

3

The Wisdom of Collectives in Organizations: An Update of the Teamwork Competencies

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Introduction

What do we mean by the *wisdom of collectives*? This is best illustrated by examining the trend toward discussing emergence within teams (Kozlowski & Klein, 2000) and other social systems (Chu, Strand, & Fjelland, 2003; Streufert, 1997). Emergence is characterized by the creation of "novel and coherent structures, patterns and properties during the process of self-organization in complex systems" (Goldstein, 1999, p. 49). Emergent properties are the result of the interaction of the components of the system from which these emergent properties arise but cannot be reduced to or described wholly in terms of the elementary components of the system considered in isolation. The whole truly is greater than (or at least different from) the sum of its parts. In this way some teams are able to synergistically combine the attributes of its members to produce outcomes well beyond the capacity of any one individual member or of the pooled or summated output of all its members (Cannon-Bowers, Salas, & Converse, 1993; Salas, Cannon-Bowers, & Johnston, 1997; Salas, Rosen, Burke, Goodwin, & Fiore, 2006). This is what we refer to with the phrase the *wisdom of collectives*: the increased capacity for performance of various types afforded by the interactions of team members.

It is the purpose of this chapter to document what is known about the mechanisms of teamwork interaction that enable the development of the wisdom of collectives. Surely all collectives are not equal. Not all teams are able to leverage their team member expertise effectively (e.g., Hirschfeld, Jordan, Feild, Giles, & Armenakis, 2006). So what separates exceptional from average and poorer performing teams? Understanding the processes

of teamwork is key to understanding the wisdom of collectives, the means by which teams successfully interact to produce superior team outcomes. This issue has been studied from many different vantage points, and a complete review of these efforts is well beyond the scope of any one chapter. Therefore, the intent of this chapter is to both retrospectively and prospectively chart the course of the study of teams by demarcating where we've been, where we are, and where we should be headed as a field of inquiry. To this end, we set out to meet the following goals. First, we provide an overview of teamwork by reviewing the current scientific understanding of teams and recent developments in the field. Second, we further delineate teamwork by updating the teamwork competencies—the knowledge, skills, and attitudes (KSAs) necessary for effective teamwork—proposed more than a decade ago by Cannon-Bowers, Tannenbaum, Salas, and Volpe (1995). Third, we present a research agenda for furthering our understanding of the wisdom of collectives in organizations.

What Are the Mechanisms of Teamwork?

In this section we provide an up-to-date global view of teamwork by reviewing recent developments in the science of teams. To discuss teamwork appropriately requires the definition of a small constellation of related terms. The interdisciplinary nature of team research has led to great theoretical and practical advances in knowledge, but the ontological drift of terminology between research communities continues to be an issue that impedes understanding and further advancement. Therefore, we begin our discussion of teamwork with a set of definitions on which we anchor the remainder of our discussion.

Definitions

First, a *team* is defined as a set of two or more individuals that adaptively and dynamically interacts through specified roles as they work toward shared and valued goals (Dyer, 1984; Salas, Dickinson, Converse, & Tannenbaum, 1992). Team member interdependency is a critical feature of defining the essence of a team (Saavedra, Earley, & Van Dyne, 1993). In addition to this, teams can often be characterized as having heterogeneous and distributed expertise (Salas, Stagl, Burke, & Goodwin, 2007); that is, team members often have different specializations in knowledge and skills. In fact, it is this diversity of expertise that creates the potential for teams to complete work outside the scope of any one individual's

capabilities. The social dynamics of effective teamwork are necessary to realize this potential.

Teamwork is the "dynamic, simultaneous and recursive enactment of process mechanisms which inhibit or contribute to team performance and performance outcomes" (Salas, Stagl, Burke & Goodwin, 2007, p. 190). To clarify this definition, it is useful to think of competencies within a team as belonging to one of two types: teamwork and taskwork (McIntyre & Salas, 1998; Morgan, Glickman, Woodard, Blaiwes, & Salas, 1986). Taskwork competencies are the knowledge, skills, attitudes, and other characteristics (KSAOs) used to accomplish individual task performance; the application of these skills does not require interdependent interaction within the team. Teamwork competencies are the KSAOs necessary for members to function within an interdependent team. Therefore, team members must possess not only individual-level expertise relevant to the technical performance of their own individual tasks but also expertise in the social dynamics of teamwork (Salas et al., 2006). Teamwork is the *process* of enacting these teamwork competencies. Much of the remainder of this chapter is devoted to the description of these teamwork processes.

Team performance is a multilevel process arising as team members enact both their individual taskwork performance processes and individual- and team-level teamwork processes (Kozlowski & Klein, 2000; Salas et al., 2007). This can be contrasted with the definition of teamwork already provided, which focuses on the enactment of teamwork processes alone. Therefore, teamwork is nested within team performance in that team performance is the combination of both individual performance and teamwork processes. This definition is consistent with the conceptualization of performance as a process and not an outcome (Campbell, 1990).

Team effectiveness is an evaluation of the outcomes of team performance processes relative to some set of criteria. It is a judgment of how well the results of performance meet some set of relatively objective (e.g., metrics of productivity) or subjective (e.g., supervisor or observer ratings) standards. These standards are ideally aligned with the goals of the team and organization. Hackman (1987) proposed three dimensions of team effectiveness. First, the relevant stakeholders judge whether the team is meeting standards of quality and quantity. Second, group members evaluate whether they are satisfied with their team participation. Third, the degree to which the team's interaction has maintained, weakened, or strengthened the work group's capacity to continue to work together should be assessed.

The increasing interest in teams has led to a proliferation of theoretical models and frameworks of teamwork, team performance, and team effectiveness. A recent review identified 138 attempts from various disciplines that model or frame aspects of team performance or team effectiveness (Salas et al., 2007). This abundance of theories, models, and frameworks is indicative of a "golden age" of interest in teams. Unfortunately, this large

number of models, which are often context or domain specific in nature, also complicates the process of translating the current understanding of teams into actionable and practical guidance for organizations. However, there have been several recent and notable efforts in the area of integrating these models and frameworks of teamwork, team performance, and team effectiveness. The following section discusses several of these efforts.

What Is Teamwork?

Teamwork is the means by which individual task expertise is translated, magnified, and synergistically combined to yield superior performance outcomes, the wisdom of the collectives. This section briefly summarizes the current state of the science regarding teamwork. Our review here is necessarily selective and focuses primarily on work seeking to characterize teamwork in a global and generalizable manner. First, we review a recently advanced model of teamwork (Salas, Sims, & Burke, 2005) because it represents a broad cross-section of the literature. Second, we turn toward other recently advanced frameworks for organizing and understanding teamwork behaviors. Third, we discuss some of the newly developed extensions to the traditional Input-Process-Output (IPO) method of describing teamwork.

A Model of Teamwork

Salas and colleagues (2005) proposed the idea that there might be a "big five" in teamwork; that is, across, for example, domains, team goals, and tasks, there are five core components of teamwork: (1) team leadership; (2) adaptability; (3) mutual performance monitoring; (4) backup behavior; and (5) team orientation. The importance of each component may vary in degree across contexts, but each of the five teamwork components in some form is essential for any type of teamwork. In addition to the five components of teamwork, three coordinating mechanisms are identified: (1) shared mental models; (2) closed-loop communication; and (3) mutual trust. These coordinating mechanisms facilitate the enactment of the five factors of teamwork. Each of the coordinating mechanisms and core components of teamwork are briefly discussed in the following sections.

The Five Core Components of Teamwork

Team leadership has substantial ramifications for the effectiveness of teams and organizations at large. The functional approach to leadership, which

has emerged as a dominant perspective (e.g., Fleishman et al., 1991; Hackman, 2002; Zaccaro, Rittman, & Marks, 2001), characterizes leadership as "social problem solving that promotes coordinated, adaptive team performance by facilitating goal definition and attainment" (Salas, Burke, & Stagl, 2004, p. 343). Leaders solve social problems through four general types of actions: (1) the search for and structuring of information; (2) the use of information in problem solving; (3) the management of personnel resources; and (4) the management of material resources.

To meet the demands of increasingly dynamic task environments, the concept of shared leadership has been explored. Shared leadership is the "transference of the leadership function among team members to take advantage of member strengths (e.g., knowledge, skills, attitudes, perspectives, contacts, and time available) as dictated by either environmental demands or the development stage of the team" (Burke, Fiore, & Salas, 2004, p. 105). This can allow the team to be more responsive to changing environmental conditions and to more optimally leverage the heterogeneous individual level expertise of team members. There is preliminary research showing that shared leadership is more effective than traditional leadership structures (Pearce & Sims, 2002).

Adaptability within teams underlies many team functions and behaviors (Burke, Stagl, Salas, Pierce, & Kendall, 2006) and can be characterized as the team's ability to change team performance processes in response to cues from the environment in a manner that results in functional team outcomes (Burke et al., 2006; Entin & Serfaty, 1999). Adaptability is an essential component of teamwork, especially for teams operating under dynamic conditions. Until recently, there has been only a small amount of research dealing with temporal aspects of team processes and performance (Dyer, 1984). This void is beginning to be addressed (e.g., Gersick, 1988; Morgan, Salas, & Glickman, 2001). For example, Burke and colleagues (2006) proposed a model of team adaptation. At the center of this model is adaptive team performance, defined as "an emergent phenomenon which compiles over time from the unfolding of a recursive cycle whereby one or more team members utilize their resources to functionally change current cognitive or behavioral goal directed action or structures to meet expected or unexpected demands" (ibid., p. 1192). Adaptive team performance is achieved as the team passes through four phases. The first phase consists of situation assessment, a process by which team members recognize cue patterns in the environment and build a coherent understanding of their present circumstances. The second phase is plan formulation, where the team generates and decides on a course of action appropriate for the current situation. The third phase is plan execution, which is achieved via team coordination mechanisms. The fourth and final phase is team learning, wherein the team evaluates the effectiveness of its performance. The results of this evaluation will feed into future performance episodes

(i.e., passes through the adaptive cycle) as emergent affective and cognitive states developed in previous performance episodes influence performance in future episodes. Adaptability has been framed in other ways as well, such as the self-regulation of processes relative to individual and team goals (Deshon, Kozlowski, Schmidt, Milner, & Wiechmann, 2004) and temporal entrainment (Harrison, Mohammed, McGrath, Florey, & Vanderstoep, 2003).

Mutual performance monitoring is the ability to "keep track of fellow team member's work while carrying out their own ... to ensure that everything is running as expected and ... to ensure that they are following procedures correctly" (McIntyre & Salas, 1995, p. 23). This is an essential component of teamwork, but it can also have negative effects on performance depending on the perceptions of performance monitoring by team members. That is, if mutual performance monitoring is thought of as team members attempting to "keep tabs" on one another for the purposes of avoiding personal responsibility for errors, the negative affect generated by this practice will likely outweigh its potential benefits. Therefore, a team must develop an accepting culture of this practice and attitudes toward mutual performance monitoring that frame it as a valuable means of elevating levels of performance. Additionally, teams must develop shared mental models for mutual performance monitoring to be successful. Team members must understand normative aspects of the team, task, and equipment to detect deviations from normal or expected conditions. Knowing *what should be* happening is a necessary condition to obtaining useful information from observations of *what is* happening at any one point in time.

