PERSONNEL PSYCHOLOGY
2005, 58, 641–672

AN EVALUATION OF GENERIC TEAMWORK SKILLS TRAINING WITH ACTION TEAMS: EFFECTS ON COGNITIVE AND SKILL-BASED OUTCOMES

ALEKSANDER P.J. ELLIS
The Eller College of Management
Department of Management and Policy
The University of Arizona

BRADFORD S. BELL
School of Industrial and Labor Relations
Cornell University

ROBERT E. PLOYHART
Moore School of Business
University of South Carolina

JOHN R. HOLLENBECK
Department of Management
Michigan State University

DANIEL R. ILGEN
Department of Psychology
Michigan State University

This study evaluated the utility of generic teamwork skills training for enhancing the effectiveness of action teams. Results from 65 4-person action teams working on an interdependent command and control simulator revealed that generic teamwork skills training had a significant and positive impact on both cognitive and skill-based outcomes. Trained team members evidenced higher levels of declarative knowledge regarding teamwork competencies and demonstrated greater proficiency in the areas of planning and task coordination, collaborative problem-solving, and communication. Furthermore, results indicated that cognitive and skill based outcomes were interrelated. Team members' declarative knowledge regarding teamwork competencies positively affected planning and task coordination, collaborative problem solving, and communication skills. However, we found that the effects of declarative knowledge differed across team members depending on their roles and responsibilities. The team benefited the most from the knowledge held by the team member who occupied the most critical position in the workflow. Implications of these findings for future research and practice are discussed.

This research was supported in part, by Grant N00014-96-1-0983 from the Cognitive and Neural Sciences Division of the Office of Naval Research. Although support for this work is gratefully acknowledged, the ideas expressed herein are those of the authors and not necessarily endorsed by the funding agency.

Correspondence and requests for reprints should be addressed to Aleksander P.J. Ellis, The Eller College of Management, Department of Management and Policy, 405 McClelland Hall, Tucson, AZ, 85721-0108.

The workplace has changed over the last several decades as organizations have shifted to team-based work systems, where two or more employees interact interdependently toward a common and valued goal or objective, and who have each been assigned specific roles or functions to perform (e.g., Ilgen, Major, Hollenbeck, & Sego, 1993). Researchers have noted that "teams and teaming have become hot topics" (Guzzo, 1995, p. 1), with more than 80% of *Fortune* 500 companies utilizing work teams extensively within their organizations (Robbins, 2003). Organizations feel that teams are more effective than individuals because team members can share the workload, monitor the behavior of their teammates, and combine their different areas of expertise (Mathieu et al., 2000).

Although they have a number of different types of teams at their disposal, organizations realize that their teams must remain flexible and adaptive, ready to expand or contract at a moment's notice while continually innovating if they hope to be successful (Cooper, Dewe, & O'Driscoll, 2001). Organizations are increasingly relying on action or performing teams, which "conduct complex, time-limited engagements with audiences, adversaries, or challenging environments in 'performance events' for which teams maintain specialized, collective skill" (Sundstrom, 1999, pp. 20–21). According to Sundstrom (1999), prototypical action teams include surgery teams, investigative units, government regulatory teams, military units, and expedition teams.

Despite their popularity, researchers have found that action teams are often unsuccessful due to a lack of teamwork knowledge and skill on the part of the members who are usually chosen for their functional technical skills (Marks, Sabella, Burke, & Zaccaro, 2002). Without such knowledge and skill, team members can be unprepared to work as an interdependent unit (Hollenbeck, DeRue, & Guzzo, 2004; Mohrman, Cohen, & Mohrman, 1995).

Although efforts have been directed toward developing effective training programs for employees who are, or will be, working in team environments (e.g., Stevens & Yarish, 1999), to date researchers have focused on developing task- and team-specific training programs (e.g., Liang, Moreland, & Argote, 1995; Marks et al., 2002; Marks, Zaccaro, & Mathieu, 2000). Action team members, who regularly transition across different task and team environments, need task- and team-generic training programs that focus on developing the knowledge and skills of individual team members that can then be applied in a variety of contexts (Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995). More team- or task-specific training is a less appealing option for action team members because, as Salas et al. (2002) note, they "would be in a constant state of retraining" (p. 242).

