

SPECIAL ISSUE ARTICLE

Information sharing and decision-making in multidisciplinary crisis management teams

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Summary

Multidisciplinary crisis management teams consist of highly experienced professionals who combine their discipline-specific expertise in order to respond to critical situations characterized by high levels of uncertainty, complexity, and dynamism. Although the existing literatures on team information processing and decision-making are mature, research specifically investigating multidisciplinary teams facing crisis situations is limited; however, given increasingly turbulent external environments that produce complex crisis situations, increasing numbers of organizations are likely to call upon multidisciplinary teams to address such events. In this paper, we investigate information processing and decision-making behaviors in an exploratory study of 12 organizational multidisciplinary crisis management teams. We identify three types of information sharing and track the emergence of distinct communicative phases as well as differences between high- and low-performing teams in the occurrence of sequences of information sharing behaviors. We close by discussing implications for research in this area and for managers of crisis management teams.

KEYWORDS

crisis management team, multidisciplinary teams, team communication, team decision-making, team information processing

1 | INTRODUCTION

When an unexpected emergency event interrupts normal operations and threatens harm to an organization, individuals representing various areas of expertise are often formed into crisis teams. These multidisciplinary teams must rapidly share information and make numerous decisions in order to address the situation (Bigley & Roberts, 2001; Smart & Vertinsky, 1977; Smith & Dowell, 2000). For example, multidisciplinary emergency management “command-and-control” team members must quickly share unique information in order to coconstruct a collective understanding of the situation they face and decide on appropriate responses (Van der Haar, Segers, Jehn, & Van den Bossche, 2015). Likewise, emergency medical teams must assemble and rapidly share information about the patient’s condition in order to effectively manage a medical emergency situation (Faraj & Xiao, 2006; Su et al., 2015; Tschan et al., 2006). And organizational crisis management teams must quickly share information and make

sense of unexpected critical events in order to limit the impact on their organizations (King, 2002; Lee, Woeste, & Heath, 2007; Nosek & McNeese, 1997).

For teams operating in complex and dynamic environments characterized by ill-structured problems, making sense of the flow of information constitutes an essential aspect of their task (Weick, Sutcliffe, & Obstfeld, 2005). In order for team members to align their actions with one another and to function as an integrated entity, team members must share crucial aspects of their understanding of the situation (Salas, Prince, Baker, & Shrestha, 1995; Rico, Sánchez-Manzanares, Gil, & Gibson, 2008) and collectively decide what actions to take (Pearson & Clair, 1998). Moreover, while engaging in active task execution, team members must share information in order to continually “update” their collective understanding of the dynamic task situation as it unfolds over time (Christianson, 2009). Given that multidisciplinary team members’ perceptions of situations may vary significantly depending on their discipline-specific orientations (Waller, Huber, &

Glick, 1995), and given that the increasingly complex nature of contemporary crises requires the attention of multidisciplinary teams (James & Wooten, 2010), understanding more about how multidisciplinary teams process information, cocreate collective understanding, and make decisions takes on added import.

Although the importance of team information processing during complex and dynamic events has been widely acknowledged (Gutwin & Greenberg, 2004; Rico et al., 2008; Roth, Multer, & Raslear, 2006; Waller, Gupta, & Giambatista, 2004), research has focused mostly on constructs related to communication or information sharing as emergent states or outcomes of team processes; for example, literature on team situation awareness has suggested that actual situation knowledge interacts with subjective confidence in predicting team functioning in dynamic environments (Hamilton, Mancuso, Mohammed, Tesler, & McNeese, 2017). Little is known about how multidisciplinary teams process information in order to create a shared understanding of a dynamic situation and make decisions in response to it.

To provide more insight regarding how such teams can improve their performance, we must go beyond investigating communication in terms of global or aggregated measures and focus intently on the actual behavioral sequences and overarching temporal phases of communication team members engage in to understand and address crises (Weingart, 1997; see also Humphrey & Aime, 2014). An in-depth investigation of process data and communication behaviors makes it uniquely possible to study information sharing behaviors over time as they occur within their temporal context (Ballard, Tschan, & Waller, 2008). Therefore, in this paper, we examine the structure, antecedents, and consequences of information sharing behaviors in the ongoing verbal exchange among the members of 12 multidisciplinary crisis teams. We identify distinct communication *phases*—periods of time characterized by a particular communicative focus or theme—and information sharing *sequences*—clusters of information sharing communication behaviors occurring among team members—that distinguish low- and high-performing teams. Our general research question is “How do high-performing multidisciplinary crisis teams share and process information and make decisions over time during complex crises?”

We believe this study advances knowledge about team dynamics in three important ways. First, by studying the specific communication phases and behavioral sequences teams engage in while making sense of the unfolding flow of information, we gain detailed insight into a collective information processing function that is central to a team's alignment with its external environment, and hence to the performance of the team and, ultimately, its effectiveness for the organization or community it serves (Maynard, Kennedy, & Sommer, 2015; Pérez-Nordtvedt, Payne, Short, & Kedia, 2008). Second, we adopt a temporal approach by investigating two temporal aspects of team action that have been found to be important for understanding team functioning: the occurrence of time-based phases in the team communication process (Gersick, 1988; Poole, 1983) and the effects of the timing of specific team communication types within the team communication process (Tschan et al., 2006; Waller, 1999). This temporal focus is congruent with a number of calls that have been made for the inclusion of dynamism in theories and studies of group and team

processes (Waller, Okhuysen, & Saghafian, 2016) and, more specifically, in the temporal aspects of team communication behaviors (e.g., Ancona, Okhuysen, & Perlow, 2001; Arrow, Poole, Henry, Wheelan, & Moreland, 2004). Third, building on literature concerning the role of artifacts in the use of information in the cocreation of shared understanding (Heath & Luff, 1992; Hutchins, 1995), we identify how the use of whiteboard structuring can function as an important antecedent of information-sharing sequences linked to team performance.

In the following sections, we review the pertinent literature on team information processing and identify three specific levels of information sharing. We then describe a field study of 12 multidisciplinary crisis management teams, during which we collected data from teams composed of highly skilled organizational participants training in their discipline-specific roles as they worked together through realistic simulated crisis events at Europe's largest sea port: the Port of Rotterdam. The port covers a geographically large area of land and water and represents a complex network of port, commercial, and government entities coordinating not only to keep commerce flowing but also to ensure safety and protect the fragile surrounding environment and population. Multidisciplinary crisis teams at the port are charged with the responsibility of quickly assembling, assessing critical situations, and carrying out a coordinated response to combat crises ranging from petrochemical spills to deliberate attacks. In our analyses, we apply an exploratory approach to the data we collected from these crisis management teams for assessing the phase structure in the team communication process and in identifying antecedents and consequences of specific types of information sharing. Finally, we provide a discussion of the results and implications for future research and practice.

1.1 | Information sharing, communication sequences, and information processing

Team information sharing is communication involving the introduction of members' individually held knowledge into the team's public space. It refers to the exchange of privately held information about the task situation with the other members of the team. In crisis management teams, members must share information about the task situation in order to develop a shared and accurate understanding of the task situation that facilitates coordination and enables high-quality decision-making (Cooke, Salas, Cannon-Bowers, & Stout, 2000; Rico et al., 2008). By exchanging information about the situation, teams may not yet create a shared understanding but a shared body of information that constitutes the input for higher level information processing. For example, studies on cooperative work teams have observed the practice of “talking to the room,” in which team members express out loud new information that is not directed at a specific individual but instead to the room at large (Heath & Luff, 1992; Kolbe et al., 2014; Waller & Uitdewilligen, 2008). By expressing information aloud in this manner, teams create common ground—a shared knowledge base combined with the “awareness” that the knowledge is shared—that can serve as an input for collective sensemaking (Clark & Brennan, 1991).

Extending this work and drawing from the situation awareness theory of Endsley (1995), we suggest a model of team information sharing encompassing three levels: fact sharing, interpretation sharing, and projection sharing. Situation awareness refers to the dynamic

understanding a team or individual has about a specific situation (Cooke et al., 2000; Salas et al., 1995; Stout, Cannon-Bowers, & Salas, 1996), and existing evidence suggests that communication of information on these three levels may differentially impact team performance (Bolstad et al., 2007). Drawing from Endsley's work and building on the notions that (a) meaning is developed in group dialog (Keyton, Beck, & Asbury, 2010) and (b) team cognition is reflected in communication (Kennedy & McComb, 2010), we propose a distinction among team information sharing behaviors pertaining to the three levels as described below, which are summarized in Table 1.

The first level, *fact sharing*, refers to the sharing of basic factual information about individual elements of the situation. When team members communicate information at this level, they forward simple factual information they possess about the task situation. This type of information sharing has been studied extensively with the hidden-profile paradigm, introduced by Stasser and Titus (1985). This research stream consistently demonstrates that teams tend to focus on information that is already shared over unshared information and that this bias negatively impacts team decision-making quality (Sohrab, Waller, & Kaplan, 2015). However, when team members have clearly identified expertise, and the other team members are aware of this expertise, this decision-making bias tends to be reduced (Baumann & Bonner, 2013; Franz & Larson, 2002; Stasser, Stewart, & Wittenbaum, 1995).

In order to develop a common understanding in multidisciplinary teams, information sharing must go beyond the communication of basic factual information, as experts must effectively transfer their unique understanding of the task situation to the other team members (Rentsch, Mello, & Delise, 2010). Therefore, the second level of information sharing, *interpretation sharing*, refers to the communication of semantically enriched information that is the result of the integration of information elements into an interpretation of the current situation. Interpretation sharing can be distinguished from fact sharing by the interpretation processes that have taken place concerning the information. Interpretation is about giving meaning to stimuli; it is the process whereby disjointed information elements are synthesized into a holistic understanding of the situation (Endsley, 1995), or informational elements are linked to existing knowledge structures (Durso & Gronlund, 1999; Starbuck & Milliken, 1988; Weick, 1995). This distinction between facts and

interpretations is akin to the distinction between exploration of information space and exploration of solution space in the work of March (March, 1991; Shore, Bernstein, & Lazer, 2015). Thus, when team members share interpretations, they communicate information that results from a combination of task information and their discipline-specific expert knowledge structures. Importantly, when team members engage in sequences of interpretation sharing and build on each other's interpretations, they may collectively make sense of their situation (Starbuck & Milliken, 1988; Weick et al., 2005).

The third level of information sharing, *projection sharing*, pertains to the communication of projections and anticipations of future states. This type of information sharing extends interpretations of the situation with projections of how the situation will develop in the near future (Endsley, 1995), a behavior particularly characteristic of proactive teams (Williams, Parker, & Turner, 2010). This requires scenario thinking in which team members reason through the implications of the information they have about the situation to deduce likely developments and potential complications (Burt & Chermack, 2008). Such thinking enables teams to develop an early warning system and proactively respond to potential opportunities or threats arising from the unfolding situation (Chermack, Bodwell, & Glick, 2010).