Backup behavior (or supporting behavior) is "the discretionary provision of resources and task-related effort to another ... [when] there is recognition by potential backup providers that there is a workload distribution problem in their team" (Porter et al., 2003, pp. 391–392). As implied already, mutual performance monitoring is a necessary prerequisite for backup behavior, and backup behavior is necessary to leverage mutual performance monitoring into performance gains. Backup behavior can be either physical or verbal (or other communicative) assistance. This supports effective team performance in three key ways (Marks, Mathieu, & Zaccaro, 2001). First, this assistance allows team members to provide timely feedback to one another so that performance processes can be adjusted. Second, backup behavior allows team members to provide assistance during task performance. Third, backup behavior allows teams to dynamically readjust their performance strategies and processes when a detrimental imbalance in the workload distribution is detected. This affords the team an adaptive capacity. Expert command and control teams exhibit two specific backup behaviors that enable consistently high levels of performance (Smith-Jentsch, Johnston, & Payne, 1998; Smith-Jentsch, Zeisig, Acton, & McPherson, 1998). First, team members correct the errors of other team

members, a process that reduces the number of errors in the team's performance and helps to develop the skill levels of team members as they receive feedback on poor performance. Second, team members provide and request assistance and backup when it is needed.

Team orientation is more than an individual's preference for working within a team versus working in isolation as an individual. It is the propensity to coordinate, evaluate, and use the task inputs of fellow teammates (Driskell & Salas, 1992). These preferences and patterns of behavior are essential for effective teamwork. For example, when teams experience increasing levels of stress (e.g., time pressure), empirical studies show that team members can succumb to attentional narrowing, in that they shift their focus away from the team and focus on their individual taskwork (Driskell & Salas, 1991; Kleinman & Serfaty, 1989). Team members under stress become less likely to accept input or feedback from others on their team. This loss of team perspective is associated with poor team performance (Driskell, Salas, & Johnston, 1999).

Coordinating Mechanisms

These five core components of teamwork are made possible by three core coordination mechanisms: shared mental models, closed-loop communication, and mutual trust. These coordination mechanisms facilitate the enactment of the five teamwork components by ensuring that information is distributed in an appropriate and timely manner. Each of these mechanisms is discussed in more detail in this section.

Shared mental models are organized knowledge structures that facilitate execution of interdependent team processes (Klimoski & Mohammed, 1994). An individual-level mental model is a knowledge structure involved in the process of integrating information and comprehending a phenomenon of interest (Johnson-Laird, 1983). Expanded to the team level, a mental model that is shared is a knowledge structure or mental representation that is partially shared and partially distributed throughout a team. This "sharedness" or distribution allows team members to interpret incoming information in a similar or compatible manner and thereby facilitates effective coordination. Team members that share mental representations are better able to develop similar causal explanations of the environment as well as inferences about possible states of the environment in the near future. This results in more effective and adaptive team performance and higher-quality decision making in teams (Cannon-Bowers et al., 1993; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000; Stout, Cannon-Bowers, & Salas, 1996). Similarly, shared mental models enable the implicit communication that is characteristic of highly effective teams (Mohammed & Dumville, 2001). However, the accuracy of mental models is more important to team performance than sharedness (Edwards,

Day, Arthur, & Bell, 2006). Accuracy can be thought of as a prerequisite to obtaining benefits from shared mental models since there is no performance gain to be had from sharing inaccurate mental models.

Closed-loop communication is a specific pattern of communication that enables effective teamwork. In general, communication is the "exchange of information between a sender and a receiver" (McIntyre & Salas, 1995, p. 25). The importance of communication as control and guidance in social systems has been understood for many years (e.g., Wiener, 1954). This point has been emphasized within team research by the information-processing perspective of teams (Hinsz, Tindale, & Vollrath, 1997), where teams must acquire information about the environment and distribute that information internally to perform actions (MacMillan, Entin, & Serfaty, 2004). Communication is the means by which teams translate individual-level understanding into the team-level dynamic representations that guide coordinated action (Cooke, Salas, Kiekel, & Bell, 2004). Effective teams are able to shift between implicit and explicit communication in response to changing environmental demands and task constraints (Entin & Serfaty, 1999; Espinosa, Lerch, & Kraut, 2004). When effective teams engage in explicit communication, they use closed-loop communication (Bowers, Jentsch, Salas, & Braun, 1998). Three characteristics defined closed-loop communication: (1) a message being initiated by the sender; (2) that message being received, interpreted, and acknowledged by the intended receiver; and (3) a follow-up by the sender ensuring that the message was received and appropriately interpreted (McIntyre & Salas, 1995). This pattern of communication helps to ensure that all team members are operating under the same goals, plans, and understanding of the situation (Orasanu, 1990, 1994).

Additionally, Smith-Jentsch and colleagues (Smith-Jentsch, Zeisig, et al. 1998; Smith-Jentsch, Johnston, et al., 1998) identified four specific teamwork behaviors contributing to good team communication. First, team members should use the proper "phraseology." Teams that speak with a specialized communication terminology are able to pass large amounts of information very quickly (Klein, Feltovich, Bradshaw, & Woods, 2005). Second, team members should provide complete internal and external reports. Third, team members should minimize unnecessary communications (e.g., chatter). This minimizes the workload inherent in team communication and coordination by focusing only on the essentials of interaction necessary for team performance. Fourth, team members should make sure that their communications are clear and audible. This minimizes the chance of misinterpretations of communications.

Mutual trust in the context of teams has been defined as "the shared perception ... that individuals in the team will perform particular actions important to its members and ... will recognize and protect the rights and interests of all the team members engaged in their joint endeavor" (Webber,

2002, p. 205). As discussed, trust is essential to effective teamwork factors such as mutual performance monitoring and backup behavior. Without mutual trust, resources of the team (e.g., attention, communication) may be squandered on unnecessary checking up on team members to ensure that they are performing adequately (Cooper & Sawaf, 1996). Mutual trust also underlies team processes and outcomes such as the degree of team member contributions and participation, outcome quality and retention (Bandow, 2001; Jones & George, 1998).

The model of teamwork is a synthesis of theoretical models of teamwork and illustrates an important point about teamwork that is best described through a comparison of teamwork with the research literature concerning individual expertise. The global view of individual expertise has come to be understood as a "prototype" of various mechanisms (e.g., metacognition, skilled memory, conceptual organization of knowledge; Hoffman, Feltovich, & Ford, 1997; Holyoak, 1991; Sternberg, 1997). However, the relative importance of these mechanisms for expert performance in any one task will be dictated by the constraints of that task. Therefore, expertise is a process of psychological and physiological adaptation to the task (Ericsson & Lehmann, 1996). We argue that the same holds true for teams. Teamwork can be delineated in a global sense as a prototype of what generally constitutes teamwork, but the importance of these teamwork processes to superior performance will differ depending on the nature of the specific team task. The following sections explore specific aspects of this prototype of teamwork in more detail.

Other Organizations of Teamwork Behaviors

The model of teamwork presented in the previous sections is an attempt to generate a parsimonious model, one that captures the essence of teamwork over as broad a range of teams, tasks, and contexts as possible, with as few constructs as possible. The five components and three coordinating mechanisms, however, are not the only aspects of teamwork identified in the literature, and other synthesized models of teamwork have been proposed for teamwork in general (e.g., Militello, Kyne, Klein, Getchell, & Thordsen, 1999; Rasmussen & Jeppesen, 2006) as well as for specific aspects of teamwork—such as distributed planning (Klein & Miller, 1999) and team coaching (Hackman & Wageman, 2005). Instead of moving toward a parsimonious model of teamwork (i.e., capturing the most explanatory power of teamwork behaviors over the broadest spectrum of contexts with the smallest number of explanatory mechanisms), some researchers have attempted to organize the bulk of the literature concerning teamwork behaviors, with the aim of inclusiveness and comprehensiveness instead of parsimony.

Notably, Rousseau, Aube, and Savoie (2006) organized a significant portion of the teamwork behavior literature (integrating 29 of the more than 100 extant frameworks of teamwork; for a complete listing of published team related frameworks, see Salas et al., 2007) around the action regulation theory of Frese and Zapf (1994). Action regulation theory asserts that high performance is attained by individuals that engage in the sequential application of regulation functions to task accomplishment. To successfully complete a task, individuals must do the following:

1. Orient themselves to the task and criteria for gauging success (i.e., an orientation phase)
2. Perform and carry out tasks (i.e., an execution phase)
3. Monitor their progress toward their goals (i.e., an evaluation phase)
4. Make adjustments as needed based on the results of performance evaluation (i.e., an adjustment phase)

Within this action regulation theory framework, Rousseau and colleagues (2006) hierarchically organized teamwork behaviors. They began with two macrolevel categories: (1) regulation of team performance; and (2) management of team maintenance. There are two categories of teamwork subsumed under management of team maintenance: (1) psychological support; and (2) integrative conflict management. There are four categories within the regulation of team performance category: (1) preparation of work accomplishment (i.e., team mission analysis, goal specification, and planning); (2) work assessment behaviors (i.e., performance monitoring, and systems monitoring); (3) task-related collaborative behaviors (i.e., coordination, cooperation, and information exchange); and (4) team adjustment behaviors (i.e., backing up behaviors, intrateam coaching, collaborative problem solving, and team practice innovation). By organizing teamwork behaviors with a framework of regulation processes, Rousseau and colleagues introduced the element of time into their conceptual structure of teamwork behaviors. Different teamwork behaviors are more likely to occur during different phases of activity (e.g., mission analysis will likely occur in a team's preparation phase). This organization parallels the temporal framework of team processes (Marks et al., 2001). The next section discusses temporal issues in teamwork more directly. In doing so, we shift from discussing the components to the structure of various models of teamwork.

Evolution of the IPO Model: A Focus on Time in Teamwork

Teamwork is most often conceptualized using the IPO model structure (e.g., Hackman, 1987; Salas et al., 1992). IPO models describe teamwork through relationships between input variables (e.g., individual and team

characteristics, task characteristics), process variables (e.g., mutual performance monitoring, communication, coordination, leadership), and outcome variables (e.g., performance outcomes, productivity, and satisfaction). Although this has been a widely adopted perspective, it has come to be criticized for representing teamwork as relatively "static" in nature (e.g., Marks et al., 2001). This general criticism comes in two specific varieties, each focused on a different time scale in the life of a team. These issues, and research targeted at remedying the shortcomings of teamwork research in relation to time, are discussed next.