The purpose of this study is to examine the utility of generic teamwork skills training for enhancing the effectiveness of action teams. Based on recommendations provided in the team training literature (e.g., Salas, Burke, & Cannon-Bowers, 2002), we develop a team- and task-generic training program focused on several teamwork competencies critical for action team effectiveness. The training is then evaluated by examining its impact on team member's knowledge of generic teamwork competencies and the transfer of this knowledge to a novel team task. This study makes several contributions to the team training literature. First, to our knowledge, this study is the first to evaluate the impact of generic teamwork skills training on both cognitive and skill-based outcomes. Thus, this study makes an important theoretical and practical contribution by providing information regarding the potential utility of generic teamwork skills training for enhancing team effectiveness. Second, the current study examines team members' knowledge of generic teamwork competencies as a key mechanism by which generic teamwork skills training translates into improved performance at the team level (Ellis & Bell, in press). We draw on theories of learning and skill acquisition (e.g., Anderson, 1982) as well as team dynamics to provide greater insight into how developing team members' knowledge of generic teamwork competencies translates into improved performance at the team level.

Team Training Analysis

The success of team training programs depends on conducting a thorough team training analysis, starting with a skills inventory to identify the competencies that are needed (Salas, Burke, & Cannon-Bowers, 2002). Competencies include "(a) the requisite knowledge, principles, and concepts underlying the team's effective task performance; (b) the repertoire of required skills and behaviors necessary to perform the team task effectively; and (c) the appropriate attitudes on the part of team members (about themselves and the team) that foster effective team performance" (Cannon-Bowers et al., 1995, pp. 336–337). These competencies can be categorized into one of four groups depending on whether they are specific or general to a particular team and specific or general to a particular task.

In the typical organization there are many different types of teams (e.g., project, production, action), and each type of team has different characteristics and, therefore, different training needs. Production teams, for example, have fairly stable membership and tend to perform a small range of tasks repetitively. These types of teams would benefit most from training on task- and team-specific competencies (Salas et al., 2002), such as knowledge of team members' characteristics and specific compensation strategies (Cannon-Bowers et al., 1995). In contrast, the lifespan of action teams is often one work cycle. Team members with specialized expertise are brought together to tackle a particular task and often disband upon completion. Because action team members perform a variety of tasks with a constantly changing set of team members, there is a need for more general competencies that are transportable across teams and tasks (Salas et al., 2002).

Past research has identified five categories of task- and team-generic competencies: (a) conflict resolution, (b) collaborative problem solving, (c) communication, (d) goal setting and performance management, and (e) planning and task coordination (Cannon-Bowers et al., 1995; Stevens & Campion, 1994; Swezey & Salas, 1992). Due to the demands that action team members face, researchers have noted that three of the categories are of particular import: planning and task coordination, collaborative problem solving, and communication.

Planning and task coordination refers to team members' capacity to effectively sequence and orchestrate activities, as well as manage procedural interdependencies among team members. As Sundstrom (1999, p. 21) has emphasized, "a hallmark of action teams is the requirement for coordination among specialized roles . . . individual members must not only maintain special technical skills but also the teamwork skills needed to synchronize their own performances with those of their counterparts." *Collaborative problem-solving* refers to team members' capacity to effectively use collective induction and deduction in order to resolve challenges and difficulties. Researchers have noted that "action teams often confront sudden, unpredictable behavior in their work environments that demands quick and sometimes improvised response" (Sundstrom, 1999, p. 21), highlighting the importance of collaborative problem solving. *Communication* refers to team members' capacity to understand information exchange networks and to utilize these networks to enhance information sharing (Stevens & Campion, 1994). Marks et al. (2002) note that action teams are highly interdependent, which makes overall performance unattainable without task contributions from each member and successful interaction among members. Communication serves as the mechanism by which team members coordinate their contributions and interact with one another (Marks, Mathieu, & Zaccaro, 2001).

In conclusion, our team training analysis uncovered three categories of task- and team-generic competencies that are particularly important for action team effectiveness. The next step is to evaluate whether a task- and team-generic training program can prove effective for developing these competencies.

Team Training Evaluation

Because training refers to "activities directed at the acquisition of knowledge, skills, and attitudes for which there is an immediate or near-term application" (Kraiger, 2003, p. 171), the effectiveness of any training program is determined not only by the successful acquisition of critical knowledge but also the ability to effectively transfer that knowledge to the performance environment. Researchers have identified three categories of learning outcomes, cognitive, skill-based, and affective (see Kraiger, Ford, & Salas, 1993; Kraiger, 2002), that can be used to evaluate training effectiveness. In this study, we concentrate on cognitive and skill-based outcomes.

