusive to team training—there is a great need to understand how training interventions should be designed and implemented so that MTSs can effectively learn and transfer learned skills back to the performance environment. Particularly in health-care, teams often depend on other teams from different disciplines to perform safely and effectively (e.g., a patient being handed off from primary care to radiology and then to oncology and so on). Accordingly, researchers might find success filling this gap by starting in health care with investigations of multidisciplinary MTSs and training to better understand how these systems fit into safety management efforts.

Researchers considering more specific team-training interventions suggest that psychological safety might be promoted through inclusive team leadership (Nembhard & Edmondson 2006). Team training in the form of leadership development might be leveraged to effectively improve psychological safety. Training targeted toward communication and information exchange have also proven effective (Brock et al. 2013), as well as the use of team debriefing interventions to improve communication of expectations and team learning (Tannenbaum & Cerasoli 2013). We refer the reader to Lacerenza et al. (2018) and Shuffler et al. (2018) for comprehensive information on team development interventions and appropriate usage. We note that the benefits of training interventions hinge on effective measurement. Measurement informs feedback, and feedback is the basis of all learning. Feedback tells the learner what is necessary for effectiveness and where deficiencies lie. Without feedback, learning cannot occur. As a way to intervene, we need more robust measurement tools that indicate levels of team processes, emergent states, and safety performance. The tools we adopt must use sophisticated technologies that allow for real-time detection and assessment of training-relevant content. Data from measures need to be psychometrically well-developed, reliable, and interpretable at individual and team levels of analysis. This is one key way to advance the science of teamwork and safety—by moving beyond the self-reported means of data collection that have served us well and onto more objective and unobtrusive measures that allow us to develop a greater understanding of team dynamics. This is not to say that self-report or survey measures no longer bring value to our field but rather that we should work harder to push the boundaries of what we consider robust.

Finally, we reiterate the impact of organizational conditions on team effectiveness that cannot be understated (Salas et al. 2018). By this we mean that research questions in organizational

psychology should not be studied solely in a vacuum, absent the influence of environmental, situational, or otherwise external factors that exist in the real world and make up the conditions under which work is performed. These conditions can make or break the effectiveness of interventions, and poor conditions such as ineffective team composition or poor leadership might restrict the resources required to elicit safe behaviors. Making lasting changes may involve tackling safety issues through multiple pathways to ensure consistency across levels. Far too many organizations employ a single safety training initiative and hope for substantial impact while ignoring other factors within the organizational system that have safety implications (e.g., selection practices that do not consider safety, compensation systems that reward production increases rather than safe behavior, any of the other factors listed in **Figure 1**). This can send mixed messages to employees that might deter the development of safety culture (see Denison 1996). We echo the sentiments of Mathieu et al. (2019) in recognizing the dynamics of organizations that are often neglected in our conceptualizations of effectiveness. Moving beyond research and into the applied environment reveals the true test of value of our science—we must embrace the complexity of real-world organizations to gain a greater understanding of employee experiences and produce practically meaningful work. Creating safer organizations requires a holistic approach that addresses all organizational levels and dynamics in between. We posit that as a central hub between micro- and macrolevels, teams may provide the most efficient and effective pathway for improving safety.

FUTURE RESEARCH DIRECTIONS

Scholars anticipate drastic changes to the world of work as we progress through the twenty-first century (see Oswald et al. 2019). We will see exponential growth and integration of advanced technology in the workplace, globalized business, and increased diversity (Cascio & Montealegre 2016). This means we may have the opportunity to broaden the concept of safety for the future of work and reassess the implications of teams. In the future, it may become more common for teams to interact with or depend on intelligent agents and automated systems to carry out safe operations. For instance, military operations may increase the use of unmanned aerial vehicles to support team missions (Cooke et al. 2016). Research shows that human-technology teaming may have important implications for trust (de Visser et al. 2018). How might teams learn to coordinate with technology when trust is limited? How could their strategies for interacting with autonomous agents impact safety?

Studies of humans coordinating with autonomous agents find that these teams process visual targets less efficiently than all-human teams, indicating potential issues with situation awareness and other challenges related to cognitive processing (McNeese et al. 2018). Autonomous agents and algorithms do not have the common sense of a human teammate that might be trusted to adapt in nonroutine or ambiguous situations, so their roles in team processes may have certain limits, but research is only just emerging on these topics. Organizational researchers should work with human-factors and engineering psychologists to understand the salient components of autonomy and the advancements needed to support team dynamics critical for safe operations. The advantages brought by sophisticated technologies have the potential to greatly improve safety in organizations—for instance, by being more reliable and less bound by the limits of human performance that can pose a risk to safe operations (e.g., fatigue, noncompliance). Researchers should work to keep up with the pace of these advances to investigate meaningful questions involving the integration of technology and teamwork. How can technology work for the team rather than hinder its effectiveness? As autonomous agents take over the responsibilities of team members, what limitations will impact the capability to perform safely? What new skills will be required to interact with autonomous agents?

Relatedly, the prevalence of international business is requiring increased use of technology by teams to function across geographical boundaries and time zones. This introduces interesting questions around the implications for safety performance in virtual teams. Research shows that it can be difficult to build effective team constructs like trust and cohesion without face-to-face interaction (Breuer et al. 2016) and that intentional action must be taken to support cognitive constructs such as SMMs (Maynard & Gilson 2014). Additionally, safety may take on new meanings in a virtual context. Modern-day concerns with cybersecurity provide new avenues for research involving Internet privacy, protection of proprietary information stored electronically, data mining, and improper handling of sensitive information or other topics that might have implications for organizational safety. Limited research currently exists concerning the role of teamwork in supporting cybersecurity. What relationships exist between cybersecurity and safety, and what roles do teams play?