First, IPO models are criticized for condensing and oversimplifying how teams function during task performance. For instance, Marks et al. (2001) provided a temporally based framework for team processes that defines the level of analysis or interest in terms of performance episodes: "distinguishable periods of time over which performance accrues and feedback is given" (p. 359). These performance episodes are distinguished in relation to goals and the team's progress toward accomplishing them. Because teams often pursue multiple goals concurrently (e.g., Deshon et al., 2004), different performance episodes can co-occur and overlap, something not explicitly accounted for in the traditional IPO models. Additionally, although most IPO models do incorporate a feedback loop, which indicates that the team outcomes of performance are "recycled" as team inputs for future performance episodes, IPOs have been criticized for focusing on too broad of a time slice, such that the cycle of the IPO indicates a large portion of the team's development. Marks and colleagues (2001) proposed that the IPO cycle should be associated with the performance episode, indicating that team performance outcomes are recycled into inputs frequently as teams accomplish goals and subgoals of their tasks. When teamwork processes are collapsed or aggregated across multiple performance episodes, the picture of team performance becomes static and summary in nature.

The second variety of criticism holds that IPO models tend to deemphasize the long-term development of teams. This is essentially the first criticism extended in the opposite direction; instead of deemphasizing short-term performance, IPOs are criticized for not addressing longer-term team development. In the real world, teams learn, develop, and mature over their lifetimes (Edmondson, 2002; Gersick, 1988, 1989; Morgan et al., 2001). Kozlowski and colleagues (1999) addressed this concern by proposing a theory of incremental and continuous learning in teams (a theory of compilation and performance across levels and time). Central to this theory is the idea that teams continuously learn and adapt as they engage in performance. This process is repeated as nested IPO cycles build team knowledge and skills while team processes and outcomes are progressively and incrementally enhanced.

Ilgen and colleagues (2005) proposed a shift from the IPO framework to what they describe as an Input-Mediator-Output-Input (IMOI) framework. The exchange of the P (i.e., process) for M (i.e., mediator) indicates that there are more factors than team processes that influence team outcomes (e.g., emergent states). The addition of the extra I indicates an increased emphasis on the cyclical nature of team performance wherein outputs of one performance episode are translated into inputs for future performance. This IMOI framework is consistent with the conceptualization of team performance as nested IPO cycles (e.g., Burke et al., 2006; Kozłowski et al., 1999; Marks et al., 2001; Salas et al., in press). This focus on time is expanded by researchers that take a dynamical systems perspective on teams and small groups (e.g., Arrow, McGrath, & Berdahl, 2000; Cooke, Gorman, & Rowe, Chapter 6 in this volume). Although this perspective holds great promise for developing more robust understanding of how teams function, it is in its infancy and represents a radical departure from the current IPO frameworks of teams (as well as from some fundamental notions in the behavioral sciences such as the nature of causation).

In sum, team researchers have made great progress on many fronts in recent years. Although criticized to some degree, the IPO framework has proven highly robust and adaptable. It has been scaled both up and down in terms of temporal frames to better explain team performance. Models and frameworks have been proposed that have great parsimony as well as great inclusiveness. What is clear from this brief review is the importance of time in the study of teams. This recent growth in understanding of teams and teamwork has led to a more robust understanding of the building blocks of superior team performance, the competencies that team members must possess to engage in effective teamwork. The following section updates a previously proposed set of teamwork competencies in light of the recent empirical and theoretical findings regarding teams.

The ABCs of Teamwork: The Competencies

The ABCs of teamwork refer to the attitudes, behaviors, and cognitions (i.e., KSAOs) that constitute team competencies. In this context, attitudes are the affective attributes necessary for effective team performance; behaviors are the skills and procedures needed for teamwork; and cognitions are the necessary elements of knowledge and experience necessary for effective teamwork. An understanding of the ABCs of teamwork is essential for designing tasks and equipment, for conducting training, for evaluating performance, and for defining selection criteria. For the purposes of training teams, it is necessary to diagnose differences between

individual and team performance (i.e., between the presence or absence of teamwork and taskwork competencies) to provide remediation and corrective feedback of the appropriate type and at the appropriate level. Feedback on individual level KSAOs can be useful in building individual-level expertise, but feedback on teamwork is necessary to leverage that expertise in expert teams by developing teamwork competencies.

Cannon-Bowers and colleagues (1995; Cannon-Bowers & Salas, 1997) proposed a set of teamwork competencies more than a decade ago. Due to the state of the literature at the time, the proposed competencies were primarily based on theory; however, the building interest in team research allows for a review and update of these proposed competencies with respect to the substantial amount of empirical literature now available. Table 3.1 provides an updated and revised list of team competencies, definitions, example markers of the presence or absence of these competencies, as well as representative sources and a rating of the degree to which the competency is supported by empirical evidence. These competencies are briefly discussed in the following sections.

Attitudes

An attitude is taken to be "an internal state that influences an individual's choices or decisions to act in a certain way under particular circumstances" (Cannon-Bowers et al., 1995, p. 352) and in the team context is taken to be the internal states that are associated with the team and that affect the team's interaction processes. In their presentation of the original proposed teamwork competencies, Cannon-Bowers and colleagues (1995) commented on the lack of work linking team attitudes or affect to team effectiveness and performance. Much has changed in the last decade. Team affect and attitude have received much theoretical and empirical attention. The original proposed team attitude competencies included team orientation, collective efficacy, team cohesion, interpersonal relations, mutual trust, and the belief in the importance of teamwork (ibid.). As can be seen in Table 3.1, most of these constructs have born out more extensive empirical investigation. Team/collective efficacy (e.g., Eby & Dobbins, 1997; Jackson, Colquitt, Wesson, & Zapata-Phelan, 2006; Tasa, Taggar, & Seijts, 2007), team/collective orientation (e.g., Gibson, 2003; Katz-Navon & Erez, 2005; Watson, Chemers, & Preiser, 2001), team cohesion (e.g., Beal, Cohen, Burke, & McLendon, 2003; Carless & De Paola, 2000), and mutual trust (e.g., Aubert & Kelsey, 2003; Bandow, 2001; Webber, 2002) are original team attitude competencies that have received extensive empirical support. In addition to these, the increased focus on continuous development, learning and adaptation in teams over time has illuminated the importance of several other team-level affects. Specifically, psychological safety (e.g., Edmondson, 1999), team-learning orientation (e.g., Bunderson & Sutcliffe,

TABLE 3.1

Summary of the ABCs of Teamwork

Proposed KSAs	Description	Example Behavioral Markers	Representative Sources	Empirical Evidence
<i>Attitudes</i>				
Team/collective orientation	"A preference for working with others and the tendency to enhance individual performance through the coordination, evaluation, and utilization of task inputs from other group members while performing group tasks" (Salas, Guthrie, Wilson, Priest, & Burke, 2005, p. 200).	Team members are accepting of input from other teammates; input is evaluated based on quality, not source. Team members have high levels of task involvement, information sharing, participatory goal setting, and strategizing. Team members value team goals over individual goals.	Alavi & McCormick (2004) Driskell & Salas (1992) Eby & Dobbins (1997) Jackson, Colquitt, Wesson, & Zapata-Phelan (2006) Mohammed & Angell (2004) Salas, Sims, & Burke (2005)	+
Team/collective efficacy	"A sense of collective competence shared among individuals when allocating, coordinating, and integrating their resources in a successful concerted response to specific situational demands" (Zaccaro, Blair, Peterson, & Zazanis, 1995, p. 309).	Team members have positive evaluations of their leader's ability. Team members share positive evaluations about the team's ability to accomplish its goals.	Bandura (1986) Gibson (2003) Katz-Navon & Erez (2005) Watson, Chemers, & Preiser (2001) Zaccaro, Blair, Peterson, & Zazanis (1995)	+

Psychological safety	<p>"A shared belief that the team is safe for interpersonal risk taking" (Edmondson, 1999, p. 354).</p>	<p>Team members believe other members have positive intentions. Team members aren't rejected for being themselves. Team members respect each other's abilities. Team members are interested in each other as people. Team members have high team efficacy. Team members seek and give feedback. Team members discuss errors. Team members experiment with processes and procedures. Team members make changes and improvements in processes. Team members seek information and feedback from outside the team. Team members manage conflict constructively.</p>	<p>Edmondson (1999)</p>	
Team learning orientation	<p>"A shared perception of team goals related to learning and competence development; goals that guide the extent, scope, and magnitude of learning behaviors pursued within a team" (Bunderson & Sutcliffe, 2003, p. 553).</p>	<p>Team members seek and give feedback. Team members discuss errors. Team members experiment with processes and procedures. Team members make changes and improvements in processes. Team members seek information and feedback from outside the team. Team members manage conflict constructively.</p>	<p>Bunderson & Sutcliffe (2003) Yazici (2005)</p>	
Team cohesion	<p>The degree to which team members exhibit interpersonal attraction, group pride, and commitment to the task.</p>	<p>Team members have a shared a task focus and commitment to attaining the goals of the team. Team members have a desire to remain a member of the team. Team members express pride associated with team membership.</p>	<p>Beal, Cohen, Burke, & McLendon (2003) Carless & De Paola (2000) Zaccaro, Gualtieri, & Minionis (1995)</p>	+

TABLE 3.1

Summary of the ABCs of Teamwork (Continued)

Proposed KSAs	Description	Example Behavioral Markers	Representative Sources	Empirical Evidence
Mutual trust	"The shared belief that team members will perform their roles and protect the interests of their teammates" (Salas, Sims, & Burke, 2005, p. 561).	Team members share a belief that team members will perform their tasks and roles. Team members share a belief that fellow team members will work to protect the interests of the team. Team members are willing to admit mistakes; they are not fearful of reprisal. Team members share information openly.	Aubert & Kelsey (2003) Bandow (2001) Webber (2002) Salas, Sims, & Burke (2005)	+
Team empowerment	"Team members' collective belief that they have the authority to control their proximal work environment and are responsible for their team's functioning" (Mathieu, Gilson, & Ruddy, 2006, p. 98).	Team members decide which team processes to engage in and how to execute those processes.	Mathieu, Gilson, & Ruddy (2006) Kirkman, Rosen, Tesluk, & Gibson (2004)	~
Team reward attitude	"An individual's general evaluation of receiving rewards based on the performance of the team" (Shaw, Duffy, & Stark, 2001, p. 904).	Team members have positive evaluations of rewarding team (versus individual) performance. Team members value teamwork.	Haines & Taggar (2006) Shaw, Duffy, & Stark (2001)	~
Team goal commitment/ team conscientiousness	The degree to which team members feel an attachment to the team level goal and the degree to which they are determined to reach this goal.	Team members have common and valued goals. Team members monitor the team's progress toward its goals. Team members engage in supportive behaviors when necessary.	Aubé & Rousseau (2005) English, Griffith, & Steelman (2004) Weldon & Weingart (1993)	~

Behaviors

Mutual performance monitoring

The ability of team members to "keep track of fellow team members' work while carrying out their own ... to ensure that everything is running as expected" (McIntyre & Salas, 1995, p. 23).