Cognition. According to Kraiger et al. (1993), cognition refers to "a class of variables related to the quantity and type of knowledge and the relationships among knowledge elements" (p. 313). The most commonly examined cognitive outcome in training evaluation studies is declarative knowledge (information about what), because declarative knowledge serves as the foundation for higher order skill development (Ackerman, 1987; Anderson, 1982). Although the majority of team training studies have examined whether or not team members are able to gain declarative knowledge that is task- and/or team-specific (e.g., Marks et al., 2002), there is some evidence task- and team-generic training may be effective for developing declarative knowledge of teamwork competencies. Chen, Donahue, and Klimoski (2004) designed a study to determine whether training could be used to develop undergraduate students' declarative knowledge regarding the team-generic competencies identified by Stevens and Campion (1994). Students participating in a semester-long training program completed readings, lectures, class discussions, group exercises, and "real world" assessment center exercises focusing on teamwork. Results indicated that the training program significantly increased students' declarative knowledge regarding team competencies, as evidenced by an improvement of 20 percentile points on Stevens and Campion's Teamwork KSA Test. Based on this evidence, we proposed the following:

> *Hypothesis 1*: Team members who receive task- and team-generic training will exhibit greater declarative knowledge of teamwork competencies.

Skill-based outcomes. A second category of learning outcomes highlighted by Kraiger et al. (1993) concerns the development of technical or motor skills. Skill development progresses through several stages, including initial skill acquisition, skill compilation, and skill automaticity (Anderson, 1982). In this study, we are interested in initial skill acquisition, where trainees translate declarative knowledge into procedural knowledge (Neves & Anderson, 1981). Kraiger et al. (1993) note that a commonly used method to evaluate skill development is by observing trainee performance in role plays or simulations conducted at the end of training. Although the majority of team-training studies have examined skill-based outcomes of task- and team-specific training (e.g., Marks et al., 2002; Prince & Salas, 1993), there is some evidence that trainees may also be able to translate knowledge into skill through task- and team-generic training (e.g., Chen et al., 2004), even though team members have no prior experience working with their teammates or the task.

Smith-Jentsch, Salas, and Baker (1996) trained 60 undergraduates in team performance-related assertiveness, which can be defined as the ability of team members to share their opinions with their teammates in a manner that is persuasive to others. Trained individually, participants in the experimental condition were introduced to one of three training methods: behavioral role modeling, lecture with demonstration, and lecture-based training. Participants were then paired to complete a PC-based flight simulation task as a two-person team. Relative to a control group that received no training, Smith-Jentsch et al. found that behavioral role modeling had a significant positive effect on performance-related assertive behavior. Based on this evidence, we predict:

> *Hypothesis 2*: Teams composed of members who have received the generic teamwork skills training will display higher levels of planning and task coordination, collaborative problem solving, and communication skills.

The Relationship Between Cognitive and Skill-Based Outcomes

Our first two hypotheses suggest that task- and team-generic training will be positively related to cognitive and skill-based outcomes at the individual- and team-level of analysis, respectively. However, researchers note that skill-based outcomes are based on a foundation provided by declarative knowledge (Anderson, 1982; Kraiger et al., 1993). Given that action team members must be trained as individuals (Cannon-Bowers et al., 1995), it is essential to determine whether individual-level cognitive learning outcomes can be translated into team-level skill-based outcomes and exactly how this process occurs.

Although research examining interrelationships among different learning outcomes of task- and team-generic training is lacking, there is some evidence that knowledge of generic teamwork competencies is related to a number of different facets of team performance. For example, Stevens and Campion (1999) conducted two validation studies of their Teamwork KSA Test involving production employees in two separate organizations. They found that higher scores on the test, which are indicative of greater knowledge of teamwork competencies, were positively related to supervisory ratings of teamwork and taskwork, which Stevens and Campion liken to the distinction between contextual performance and OCBs on the one hand and task performance and in-role behavior on the other. McClough and Rogelberg (1998) also found that knowledge of teamwork competencies, as assessed through the Teamwork KSA Test, related to team performance, which was assessed by examining conflict resolution, collaborative problem solving, communication, performance management, and task coordination within the team.

Based on these results, we hypothesize that:

> *Hypothesis 3*: The team's level of declarative knowledge of teamwork competencies will positively affect planning and task coordination, collaborative problem-solving, and communication skills.