These three levels of information sharing differ in terms of the broad character or nature of communication taking place within a team. For example, should a team's communication be skewed to the first level—fact sharing—the team, while perhaps technically accurate in the information collected and shared, would likely suffer in terms of effectiveness by being starved of the insights and interpretations represented by the expertise of its members. Likewise, a team overly preoccupied with projection sharing and creating contingency plans might ignore or misinterpret important facts emerging from a dynamic situation. Although scholars have suggested that a shared higher level understanding of the task situation is a crucial antecedent of effective team performance and decision-making for teams functioning under highly dynamic circumstances (Bigley & Roberts, 2001; Endsley, 1997; Rico et al., 2008) and although we expect that these three types of information sharing contribute to a rich understanding of the situation, much remains unclear regarding the extent to which the teams engage in behaviors at these levels, how they are distributed over time among other communication behaviors, and how they are related to team performance.

TABLE 1 Information sharing types, definitions, sample behaviors, and related theories

	Fact sharing	Interpretation sharing	Projection sharing
Definitions	Sharing of basic factual information about individual elements of the situation	Sharing of semantically enriched information that is the result of the integration of information elements into an interpretation of the current situation	Sharing projections and anticipations of future states
Sample behaviors	"The driver of the first truck is severely wounded." "Sulfuric acid is leaking from the first vehicle."	"These chemicals make this situation here very explosive." "Given that traffic from these two roads will come together here, this traffic route will be heavily overcrowded."	"If that tanker remains at that location, it can also catch fire." "If these people will be in this traffic jam for much longer we will have to supply them with food and water."
Related theoretical concepts	Information sharing (Stasser & Titus, 1985), exploration of information space (March, 1991), situation awareness Level 1 (Endsley, 1995)	Schema-enriched communication (Rentsch, Mello, & Delise, 2010), exploration of solution space (March, 1991), situation awareness Level 2 (Endsley, 1995)	Scenario planning (Chermack et al., 2010), team proactivity (Williams, Parker, & Turner, 2010), situation awareness Level 3 (Endsley, 1995)

1.2 | Team phases and the timing of communication sequences

Previous studies of team processes over time suggest that particular clusters of team activities often occur during specific periods in the team process, suggesting the occurrence of segments or phases in the team process (e.g., Gersick, 1988; Poole, 1983). Poole and Holmes (1995) define a phase as "a coherent period of group interaction and activity that serves an identifiable function, such as a period of problem definition" (p.102). An often-cited example of a phase structure in the team process is Gersick's (1988) observation that teams shift the nature of their activities when half of the time they have been allotted has expired.

Ballard et al. (2008) noted that although group processes are often clearly segmented, because the segments are not regularly distributed over time, they may not be identifiable by simply dividing the task in evenly distributed time intervals. Therefore, we expect that the global structure of the team communication process will manifest the occurrence of changes in the concentration of specific types of team communication over the complete team task episode. If similar shifts in the concentration of activities occur in most of the teams, this suggests the existence of a phase structure in teams' communication—in other words, the existence of specific periods in which the teams engage in activities that are qualitatively different from the activities in the adjacent periods (Poole, 1983). Note that these shifts in the communication structure do not necessarily occur at the same time in all teams; teams may differ in the amount of time they spend in each phase and therefore also in the moment in time they shift from one phase to another. Previous studies on team communication suggest that it is not the total frequency of specific behaviors per se but the timing of team behaviors that is important for successful team performance (Tschan et al., 2006; Waller, 1999). Therefore, we expect that teams will manifest an identifiable phase structure in the team communication process and that the timing of communication within the team phases will be important for team performance. Because we cannot a priori establish the phase structure in the team communication processes, we do not propose a formal hypothesis; instead, we will explore the phase structure to specify more precisely when in teams' communication processes specific behaviors and processes are most beneficial for team performance.

Research Question 1: (a) What phases can be identified in the communication of multidisciplinary crisis management teams, and (b) are there differences in the phase structure between low- and high-performing teams?

1.3 | Communication sequences and information processing

The information sharing behaviors described above, while taking place within a team, represent individual-level behaviors or constructs, as they are acts of communication performed by individual team members. Simply considering single communication behaviors ignores the

temporal context in which these behaviors occur (Weingart, 1997). Although frequencies of the occurrence of these behaviors during a specific period may provide us with an estimation of the amount and type of information that is shared, they provide no information regarding how the team processes this information over time. Therefore, the exact meaning of a communication behavior should be considered in context of the behaviors that precede it in time (Ballard et al., 2008; Weingart, 1997). This notion is congruent with the work of Beck and Keyton, who maintain that "(t)he sequential nature of interaction is essential to understanding process, necessitating research methodologies inclusive of the sequential flow of group talk" (2012, p. 472). For example, information concerning fact sharing that is provided by a team member in response to a question may indicate a different type of team communication than would the same information when provided without a specific request (e.g., Rico et al., 2008; Stachowski, Kaplan, & Waller, 2009). Therefore, we argue that in addition to the extent to which teams engage in information sharing, the specific form of this information sharing process also matters. More specifically, we expect that the extent to which the teams engage in collective interpretation and sensemaking will be important for team performance.

The information processing model of groups poses that just like individuals, teams collectively process information by encoding, remembering, processing, and responding to information (Hinsz, Tindale, & Vollrath, 1997). Team members can individually process lower level information into higher level understanding (e.g., Fraidin, 2004), but they can also do this collectively in an interaction process taking place among the team members. Team members can explicitly process information by speaking out loud during interaction, thereby enabling each other to adjust, correct, refine and cocreate higher order information from lower order information elements (Van den Bossche, Gijssels, Segers, & Kirschner, 2006). Because team members have different background knowledge (e.g., discipline-specific mental models), they may apply to the information, they may process similar pieces of information differently, and consequently come to differing interpretations. By asking questions and publicly making inferences, team members impact not only their own but also other members' interpretations of that information, thereby engaging in deeper levels of information processing.

In sum, in complex and ambiguous environments, team information processing cannot be represented merely by the amount of information shared within the team; instead, it is strongly dependent on the extent to which a team collectively engages in higher level processing of the available information. Supported by work on the positive effects of reciprocal communication in hospital trauma teams (Su et al., 2017), we suggest that team processes in which team members engage in an exchange of their interpretations about the situation will lead to positive team outcomes for teams facing a complex, dynamic, and time pressured situation. Therefore, we pose the following research question:

Research Question 2: (a) How are team information sharing behaviors embedded in sequences, (b) and are there differences in the occurrence of these sequences between low- and high-performing teams?

1.4 | Knowledge tools and team information processing

Teams may use knowledge tools, such as whiteboards and other shared graphical displays, to structure their communication processes. One of the biggest challenges to teams responding to time-pressured crises is the balancing of sometimes conflicting needs for collective information processing and the needs to direct activities and collect updated information from the system or location of the crisis. In order to comply with these dual purposes, teams often struggle to optimize the efficiency of their transition processes in such a way that they can maximize the amount and quality of information processing in the minimum amount of time. Important factors, therefore, in explaining team performance are the practices and behaviors a team uses to structure its communication process (Bales, 1999; Maier, 1967). Work on distributed cognition emphasizes the role of artifacts in the formation of a shared understanding (Heath & Luff, 1992; Hutchins, 1995).

Use of knowledge tools seems to be beneficial not only because they structure the communication behaviors—such as speaking turns and sequence of topics that are discussed—but more particularly because they can provide team members with a cognitive structure that may help them to keep an overview of and efficiently remember the information that is presented in the team (Fiore, Cuevas, & Oser, 2003; Suthers & Hundhausen, 2003). This role of a shared graphical device as a cognitive structuring device gains support from an experimental study of Rentsch, Delise, Salas, and Letsky (2010), in which they trained half of their teams to exchange information on an information board using schema-enriched communication. They found that teams in the training condition made significantly more use of the information board and consequently had higher quality knowledge and more cognitive congruence than teams in a control condition. Maier (1967) suggested that groups, like individuals, can be considered to have working memory in which they keep active the information that is relevant for the task. An external knowledge tool can help a team to structure its knowledge and offload the limited working memory capacity of the team members (Scaife & Rogers, 1996). Therefore, we suggest that the use of a knowledge tool may facilitate collective sensemaking (Weick et al., 2005) in multidisciplinary teams as they collectively interpret a complex, dynamic, and time-pressured situation.

Research Question 3: (a) How does the use of a knowledge tool relate to the extent to which a multidisciplinary team engages in collective sensemaking, and (b) are there differences in the use of a knowledge tool between low- and high-performing teams?

The following section describes a study regarding 12 multidisciplinary crisis management teams we used to investigate these research questions.

2 | METHODS

2.1 | Setting

We collected data from 12 multidisciplinary crisis management teams as they participated in crisis management training simulations at the

Port of Rotterdam. The Port of Rotterdam and the adjacent industrial area stretch over a length of 40 km (25 mi.) and covers 10,500 ha (26,000 ac). It contains five oil refineries, 44 chemical and petrochemical companies, three industrial gas producers, six raw oil producers, 19 independent tank terminals for oil and chemical products, and four independent terminals for edible oils and fats. Almost half of the total transshipment of the port consists of oil and chemical products; this, together with the sheer volume of interdependent activities taking place within a relatively confined location close to a densely populated residential area, makes the port region vulnerable to both human and environmental disasters.

We first met with and explained the nature of our research goals to the president of the port, who generously provided us with a day-long orientation and tour of the port and its operations, and thereafter facilitated access to the crisis management teams. All team members were active employees of the port or of stakeholder emergency services and were individuals who might be called upon in reality to serve on a crisis management team during an actual crisis at the port. Each nine-member multidisciplinary team was led by an officer of the fire brigade and was comprised of an additional officer of the fire brigade, an officer of the police force, an officer of the port authority, a chemical specialist from the environmental protection service, a representative of the medical emergency service, a representative of the municipality, an information manager, and a public relations official of the police department. The participants were assigned to these ad hoc teams based on their work schedules and availability, as they would be for real crisis management teams. The average age of respondents was 43.98 years ($SD = 9.43$), their average organizational tenure was 16.20 years ($SD = 12.52$), and they had served as a member of various crisis management teams on average for 6.82 years ($SD = 6.64$). All teams consisted of Dutch members who spoke Dutch during the simulation.