Team members recognize errors in their teammates' performance.
Team members recognize superior performance in their teammates.
Team members offer relevant information/resources before requested.
Team members have an accurate understanding of their teammates' workload.
Team members offer feedback to their fellow teammates to facilitate self-correction.

Dickinson & McIntyre (1997)
Marks & Panzer (2004)
McIntyre & Salas (1995)
Salas, Sims, & Burke (2005)

+

Adaptability

"Ability to adjust strategies based on information gathered from the environment through the use of backup behavior and reallocation of intrateam resources. Altering a course of action or team repertoire in response to changing conditions (internal or external)" (Salas, Sims, & Burke, 2005, p. 560).

Team members modify or replace routine performance strategies when characteristics of the environment and task change.
Team members detect changes in the internal team and external environments.
Team members make accurate assessments about underlying causes of environmental changes.

Burke, Stagl, Salas, Pierce, & Kendall (2006)
Entin & Serfaty (1999)
Kozlowski, Gully, Nason, & Smith (1999)
LePine (2003, 2005)
Salas, Sims, & Burke (2005)

+

Backup/supportive behavior

"Ability to anticipate other team member's needs through accurate knowledge about their responsibilities. This includes the ability to shift workload among members to achieve balance during high periods of workload or pressure" (Salas, Sims, & Burke, 2005, p. 560).

Team members proactively step in to assist fellow team members when needed.
Team members communicate the need for assistance.
Team members can identify unbalanced workload distributions.
Team members redistribute workload to underutilized team members.

Marks, Mathieu, & Zaccaro (2000)
McIntyre & Salas (1995)
Porter et al. (2003)
Salas, Sims, & Burke (2005)

+

TABLE 3.1

Summary of the ABCs of Teamwork (Continued)

Proposed KSAs	Description	Example Behavioral Markers	Representative Sources	Empirical Evidence
Implicit coordination strategies	"Synchronization of member actions based on unspoken assumptions about what others in the group are likely to do" (Wittenbaum & Strasser, 1996, p. 23).	Team members compensate for increasing workload conditions by reducing the "communication overhead" (i.e., explicit communication). Team members sequence interdependent taskwork without overt communication.	Adelman, Miller, Henderson, & Schoelles (2003) Entin & Serfaty (1999) Espinosa, Lerch, & Kraut (2004) MacMillan, Entin, & Serfaty (2004) Rico, Sanchez-Manzanares, Gill & Gibson (2008)	+
Shared/distributed leadership	"The transference of the leadership function among team members in order to take advantage of member strengths (e.g., knowledge, skills, attitudes, perspectives, contacts, and time available) as dictated by either environmental demands or the development stage of the team" (Burke, Fiore, & Salas, 2004, p. 105).	Team members accurately recognize and identify the member with the highest levels of relevant knowledge and skill for a particular situation/problem. Team members shift leadership functions in response to changing task/environmental conditions.	Pearce & Sims (2002) Hiller, Day, & Vance (2006) Day, Gronn, & Salas (2004)	~

Mission analysis	<p>"The interpretation and evaluation of the team's mission, including identification of its main tasks as well as the operative environmental conditions and team resources available for mission execution" (Marks, Mathieu, & Zaccaro, 2001, p. 365).</p>	<p>Team members explicitly articulate the team's objectives. Team members discuss the purpose of the team in the context of the present performance environment. Team members discuss how the available team resources can be applied to meeting the team goals.</p>	<p>Marks, Mathieu, & Zaccaro (2001) Mathieu & Schulze (2006)</p>
Problem detection	<p>An initial sensing that a problem requiring attention exists or will soon exist.</p>	<p>Team members rapidly detect problems or potential problems in their environment. Team members work to determine underlying causes in conflicting knowledge. Team members quickly recognize a need for action when it arises. Team members clearly communicate problem definitions.</p>	<p>Larson & Christensen (1993) Moreland & Levine (1992)</p>
Conflict resolution/management	<p>"Preemptive conflict management involves establishing conditions to prevent, control, or guide team conflict before it occurs. Reactive conflict management involves working through task and interpersonal disagreements among team members" (Marks, Mathieu, & Zaccaro, 2001, p. 363).</p>	<p>Team members seek solutions that have mutual gains for all interests. Team members openly discuss task related conflict. Team members (find it acceptable to) change their minds and express their doubts.</p>	<p>De Dreu & Weingart (2003) Gladstein, 1984 Jehn (1995) Jordan & Troth (2004) Simons & Peterson (2000)</p>

TABLE 3.1

Summary of the ABCs of Teamwork (Continued)

Proposed KSAs	Description	Example Behavioral Markers	Representative Sources	Empirical Evidence
Motivation of others	Generating and maintaining goal directed effort toward completion of the team's mission.	Team members encourage each other to perform better or to continue performing well. Team members provide feedback regarding team successes. Team members communicate beliefs of the teams' ability to succeed.	Fleishman & Zaccaro (1992) Marks, Mathieu, & Zaccaro (2001)	~
Intrateam feedback	The provision of information about team or individual performance either before, during, or after a performance episode.	Team members engage in a cycle of prebrief, performance, debrief. Team members provide preperformance information (feed forward). Team members develop and integrate lessons learned from past performance. Team members provide information to correct deficient performance during a performance episode. Team members provide constructive and specific comments to other team members.	Inzana, Driskell, Salas, & Johnston (1996) Smith-Jentsch, Johnston, & Payne (1998) Smith-Jentsch, Zeisig, Acton, & McPherson (1998)	+
Task-related assertiveness	"The capacity to effectively communicate in interpersonal encounters by sharing ideas clearly and directly" (Pearsall & Ellis, 2006, p. 577).	Team members communicate task-relevant information without hesitation. Team members share their opinions with others in a persuasive manner.	Marks, Mathieu, & Zaccaro (2001) Pearsall & Ellis (2006) Smith-Jentsch, Salas, & Baker (1996)	+

Planning	The generation of a proposed sequence of actions intended to accomplish a set goal.	<p>Team members explicitly articulate expectations for how a proposed course of action should unfold.</p> <p>Team members explicitly define desired outcomes.</p> <p>Team members collectively visualize how a planned course of action will be carried out and where it can go wrong.</p> <p>Team members seek out information and feed it to fellow team members.</p> <p>Team members share unique information.</p>	<p>Klein & Miller (1999)</p> <p>Mathieu & Schulze (2006)</p> <p>Militello, Kyne, Klein, Getchell, & Thordson (1999)</p> <p>Stout, Cannon-Bowers, Salas, & Milanovich (1999)</p>	+
Coordination	"The process of orchestrating the sequence and timing of interdependent actions" (Marks, Mathieu, & Zaccaro, 2001, pp. 367-368).	<p>Team taskwork behaviors are sequenced so that "down time" for team members is minimized (e.g., team members don't have to wait for other team members' input to do their taskwork).</p> <p>Team members communicate information about their status, needs, and objectives as often as necessary (and not more).</p> <p>Team members synchronize teamwork behaviors without overt communication in high-workload conditions.</p> <p>Team members pass information to one another relevant to the task in a timely and efficient manner.</p>	<p>Brannick, Prince, Prince, & Salas (1992)</p> <p>Fleishman & Zaccaro (1992)</p> <p>Malone & Crowston (1994)</p> <p>Marks, Mathieu, & Zaccaro (2001)</p> <p>Smith-Jentsch, Johnston, & Payne (1998)</p>	+

TABLE 3.1

Summary of the ABCs of Teamwork (Continued)

Proposed KSAs	Description	Example Behavioral Markers	Representative Sources	Empirical Evidence
Team leadership	"Ability to direct and coordinate the activities of other team members, assess team performance, assign tasks, develop team knowledge, skills, and abilities, motivate team members, plan and organize, and establish a positive atmosphere" (Salas, Sims, & Burke, 2005, p. 560).	<p>Team leaders instill shared affects and motivation and define team goals with 'prebriefs.</p> <p>Team leaders promote team learning through two-way interactions in debriefs to generate lessons learned from performance episodes.</p> <p>Team leaders create team interdependencies.</p> <p>Team leaders communicate a clear mission and vision for the team.</p> <p>Team leaders gather and provide performance relevant information to team members.</p> <p>Team leaders work to keep teams intact.</p>	<p>Burke, Stagl, Klein, et al. (2006)</p> <p>Day, Gronn, & Salas (2004)</p> <p>Salas, Sims, & Burke (2005)</p> <p>Stagl, Salas, & Burke (2006)</p> <p>Zaccaro, Rittman, & Marks (2001)</p>	+
Problem solving	The process of (1) identifying and representing a discrepancy between the present and desired state of the environment and (2) discovering a means to close this "gap."	<p>Team members rapidly knowledge information when needed.</p> <p>Teams engage in contingency planning.</p> <p>Teams accurately recognize the internal expertise in the team and weights input accordingly.</p> <p>Team members accurately prioritize problem features.</p> <p>Team members dynamically assess and adjust their problem solution.</p>	<p>Bonner (2004)</p> <p>Jordan & Troth (2004)</p> <p>Oser, Gualtieri, Cannon-Bowers, & Salas (1999)</p>	+

Closed-loop communication/information exchange	A pattern of communication characterized by (1) a message being initiated by the sender, (2) the message being received, interpreted, and acknowledged by the intended receiver, and (3) a follow-up by the sender ensuring that the message was received and appropriately interpreted.	Team members follow up to ensure that messages are received and understood. Team members acknowledge messages when they are sent. Team members cross check information with the sender to ensure that the message's meaning is understood. Team members seek information from all available sources. Team members provide "big picture" updates to one another as appropriate. Team members proactively pass information without being asked.	Bowers, Jentsch, Salas, & Braun (1998) McIntyre & Salas (1995) Salas, Sims, & Burke (2005) Smith-Jentsch, Johnston, & Payne (1998) Smith-Jentsch, Zeisig, Acton, & McPherson (1998)	+
<i>Cognitions</i>	Rules for matching a situation with an appropriate action (cue-strategy associations)	Team members are able to rapidly recall an appropriate course of action when presented with a common situation and collectively decide on its fit with that situation. Team members shift strategies in response to changes in the task, team, and environment as appropriate.	Cannon-Bowers & Salas (1997) Kline (2005) Stout, Cannon-Bowers, Salas, & Milanovich (1999)	+

TABLE 3.1

Summary of the ABCs of Teamwork (Continued)