However, translating knowledge into skill may also be an indirect process, as both planning and task coordination and collaborative problem-solving behavior rely heavily on communication. Researchers have suggested that communication is a necessary component of coordination (e.g., Brannick et al., 1993) and "teams experiencing 'communication breakdowns' and those that get 'out of sync' are likely to be experiencing problems with their coordination processes" (Marks et al., 2001, p. 368). Researchers have also suggested that communication is a necessary component of collaborative problem solving (e.g., Laughlin & Ellis, 1986) and teams will find it much more difficult to find the correct solution without it (e.g., Laughlin, 1988; Laughlin & McGlynn, 1986). Because there may be a "skill hierarchy" in operation where communication skills contribute to planning and task coordination and collaborative problem solving skills, we hypothesize that:

> *Hypothesis 4*: Communication skills will partially mediate the effects of the team's declarative knowledge on their planning and task coordination and collaborative problem-solving skills.

Although we expect skill-based outcomes to be contingent on the team's level of declarative knowledge, the translation of individual-level knowledge into team-based performance may not be equivalent across all team members. Because the team training program we examine in this study is task and team generic, trainees must take what they learned in training and apply it to a task whose components are completely unrelated to the content of the training program. Trainees must also work interdependently with other individuals, none of whom have any prior experience working with one another. As a result, action-team members' roles may change as they move from task to task and from team to team. Team members bring their knowledge into situations where their roles and responsibilities may exhibit varying degrees of overlap with their teammates. Although any knowledge action-team members gain in training will be useful for the team, it should be most useful when the team member plays a critical role in the workflow network.

Criticality, or workflow centrality, refers to the extent to which "removal of a task position, and its direct workflow links, breaks the workflow chain" (Brass, 1984, p. 522). Critical team members "act as go-betweens, bridging the 'structural holes' between disconnected others, facilitat[ing] resource flows and knowledge sharing" (Mehra, Kilduff, & Brass, 2001, p. 121). An action-team member whose role is critical to the team's workflow network exhibits little overlap with the roles of his or her teammates and "controls the workflow—the extent to which the organization depends on that particular person for the continual flow of work" (Brass, 1985, p. 332). His or her workflow position cannot be easily replaced and any effort to do so would change the inputs acquired and outputs distributed within the team (Brass, 1984). In essence, he or she is in charge of some portion of the task that is required, but cannot be completed, by his or her teammates.

Because researchers have shown that team members can derive status from a number of different sources, including workflow criticality, this affords the most critical team member with a certain degree of power within the team (e.g., Mechanic, 1962; Pfeffer, 1981), which can be defined as "any force that results in behavior which would not have occurred if the force had not been present" (Mechanic, 1962, p. 351). The power derived from criticality can also be used to mobilize support, information, and other resources in a specific direction (e.g., Kanter, 1983, 1988; Kimberly, 1981; Van de Ven, 1986). This can affect a number of different outcomes because the most critical team member can determine whether or not the team is able to complete its task (Mintzberg, 1983; Salancik & Pfeffer, 1977).

We propose that, although the cognitive outcomes of his or her teammates still play a role in skill-based outcomes, the central role of the most critical team member in the team's role network will amplify the impact of his or her knowledge on the team's performance. In essence, the most critical team member must work with his or her teammates if they hope to succeed. Therefore, his or her knowledge of teamwork competencies may be more critical to the team' success than the knowledge of his or her teammates. We propose that, when the most critical team member is not aware of his or her impending role, as is the case for most action team members, his or her teamwork competencies form the foundation for planning and task coordination, collaborative problem solving, and communication within the team, leading to the following hypotheses:

> *Hypothesis 5*: The most critical action-team member's declarative knowledge of teamwork competencies will have a significant impact on the team's planning and task coordination, collaborative problem solving, and communication skills.

> *Hypothesis 6*: Communication behavior will partially mediate the effects of the most critical action team member's declarative knowledge of teamwork competencies on the team's planning and task coordination and collaborative problem-solving skills.

Method

Research Participants

Participants included 260 students (136 control and 124 trained) from an introductory management course at a large midwestern university who were arrayed into 65 four-person teams. The average age of the participants was 21 years, 61% were men, and 88% were White. In exchange for their participation, each earned class credit and all were eligible for cash prizes (up to $40 per session) based upon the team's performance. All participants were informed of the opportunity to receive an award before signing up for the research and 40% of the teams received the cash award.

Task

Participants engaged in a modified version of the Distributed Dynamic Decision Making (DDD) Simulation (see Miller, Young, Kleinman, & Serfaty, 1998). The DDD is a dynamic command and control simulation requiring team members to monitor activity in a geographic region and defend it against invasion from unfriendly air or ground tracks or tracks that enter the region. The objective of the simulation is to maximize the number of team points, which can be accomplished by identifying tracks that enter the space, determining whether they are friendly or unfriendly, and, if unfriendly, keeping them out of restricted areas (see below). Teams with the most points were awarded the cash prizes.