We studied the teams as they performed a regularly scheduled training exercise consisting of a simulated scenario of an incident comparable to the type of incidents they would encounter in their role as team members during crisis management operations in the Port of Rotterdam. Examples of possible crises at the port include chemical leakages on a cargo ship, a fire at a chemical plant, and large-scale accidents involving chemical substances. The scenario used for our study was developed by industry experts working with representatives from the various emergency services. Team members were seated at individual workstations, each containing two computers. On the first computer, they received role-specific information, and they could input commands, send messages to each other, and ask questions of the simulation trainers. They could use the second computer for accessing the internet or their own organizational databases to collect additional information. At regular intervals, team members came together in the corner of the room at a rectangular table to share information, construct a shared understanding of the situation, and collectively make decisions. The training exercise was developed to reflect the actual task situation the teams could face in the field as closely as possible. The messaging and communication system was similar to the communication system they would use in real life. One major difference between the real life context and the simulated context is that they do receive most of their information in real life

situations not from computer terminals but from direct observation and communication with their units in the field.

These meetings were video recorded using two cameras and three microphones connected to the ceiling of the room. All teams engaged in at least two meetings. Some teams engaged in a third collective meeting; however, this final meeting was mainly used for reflective training purposes and little or no relevant task decisions were made in this meeting. Therefore, in order to ensure comparability among the teams, we used only the first two meetings for the analysis. We found no relationship between number of meetings and team performance.

2.1.1 | Procedure

Team members were invited to attend one of 12 crisis management simulation sessions taking place over the course of 1 year. At the start of each session, team members were provided with a presentation instructing them on the purpose and goal of the simulation, the simulation procedures, and the use of the simulation interface. In order to familiarize the participants with the procedures and simulation interface, they started with a short practice scenario. After the practice scenario, team members were asked to seat themselves at their individual work stations and the main scenario was started. The main scenario had an average duration of 3 hr. Participants received information about the emergency incident during the scenario at pre-established times. Participants of the emergency services received information that corresponded with their discipline-based role in the simulation and that was comparable to the information they would encounter in the field during actual emergency operations. During the simulation, participants could send short messages to each other and contact the simulation trainers to gather additional information. Apart from information presented on their computers, participants received scripted information from simulation trainers who played the role of field officers and representatives of the companies involved. Information provided to the participants was scripted; however, the amount and type of additional information team members could gather depended upon the questions they asked to the simulation trainers. The team leader was responsible for initiating and deciding upon the duration of the team meetings. After the simulation, team members completed a short questionnaire regarding their background and experience during the simulation.

2.1.2 | Scenario

The scenario consisted of a large-scale traffic incident at a busy traffic intersection within the port, involving multiple trucks and vehicles, chemicals (formic acid and styrene) leaking from a higher to a lower roadway, and multiple casualties. The scenario was developed so that each emergency service organization (each discipline-specific team member role) would be involved in the incident. For example, the chemical advisor supervised the measurement of substances and informed the other services on the effects and dangers associated with them, whereas the fire brigade officer was responsible for rescuing casualties and executing all activities that took place directly at the incident location. The task roles were highly interdependent, for example, and consistent with standard operating procedures, whereas

the medical services are in charge of treating and transporting casualties, they were not allowed to enter the incident area itself and therefore depended upon the fire brigade to rescue the wounded from the vehicles and supply initial medical care. Because of the complexity of the scenario and the fragmented distribution of information, it was crucial for the team members to share information and collectively construct a representation of the incident situation during the team meetings. Furthermore, not all information about the scenario became available to the team members immediately; instead, information was released over time as the events in the scenario unfolded. The scenario was interactive to a limited extent; contingent on decisions of the team members, the scenario could take separate directions (e.g., traffic jams could be limited to the extent that teams chose to divert traffic streams early on in the scenario). However, the overarching logic of the scenario and the main information elements remained similar across teams, regardless of the decisions made by the teams.

2.2 | Data coding

Our measures of information sharing are based on behavioral observation of the video recordings of the team meetings. We based our coding system on behavioral communication observation systems that were developed for similar contexts of action teams making decisions in complex task situations (e.g., Kanki & Foushee, 1989; Stachowski et al., 2009). However, in contrast to these systems, we more precisely specified the information sharing behaviors based on the three levels described previously, namely, fact sharing, interpretation sharing, and projection sharing. Using the coding scheme described below, one trained independent coder—a master's student in business—blind to the research questions, coded team members' communication behaviors on activity logs while watching the video recordings. We divided the team meetings in 10-s intervals and within each 10-s interval, the coder assigned a unique category to each communication behavior that occurred. Prior to the start of the actual coding, the primary coder received a training to apply the coding scheme and met with a supervisor of the crisis management training sessions to resolve questions that arose from the specific research context. A second master's student coded two of the 12 simulation sessions in order to establish interrater reliability measures. Overall interrater reliability, calculated by Cohen's kappa was .74, indicating an acceptable value for data of this level of complexity (Meyers & Seibold, 2012). Thus, we used the first (blind) coder's activity logs for the analyses. The activity logs contained information about the order and start time of a communication behavior (within 10-s intervals), the role (i.e., fire brigade officer, police officer, etc.) of the team member and the type of communication behavior.

Fact sharing was coded as occurring each time a team member reported a simple fact. With "simple facts," we refer to information the team members have received almost literally through the simulation and simply forward to other members. An example would be, "The driver of the first truck is severely wounded." In addition, this category includes simple information about what actions team members have taken as well as informative confirming or disconfirming answers to questions. For example, in case a team member would ask whether the chemical substance styrene was involved in the

incident and another member would answer with “yes,” this answer would be coded as fact sharing.

Utterances referring to interpretations of the situation were coded as interpretation sharing. With interpretations, we refer to an integration of simple information elements or a combination of simple information and a team member's background knowledge (Endsley, 1995). Examples include, “Given that traffic from these two roads will come together here, this traffic route will be heavily overcrowded” and “These chemicals make this situation here very explosive.” Communication behaviors that include an anticipation of a future situation or the development of possible scenarios on how the incident could develop in the near future were coded as projection sharing. Examples of this category include “If that tanker remains at that location, it can also catch fire” and “If these people will be in this traffic jam for much longer we will have to supply them with food and water.”

In addition to coding these three levels of information sharing, in order to accurately depict the communication context within which information sharing sequences might be embedded, seven key communication behaviors were coded: decisions, structuring, questions, affirmations, commands, proposals, and nontask-related communication. As noted previously, these behaviors were based on existing coding systems used with similar types of teams. *Decisions* were coded when the team closed a raised topic or problem. Thus, a decision always concluded a topic that had been raised and discussed beforehand. Examples include “So, we'll scale up the incident to Level Two” or “Ok, then we'll place two contamination units, one here and one here.” *Structuring* was coded every time a behavioral action occurred in which a team member created structure in the team process. This category included statements specifying the agenda of the meeting, asking/allowing someone to talk, urging members to hurry, and inquiring whether the information is clear for all members. *Questions* were coded as occurring when a team member requested information, including clarifications. Examples are “What kind of chemicals are involved in the incident?” and “What does that mean?” *Affirmations* were coded as occurring when a person agreed to take a specific action—for example, “Yes, I will do that.” *Commands* were coded as occurring when a team member told other team members what actions they should take or what information they should gather. Examples include “So you will inquire what will happen on the water then!” and “Could you draw that in here please?” *Proposals* were defined as opinions or suggestions regarding how the incident should be dealt with. For example, “Maybe we should call in another CoPI team” and “We can ask the company manager to join the meeting.” Finally, *nontask-related communication* was coded as all communication behaviors that did not seem to have a direct relationship to the simulation task. This would include communication about general aspects of the job or about colleagues, as well as infrequent jokes and laughter.

Whiteboard use was measured based on whether the team made use of the whiteboard in order to structure their communication. Whiteboard use was coded as present if team members actively noted down information on the whiteboard during their team discussion. It was coded as absent if team members did not write anything on the whiteboard, only wrote on the whiteboard before but not during the discussion, or only drew a sketch of the situation on the whiteboard.

Seven teams actively used the whiteboard whereas five teams did not make active use of it during their meetings.

2.2.1 | Team performance

We measured team performance with a short questionnaire that was completed by the simulation instructors after the team simulation exercise. Team functioning was judged by two instructors for six teams and by three instructors for the other six teams. Team performance was measured with three questions regarding general perceptions of team performance—for example, “Please indicate to what extent this team performed well during the crisis management simulation?” Answers were given on 7-point Likert scales. Cronbach's alpha over the three items was .95. $R_{wgP}(j)$ s calculated with a moderately skewed null distribution—given a tendency of the raters to give ratings on the high end of the scale—ranged from .78 to .98, with an average of .94, indicating acceptable agreement among the raters (LeBreton & Senter, 2008). Previous research in this area suggests that the distribution of performance is likely to be bimodal (Tschan, 1995; Waller, 1999; Waller et al., 2004); although the deviation from normality is not significant, our performance distribution also shows a bimodal shape. Therefore, in line with previous research, teams were categorized as low- or high-performing on the basis of a median split on the performance score (Tschan, 1995; Waller, 1999). High-performance teams were indicated by trainers as “exemplary for good crisis management,” whereas for low-performance teams, trainers made statements such as “this team still has much to learn.”

3 | RESULTS

Table 2 displays the relationship between demographic variables, whiteboard use, total time used by the teams, and team performance. Notably, teams with higher average tenure tend to use more time in total for the scenario. None of these variables was significantly related to performance.

3.1 | Phase structure of the team communication process

To explore Research Question 1a regarding the phase structure of the decision-making process, we conducted an exploratory analysis to determine the phase structure of the team communication processes. As Ballard et al. (2008, p. 338) indicated, “phases typically are not

TABLE 2 Means, standard deviations, and intercorrelations among variables of interest

	Mean	SD	1	2	3	4
1. Average age	43.40	3.33				
2. Average tenure	15.07	4.40	.79**			
3. Whiteboard use	0.58	0.94	.00	-.16		
4. Total time in sec	2,000.83	499.19	.37	.58*	-.15	
5. Performance	5.64	0.97	.34	.34	.46	-.24

Note. $N = 12$.

[†] $p < .10$. * $p < .05$. ** $p < .01$.

regularly distributed over time.” Whereas sessions may indicate one form of phase structure within the teams, additional phases may exist within specific sessions and extend over multiple sessions. A direct examination of the team processes may facilitate the development of well-informed temporal theories, for example, as it may inform us on phases in team interaction, which could not have been identified with simple summary measures of team member behaviors (e.g., Gersick, 1988). Our coding method allowed us to analyze such temporal patterns in the team communication data. As a first step, we created graphical representations of the team communication sequences, as represented in Figure 1. As Langley (1999, p. 700) noted

(V)isual graphical representations are particularly attractive for the analysis of process data because they

allow the simultaneous representation of a large number of dimensions, and they can easily be used to show precedence, parallel processes, and the passage of time.