Proposed KSAs	Description	Example Behavioral Markers	Representative Sources	Empirical Evidence
Accurate problem models	"Shared understanding of the situation, the nature of the problem, the cause of the problem, the meaning of available cues, what is likely to happen in the future, with or without action by the team members, shared understanding of the goal or desired outcome, and a shared understanding of the solution strategy" (Orasanu, 1994, p. 259).	<p>Team members make compatible predictions about the consequences of proposed courses of action.</p> <p>Team members recognize the need for action and adjustments to planned courses of action when these solutions don't go as planned.</p> <p>Team members make similar judgments about the causes of successful and ineffectual plans.</p> <p>Team members engage in closed-loop communication to build this shared mental representation.</p>	<p>Fiore & Schooler (2004)</p> <p>Orasanu (1990, 1994)</p> <p>Orasanu & Salas (1993)</p> <p>Salas, Rosen, Burke, Nicholson, & Howse (2007)</p>	+
Accurate and shared mental models (transactive memory and team situational awareness)	"An organized knowledge structure of the relationships among the task the team is engaged in and how the team members will interact" (Salas, Sims, & Burke, 2005, p. 561).	<p>Team members are able to recognize when other team members need information they have.</p> <p>Team members anticipate and predict the needs of their fellow team members.</p> <p>Team members implicitly adjust performance strategies to changing conditions in the team, task, and environment as needed.</p> <p>Team members use standardized terminology ("phraseology").</p>	<p>Artman (2000)</p> <p>Cannon-Bowers & Salas (1997)</p> <p>Cannon-Bowers, Tannenbaum, Salas, & Volpe (1995)</p> <p>Endsley (1995)</p> <p>Klein, Feltovich, Bradshaw, & Woods (2005)</p> <p>Klimoski & Mohammed (1994)</p>	+

<p>Team mission, objectives, norms, resources</p>	<p>An understanding of the purpose, vision, and means available to the team for reaching the team objectives and completing the mission as well as the "shared expectations that constrain and drive the action of group members" (Graham, 2003, p. 323).</p>	<p>Team members use concise communication. Team members have compatible explanations of task cues. Team members attempt to determine the underlying causes of conflicts information. Team members actively seek information relevant to the task. Problems are explicitly defined. Team members engage in confirming and cross-checking information. Team members rapidly identify problems or potential problems.</p>	<p>Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers (2000) Salas, Cannon-Bowers, Fiore, & Stout (2001) Salas, Prince, Baker, & Shrestha (1995) Salas, Sims, & Burke (2005) Stout, Cannon-Bowers, & Salas, (1996)</p>	<p>Team members make compatible task prioritizations. Team members agree on the methods and approaches the team should take to work toward its goal (e.g., low task conflict related to selection of performance strategies).</p>	<p>Cannon-Bowers & Salas (1997) Cannon-Bowers, Tannenbaum, Salas, & Volpe (1995) Marks, Mathieu, & Zaccaro (2001)</p>
<p>Understanding of multiteam system (MTS) couplings</p>	<p>An understanding in the team of how their performance (inputs, processes, and outcomes) is tied to the larger organizational structure, including other teams.</p>	<p>Team members (especially leaders) understand the goal hierarchies in the larger organizational unit and work to meet these goals. Team members (especially leaders) engage in appropriate levels of effective conflict management with other team leaders in the MTS when different aspects of the goal hierarchy conflict.</p>	<p>Hoegl, Weinkauff, & Genueuden (2004) Marks, DeChurch, Mathieu, Panzer, & Alonso (2005) Williams & Mahan (2006)</p>		

Note: + indicates substantial empirical support; ~ indicates moderate empirical support; x indicates no empirical support.

2003; Yazici, 2005), and team-goal commitment (e.g., Aubé & Rousseau, 2005; English, Griffith, & Steelman, 2004; Weldon & Weingart, 1993) are necessary for teams to effectively learn and develop. Additionally, a team reward attitude (e.g., Haines & Taggar, 2006; Shaw, Duffy, & Stark, 2001) and team empowerment (e.g., Kirkman, Rosen, Tesluk, & Gibson, 2004; Mathieu, Gilson, & Ruddy, 2006) have been linked to team effectiveness.

Behaviors

Cannon-Bowers and colleagues (1995) provided an extensive list of team-work behaviors (or skills) including task organization, mutual performance monitoring, shared problem-model development, flexibility, compensatory behavior, information exchange, dynamic reallocation of functions, and mission analysis, among many others. They noted that there had been much more theoretical and empirical work devoted to delineating the skills (or behaviors) of teamwork than either team attitudes or cognitions. This is likely true today as well for the simple reason that team behaviors are much more amenable to measurement than are team attitudes or cognitions. Many of the original team behavior competencies remain, with increased empirical support; however, some have been dropped or subsumed within others. For example, task organization—"sequencing and integrating task inputs according to team and task demands" (Cannon-Bowers & Salas, 1997)—has not been attended to empirically, most likely do to its similarity to coordination. As discussed in the big five model of teamwork, mutual performance monitoring, adaptability, backup/supportive behavior, and team leadership (in both the traditional hierarchical sense and in shared or distributed configurations) are critical for effective teamwork. Additionally, closed-loop communication and information exchange (e.g., Bowers et al., 1998; Orasanu, 1990; Smith-Jentsch et al., 1998) help to ensure that everyone on the team is operating under the most up-to-date and accurate information. This, in turn, enables coordination within the team (e.g., Brannick, Prince, Prince, & Salas, 1992; Marks et al., 2001; Smith-Jentsch et al., 1998); however, effective teams are able to coordinate implicitly without this overt communication during high workload performance episodes (e.g., Adelman, Miller, Henderson, & Schoelles, 2003; Entin & Serfaty, 1999; MacMillan et al., 2004). Problem detection and solving skills (e.g., Larson & Christensen, 1993; Moreland & Levine, 1992) remain highly important, as well as task related assertiveness (e.g., Pearsall & Ellis, 2006; Smith-Jentsch, Salas, & Baker, 1996). Related to communication skills enacted during a performance episode, intra-team feedback (e.g., Inzana, Driskell, Salas, & Johnston, 1996; Smith-Jentsch, Zeisig, et al., 1998) concerning performance as well as conflict resolution and management skills (e.g., De Dreu & Weingart, 2003; Jordan & Troth, 2004; Simons & Peterson, 2000) are essential to increase a team's

performance levels. Additionally, there are several team behaviors that generally occur before task performance such as mission analysis (e.g., Marks et al., 2001; Mathieu & Schulze, 2006), planning (e.g., Klein & Miller, 1999; Mathieu & Schulze, 2006; Stout, Cannon-Bowers, Salas, & Milanovich, 1999), and the motivation of fellow team members (e.g., Fleishman & Zaccaro, 1992; Marks et al., 2001).

Cognitions

Shared mental model theory was the impetus behind many of the original knowledge competencies for teams (Cannon-Bowers et al., 1995). As is apparent by the team cognition competencies listed in Table 3.1, this remains an influential perspective. Team members must have accurate and shared knowledge of the team's mission, objectives, norms, and resources (Graham, 2003; Marks et al., 2001). Additionally, team members must share mental models about the task as well as team members' roles, specialized knowledge, and skill (i.e., transactive memory; Austin, 2003; Lewis, 2004). As team members engage in performance, this shared knowledge helps them to build accurate problem models, a critical step in dynamic team performance. The team (or shared) problem model consists of a "shared understanding of the situation, the nature of the problem, the cause of the problem, the meaning of available cues, what is likely to happen in the future, with or without action by the team members, shared understanding of the goal or desired outcome, and a shared understanding of the solution strategy" (Orasanu, 1994, p. 259). These problem models are emergent cognitive states in that they are formed dynamically as the team members interact with the task environment and their fellow team members. In fact, problem models can be thought of as a specific instance of team situation awareness (SA; Artman, 2000; Salas, Prince, Baker, & Shrestha, 1995) that is considered to be "built on a combination of the degree of shared understanding within the team (i.e., shared mental models) and each individual member's SA (based on preexisting knowledge bases and cue/pattern assessments)" (Salas, Cannon-Bowers, Fiore, & Stout, 2001, p. 173). Problem models and team situation awareness more generally form the basis of a team's ability to apply cue-strategy associations or matching rules for applying specific team strategies to different situations. This requires that team members have a repertoire of strategies and associated cues (Stout, Cannon-Bowers, Salas, & Milanovich, 1999). In addition to these knowledge competencies that do not differ much from the originally proposed competencies, team members (especially team leaders) must have knowledge of their relationship to the larger organizational system (i.e., multiteam systems; MTS). Teams must understand the interdependencies between multiple teams to effectively function in larger units (Marks et al., 2005).

As with all types of performance, reaching high levels of team performance requires fitting the appropriate skills and strategies to the task constraints. Characteristics of the work to be done will determine the effectiveness of various teamwork and team performance processes. Table 3.2 provides a list of mechanisms of expert team performance. These mechanisms are adaptations that mediate performance and allow teams to exhibit reliably and consistently superior levels of performance outcomes.

Where Do We Go from Here?

There is no question that collective (whether teams, groups, units, or networks) wisdom has contributed to the welfare of industries, agencies, and organizations at large. Recent reviews have clearly demonstrated this and more. From this, a robust science of team performance and team effectiveness has emerged. To paraphrase Levine and Moreland (1990), this science is alive, well, energized, and multidisciplinary. But, of course, more remains to be done. This section highlights three premises that will evolve (we hope) our understanding of the wisdom of collectives.

First, we believe that shared cognition in teams needs a deeper look. Though some progress has been made, the precise meaning and nature of shared cognition remains elusive. There are a plethora of labels for this construct, and we continue to struggle with the measurement of shared cognition. So, no science will emerge here until we develop precise, reliable, valid, and diagnostic metrics of shared cognition. In the absence of metrics, confusion on what share cognition is will remain. We need operational and measurable definitions of what shared cognition is and what elements contribute to it. Recent work in this area (e.g., Burke, Burke, Lazara, Smith-Jentsch, & Salas, 2007; Cooke et al., 2004; Gorman, Cooke, & Winner, 2006; Letsky, Warner, Fiore, Rosen & Salas, 2007; Smith-Jentsch & Scielzo, 2007) may shed some light on this issue.

Second, the wisdom of the collectives is dynamic. It comprises processes that unfold over time and that operate on different time scales. And so we cannot ignore the effect of time in teams. It seems that as a science we continue to have theories, methods, studies, and findings that ignore the dynamic nature of team performance. We must move toward making time and its effects part of our routine team studies. While this is difficult, it is not impossible. So, the call for more longitudinal or time-based studies goes out again.

Finally, wisdom cannot be solely extracted by looking at self-report data or ratings of overall performance—the predominate methods used to collect data in team research. Of course, we need better, richer, deeper, and

TABLE 3.2

Mechanisms of Expert Team Performance

Expert Teams...

Hold Shared Mental Models

They have members who anticipate each other.

They can communicate without the need to communicate overtly.

They interpret environmental cues in a compatible or complementary manner.

They can reach an intuitive consensus on problem definition and course of action selection.

They use concise communication and standardized terminology.

Optimize Resources by Learning and Adapting

They are self-correcting.

They compensate for each other.

They reallocate functions.

They engage in a deliberate process of maintaining and building expertise.

They adjust performance processes to meet changes in the task/environment.

They seek feedback from within and outside the team.

They discuss errors.

Have Clear Roles and Responsibilities

They manage expectations.

They have members who understand each others' roles and how they fit together.

They ensure team member roles are clear but not overly rigid.