The DDD was chosen to test the hypotheses outlined in this study because it allows for the observation of numerous teams performing the same task under the same type of experimental conditions. As a result, it allowed for the manipulation of task- and team-generic teamwork skills training and criticality, direct assessment of planning and task coordination, collaborative problem solving, and communication, and strict control over extraneous variables (Bowers, Salas, Prince, & Brannick, 1992). Because team members participating in the DDD have highly specialized roles, are brought together for a short amount of time, are self-managing, and are faced with novel situations, the DDD closely simulates an action team environment (see Beersma et al., 2003).

The DDD grid. Figure 1 is a display of the geographic region, which is partitioned into four quadrants of equal size. Each team member in a four-person team is assigned responsibility for one of the four quadrants and operates from a workstation. In the center of the screen, there is a four- by -four square designated as the “highly restricted zone,” which is nested within a larger 12- by -12 square called the “restricted zone.” Outside the restricted zones is a neutral space. Each team member in the

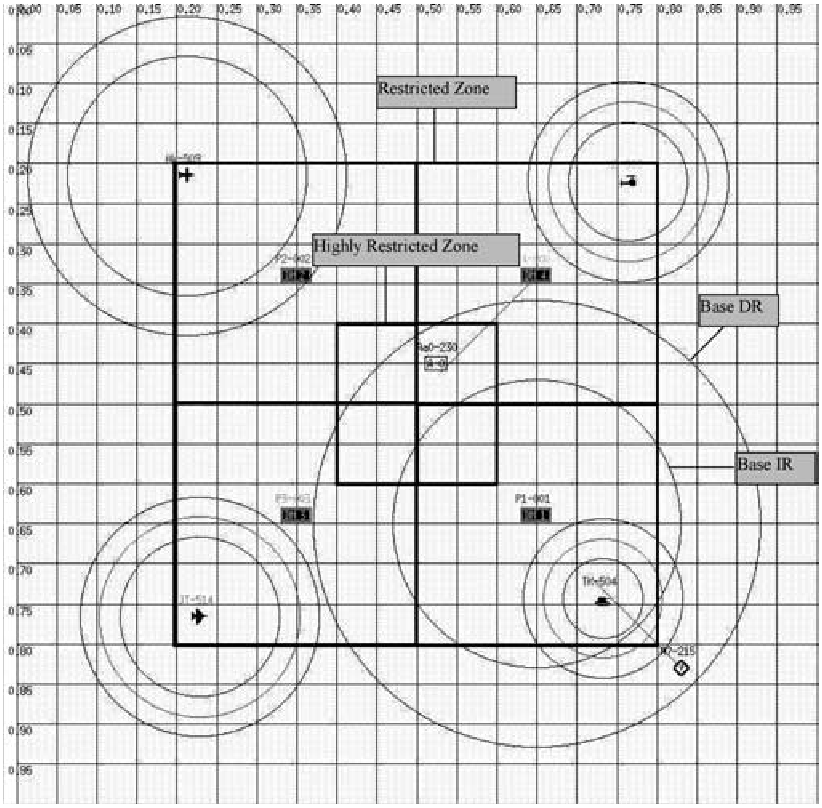

Figure 1: **The DDD Grid, Including Bases, Vehicles, and Tracks.**

configuration illustrated in Figure 1 is responsible for an equal portion of highly restricted, restricted, and neutral space.

Bases and vehicles. Each participant in this simulation is physically located at the center of one of the four quadrants and is assigned four vehicles that may be used to defend the space (i.e., keep unfriendly tracks out of restricted areas). The bases and vehicles have a combination of rings around them. The outermost ring is referred to as the detection ring, which allows each team member to view tracks on the screen. The inner ring, which is called the identification ring, allows team members to identify whether the track is friendly or enemy. The tank, helicopter, and jet also have a third ring between the detection and identification rings representing the area in which the approaching track can be engaged.