We first analyzed the team communication data for indications of global patterns—phases—of team communication occurring in all teams. We alternated between investigation of the graphical representations of the team processes represented in Figure 1 and viewing of the actual videos for identification of phases in the communication data. Figure 1 displays the phases we identified, described below, along with the sequences of teams' communication behaviors for two high-performing and two low-performing teams. Sequences are ordered from left to right according to their temporal order and each sign represents a specific communication act. If successive communication acts are located on the same height, this suggests that they

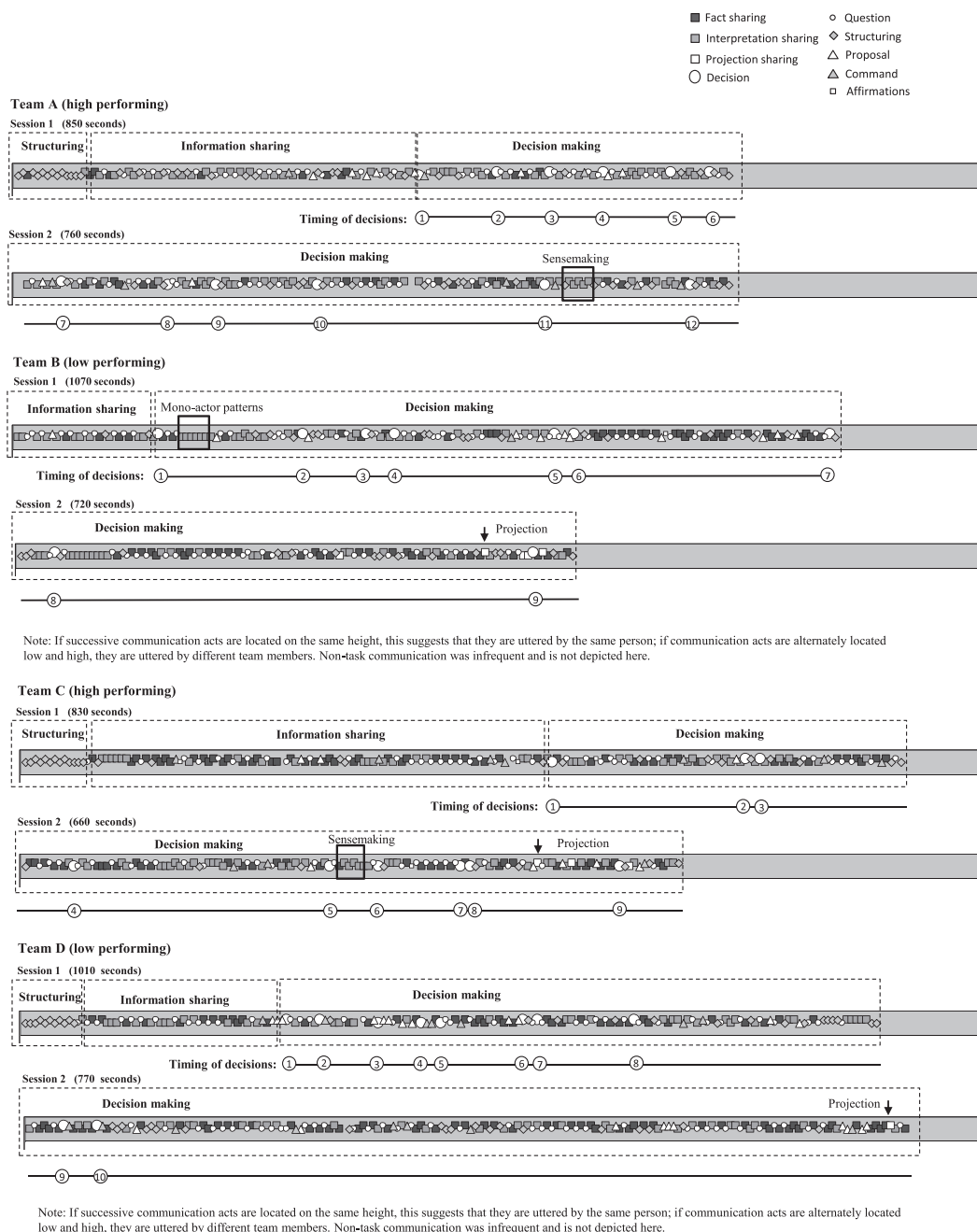


FIGURE 1 Team communication behaviors in high- and low-performing teams

are uttered by the same person; if communication acts are alternately located low and high, they are uttered by different team members.

Our analyses of the video data and the communication data displayed in Figure 1 suggest that clusters of specific communication activities can be identified in almost all teams, providing a replication of the observed phase structure. Although this broad structure seems to occur in all teams, the time each team spends on each phase and the specific activities they engage in within the phases differ significantly.

All but one team start with a *structuring phase*, in which they typically clarify team members' roles, lay out ground rules about the communication processes, and determine the outline of the meetings. Generally, the leader initiates this structuring, but other team members contribute structuring communication as well. The teams spend on average 44 s in this phase ($SD = 40.1$). The structuring phase can be clearly seen for team A, C, and D in Figure 1. Team B was the only team that does not start with initial structuring activities.

After this initial structuring, the information sharing phase commences, in which team members share the information they have gathered and provide explanations about this information to the other team members without explicitly formulating implications for actions. The teams spend on average 300 s in this phase ($SD = 83.23$). This phase can be identified in the data by the absence of decision-making—the initial period before decisions start to follow upon each other in a rapid succession. Often team members do a “round” in which all team members successively share their information with the other members. Team members share information as they are given speaking turns by the team leader, in response to questions from other team members, or as they add details or explanations to information shared by another team member. The goal of this phase is to create a shared understanding of the incident, including aspects such as a spatial understanding of the incident location, knowledge of the chemical substances involved, and an overview of the amount and severity of casualties caused by the incident. The length of this information sharing phase differs among the teams, as can be seen in Figure 1: Teams A and C engage in a relatively long information sharing phase, whereas Teams B and D engage more rapidly in decision-making actions. As soon as a first decision has been made, additional decisions follow more rapidly. This suggests that a distinction can be made between the information sharing phase and a subsequent decision-making phase.

The *decision-making phase* is initiated when team communication shifts from general information sharing about the incident to communication regarding specific decision topics. Whereas the information sharing phase is aimed at providing a general structure for the sessions and pooling all important information that is held by the team members, the decision-making phase is aimed at making decisions that are functional for the team's actions and coordination. This phase can be identified in the data by a regular punctuation of the communication with proposals and decisions. The teams spend on average 1,197 s in this phase ($SD = 179.76$). In the decision-making phase, team communication is concentrated around specific decision topics and often culminates in the team closing of the topic with a decision. Unlike many laboratory decision-making tasks in which teams must make only one decision, crisis management teams need to make decisions on a variety of subjects ranging from determining the optimal location of medical and decontamination units to establishing a strategy for containing spilled chemicals and deciding whether the incident should be scaled up to a higher emergency level. In the information sharing phase, information is shared per person as each team member shares all knowledge they consider relevant for the other members' understanding of the incident situation; in the decision-making phase, the team members contribute and explicitly interpret information in relation to a specific decision topic.

Finally, 11 out of 12 teams share projections of the future development of the scenario (Mean = 2.33, $SD = 1.97$). However, as can be seen in Figure 1, all of these teams engage in projection sharing only during the final part of the decision-making phase. There is no significant difference between low- and high-performing teams in the extent to which they engage in projection sharing ($t = 0.57$, $p = .58$) nor in the time when they start discussing future projections ($t = -0.139$, $p = .89$).

We used paired sample t tests to assess whether the relative amount of communication behaviors differed within the teams among the phases. As can be seen from Table 3, the percentages of commands, fact sharing, situation comprehension, future projection, and questions differed between the structuring phase and the information sharing phase and the percentages of all communication behaviors except proposals, commands, and fact sharing differed between the information sharing phase and the decision-making phase.

TABLE 3 Percentages of behaviors per phase

	Structuring phase	Information sharing phase	Decision-making phase
Time in seconds (SD)	47 (36)	299 (87)	1,197 (180)
Agreement	0	0	0.8**
Command	0	2.1 [†]	3.0
Fact sharing	3.6	18.2*	23.9
Interpretation sharing	0	45.3**	23.9*
Projection sharing	0	0	1.18**
Question	0	25.2**	26.8**
Structure	94.5	6**	11.3*
Proposal	1.9	3.1	3.5
Decision	0	0	5.1**
Nontask	0	0	0.6**

[†] $p < .10$. * $p < .05$. ** $p < .01$ indicate the significance of change in the relative use of the behavior in the phase compared with the previous phase.

3.2 | Phase structure and team performance

After we identified the general phase structure in the communication over all teams, we explored Research Question 1b, examining whether differences exist in the phase structures of the low- and high-performing teams. We were interested in whether the extent to which the teams adopted the specific generic phase communication structure was positively associated with team performance. Therefore, we assessed the amount of time teams spent in then structuring and the information sharing phase and the average time they spent per decision in the decision-making phase.

As can be seen from Table 4, the time teams used for the structuring phase did differ ($t = -2.04$, $p = .069$) between the low (Mean = 23.33 s) and the high-performing teams (Mean = 65.00 s). Also, the time they spent in the information sharing phase differed ($t = -2.16$, $p = .058$) between the low (Mean = 255 s) and high-performing teams (Mean = 345 s), suggesting that investing more time in the initial phases is positively related to team performance.

Finally, whereas there were no significant differences between low- and high-performing teams in the total amount of decisions per phase, the data suggest differences in the amount of time teams spent per decision in the decision-making phase. As can be seen in Table 4, the average time per decision in the decision-making phase is substantially higher for the low-performing teams ($M = 143.92$, $SD = 30.15$) than for the high-performing teams ($M = 110.89$, $SD = 14.74$). Overall, these results indicate that the answer to Research Question 1 is that specific phases can be identified in multidisciplinary crisis team communication and significant differences in the phase structure can be identified between low- and high-performing teams.

3.3 | Information sharing sequences

To explore Research Question 2a regarding the embeddedness of information sharing behaviors in sequences, we examined the graphical representation of the communication sequences for regularities in the information sharing behaviors. The coded communication acts described above represent individual-level constructs, as they are acts of communication performed by individual team members. As noted previously, aggregation of single communication behaviors ignores the temporal context in which these behaviors occur (Weingart, 1997); thus, the exact meaning of a communication behavior should be considered in context of the behaviors that preceded it in time. For example, sharing an interpretation in response to a question may

indicate a different type of team communication than when this information is provided without a specific request. Given that in teams, communication behaviors often occur in reaction to behaviors of other team members, we investigated how team-level information sharing behaviors occurred as sequences of contiguous communication behaviors. The most basic behavioral sequences consist of two subsequent communication behaviors, and most communication of the teams can be summarized by five main two-behavior sequences: question followed by fact sharing, question followed by interpretation sharing, fact sharing and interpretation sharing iterations, interpretation sharing iterations, and monoactor sequences (somewhat similar to soliloquies or monologs). Together, these sequences cover 65% of all communication acts in the teams. Figure 2 shows the five main communication sequences, including examples.