Continuing with globalization effects, interesting questions exist around how international or cross-cultural dynamics impact safety through teamwork. Research on cross-cultural diversity indicates that international teams may enjoy increased creativity and satisfaction but also experience process losses via task conflict and decreased social integration (Stahl et al. 2010). Despite a growing trend toward multinational organizations with teams composed of employees from countries around the world, the study of teamwork and safety across cultures has not been investigated as thoroughly as teams in Western, culturally homogenous settings (Feitosa et al. 2018).

Some researchers have begun to investigate the role of team diversity in safety, noting the importance of safety in many blue-collar occupations, where cultural diversity is particularly prevalent. Research indicates that national culture may have the potential to shape safety motivation and risk perceptions, which may become more important as teams become more culturally diverse (Starren et al. 2013). Specifically, safety performance in cross-cultural teams may be impacted by factors that are more difficult to transmit across a team's language barriers, such as safety knowledge, as well as safety motivation, which might be experienced differently by individuals from cultures with varying perceptions of power distance or uncertainty avoidance (Christian et al. 2009, Starren et al. 2013). We urge researchers to continue efforts to better understand the implications of cross-cultural teamwork. Specifically, investigating both deep-level (e.g., values) and surface-level (e.g., language) characteristics will shed light on the variety of ways in which safety is impacted by culture and support the development of interventions to mitigate the negative effects of cultural barriers and facilitate the positive effects diversity brings to teams.

CONCLUSION

Yes, teamwork can promote safety. It is not a panacea but a powerful deterrent of human error and often the last line of defense when failures threaten the safety systems in place. With this review, we aimed to lend a novel perspective to looking at safety beyond the individual actor and safety manual by examining the processes at play in promoting safety. Foundational variables spark the potential for safety to exist, but teamwork is the catalyst inciting its emergence. We unpacked the complex relationship between factors in the dynamic teamwork process and safety in order to state the case of current scientific progress and reveal potential research directions (**Table 2**). We also operationalized our conclusions in the real-world context of organizations leveraging teams to manage safety and improving safety through team development.

Safety is not just an outcome of safe behavior—it is a way of organizational life ingrained in the culture and identity of employees. We hope our systems perspective of how teamwork promotes and fosters safety will bring about valuable contributions in the next generation of scientific inquiry to minimize the often-dire consequences that result from ineffective teamwork.

Table 2 Future research directions and implications for science and practice

Future research area(s)	Implications for Science	Implications for practice
Considerations for HROs and other safety-critical organizations	Unpack the various contextual influences of teamwork and safety within and between safety-critical contexts to establish a more nuanced understanding of high-risk work. Clarify the specific behaviors required to mitigate and respond to emergencies, their triggers, and how to maximize their training.	Examine how relationships between teamwork and safety vary based on job/task characteristics (e.g., frequency and regularity of safety incidents, potential for and impact of failures). Further explore training teams to respond to nonroutine and unanticipated situations (e.g., perturbation training for adaptive coordination).
Safety improvement via team interventions	Develop theory underlying training effectiveness for MTSs and the impact of MTSs on safety performance. When it comes to training, learning hinges on effective measurement—more work should be done to develop robust and psychometrically sound measurement tools.	Broadly, targeting teamwork skills with team training can improve safety outcomes. Developing tangible learning tools, such as job aids, might be useful for critical incidents. Consider interventions to aid in recovery from high-risk work, such as those focused on resilience.
The future of work	Investigate how to facilitate collaboration between humans and autonomous agents to promote rather than hinder safety efforts. Organizational researchers should work with human-factors and engineering psychologists to understand the salient components of autonomy and advancements needed to support team dynamics critical for safe operations.	Technology may substantially change the meaning and management of safety in organizations. Consider how teams interact with autonomous agents to impact safety (e.g., trust, coordination). Humans and autonomous agents have different capabilities and limitations—the right mix may be required for safe collaboration.
Cross-cultural and diversity topics	Examine deep-level (e.g., values) and surface-level (e.g., language) characteristics to shed light on how safety is impacted by culture. Uncover the mechanisms that underlie building relationships across time zones and in virtual contexts to inform the future of team safety in geographically distributed teams.	Explore pathways for mitigating negative effects of cultural barriers and facilitating the positive effects diversity brings to teams and safety. Study teams that operate outside of the Western culture in the context of their work in order to develop practical guidelines for teamwork and safety across the globe.

Abbreviations: HRO, high-reliability organization; MTS, multiteam system.

SUMMARY POINTS

1. Although not a panacea, teamwork serves as a powerful deterrent of error and a catalyst for safety emergence in organizations. Without effective teamwork, safety cannot exist.
2. Five team-level emergent states—psychological safety, team trust, collective efficacy, shared mental models, and situation awareness—enable not only effective but also safe teamwork in organizations.
3. Team safety climate serves as a perspective lens that shapes how foundational elements are perceived by individuals, providing context for their engagement in safe or unsafe behavior.
4. Safety culture in organizations emerges over time through the continuous interplay of team foundational variables, teamwork processes and emergent states, safety climate, and safety performance.

DISCLOSURE STATEMENT

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