Vehicles vary on four capabilities: vision, speed, fuel capacity, and power. Capabilities are distributed among the vehicles so that each has both strengths and weaknesses. For example, the AWACS has the greatest

TABLE 1
Summary of Assets and Tracks

	Duration (in min.)	Assets speed	Vision	Power	Speed	Tracks power	Nature	Need to disable
Assets								
Tank	8:00	Slow	Very limited	high (5)				
Helicopter	4:00	Medium	Limited	med. (3)				
Jet	2:00	Very fast	Far	low (1)				
AWACS	6:00	Fast	Very far	none				
Tracks								
A0					Fast	none	Friendly	TK, HE, JT
A1					Fast	low (1)	Enemy	TK, HE, JT
A3					Fast	med. (3)	Enemy	TK, HE
A5					Fast	high (5)	Enemy	TK
G0					Slow	none	Friendly	TK, HE, JT
G1					Slow	low (1)	Enemy	TK, HE, JT
G3					Slow	med. (3)	Enemy	TK, HE
G5					Slow	high (5)	Enemy	TK
U+ (A0)					Fast	none	Friendly	TK, HE, JT
U− (A1)					Fast	low (1)	Enemy	TK, HE, JT
UX (A3)					Fast	med. (3)	Enemy	TK, HE
U# (A5)					Fast	high (5)	Enemy	TK

Notes. *For vehicles*: *duration* = amount of time a vehicle may stay away from the base before needing to refuel, *speed* = how fast the vehicle travels across the game screen, *vision* = refers to the range of vision the vehicle has to both see and identify tracks, *power* = the ability of the vehicle to engage enemy tracks. *For tracks*: *nature* = whether the track is an enemy or friend, *speed* = how fast the track travels across the game screen, *need to disable* = which of the vehicles can successfully engage the track.

range of vision but no power to engage unfriendly tracks. Tanks, on the other hand, have the highest level of power but their range of vision is small and their speed is slow. Table 1 provides capability values for each vehicle.

Tracks. Tracks enter the screen from the sides of the grid with a line (i.e., a vector) attached to them indicating the direction they are moving through the space. Initially, when tracks enter one's detection ring, they show up as unidentified, which is represented by a small diamond with a question mark in the middle (see Figure 1). Once the track enters one's identification ring, it can be identified. When tracks are identified, the diamond turns into a box with a letter and a number inside of it, as shown by track Aa0-230 in the top right quadrant's highly restricted zone in Figure 1. Inside the box it says A0, which, according to Table 1, means that it is a friendly air-based (as opposed to ground-based) track.

Actions taken toward tracks. Once a track is identified as unfriendly, a team member can engage the track by moving an asset near enough so that the track is within the attack ring. If the asset has enough power, the track can be disabled (see Table 1). Team members can make the decision to engage a track individually or they can be instructed by other team members to engage a track that is transitioning from one quadrant to another (i.e., a hand-off).

Procedures

When participants arrived for their scheduled 3-hour experimental session, they were randomly assigned to either the training or control condition. Individuals assigned to the training condition participated in a 30-minute training session. When the training was completed, they were administered Stevens and Campion's (1994) Teamwork KSA Test and then were assigned to a four-person team with three team members who had also undergone the training. Individuals in the control condition completed the Teamwork KSA Test upon arrival at the experiment and then were immediately placed in a four-person team.

Participants were then trained on the declarative and procedural aspects of the simulation as a team, which took approximately 60-minute. Participants were seated in close proximity to one another at four networked computer terminals. Verbal communication was the only method of communication allowed during the task.

After the 60-minute practice session, team members completed the 1-hour experimental session. During the experimental session, planning and task coordination, collaborative problem solving, and communication skills were measured.

Manipulations

Task- and team-generic training. Having done our team training analysis, the next step was to design and deliver the training program (Salas et al., 2002). Although there are a variety of different training methods, we utilized a lecture format. Instructional methods such as lectures are considered acceptable training methods (e.g., Kraiger, Ford, & Salas, 1993; Salas & Cannon-Bowers, 1997) and have been used in a number of team-training studies (e.g., Smith-Jentsch et al., 1996). Furthermore, based on researchers' recommendations (e.g., Cannon-Bowers et al., 1995; Kozlowski & Bell, 2003; Salas et al., 2002), we conducted our training at the individual level to accommodate the unique needs of action team members.

To construct our training lecture, we developed an instructional guide containing a number of case studies. The nine case studies (i.e., three per competency) were designed to highlight the critical aspects of planning/task coordination, collaborative problem solving, and communication (see Stevens & Campion, 1994). Each case study described a work-related problem that could occur in any team situation, giving participants several options regarding the appropriate course of action (see Appendix). The experimenter began the 30-minute training session with a short (approximately 2-minute) introduction that described the goals of the training (i.e., developing teamwork skills) and provided some general background on the case study. During the next 28-minute, the experimenter worked through the nine case studies with participants. For each case study, the experimenter instructed trainees to read the case and individually choose a course of action. The experimenter would then read a short explanation of why the correct answer was an effective response and why the incorrect answers were ineffective responses. Past research has shown that combining positive and negative model displays is an effective means of training interpersonal skills (e.g., communication), particularly when those skills must be generalized to novel contexts (Baldwin, 1992). After reviewing the positive and negative examples, participants moved to the next case study.