Question-and-information sharing sequences make up a large part of the team communication, occurring on average 66 times per team, or 41 times ($SD = 20.82$) as *question-fact sharing* and 25 times ($SD = 8.46$) as *question-interpretation sharing* sequences. The high occurrence of these sequences in the data suggests that in these teams, members actively probe each other for additional facts and interpretations about the incident situation. It should be noted that the presumed order of first a question and then an information communication is based on common sense logic as it cannot be derived unambiguously from the data whether the question triggers the information sharing or whether a previous information sharing triggers a question. As can be seen in Figure 1, strings of repeated question-information sharing often occur, suggesting the occurrence of small segments of active question driven information sharing.

Sequences composed only of information sharing behaviors occur on average 47.22 times ($SD = 19.92$) in the teams. There are two types of these sequences: (a) *fact sharing-interpretation sharing* sequences and (b) *interpretation sharing-interpretation sharing* sequences. For the former, these combinations suggest that team members are pooling information on a specific topic or sharing interpretations about the situation, for example, as one member provides initial facts and another member adds an interpretation. For an average of 32.78 occurrences, this constitutes combinations of fact sharing and interpretation sharing. For the latter type of sequence, an average of 14.44 ($SD = 7.91$) cases constitute combinations in which interpretation sharing of one team member is followed by interpretation sharing of another team member. These interpretive communication sequences also indicate that teams are engaging in collective sensemaking, whereby team members build on, correct, or add to

TABLE 4 Differences in phase structure between low- and high-performing teams

	Structuring				Information sharing				Decision making			
	M	SD	t	p	M	SD	t	p	M	SD	t	p
Time												
Low-performing teams	23.33	33.27	-2.04	0.07	255.00	61.56	-2.16	0.06	1,241.67	235.49	0.86	0.42
High-performing teams	65.00	37.28			345.00	81.18			1,151.67	103.81		
Time per decision												
Low-performing teams									143.92	30.15	2.41	0.05
High-performing teams									110.89	14.74		

Note. $N = 12$ teams; analyses are conducted with Welch's t test.

Category	Simple Form	Example
Question – Fact Sharing		 Medical specialist: “how many wounded do we have?” Fire brigade officer: “four... at least four” Information manager: “Are they still in the vehicles?” Fire brigade officer: “Yes, at least one is still in the truck”
Question- Interpretation Sharing		 Fire brigade commander: “Ok then can you tell me what the dangers of sulfuric acid are?” Chemical advisor: “It burns the skin, so you should run a lot of water, through the decontamination unit as fast as possible” Fire brigade officer: “Ok, and for breathing in the gas?” Chemical advisor: “That is only a secondary problem”
Fact-Interpretation sharing	 	 Fire brigade commander: “There is a bus inside this tunnel” Medical specialist: “Inside there are seven children, throwing up” Chemical advisor: “Throwing up is not a symptom that fits with (these) dangerous chemicals”
Interpretation – Interpretation sharing (sensemaking)		 Chemical advisor: “The amount of liquid containing chemicals in this area is accumulating rapidly” Fire brigade officer: “this poses the risk that the chemicals may ignite” Fire brigade commander: “Yes but they do evaporate quickly”
Mono Actor		 Fire brigade commander: “For now we will assume the worst case scenario ” Fire brigade commander: “Our first priority is to settle on the location of the wounded” Fire brigade commander: “we assume that everyone has to be sent through the deco”

FIGURE 2 Information sharing sequences

the situation comprehension of other team members. As can be seen in Figure 1, strings of repeated interpretation sharing by different members occur, suggesting that teams engage in specific periods in which they combine their interpretations, thereby engaging in team-level sensemaking activities (Klein, Wiggins, & Dominguez, 2010).

A fifth sequence cannot be considered interaction per se as it relates to sequences of communication behaviors from one single team member. These monoactor sequences (see Zijlstra, Waller, & Phillips, 2012), often consisting of interpretation sharing followed by additional interpretation sharing of the same team member, occur on average 24.9 times ($SD = 10.65$) per team. The occurrence of this sequence suggests that one team member is providing explanations to the other members about a specific topic.

3.4 | Comparison of communication behaviors and sequences between low- and high-performing teams

To investigate Research Question 2b, we investigated whether there were differences in the occurrences of the different sequences of communication per phase between the low- and the high-performing teams. We specifically considered the frequency of sequences in which one member's voicing of an interpretation followed the sharing of an interpretation from another team member, as an indication of collective sensemaking. As can be seen from Table 5, whereas the low- and high-performing teams do not significantly differ in terms of the four other sequences, in the decision-making phase, high-performing teams use significantly ($p < .05$) more interpretation–interpretation sharing sequences ($M = 13.33$), and thus collective sensemaking, than low-performing teams ($M = 4.83$). In contrast as

shown in Table 6, t tests comparing the amount fact sharing, interpretation sharing, and projection sharing between the low- and the high-performing teams per phase showed no significant differences between low- and high-performing teams. Regarding Research Question 2b, these results suggest that there are differences in the occurrence of collective sensemaking between low- and high-performing team, and the effect of the use of collective sensemaking depends on the timing of this behavior specifically in the decision-making phase.

Finally, to explore Research Question 3a regarding the relationship between the use of a knowledge tool and collective sensemaking, we investigated the effects of whiteboard use on collective sensemaking sequences (operationalized as interpretation–interpretation sharing sequences). As can be seen from Table 7, structured use of the whiteboard is positively related to the use of collective sensemaking ($p < .10$). Additionally, regarding Research Question 3b, a regression analyses of whiteboard use predicting team performance, suggests a positive, although non-significant beta ($\beta = 2.27$ [1.41], $df = 1$, $p = .13$).

4 | DISCUSSION

The purpose of this study was to assess the structure, antecedents, and consequences of information sharing behaviors in multidisciplinary teams facing complex and dynamic crisis situations. To pursue our study, we collected behavioral data from multidisciplinary teams of professionals as they occupied their discipline-specific roles in realistic crisis simulations at the Port of Rotterdam. The teams that participated in our study were taking part in regularly scheduled

TABLE 5 Differences in behavior sequences between low- and high-performing teams

	Information sharing phase				Decision-making phase			
	<i>M</i>	<i>SD</i>	<i>t</i>	<i>p</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>p</i>
Interpretation–interpretation sharing (sensemaking)								
Low-performing teams	1.00	1.67	0.00	1.00	4.83	3.97	−2.94	0.02
High-performing teams	1.00	1.10			13.33	5.85		
Question–fact sharing								
Low-performing teams	2.83	2.99	−0.76	0.47	27.00	14.03	1.00	0.36
High-performing teams	4.83	5.71			21.17	2.86		
Question–interpretation sharing								
Low-performing teams	3.33	2.73	0.50	0.63	15.50	5.36	−0.40	0.70
High-performing teams	2.67	1.75			17.00	7.48		
Fact sharing–interpretation sharing								
Low-performing teams	4.33	3.61	−0.33	0.75	24.83	12.61	−1.27	0.23
High-performing teams	5.33	6.44			33.00	9.47		
Monoactor sequence								
Low-performing teams	3.67	2.94	−1.48	0.17	16.17	10.59	1.10	0.31
High-performing teams	6.83	4.36			11.00	4.47		

Note. *N* = 12 teams; analyses are conducted with Welch's *t* test.

TABLE 6 Means, standard deviations, and *t* tests of information sharing behaviors per phase for low- and high-performing teams

	Structuring phase				Information sharing phase				Decision-making phase			
	<i>M</i>	<i>SD</i>	<i>t</i>	<i>p</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>p</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>p</i>
Fact sharing												
Low performing	0.33	(0.52)	0.00	1.00	4.50	(4.04)	−0.89	0.41	54.17	(24.61)	1.31	0.24
High performing	0.33	(0.52)			9.83	(14.13)			40.17	(8.73)		
Interpretation sharing												
Low performing	0.00	(0.00)			10.83	(7.60)	−1.60	0.15	38.67	(17.25)	−1.82	0.10
High performing	0.00	(0.00)			16.83	(5.19)			55.17	(14.03)		
Projection sharing												
Low performing	0.00	(0.00)			0.00	(0.00)			2.67	(2.34)	0.57	0.58
High performing	0.00	(0.00)			0.00	(0.00)			2.00	(1.67)		

Note. *N* = 12 teams; analyses are conducted with Welch's *t* test.

TABLE 7 Results of regression analysis of whiteboard use predicting sensemaking

	Control		Model 1	
	Beta	<i>SD</i>	Beta	<i>SD</i>
Intercept	7.69	(6.80)	1.33	(6.83)
Total communication	0.02	(0.02)	0.02	(0.02)
Whiteboard use			8.06 [†]	(4.12)
Total <i>R</i> ²	0.05		0.34	
<i>R</i> ² Change			0.28 [†]	

Note. *N* = 12.

[†]*p* < .10. **p* < .05.

training, and as professionals, took both their individual and team performance in the simulations very seriously; these were decidedly not “day off” training situations for the participants, as the skills they practiced were ones the participants fully expected to need during real crises in the future. Our exploratory analysis of the phase

structure of teams' communication indicates that the process can be divided into three separate phases: (a) a structuring phase, in which teams set the ground rules and outline for the meeting, (b) an information sharing phase in which members share individually held information and provide explanations, and (c) a decision-making phase in which the teams focus on making decisions on actions to take. Additional analyses indicated that, compared with low-performing teams, high-performing teams spent more time in the structuring and information sharing phase and made decisions more rapidly in the decision-making phase. Furthermore, our findings indicate that although the frequency of single information-related behaviors—not considering their timing relative to the communication acts of other team members—was not directly related to team performance, high-performing teams engaged in significantly more collective sensemaking than did low-performing teams during the decision-making phase. Moreover, schematic use of the whiteboard was related to the extent to which teams engaged in these collective sensemaking. We will now turn to a discussion of these findings.

4.1 | Phase structure in the team communication process

Previous studies have often indicated that phase structures can be identified in team communication processes (Poole, 1983). The present study contributes to these previous findings by showing that differences in teams' phase structures can be associated with differences in team performance. Compared with low-performing teams, high-performing teams had a clear phase structure characterized by relatively long initial phases and a decision-making phase in which decisions followed each other quite rapidly. Existing literature indicates that team processes occurring early on in teams' life spans have long-lasting effects on team performance (Ericksen & Dyer, 2004; Gersick, 1988; Mathieu & Rapp, 2009; Zijlstra et al., 2012). In particular, initial planning activities have been related to team performance in later phases (e.g., Lei, Waller, Hagen, & Kaplan, 2015; Mathieu & Rapp, 2009).