Have a Clear, Valued, and Shared Vision

They have a clear and common purpose.

They are guided by common values.

Engage in a Cycle or Discipline of Pre-brief → Performance → Debrief

They regularly provide feedback to each other, both individually and as a team.

They establish and revise team goals and plans.

They differentiate between higher and lower priorities.

They have mechanisms for anticipating and reviewing issues or problems of members.

They periodically diagnose team "effectiveness," including its results, its processes, and its vitality (morale, retention, energy).

They generate lessons learned from performance episodes.

They plan for performance by discussing performance strategies.

Have Strong Team Leadership

They are led by someone with good leadership skills and not just technical competence.

They have team members who believe the leaders care about them.

They have leaders that provide situation updates.

- Arrow, H., McGrath, J. E., & Berdahl, J. L. (2000). *Small groups as complex systems: Formation, coordination, development, and adaptation*. Thousand Oaks, CA: Sage.
- Artman, H. (2000) Team situation assessment and information distribution. *Ergonomics*, 43(8), 1111-1129.
- Aubé, C., & Rousseau, V. (2005). Team Goal Commitment and Team Effectiveness: The Role of Task Interdependence and Supportive Behaviors. *Group Dynamics: Theory, Research, and Practice*, 9(3), 189-204.
- Aubert, B. A., & Kelsey, B. L. (2003). Further Understanding of Trust and Performance in Virtual Teams. *Small Group Research*, 34(5), 575-618.
- Austin, J. R. (2003). Transactive memory in organizational groups: The effects of content, consensus, specialization, and accuracy on group performance. *Journal of Applied Psychology*, 88(5), 866-878.
- Bandow, D. (2001). Time to create sound teamwork. *Journal for Quality and Participation*, 24, 41-47.
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NY: Prentice-Hall.
- Beal, D. J., Cohen, R. R., Burke, M. J., & McLendon, C. L. (2003). Cohesion and performance in groups: A meta-analytic clarification of construct relations. *Journal of Applied Psychology*, 88(6), 989-1004.
- Boas, S., Zakay, E., Esther, B., & Popper, M. (2000). Leadership and social identification in military units: Direct and indirect relationships. *Journal of Applied Social Psychology*, 30(3), 612-640.
- Bonner, B. L. (2004). Expertise in group problem solving: Recognition, social combination, and performance. *Group Dynamics: Theory, Research, and Practice*, 8(4), 277-290.
- Bowers, C. A., Jentsch, F., Salas, E., & Braun, C.C. (1998). Analyzing communication sequences for team training needs assessment. *Human Factors*, 40(4), 672-679.
- Brannick, M. T., Prince, A., Prince, C. & Salas, E. (1995). The measurement of team process. *Human Factors*, 37(3), 641-651.
- Bunderson, J. S. & Sutcliffe, K.M. (2003). Management team learning orientation and business unit performance. *Journal of Applied Psychology*, 88(3), 552-560.
- Burke, C. S., Fiore, S. M., & Salas, E. (2004). The role of shared cognition in enabling shared leadership and team adaptability. In C. L. Pearce & J. A. Conger, (Eds.), *Shared leadership: Reframing the hows and whys of leadership* (pp. 103-121). Thousand Oaks, CA: Sage.
- Burke, C. S., Stagl, K. C., Salas, E., Pierce, L., & Kendall, D. (2006). Understanding team adaptation: A conceptual analysis and model. *Journal of Applied Psychology*, 91, 1180-1207.
- Campbell, J. P. (1990). Modeling the performance prediction problem in Industrial and Organizational Psychology. In M. D. Dunette & L. M. Hough, (Eds.), *Handbook of industrial and organizational psychology*. Palo Alto, CA: Consulting Psychologists Press.
- Campion, M. A., Medsker, G.J. & Higgs, A.C. (1993). Relations between work group characteristics and effectiveness: Implications for designing effective work groups. *Personnel Psychology*, 46, 823-847.

- Cannon-Bowers, J. A. & Salas, E. (1997). Teamwork Competencies: The interaction of team member knowledge, skills, and attitudes. In H. F. O'Neil, Jr. (Ed.), *Workforce readiness: Competencies and assessment* (pp. 151-174). Mahwah, NJ: Erlbaum.
- Cannon-Bowers, J. A., Salas, E., & Converse, S. (1993). Shared mental models in expert team decision making. In N. J. J. Castellan (Ed.), *Individual and group decision making* (pp. 221-246). Hillsdale, NJ: Erlbaum.
- Cannon-Bowers, J. A., Tannenbaum, S. I., Salas, E., & Volpe, C. E. (1995). Defining competencies and establishing team training requirements. In R. Guzzo & E. Salas (Eds.), *Team effectiveness and decision making in organizations* (pp. 333-380). San Francisco, CA: Jossey-Bass.
- Carless, S. A. & DePaola, C. (2000). The measurement of cohesion in work teams. *Small Group Research*, 31(1), 71-88.
- Castka, P., Bamber, C., Sharp, J., & Belohoubek, P. (2001). Factors affecting successful implementation of high performance teams. *Team Performance Management*, 7(7-8), 123-134.
- Chidester, T. R., Helmreich, R. L., Gregorich, S. E., & Geis, C. E. (1991). Pilot personality and crew coordination: Implications for training and selection. *International Journal of Aviation Psychology*, 1(1), 25-44.
- Chu, D., Strand, R., & Fjelland, R. (2003). Theories of complexity: Common denominators of complex systems. *Complexity*, 8(2), 19-30.
- Cooke, N. J., Salas, E., Kiekel, P. A., & Bell, B. (2004). Advances in measuring team cognition. In E. Salas & S. M. Fiore, (Eds.), *Team cognition: Understanding the factors that drive process and performance* (pp. 83-106). Washington, DC: American Psychological Association.
- Cooper, R. & Sawaf, A. (1996). *Executive EQ: Emotional intelligence in leadership and organizations*. New York: Grosset/Putnam.
- Day, D. V., Gronn, P., & Salas, E. (2004). Leadership capacity in teams. *Leadership Quarterly*, 15(6), 857-880.
- De Dreu, C. K., & Weingart, L. R. (2003). Task versus relationship conflict, team performance, and team member satisfaction: a meta-analysis. *Journal of Applied Psychology*, 88(4), 741-749.
- Dekker, S. (2003). Failure to adapt or adaptations that fail: contrasting models on procedures and safety. *Applied Ergonomics*, 34, 233-238.
- DeShon, R. P., Kozlowski, W. J., Schmidt, A. M., Milner, K. R., & Wiechmann, D. (2004). A multiple-goal, multilevel model of feedback effects on the regulation of individual and team performance. *Journal of Applied Psychology*, 89(6), 1035-1056.
- Dickinson, T. L. & McIntyre, R. M. (1997). A Conceptual framework for team measurement. In M. T. Brannick, Salas, E., & Prince, C. (Ed.), *Team performance measurement: Theory, methods, and applications* (pp. 19-43). Mahwah, NJ: Erlbaum.
- Driskell, J. E. & Salas, E. (1991). Group decision making under stress. *Journal of Applied Psychology*, 76(3), 473-478.
- Driskell, J. E. & Salas, E. (1992). Collective behavior and team performance. *Human Factors*, 34, 277-288.
- Driskell, J. E., Salas, E., & Johnston, J. (1999). Does stress lead to a loss of team perspective? *Group Dynamics: Theory, Research, and Practice*, 3(4), 291-302.

- Dyer, J. L. (1984). Team research and team training: A state of the art review. In F. A. Muckler (Ed.), *Human factors review* (pp. 285-323). Santa Monica, CA: Human Factors Society.
- Eby, L. T. & Dobbins, G. H. (1997). Collectivistic orientation in teams: an individual and group-level analysis. *Journal of Organizational Behavior*, 18, 275-295.
- Edmondson, A. C. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly*, 44, 350-383.
- Edmondson, A. C. (2002). The local and variegated nature of learning in organizations: A group-level perspective. *Organization Science*, 13(2), 128-146.
- Edmondson, A. C. (2003). Speaking up in the operating room: How team leaders promote learning in interdisciplinary action teams. *Journal of Management Studies*, 40(6), 1419-1452.
- Edmondson, A. C., Bohmer, R. M., & Pisano, G. P. (2001). Disrupted routines: team learning and new technology implementation in hospitals. *Administrative Science Quarterly*, 46(4), 685-716.
- Edwards, B. D., Day, E. A., Arthur, W., & Bell, S. T. (2006). Relationships among team ability composition, team mental models, and team performance. *Journal of Applied Psychology*, 91(3), 727-736.
- Eisenstat, R. A. & Cohen, S. G. (1990). Summary: Top management groups. In J. R. Hackman (Ed.), *Groups that work (and those that don't): Creating conditions for effective teamwork* (pp. 78-86). San Francisco, CA: Jossey-Bass.
- Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. *Human Factors*, 37(1), 32-64.
- English, A., Griffith, R. L. & Steelman, L. A. (2004). Team Performance: The Effect of Team Conscientiousness and Task Type. *Small Group Research*, 35(6), 643-665.
- Entin, E. E. & Serfaty, D. (1999). Adaptive team coordination. *Human Factors*, 41(2), 312-325.
- Ericsson, K. A. & Lehmann, A. C. (1996). Expert and exceptional performance: Evidence of maximal adaptation to task constraints. *Annual Review of Psychology*, 47, 273-305.
- Espinosa, J. A., Lerch, F. J., & Kraut, R. E. (2004). Explicit versus implicit coordination mechanisms and task dependencies: One size does not fit all. In E. Salas & S. M. Fiore, (Eds.), *Team cognition: Understanding the factors that drive process and performance* (pp. 107-129). Washington, DC: American Psychological Association.
- Fiore, S. M. & Schooler, W. J. (2004). Process mapping and shared cognition: Teamwork and the development of shared problem models. In E. Salas & S. M. Fiore (Eds.), *Team cognition: Understanding the factors that drive process and performance* (pp. 133-152). Washington, D.C.: American Psychological Association.
- Fleishman, E. A. & Zaccaro, S. J. (1992). Toward a taxonomy of team performance functions. In R. Swezey & E. Salas (Eds.), *Teams: Their Training and Performance* (pp. 31-56). Norwood, NJ: Ablex.
- Fleishman, E. A., Mumford, M. D., Zaccaro, S. J., Levin, K. Y., Korotkin, A. L., & Hein, M. B. (1991). Taxonomic efforts in the description of leader behavior: A synthesis and functional interpretation. *Leadership Quarterly*, 4, 245-287.