It should be noted that the training was *not* task nor team specific and provided participants with *no* information regarding situations they might encounter in the DDD simulation. The training was also conducted at the individual level. That is, team members were trained individually without any interaction with their soon-to-be teammates. Furthermore, the training involved one-way communication from the instructor to the trainees. We chose to train team members at the individual level based on recommendations in the literature. Specifically, researchers have suggested that task- and team-generic training should be done at the individual level to ensure the knowledge and skills remain generic and do not take on team-specific components (Salas et al., 2002).

Criticality. According to Brass (1984, 1985), criticality can be indexed by the number of alternative workflow routes or resource options if a team member is removed from the team; the higher the number, the less critical the team member. For example, when a team member provides the same resources as the majority of his or her teammates, he or she would be low in criticality because changes in the inputs acquired and outputs distributed within the team would be minimal upon losing that individual. Therefore, in this study we manipulated criticality by distributing assets unequally between the team members. Specifically, during the task, one team member was in charge of all four AWACS planes, another was in charge of all four tanks, another was in charge of all four helicopters, and the final team member was in charge of all four jets. In this resource allocation structure, the team member that was in control of the tanks was the only team member that could engage tracks with a power level of five. None of the team members could act as his or her replacement. All three of the other teammates had to rely on him or her for the continual flow of work, providing him or her with a high degree of power and control over the team. None of the other team members' roles exhibited the same characteristics. That is, no other roles were uniquely capable of performing any single task, and thus, with the exception of the most critical team member, there was horizontal substitutability to varying degrees for all other roles (Hollenbeck et al., 2002). Therefore, this person was labeled as the most critical team member and was the focus of our hypothesis tests. As for the other team members, the second most critical team member was in charge of the helicopters (he or she could be replaced by the most critical team member), the third most critical team member was in charge of the jets, and the least critical team member was in charge of the AWACS planes. Although team members were aware of each other's resources, they were not informed of the relative criticality of their roles.

Cognitive Measures

Declarative knowledge. Kraiger et al. (1993) note that multiple-choice exams are one of the most commonly used methods to assess the acquisition of declarative knowledge during training. In the current study, Stevens and Campion's (1994) Teamwork KSA Test was used to evaluate the knowledge acquisition that occurred as a result of our task- and team-generic training program. The Teamwork KSA Test is a 35-item multiple-choice test designed to assess the five categories of teamwork competencies previously discussed. Participants received one point for every correct answer, yielding a possible range of scores from 0 to 35. However, because we were primarily interested in three specific competencies (i.e., collaborative problem solving, communication, and planning and task coordination), we focused on the 26 items tapping those three areas. Each competency consisted of different numbers of items, so we standardized scores before combining them in order to give equal weight to each competency.

To represent each team's overall score, we followed the recommendations of other researchers who have focused primarily on the nature of the task when aggregating individual-level variables to the team level. Team tasks conform to conjunctive, disjunctive, or additive models (Steiner, 1972). The team task used in this study conforms to an additive model (see Ellis et al., 2003). Therefore, the average of team members' scores was used to represent the team's level of declarative knowledge (see Barrick et al., 1998).

Skill-Based Measures

Planning and task coordination skills. Earlier, we conceptually defined planning and task coordination as the team members' capacity to effectively sequence and orchestrate activities, as well as manage procedural interdependencies among team members. Although planning and task coordination has been broadly defined, one of its critical components involves ensuring proper balancing of workload and support within the team (Erez, LePine, & Elms, 2002; Stevens & Campion, 1999). Cannon-Bowers and Salas (1997), for example, note that one critical coordination activity is the dynamic reallocation of function, which involves the shifting of responsibilities across team members. Fleishman and Zaccaro's (1992) taxonomy of team performance functions emphasizes the importance of load balancing, and Waller (1999) notes that a critical part of coordination pertains to the distribution of tasks among group members. Cannon-Bowers, Tannenbaum, Salas, and Volpe (1995) note the importance of team being able to "shift the workload among its team members to achieve balance during high-workload, time-pressured, or emergency situations" (p. 351).