A number of explanations can be proposed for the positive relationship between the duration of the structuring and information sharing phase and team performance. A longer structuring phase is likely to provide predictability, efficiency, and clarity regarding the subsequent communication process, which may facilitate information sharing enabling the team to focus on the content of the task (Bunderson & Boumgarden, 2010). This is also consistent with previous findings that verbal behaviors that structure the group process, promote proactive communication, and inhibit dysfunctional meeting behaviors (Lehmann-Willenbrock, Allen, & Kauffeld, 2013). As such, the structuring phase functions as a transition phase that facilitates effective team processes in the subsequent decision-making phase (Marks, Mathieu, & Zaccaro, 2001).

In the information sharing phase, team members are free to contribute all information they consider relevant for the other team members; however, during the subsequent decision-making phase, team communication is focused on specific decision topics and members may be withheld from sharing information that is not immediately relevant to the topic at hand. As some information may not fit to any of the topics a team may discuss, it is important that all team members are provided the opportunity to contribute to the collective information that may be relevant for the functioning of the team. Therefore, an initial information sharing phase may help to encourage proactive behaviors from team members, such as voicing concerns and suggesting ideas (Edmondson, 2003; Farh & Chen, 2018), and may decrease biased information sharing (Larson, Christensen, Abbott, & Franz, 1996; Sohrab et al., 2015). Moreover, because the decision topics that will be discussed in the decision-making phase are not *a priori* determined, in the information sharing phase, team members may present decision topics they consider relevant to be discussed in the subsequent decision-making phase. If teams in the information sharing phase spend time on establishing a well-considered agenda of decision topics, this may lead to more structured communication and more "complete" coverage of the decision topics during the decision phase.

In addition to the longer information sharing phase, the high-performing teams made decisions more rapidly in the decision-making phase. Although in the initial information sharing phase it is important that all team members get the opportunity to share their individually

held information, in the decision-making phase, "too much" information sharing may become detrimental to performance. Because teams are under high pressure to make their decisions rapidly, it is important that they engage in a focused discussion of the decision topics and avoid spending precious time on sharing information that is not directly relevant for the team's decisions. As Weick (1995) indicated, it is often not accuracy but an acceptable shared understanding of the situation that is important for successful team performance in high-paced dynamic situations. Therefore, during this phase, it is important that team communication is aimed at leveraging a complete and shared understanding to formulate decisions that enable actions and facilitate coordination. Teams that do not take this pragmatic approach run the risk of rambling on about an issue without reaching a fact-based, timely decision (see also Denis, Dompierre, Langley, & Rouleau, 2011). An analysis of the videos suggests that the lower performing teams often engaged in unstructured, widely diverging discussion in which a variety of related issues are discussed but no clear decisions were made about any of these subjects.

4.2 | Collective interpretation processes

Although the frequencies of communication acts considered in isolation were not directly related to team performance, high-performing teams engaged in significantly more collective interpretation processes than low-performing teams during the decision-making phase. This finding is congruent with information elaboration theory, which poses that team decision-making benefits if team members engage in higher level information processing before making collective decisions (Van Knippenberg, De Dreu, & Homan, 2004). It also concurs with a study by Van den Bossche et al. (2006), who found that coconstruction of meaning in teams—collectively developing an understanding of the situation by refining, building, or modifying publicly voiced interpretations—leads to high levels of shared understanding and consequently to effective team performance. The present study thereby contributes to a growing body of research that looks into the microlevel interaction patterns that are used by high-performing teams to effectively share and interpret information (Stachowski et al., 2009; Zijlstra et al., 2012).

Collective information processing stands in contrast with individual information processing, where team members individually process information without explicitly discussing their interpretations with the other team members. Particularly when team members have varying discipline-based backgrounds, they may reach diverging interpretations based on similar information (Rico et al., 2008). Although previous research suggests that teams may benefit from receiving sensemaking input from an external team leader (Randall, Resick, & DeChurch, 2011), collective interpretation processes may preclude team members from running into misunderstandings, which may occur when interpretations are privately reached. When interpretations are communicated within the meetings, other team members have the ability to compare the voiced interpretations with their own understanding and, if needed, correct or add to this interpretation, thereby facilitating the development of a more comprehensive understanding of the situation and reducing "representational gaps" between the team members (Cronin & Weingart, 2007). As such, our findings

corroborate those of Kolbe et al. (2014) that high-performing teams tended to follow talking to the room by further talking to the room. Therefore, and as indicated in our study, careful and open collective processing is likely to lead not only to more refined but also to more similar team-level understanding of a crisis situation.

4.3 | Whiteboard structuring

Finally, teams that used the whiteboard to sketch the details of the situation and structurally depict information from various sources engaged in more collective sensemaking behaviors than teams that did not actively made use of the whiteboard. As an efficient method for communicating and emphasizing the main facts of the situation, whiteboard use can provide a shared problem space that functions as a springboard for deeper level information processing. For instance, in some teams, the officer of the fire brigade—who held the most general information about the particulars of the incident—had already started writing down information before all members arrived at the meeting, thereby economizing on valuable meeting time and allowing the team to immediately engage in a discussion of the implication of the information on the whiteboard (Artman & Garbis, 1998). This finding emphasizes the role of knowledge objects in team cognitive processing. Descriptive field studies from a variety of contexts including aviation flight decks, systems control rooms, and medical dispatch centers (e.g., Artman & Garbis, 1998; Blandford & Wong, 2004; Heath & Luff, 1992) have emphasized the role of technology and artifacts in the representation and propagation of knowledge within the team. As existing work on team cognition has rarely modeled or tested how such knowledge artifacts impact a group's cognitive functioning, we propose this as a fruitful avenue for further research.

5 | LIMITATIONS

Our choice to study teams composed of actual organizational members as they trained in a highly realistic simulated environment afforded us many advantages, including participant engagement and immersion as well as organizationally relevant outcomes and performance measures; however, some limitations were also associated with our choice. One possible limitation of our study is the reliability of the coding, as a Cohen's kappa of .74 is acceptable reliability, but only to a moderately high level (Meyers & Seibold, 2012). An explanation for this can be found in the relatively large team size (nine members) and the time-pressured and sometimes chaotic nature of the communication within the crisis teams as they worked during the highly realistic scenario. Hence, this reliability is not inconsistent with reliabilities found on other studies in similar high reliability contexts. For instance, in nuclear power plant control teams, Stachowski et al. (2009) found a Cohen's kappa of .73. Nevertheless, given that the coding scheme was developed particularly for this research setting, additional research is needed to assess the reliability of the coding scheme and its generalizability to other settings.

Additionally, limitations also arise from the small sample size of the study. First, the small sample size limits the possibility to find small- and medium-sized effects. Given the exploratory nature of the

study, it is possible that some effects are idiosyncratic for these specific teams and may not generalize to a broader population, although the findings are certainly supported by a variety of existing literature. Additionally, given the exploratory nature of our work, we identified broad research questions rather than hypotheses, precluding the use of strict criteria using Bonferroni corrections—controlling for the increased probability of finding significant results when running multiple analyses—in testing differences between low- and high-performing teams (Shaffer, 1995). Therefore, the findings from the present study should be considered as initial indications, albeit rich and informative; additional research with larger sample sizes is needed to test the robustness of these effects. Second, the small sample size limits the possibility of identifying heterogeneity in the phase structure among the teams. Although the basic three phase structure could be identified in almost all teams, the existence of variation among the teams in the length of the phases and the type of activities within the phases suggests that there may exist additional heterogeneity in the global communication structures, which has not been fully captured by the three-phase structure. For example, the longer time periods between the decisions during the decision-making phase may indicate that some teams actually reverted back to the information sharing phase after making their first decisions. Larger samples of teams are required to identify more fine-grained aspects of heterogeneity in teams' phase structures.

Finally, there are some boundary conditions of our work that should be articulated. First, the multidisciplinary teams we focused on in this paper consist of *experienced professionals*. Research on expertise in problem-solving indicates that experienced task performers are more effective in filtering information and more rapid in assessing underlying causes of problems than novice task performers (Larkin, McDermott, Simon, & Simon, 1980). Second, the present study concerns temporal “swift starting” teams (McKinney, Barker, Davis, & Smith, 2005)—that is, teams composed of those organizational members who are available at the moment or who hold pertinent expertise and hence may have no or limited previous experience in working together as a team (Faraj & Xiao, 2006; Tschan et al., 2006). Third, the specific challenges faced by these teams stem, to a large extent, from the high levels of complexity, dynamism, and time pressure exerted by the environments in which they function, serving to encumber the formation of an understanding of the situation and necessitate that teams rapidly engage in extensive interpretive or diagnostic activity in order to be able to take effective action (Nosek & McNeese, 1997; Rudolph, Morrison, & Carroll, 2009; Waller et al., 2004; Weick et al., 2005).

6 | PRACTICAL IMPLICATIONS

Although stemming from a very specific context, the findings of this study suggests practical implications on how to optimally structure the team communication process to facilitate collective decision-making and the development of team situation awareness. When faced with complex crises under high levels of time pressure, teams need to balance the requirement for a rapid response with the need to act based upon a shared and comprehensive understanding of the situation. On

one hand, this requires a highly disciplined communication structure, characterized by a clear phase structure and focused discussion on specific decisions. On the other hand, team members must be provided with the opportunity to disagree with each other's interpretations and to collectively make sense of the situation, as doing otherwise dilutes the advantages of bringing together experienced team members from multiple disciplines to respond to a crisis.

By using realistic crisis scenarios to focus on team behaviors in addition to technical responses (Waller, Lei, & Pratten, 2014), training can be designed to help teams, leaders, and team members to find this optimal balance between meeting discipline and assertiveness. For instance, recent research suggests that team interventions aimed at delaying the start of the action phase can benefit optimal team communication (Kennedy & McComb, 2014). Interventions can also be focused specifically on the use of knowledge tools. Additionally, Rentsch et al. (2010) found that an intervention promoting structured use of a whiteboard facilitated the development of cognitive congruence in teams solving complex problems.

Our findings suggest that teams benefit from a clear meeting structure and discipline. This can be promoted by training crisis management team leaders to be process directive—taking control of the process by which decisions are made in contrast to taking control of the substance of decisions (Peterson, 1997). Similarly, individual team members may be trained to increase the efficiency and effectiveness by which they share their expert knowledge within the team. Individual training can focus on team members skills in selecting which information elements should be shared with the other team members and which information can be filtered out (Ancona & Caldwell, 1992). Finally, training can help to build expert team members' ability to succinctly explain their knowledge to other members who do not share the same expertise in order to ensure effective knowledge transfer (Argote, Ingram, Levine, & Moreland, 2000; Hinds, Patterson, & Pfeffer, 2001) and reduce potential representational gaps (Cronin & Weingart, 2007).