- Frese, M. & Zapf, D. (1994). Action as the core of work psychology: A German approach. In M. D. Dunnette & L. M. Hough (Eds.), *Handbook of Industrial and Organizational Psychology* (2nd ed., Vol. 4, pp. 271–340). Palo Alto, CA: Consulting Psychologists.
- Gersick, C. J. (1988). Time and transition in work teams: Toward a new model of group development. *Academy of Management Journal*, 31(1), 9–41.
- Gersick, C. J. (1989). Marking time: Predictable transitions in task groups. *Academy of Management Journal*, 32(2), 274–309.
- Gibson, C. B. (2003). The Efficacy Advantage: Factors Related to the Formation of Group Efficacy. *Journal of Applied Social Psychology*, 33(10), 2153–2186.
- Ginnett, R. C. (1990). Airline cockpit crew. In J. R. Hackman (Ed.), *Groups that work (and those that don't): Creating conditions for effective teamwork* (pp. 427–448). San Francisco, CA: Jossey-Bass.
- Gladstein, D. L. (1984). Groups in Context: A Model of Task Group Effectiveness. *Administrative Science Quarterly*, 29(4), 499–517.
- Goldstein, J. (1999). Emergence as a construct: History and issues. *Emergence*, 1(1), 49–72.
- Gorman, J. C., Cooke, N. J., & Winner, J. L. (2006). Measuring team situation awareness in decentralized command and control environments. *Ergonomics*, 49(12–13), 1312–1325.
- Graham, C. R. (2003). A model of norm development for computer-mediated teamwork. *Small Group Research*, 34(3), 322–352.
- Hackman, J. R. (1987). The design of work teams. In J. Lorsch (Ed.), *Handbook of organizational behavior* (pp. 315–342). New York: Prentice Hall.
- Hackman, J. R. (2002). *Leading teams: setting the stage for great performances*. Boston, MA: Harvard Business School Press.
- Hackman, J. R. & Wageman, R. (2005). A theory of team coaching. *Academy of Management Review*, 30(2), 269–287.
- Haines, V. Y. & Taggar, S. (2006). Antecedents of team reward attitude. *Journal of Management Review*, 30(2), 194–205.
- Harrison, D. A., Mohammed, S., McGrath, J. E., Florey, A. T., & Vanderstoep, S. W. (2003). Time matters in team performance: effects of member familiarity, entrainment, and task discontinuity on speed and quality. *Personnel Psychology*, 56(3), 633–669.
- Hiller, N. J., Day, D. V. & Vance, R. J. (2006). Collective enactment of leadership roles and team effectiveness: A field study. *The Leadership Quarterly*, 17, 387–397.
- Hinsz, V. B., Tindale, R. S., & Vollrath, D. A. (1997). The emerging conceptualization of groups as information processors. *Psychological Bulletin*, 121(1), 43–64.
- Hirschfeld, R. R., Jordan, M. H., Feild, H. S., Giles, W. F., & Armenakis, A. A. (2006). Becoming team players: Team members' mastery of teamwork knowledge as a predictor of team task proficiency and observed teamwork effectiveness. *Journal of Applied Psychology*, 91(2), 467–474.
- Hoegl, M., Weinkauff, K., & Gemuenden, H. G. (2004). Interteam Coordination, Project Committee, and Teamwork in Multiteam R&D Projects: A Longitudinal Study. *Organizational Science*, 15(1), 38–55.
- Hoffman, R. R. (Ed.). (2007). *Expertise out of context*. Mahwah, NJ: Erlbaum.

- Hoffman, R. R., Feltovich, P. J., & Ford, K.M. (1997). A general conceptual framework for conceiving of expertise and expert systems. In P. J. Feltovich, K. M. Ford, & R. R. Hoffman, (Eds.), *Expertise in context* (pp. 543-580). Menlo Park, CA: AAAI Press/MIT Press.
- Holyoak, K. J. (1991). Symbolic connectionism: toward third-generation theories of expertise. In K.A. Ericsson & J. Smith, (Eds.), *Toward a general theory of expertise: Prospects and limits* (pp. 301-335). Cambridge, England: Cambridge University Press.
- Ilggen, D. R. Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in organizations: From input-process-output models to IMO models. *Annual Review of Psychology*, 56, 517-543.
- Inzana, C. M., Driskell, J. E., Salas, E., & Johnston, J. H. (1996). Effects of preparatory information on enhancing performance under stress. *Journal of Applied Psychology*, 81(4), 429-435.
- Jackson, C. L. Colquitt, J. A., Wesson, M. J., & Zapata-Phelan, C.P. (2006). Psychological Collectivism: A Measurement Validation and Linkage to Group Member Performance. *Journal of Applied Psychology*, 91(4), 884-899.
- Jehn, K. A. (1995). A Multimethod Examination of the Benefits and Detriments of Intragroup Conflict. *Administrative Science Quarterly*, 40(2), 256-282.
- Johnson-Laird, P. N. (1983). *Mental Models: Towards a cognitive science of language, inference, and consciousness*. Cambridge, MA: Harvard University Press.
- Johnston, J. H., Smith-Jentsch, K. A., & Cannon-Bowers, J. A. (1997). Performance measurement tools for enhancing team decision-making training. In M. T. Brannick, E. Salas, & C. Prince (Eds.), *Team performance assessment and measurement: Theory, methods, and applications* (pp. 311-327). Mahwah, NJ: Erlbaum.
- Jones, G. & George, J. (1998). The experience and evolution of trust: Implications for cooperation and teamwork. *Academy of Management Review*, 23, 531-546.
- Jordan, P. J., & Troth, A. C. (2004). Managing emotions during team problem solving: Emotional intelligence and conflict resolution. *Human Performance*, 17(2), 195-218.
- Katz-Navon, T. Y., & Erez, M. (2005). When collective- and self-efficacy affect team performance: The role of task interdependence. *Small Group Research*, 36(4), 437-465.
- Kirkman, B. L., Rosen, B., Tesluk, T., & Gibson, C. (2004). The impact of team empowerment on virtual team performance: The moderating role of face-to-face interaction. *Academy of Management Journal*, 47, 175-192.
- Klein, G., Feltovich, P. J., Bradshaw, J. M., & Woods, D. D. (2005). Common ground and coordination in joint activity. In W. B. Rouse & K. R. Boff, (Eds.), *Organizational simulation* (pp. 139-184). Hoboken, NJ: Wiley-Interscience.
- Klein, G. & Miller, T. E. (1999). Distributed planning teams. *International Journal of Cognitive Ergonomics*, 3(3), 203-222.
- Kleinman, D. L. & Serfaty, D. (1989). *Team performance assessment in distributed decision-making*. Paper presented at the Symposium on Interactive Networked Simulation for Training, Orlando, FL.
- Klimoski, R. & Mohammed, S. (1994). Team mental model: Construct or metaphor? *Journal of Management*, 20(2), 403-437.
- Kline, D. A. (2005). Intuitive team decision making. In H. Montgomery, R. Lipshitz, & B. Brehmer (Ed.), *How professionals make decisions* (pp. 171-182). Mahwah, NJ: Erlbaum.

- Kozlowski, S. W. J., Gully, S. M., Nason, E. R., & Smith, E. M. (1999). Developing adaptative teams: A theory of compilation and performance across levels and time. In D. R. Ilgen & E. D. Pulakos (Eds.), *The Changing Nature of Work and Performance: Implications for Staffing, Personnel Actions, and Development*. San Francisco, CA: Jossey-Bass.
- Kozlowski, S. W. J. & Klein, K. J. (2000). A multilevel approach to theory and research in organizations: Contextual, temporal, and emergent processes. In K. J. Klein & S. W. J. Kozlowski (Eds.), *Multilevel theory, research, and methods in organizations: Foundations, extensions, and new directions* (pp. 3-90). San Francisco, CA: Jossey-Bass.
- Larson, J. R. & Christensen, C. (1993). Groups as problem-solving units: Toward a new meaning of social cognition. *Br. J. Soc. Psychol.*, 32, 5-30.
- LaPorte, T. R. & Consolini, P. M. (1991). Working in practice but not in theory: Theoretical challenges of high reliability organizations. *Journal of Public Administration Research and Theory*, 1(1), 19-48.
- Letsky, M., Warner, N., Fiore, S. M., Rosen, M. A., & Salas, E. (2007). *Macro cognition in complex team problem solving*. Paper presented at the 11th International Command and Control Research and Technology Symposium (ICCRTS), Cambridge, England.
- LePine, J. A. (2003). Team adaptation and post change performance: Effects of team composition in terms of members' cognitive ability and personality. *Journal of Applied Psychology*, 88, 27-39.
- LePine, J. (2005). Adaptation of teams in response to unforeseen change: effects of goal difficulty and team composition in terms of cognitive ability and goal orientation. *Journal of Applied Psychology*, 90(6), 1153-1167.
- Levine, J. M. & Moreland, R. L. (1990). Progress in small group research. *Annual Review of Psychology*, 41, 585-634.
- Lewis, K. (2004). Knowledge and performance in knowledge-worker teams: A longitudinal study of transactive memory systems. *Management Science*, 50(11), 1519-1533.
- MacMillan, J., Entin, E. E., & Serfaty, D. (2004). Communication overhead: The hidden cost of team cognition. In E. Salas & S. M. Fiore (Eds.), *Team cognition: Understanding the factors that drive process and performance* (pp. 61-82). Washington, DC: American Psychological Association.
- Malone, T. W. & Crowston, K. (1994). The interdisciplinary study of coordination. *ACM Computing Surveys*, 26(1), 87-119.
- Marks, M. A., DeChurch, L. A., Mathieu, J. E., Panzer, F. J., & Alonso, A. (2005). Teamwork in multiteam systems. *Journal of Applied Psychology*, 90(5), 964-971.
- 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.
- Marks, M. A. & Panzer, F. J. (2004). The influence of team monitoring on team processes and performance. *Human Performance*, 17(1), 25-41.
- Mathieu, J. E., Gilson, L. L. & Ruddy, T. M. (2006). Empowerment and team effectiveness: An empirical test of an integrated model. *Journal of Applied Psychology*, 91(1), 97-108.