7 | CONCLUSION

Weingart (1997) distinguished between analyses of what groups do—relating to the frequencies of specific behaviors—and analyses of how groups do it—focusing on the sequential nature of team member interaction. Although an increasing number of studies investigate team processes over time, these studies still often use perception-based summary measures or frequencies of behaviors summarized over a period of time (e.g., Jehn & Mannix, 2001; van der Kleij, Schraagen, Werkhoven, & De Dreu, 2009). Although these studies provide information on the dynamics of team processes over time, they do not give us insight into how teams actually execute their tasks, nor do they provide information on the actual sequences of behavior that make up the team process. In order to gain more insight into the “how” of team processes, Ballard et al. (2008) issued a call to more explicitly incorporate time in the analyses of team communication data. With this study, we attempted to answer this and other similar calls in three ways. First, we analyzed the team communication data for indications of a global structure—phases—of team communication occurring in all

teams. Second, apart from looking at frequencies of behaviors, we identified local patterns—sequences—of contiguous communication acts that indicated collective information sharing embedded in the behavioral communication context. Third, we compared low- and high-performing teams on their use of both frequencies and sequences in the different phases of the team communication process. The results of these analyses clearly indicate the added benefit of adopting a temporal approach to analyzing team communication and provide a new window to the processes of effective interdisciplinary crisis management teams.

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REFERENCES

- Ancona, D. G., & Caldwell, D. F. (1992). Bridging the boundary: External activity and performance in organizational teams. *Administrative Science Quarterly*, 37, 634–665.
- Ancona, D. G., Okhuysen, G. A., & Perlow, L. A. (2001). Taking time to integrate temporal research. *Academy of Management Review*, 26, 512–529. <https://doi.org/10.5465/AMR.2001.5393887>
- Argote, L., Ingram, P., Levine, J. M., & Moreland, R. L. (2000). Knowledge transfer in organizations: Learning from the experience of others. *Organizational Behavior and Human Decision Processes*, 82, 1–8.
- Arrow, H., Poole, M. S., Henry, K. B., Wheelan, S., & Moreland, R. (2004). Time, change, and development: The temporal perspective on groups. *Small Group Research*, 35, 73–105. <https://doi.org/10.1177/1046496403259757>
- Artman, H., & Garbis, C. (1998). Situation awareness as distributed cognition. Paper presented at the *European Conference on Cognitive Ergonomics, Cognition and Cooperation*, Limerick, Ireland.
- Bales, R. F. (1999). *Social interaction systems: Theory and measurement*. New Brunswick, NJ: Transaction.
- Ballard, D. I., Tschan, F., & Waller, M. J. (2008). All in the timing: Considering time at multiple stages of group research. *Small Group Research*, 39, 328–351. <https://doi.org/10.1177/1046496408317036>
- Baumann, M. R., & Bonner, B. L. (2013). Member awareness of expertise, information sharing, information weighting, and group decision making. *Small Group Research*, 44, 532–562. <https://doi.org/10.1177/1046496413494415>
- Beck, S. J., & Keyton, J. (2012). Team cognition, communication, and message interdependence. In E. Salas, S. M. Fiore, & M. P. Letsky (Eds.), *Theories of team cognition: Cross-disciplinary perspectives* (pp. 471–494). New York: Routledge.
- Bigley, G. A., & Roberts, K. H. (2001). The incident command system: High-reliability organizing for complex and volatile task environments. *Academy of Management Journal*, 44, 1281–1299. <https://doi.org/10.2307/3069401>
- Blandford, A., & Wong, B. W. (2004). Situation awareness in emergency medical dispatch. *International Journal of Human-Computer Studies*, 61, 421–452.
- Bolstad, C. A., Foltz, P., Franzke, M., Cuevas, H. M., Rosenstein, M., & Costello, A. M. (2007). Predicting situation awareness from team communications. *Proceedings of the 51st Annual Meeting of the Human Factors and Ergonomics Society*. Santa Monica, CA: HFES.
- Bunderson, J. S., & Boumgarden, P. (2010). Structure and learning in self-managed teams: Why “bureaucratic” teams can be better learners. *Organization Science*, 21, 609–624.
- Burt, G., & Chermack, T. J. (2008). Learning with scenarios. *Advances in Developing Human Resources*, 10, 285–295.

- Chermack, T. J., Bodwell, W., & Glick, M. (2010). Two methods for leveraging teams toward organizational effectiveness: Scenario planning and organizational ambidexterity. *Advances in Developing Human Resources*, 12, 137–156. <https://doi.org/10.1177/1523422310365669>
- Christianson, M. K. (2009). Updating as part of everyday work: An interactional perspective. Unpublished dissertation, University of Michigan.
- Clark, H. H., & Brennan, S. E. (1991). Grounding in communication. *Perspectives on Socially Shared Cognition*, 13, 127–149.
- Cooke, N. J., Salas, E., Cannon-Bowers, J. A., & Stout, R. J. (2000). Measuring team knowledge. *Human Factors*, 42, 151–173.
- Cronin, M. A., & Weingart, L. R. (2007). Representational gaps, information processing, and conflict in functionally diverse teams. *Academy of Management Review*, 32, 761–773. <https://doi.org/10.5465/AMR.2007.25275511>
- Denis, J. L., Dompierre, G., Langley, A., & Rouleau, L. (2011). Escalating indecision: Between reification and strategic ambiguity. *Organization Science*, 22, 225–244. <https://doi.org/10.1287/orsc.1090.0501>
- Durso, F. T., & Gronlund, S. D. (1999). Situation awareness. In F. T. Durso (Ed.), *Handbook of applied cognition* (pp. 283–314). New York, NY: John Wiley & Sons Ltd.
- Edmondson, A. C. (2003). Speaking up in the operating room: How team leaders promote learning in interdisciplinary action teams. *Journal of Management Studies*, 40, 1419–1452. <https://doi.org/10.1111/1467-6486.00386>
- Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. *Human Factors*, 37, 32–64.
- Endsley, M. R. (1997). The role of situation awareness in naturalistic decision making. In C. Zsombok, & G. Klein (Eds.), *Naturalistic decision making* (pp. 269–283). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Ericksen, J., & Dyer, L. (2004). Right from the start: Exploring the effects of early team events on subsequent project team development and performance. *Administrative Science Quarterly*, 49, 438–471. <https://doi.org/10.2307/4131442>
- Faraj, S., & Xiao, Y. (2006). Coordination in fast-response organizations. *Management Science*, 52, 1155–1169. <https://doi.org/10.1287/mnsc.1060.0526>
- Farh, C. I., & Chen, G. (2018). Leadership and member voice in action teams: Test of a dynamic phase model. *Journal of Applied Psychology*, 103, 97–110.
- Fiore, S. M., Cuevas, H. M., & Oser, R. L. (2003). A picture is worth a thousand connections: The facilitative effects of diagrams on mental model development and task performance. *Computers in Human Behavior*, 19, 185–199.
- Fraidin, S. N. (2004). When is one head better than two? Interdependent information in group decision making. *Organizational Behavior and Human Decision Processes*, 93, 102–113.
- Franz, T. M., & Larson, J. R. (2002). The impact of experts on information sharing during group discussion. *Small Group Research*, 33, 383–411. <https://doi.org/10.1177/104649640203300401>
- Gersick, C. J. G. (1988). Time and transition in work teams: Toward a new model of group development. *Academy of Management Journal*, 31, 9–41.
- Gutwin, C., & Greenberg, S. (2004). The importance of awareness for team cognition in distributed collaboration. In E. Salas, & S. M. Fiore (Eds.), *Team cognition: Understanding the factors that drive process and performance* (pp. 177–201). Washington, DC: American Psychological Association.
- Hamilton, K., Mancuso, V., Mohammed, S., Tesler, R., & McNeese, M. (2017). Skilled and unaware: The interactive effects of team cognition, team metacognition, and task confidence on team performance. *Journal of Cognitive Engineering and Decision Making*, 11, 382–395.
- Heath, C., & Luff, P. (1992). Collaboration and control: Crisis management and multimedia technology in London Underground line control rooms. *Journal of Computer Supported Cooperative Work*, 1, 24–48.
- Hinds, P. J., Patterson, M., & Pfeffer, J. (2001). Bothered by abstraction: The effect of expertise on knowledge transfer and subsequent novice performance. *Journal of Applied Psychology*, 86, 1232–1243.
- Hinsz, V. B., Tindale, R. S., & Vollrath, D. A. (1997). The emerging conceptualization of groups as information processes. *Psychological Bulletin*, 121, 43–64.
- Humphrey, S. E., & Aime, F. (2014). Team microdynamics: Toward an organizing approach to teamwork. *Academy of Management Annals*, 8, 443–503.
- Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA, US: The MIT Press.
- James, E. H., & Wooten, L. P. (2010). *Leading under pressure: From surviving to thriving before, during and after a crisis*. New York: Routledge.
- Jehn, K. A., & Mannix, E. A. (2001). The dynamic nature of conflict: A longitudinal study of intragroup conflict. *Academy of Management Journal*, 44, 238–251.
- Kanki, B. G., & Foushee, H. C. (1989). Communication as group process mediator of aircrew performance. *Aviation, Space, and Environmental Medicine*, 60, 402–410.
- Kennedy, D. M., & McComb, S. A. (2010). Merging internal and external processes: Examining the mental model convergence process through team communication. *Theoretical Issues in Ergonomics Science*, 11, 340–358.
- Kennedy, D. M., & McComb, S. A. (2014). When teams shift among processes: Insights from simulation and optimization. *Journal of Applied Psychology*, 99, 784–815.
- Keyton, J., Beck, S. J., & Asbury, M. B. (2010). Macrocognition: A communication perspective. *Theoretical Issues in Ergonomics Science*, 11, 272–286.
- King, G. (2002). Crisis management & team effectiveness: A closer examination. *Journal of Business Ethics*, 41, 235–249.
- Klein, G., Wiggins, S., & Dominguez, C. O. (2010). Team sensemaking. *Theoretical Issues in Ergonomics Science*, 11, 304–320.
- Kolbe, M., Grote, G., Waller, M. J., Wacker, J., Grande, B., Burtcher, M. J., & Spahn, D. R. (2014). Monitoring and talking to the room: Autochthonous coordination patterns in team interaction and performance. *Journal of Applied Psychology*, 99, 1254–1267.
- Langley, A. (1999). Strategies for theorizing from process data. *Academy of Management Review*, 24, 691–710.
- Larkin, J., McDermott, J., Simon, D. P., & Simon, H. A. (1980). Expert and novice performance in solving physics problems. *Science*, 208, 1335–1342.
- Larson, J. R., Christensen, C., Abbott, A. S., & Franz, T. M. (1996). Diagnosing groups: Charting the flow of information in medical decision-making teams. *Journal of Personality and Social Psychology*, 71, 315–330.
- LeBreton, J. M., & Senter, J. L. (2008). Answers to 20 questions about interrater reliability and interrater agreement. *Organizational Research Methods*, 11, 815–852.
- Lee, J., Woeste, J. H., & Heath, R. L. (2007). Getting ready for crises: Strategic excellence. *Public Relations Review*, 33, 334–336.
- Lehmann-Willenbrock, N., Allen, J. A., & Kauffeld, S. (2013). A sequential analysis of procedural meeting communication: How teams facilitate their meetings. *Journal of Applied Communication Research*, 41, 365–388. <https://doi.org/10.1080/00909882.2013.844847>
- Lei, Z., Waller, M. J., Hagen, J., & Kaplan, S. (2015). Team adaptiveness in dynamic contexts: Contextualizing the roles of interaction patterns and in-process planning. *Group & Organization Management*, 41, 491–525. <https://doi.org/10.1177/1059601115615246>
- Maier, N. R. (1967). Assets and liabilities in group problem solving: The need for an integrative function. *Psychological Review*, 74, 239–249.
- March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, 2, 71–87.

- Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review*, 26, 356–376.
- Mathieu, J. E., & Rapp, T. L. (2009). Laying the foundation for successful team performance trajectories: The roles of team charters and performance strategies. *Journal of Applied Psychology*, 94, 90–103.
- Maynard, M. T., Kennedy, D. M., & Sommer, S. A. (2015). Team adaptation: A fifteen-year synthesis (1998–2013) and framework for how this literature needs to “adapt” going forward. *European Journal of Work and Organizational Psychology*, 24, 652–677.
- McKinney, E. H., Barker, J. R., Davis, K. J., & Smith, D. (2005). How swift starting action teams get off the ground. *Management Communication Quarterly*, 19, 198–237.
- Meyers, R. A., & Seibold, D. R. (2012). Coding group interaction. In A. B. Hollingshead, & M. S. Poole (Eds.), *Research methods for studying groups and teams: A guide to approaches, tools, and technologies* (pp. 329–357). New York, NY: Routledge.
- Nosek, J. T., & McNeese, M. D. (1997). Augmenting groups sense making in ill-defined emerging situations: Experiences, lessons learned and issues for future development. *Information Technology, & People*, 10, 241–252.
- Pearson, C. M., & Clair, J. A. (1998). Reframing crisis management. *Academy of Management Review*, 23, 59–76.
- Pérez-Nordtvedt, L., Payne, G. T., Short, J. C., & Kedia, B. L. (2008). An entrainment-based model of temporal organizational fit, misfit, and performance. *Organization Science*, 19, 785–801.
- Peterson, R. S. (1997). A directive leadership style in group decision making can be both virtue and vice: Evidence from elite and experimental groups. *Journal of Personality and Social Psychology*, 72, 1107–1121.
- Poole, M. S. (1983). Decision development in small groups: II. A study of multiple sequences in decision making. *Communication Monographs*, 50, 206–232.
- Poole, M. S., & Holmes, M. E. (1995). Decision development in computer-assisted group decision making. *Human Communication Research*, 22, 90–127.
- Randall, K. R., Resick, C. J., & DeChurch, L. A. (2011). Building team adaptive capacity: The roles of sensegiving and team composition. *Journal of Applied Psychology*, 96, 525–540.
- Rentsch, J. R., Delise, L. A., Salas, E., & Letsky, M. P. (2010). Facilitating knowledge building in teams: Can a new team training strategy help? *Small Group Research*, 41, 505–523.
- Rentsch, J. R., Mello, A. L., & Delise, L. A. (2010). Collaboration and meaning analysis process in intense problem solving teams. *Theoretical Issues in Ergonomics Science*, 11, 287–303.
- Rico, R., Sánchez-Manzanares, M., Gil, F., & Gibson, C. (2008). Team implicit coordination processes: A team knowledge-based approach. *Academy of Management Review*, 33, 163–184.
- Roth, E. M., Multer, J., & Raslear, T. (2006). Shared situation awareness as a contributor to high reliability performance in railroad operations. *Organization Studies*, 27, 967–987.
- Rudolph, J. W., Morrison, J. B., & Carroll, J. S. (2009). The dynamics of action-oriented problem solving: Linking interpretation and choice. *Academy of Management Review*, 34, 733–756.
- Salas, E., Prince, C., Baker, D. P., & Shrestha, L. (1995). Situation awareness in team performance: Implications for measurement and training. *Human Factors*, 37, 123–136.
- Scaife, M., & Rogers, Y. (1996). External cognition: How do graphical representations work? *International Journal of Human-Computer Studies*, 45, 185–213.
- Shaffer, J. P. (1995). Multiple hypothesis testing. *Annual Review of Psychology*, 46, 561–584.
- Shore, J., Bernstein, E., & Lazer, D. (2015). Facts and figuring: An experimental investigation of network structure and performance in information and solution spaces. *Organization Science*, 26, 1432–1446.
- Smart, C., & Vertinsky, I. (1977). Designs for crisis decision units. *Administrative Science Quarterly*, 22, 640–657.
- Smith, W., & Dowell, J. (2000). A case study of co-ordinative decision-making in disaster management. *Ergonomics*, 43, 1153–1166.
- Sohrab, S. G., Waller, M. J., & Kaplan, S. (2015). Exploring the hidden-profile paradigm: A literature review and analysis. *Small Group Research*, 46, 489–535.
- Stachowski, A. A., Kaplan, S. A., & Waller, M. J. (2009). The benefits of flexible team interaction during crises. *Journal of Applied Psychology*, 94, 1536–1543.
- Starbuck, W. H., & Milliken, F. J. (1988). Executives' perceptual filters: What they notice and how they make sense. In D. C. Hambrick (Ed.), *The executive effect: Concepts and methods for studying top managers* (pp. 35–65). Us: Elsevier Science/JAI Press.
- Stasser, G., Stewart, D. D., & Wittenbaum, G. M. (1995). Expert roles and information exchange during discussion: The importance of knowing who knows what. *Journal of Experimental Social Psychology*, 31, 244–265. <https://doi.org/10.1006/jesp.1995.1012>
- Stasser, G., & Titus, W. (1985). Pooling of unshared information in group decision making: Biased information sampling during discussion. *Journal of Personality and Social Psychology*, 48, 1467–1478.
- Stout, R. J., Cannon-Bowers, J. A., & Salas, E. (1996). The role of shared mental models in developing team situational awareness: Implications for training. *Training Research Journal*, 2, 85–116.
- Su, L., Kaplan, S., Burd, R., Winslow, C., Hargrove, A., & Waller, M. (2017). Trauma resuscitation: Can team behaviors in the pre-arrival period predict resuscitation performance? *British Medical Journal: Simulation & Technology Enhanced Learning*, 3, 106–110. <https://doi.org/10.1136/bmjstel-2016-000143>
- Su, L., Waller, M., Kaplan, S., Watson, A., Jones, M., & Wessel, D. L. (2015). Cardiac resuscitation events: One eyewitness is not enough. *Pediatric Critical Care Medicine*, 16, 335–342.
- Suthers, D. D., & Hundhausen, C. D. (2003). An experimental study of the effects of representational guidance on collaborative learning processes. *The Journal of the Learning Sciences*, 12, 183–218.
- Tschan, F. (1995). Communication enhances small group performance if it conforms to task requirements: The concept of ideal communication cycles. *Basic and Applied Social Psychology*, 17, 371–393.
- Tschan, F., Semmer, N. K., Gautschi, D., Hunziker, P., Spychiger, M., & Marsch, S. (2006). Leading to recovery: Group performance and coordinative activities in medical emergency driven groups. *Human Performance*, 19, 277–304.
- Van den Bossche, P., Gijssels, W. H., Segers, M., & Kirschner, P. A. (2006). Social and cognitive factors driving teamwork in collaborative learning environments. *Small Group Research*, 37, 490–521.
- Van der Haar, S., Segers, M., Jehn, K., & Van den Bossche, P. (2015). Investigating the relation between team learning and the team situation model. *Small Group Research*, 46, 50–82.
- van der Kleij, R., Schraagen, J. M., Werkhoven, P., & De Dreu, C. K. W. (2009). How conversations change over time in face-to-face and video-mediated communication. *Small Group Research*, 40, 355–381.
- Van Knippenberg, D., De Dreu, C. K. W., & Homan, A. C. (2004). Work group diversity and group performance: An integrative model and research agenda. *Journal of Applied Psychology*, 89, 1008–1022.
- Waller, M. J. (1999). The timing of adaptive group responses to nonroutine events. *Academy of Management Journal*, 42, 127–137.
- Waller, M. J., Gupta, N., & Giambattista, R. C. (2004). Effects of adaptive behaviors and shared mental models on control crew performance. *Management Science*, 50, 1534–1545.
- Waller, M. J., Huber, G. P., & Glick, W. H. (1995). Functional background as a determinant of executives' selective perception. *Academy of Management Journal*, 38, 943–974.
- Waller, M. J., Lei, Z., & Pratten, R. (2014). Exploring the role of crisis management teams in crisis management education. *Academy of Management Learning & Education*, 13, 208–221.

- Waller, M. J., Okhuysen, G. A., & Saghafian, M. (2016). Conceptualizing emergent states: A strategy to advance the study of group dynamics. *Academy of Management Annals*, 10, 561–598. <https://doi.org/10.1080/19416520.2016.1120958>
- Waller, M. J., & Uitdewilligen, S. (2008). Talking to the room: Collective sensemaking during crisis situations. In R. Roe, M. J. Waller, & S. Clegg (Eds.), *Time in organizational research: Approaches and methods* (pp. 186–203). London: Routledge.
- Weick, K. E. (1995). *Sensemaking in organizations*. Thousand Oaks, CA: Sage.
- Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of sensemaking. *Organization Science*, 16, 409–421.
- Weingart, L. R. (1997). How did they do that? The ways and means of studying group process. In L. L. Cummings, & B. M. Staw (Eds.), *Research in organizational behavior* (Vol. 19) (pp. 189–239). Greenwich: JAI Press.
- Williams, H. M., Parker, S. K., & Turner, N. (2010). Proactively performing teams: The role of work design, transformational leadership, and team composition. *Journal of Occupational and Organizational Psychology*, 83, 301–324.
- Zijlstra, F. R., Waller, M. J., & Phillips, S. I. (2012). Setting the tone: Early interaction patterns in swift-starting teams as a predictor of effectiveness. *European Journal of Work and Organizational Psychology*, 21, 749–777.

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