- Mathieu, J. E., Heffner, T. S., Goodwin, G. F., Salas, E., & Cannon-Bowers, J. (2000). The influence of shared mental models on team process and performance. *Journal of Applied Psychology, 85*(2), 273–283.
- Mathieu, J. E. & Schulze, W. (2006). The influence of team knowledge and formal plans on episodic team process-performance relationships. *Academy of Management Journal, 49*(3), 605–619.
- Militello, L. G., Kyne, M. M., Klein, G., Getchell, K., & Thordson, M. (1999). A synthesized model of team performance. *International Journal of Cognitive Ergonomics, 3*(2), 131–158.
- McIntyre, R. M. & Salas, E. (1995). Measuring and managing for team performance: Emerging principles from complex environments. In R. A. Guzzo & E. Salas (Eds.), *Team effectiveness and decision making in organizations* (pp. 9–45). San Francisco, CA: Jossey Bass.
- Mohammed, S. & Angell, L. C. (2004). Surface- and deep-level diversity in workgroups: examining the moderating effects of team orientation and team process on relationship conflict. *Journal of Organizational Behavior, 25*(8), 1015–1039.
- Mohammed, S. & Dumville, B. C. (2001). Team mental models in a team knowledge framework: Expanding theory and measure across disciplinary boundaries. *Journal of Organizational Behavior, 22*(2), 89–103.
- Moreland, R. L. & Levine, J. M. (1992). Problem identification by groups. In S. W. Worchel, W. Wood, & J. A. Simpson (Eds.), *Group processes and productivity* (pp. 17–47). Newbury Park, CA: Sage.
- Morgan, B. B., Jr., Glickman, A. S., Woodward, E. A., Blaiwes, A. S., & Salas, E. (1986). *Measurement of team behaviors in a Navy environment* (No. 86-014). Orlando, FL: Naval Training Systems Center.
- Morgan, B. B., Jr., Salas, E., & Glickman, A. S. (2001). An analysis of team evolution and maturation. *Journal of General Psychology, 120*(3), 277–291.
- Orasanu, J. (1990). *Shared mental models and crew decision making* (No. 46). Princeton, NJ: Princeton University, Cognitive Science Laboratory.
- Orasanu, J. (1994). Shared problem models and flight crew performance. In N. Johnston, N. McDonald, & R. Fuller (Eds.), *Aviation psychology in practice* (pp. 255–285). Brookfield, VT: Ashgate.
- Orasanu, J. & Salas, E. (1993). Team decision making in complex environments. In G. Klein, J. Orasanu, R. Calderwood & C. E. Zsombok (Eds.), *Decision making in action: Models and methods* (pp. 327–345). Norwood, NJ: Albex.
- Oser, R. L., Gualtieri, J. W., Cannon-Bowers, J. A., & Salas, E. (1999). Training team problem solving skills: an event-based approach. *Computers in human behavior, 15*, 441–462.
- Patel, V. L. & Arocha, J. F. (2001). The nature of constraints on collaborative decision making in health care settings. In E. Salas & G. Klein (Eds.), *Linking expertise and naturalistic decision making* (pp. 383–405). Mahwah, NJ: Lawrence Erlbaum Associates.
- Pearce, C. L. & Ensley, M. D. (2004). A reciprocal and longitudinal investigation of the innovation process: the central role of shared vision in product and process innovation teams. *Journal of Organizational Behavior, 25*, 259–278.

- Pearce, C. L. & Sims, H. P. (2002). Vertical versus shared leadership as predictors of the effectiveness of change management teams: An examination of aversive, directive, transactional, transformational and empowering leader behaviors. *Group Dynamics: Theory, Research, and Practice*, 6(2), 172–197.
- Pearsall, M. J. & Ellis, A. P. J. (2006). The effects of critical team member assertiveness on team performance and satisfaction. *Journal of Management*, 32(4), 575–594.
- Perkins, A. L., Shaw, R. B., & Sutton, R. I. (1990). Summary: Human service teams. In J. R. Hackman (Ed.), *Groups that work (and those that don't): Creating conditions for effective teamwork* (pp. 349–360). San Francisco: Jossey-Bass.
- Porter, C. O., Hollenbeck, J. R., Ilgen, D. R., Ellis, A. P., West, B. J., & Moon, H. (2003). Backing up behaviors in teams: the role of personality and legitimacy of need. *Journal of Applied Psychology*, 88(3), 391–403.
- Rasmussen, T. H. & Jeppesen, H. J. (2006). Teamwork and associated psychological factors: A review. *Work & Stress*, 20(2), 105–128.
- Rico, R., Sánchez-Manzanares, M., Gil, F., & Gibson, C. (2008). Team Implicit Coordination Processes: A Team Knowledge-Based Approach. *The Academy of Management Review*, 33(1), 163–184.
- Rousseau, V., Aubé, C., & Savoie, A. (2006). Teamwork behaviors: A review and an integration of frameworks. *Small Group Research*, 37(5), 540–570.
- Saavedra, R., Earley, P. C., & Van Dyne, L. (1993). Complex interdependence in task-performing groups. *Journal of Applied Psychology*, 78(1), 61–72.
- Salas, E., Burke, C. S., & Stagl, K. C. (2004). Developing teams and team leaders: Strategies and principles. In D. Day, S. J. Zaccaro, & S. M. Halpin (Eds.), *Leader development for transforming organizations: Growing leaders for tomorrow* (pp. 325–355). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Salas, E., Cannon-Bowers, J. A., Church-Payne, S., & Smith-Jentsch, K. A. (1998). Teams and teamwork in the military. In C. Cronin (Ed.), *Military psychology: An introduction* (pp. 71–87). Upper Saddle River, NJ: Pearson.
- Salas, E., Cannon-Bowers, J. A., Fiore, S. M., & Sout, R. J. (2001). Cue-recognition training to enhance team situation awareness. In M. McNeese, E. Salas, & M. Endsley (Eds.), *New trends in collaborative activities: Understanding system dynamics in complex environments* (pp. 169–190). Santa Monica, CA: Human Factors and Ergonomics Society.
- Salas, E., Cannon-Bowers, J. A., & Johnston, J. H. (1997). How can you turn a team of experts into an expert team?: Emerging training strategies. In C. E. Zsombok & G. Klein (Eds.), *Naturalistic decision making* (pp. 359–370). Mahwah, NJ: Erlbaum.
- Salas, E., Dickinson, T., Converse, S., & Tannenbaum, S. (1992). Toward an understanding of team performance and training. In R. Swezey & E. Salas (Eds.), *Teams: Their training and performance*. Norwood, NJ: Ablex Publishing.
- Salas, E., Prince, C., Baker, D. P. & Shrestha, L. (1995). Situation awareness in team performance: Implications for measurement and training. *Human Factors*, 37(1), 123–136.
- Salas, E., Rosen, M. A., Burke, C. S., Goodwin, G. F., & Fiore, S. (2006). The making of a dream team: when expert teams do best. In K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman, (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 439–453). New York: Cambridge University Press.

- Salas, E., Rosen, M. A., Burke, C. S., Nicholson, D., & Howse, W. R. (2007). Markers for enhancing team cognition in complex environments: The power of team performance diagnosis. *Aviation, Space, and Environmental Medicine Special Supplement on Operational Applications of Cognitive Performance Enhancement Technologies*, 78(5), B77-85.
- Salas, E., Sims, D. E., & Burke, C. S. (2005). Is there a big five in teamwork? *Small Group Research*, 36(5), 555-599.
- Salas, E., Stagl, K. C., Burke, C. S., & Goodwin, G. F. (2007). Fostering team effectiveness in organizations: Toward an integrative theoretical framework of team performance. In J. W. Shuart, W. Spaulding, and J. Poland (Eds.), *Modeling complex systems: Motivation, cognition and social processes, Nebraska Symposium on Motivation* (Vol. 51). Lincoln: University of Nebraska Press.
- Shaw, J. D., Duffy, M. K., & Stark, E. M. (2001). Team reward attitude: Construct development and initial validation. *Journal of Organizational Behavior*, 22, 903-917.
- Simons, T. L. & Peterson, R. S. (2000). Task conflict and relationship conflict in top management teams: The pivotal role of intragroup trust. *Journal of Applied Psychology*, 85(1), 102-111.
- Smith-Jentsch, K. A. (1995). *Measurement and debriefing tools refined and validated as SWOS*. Presentation at the meeting of the TADMUS Technical Advisory Board, Moorestown, NJ.
- Smith-Jentsch, K. A., Johnston, J. A., & Payne, S. C. (1998). Measuring team-related expertise in complex environments. In J. A. Cannon-Bowers & E. Salas (Eds.), *Making decisions under stress: Implications for individual and team training* (pp. 61-87). Washington, DC: American Psychological Association.
- Smith-Jentsch, K. A., Salas, E., & Baker, D. P. (1996). Training team performance-related assertiveness. *Personnel Psychology*, 49(909-36).
- Smith-Jentsch, K. A. & Scielzo, S. (2007). *An empirically-tested approach for measuring team-related cognition and behavior to support training and development*. Paper presented at the Second Annual Conference of the Interdisciplinary Network for Group Research, Lansing, MI.
- Smith-Jentsch, K. A., Zeisig, R. L., Acton, B., & McPherson, J. A. (1998). Team dimensional training: A strategy for guided team self-correction. In J. A. Cannon-Bowers & E. Salas (Eds.), *Making decisions under stress: Implications for individual and team training* (pp. 271-297). Washington, DC: American Psychological Association.
- Stagl, K. C., Salas, E., & Burke, C. S. (2006). Best practices in team leadership: What team leaders do to facilitate team effectiveness. In J. A. Conger, & R.E. Riggio, (Eds.), *The practice of leadership: Developing the next generation of leaders* (pp. 172-198). Hoboken, NJ: John Wiley & Sons.
- Sternberg, R. J. (1997). Cognitive conceptions of expertise. In P. J. Fletovich, K. M. Ford, & R. R. Hoffman, (Eds.), *Expertise in context* (pp. 149-162). Menlo Park, CA: AAAI Press/MIT Press.
- 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.
- Stout, R. J., Cannon-Bowers, J. A., Salas, E., & Milanovich, D. M. (1999). Planning, shared mental models, and coordinated performance: An empirical link is established. *Human Factors*, 41(1), 61-71.

- Streufert, S. (1997). Complexity: An integration of theories. *Journal of Applied Social Psychology*, 27(23), 2068–2095.
- Tasa, K., Taggar, S., & Seijts, G. H. (2007). The development of collective efficacy in teams: A multilevel and longitudinal perspective. *Journal of Applied Psychology*, 92(1), 17–27.
- Watson, C. B., Chemers, M. M., & Preiser, N. (2001). Collective efficacy: A multi-level analysis. *Personality and social psychology bulletin*, 27(8), 1057–1068.
- Webber, S. S. (2002). Leadership and trust facilitating cross-functional team success. *Journal of Management Development*, 21, 201–214.
- Weldon, E., & Weingart, L. R. (1993). Group goals and group performance. *British Journal of Social Psychology*, 32(4), 307–328.
- Wiener, N. (1954). *The human use of human beings: Cybernetics and society*. Boston, MA: Houghton Mifflin.
- Williams, C. C. & Mahan, R. P. (2006). Understanding multiteam system functioning. In W. Bennett, Jr., C. E. Lance & D. J. Woehr (Eds.), *Performance measurement: Current perspectives and future challenges* (pp. 205–224). Mahwah, NJ: Erlbaum.
- Yazici, H. J. (2005). A study of collaborative learning style and team learning performance. *Education and Training*, 47(3), 216–229.
- Zaccaro, S. J. Blair, V., Peterson, C., & Zazanis, M. (1995). Collective Efficacy. In J. E. Maddux (Ed.), *Self-Efficacy, Adaptation, and Adjustment: Theory, Research, and Application*. New York, NY: Plenum.
- Zaccaro, S. J. Gualtieri, J., & Minionis, D. (1995). Task Cohesion as a Facilitator of Team Decision Making Under Temporal Urgency. *Military Psychology*, 7(2), 77–93.
- Zaccaro, S. J., Rittman, A. L., & Marks, M. A. (2001). Team leadership. *Leadership Quarterly*, 12, 451–483.