Kraiger et al. (1993) note that skill-based outcomes have traditionally been assessed by observing trainee's performance in simulations conducted at the end of training. In the current task environment, to balance the team's workload, team members had to venture out of their own quadrants and help each other. For example, one team member only had access to four AWACS planes, so the presence of any unfriendly tracks in this person's quadrant required assistance from his or her teammates. This required that this individual work interdependently with the other team members to vector a weapons-bearing vehicle into his or her region. One of the other team members had only tanks, which had extremely limited vision. This person had to coordinate with the team member who controlled the AWACS planes in order to see where help was needed.

Therefore, counting and summing together the number of times team members assisted each other by engaging enemy tracks in their teammates' quadrants assessed proficiency in planning and task coordination. This type of support behavior could only occur as a result of effective planning and coordination and, hence, matches our conceptual definition that emphasized the capacity to sequence and orchestrate activities, as well as manage information exchange and interdependencies among team members. This method is comparable to the behavioral event format (e.g., Salas, Cannon-Bowers, & Blickensderfer, 1993; Zalesny, Salas, & Prince, 1995), in which scenarios are created to examine whether appropriate teamwork behaviors occur. However, rather than having observers code team responses, the simulation used in this study provides the capability to record team actions to make such assessments.

Collaborative problem-solving skills. Earlier, we conceptually defined collaborative problem solving as the team members' capacity to effectively use collective induction and deduction in order to resolve challenges and difficulties. In order to capture this in this simulation, we created several "unknown tracks" and inserted these into the experimental session.

These tracks were unknown in the sense that when the session began, no team member had any knowledge about the nature of these tracks and they were not covered in any aspect of their training. Learning the nature of the four unknown tracks could only be accomplished by collective trial and error experience. In fact, because each team member possessed only one type of vehicle (and hence could only test a sub set of all the possible hypotheses), it was virtually impossible for any individual member to solve this problem on his or her own.

For example, the tank operator could successfully engage all tracks regardless of level, and hence, if he or she successfully engaged the track, he or she could not discriminate if it had a power of one, three, or five. A jet operator could unsuccessfully engage a track but would not know if the track was a three or a five. The only way for the team to learn the nature of the tracks was to have each team member engage it and then share and discuss their collective experience. Thus, if all three team members engaged a *U* target and they found that the jet operator was unsuccessful, but both the helicopter and tank operator were successful when they engaged it, it could only be a power of three. Thus, in line with our conceptual definition, successful execution of the unknown tracks required both collective induction and deduction.

Our index of collaborative problem-solving skills was based on the effectiveness and efficiency with which these *U* tracks were engaged. An effective engagement was defined as clearing an unfriendly track, and efficiency was defined as clearing the track using an asset with the exact power required. Therefore, during effective and efficient engagements, team members matched the power of an unfriendly unknown track with the power of their asset (e.g., engaging a target with a power of one with a jet). This situation indicated that the team member had the requisite knowledge and skill to deal with that specific track. However, there were situations where team members effectively attacked *U* tracks without being efficient. For instance, if the track had a power of one, it could be engaged with the helicopter, tank, and jet. If a team member attacked it with the helicopter or tank, it was unclear whether he or she learned the exact power of the track, but it was clear that he or she learned that the track was unfriendly. In other situations, team members were both ineffective and inefficient, attacking the friendly *U* track or attacking an unknown without enough power. Clearly, the team member had failed to learn anything about the unknown track. Based on the efficiency and effectiveness of team members' behaviors toward the *U* tracks, we developed the following scoring system:

+2 Effective and efficient engagements
+1 Effective engagements
−2 Ineffective and inefficient engagements

Through this scoring system, gaps in team members' knowledge structures could be pinpointed, so we could easily assess what team members *did not* know. Because failure to learn the nature of these tracks could be traced strictly to failures in the area of collaborative problem solving, this index closely matched our conceptual definition of collaborative problem solving.

Communication skills. Communication refers to team members' capacity to understand information exchange networks and to utilize these to enhance information sharing (Stevens & Campion, 1994). Researchers have suggested that the amount of work-related information shared by team members represents a good indication of the degree to which the team members understand and utilize communication networks within the team (e.g., Gladstein & Reilly, 1985). Team members were only allowed to communicate verbally with one another. Therefore, we observed each team performing the task and coded each instance of task-related information sharing during the task (e.g., "My tanks are on their way to the southeast quadrant" or "There are a dozen targets entering the northwest restricted area").

One of two experimenters coded communication for the 65 teams. In order to ensure that the coding was accurate and consistent, 10 (15.38%) of the teams were coded by two experimenters and inter rater agreement was assessed. Cohen's (1960) κ has been supported as a good index of agreement when presence/absence coding schemes are used. In this study, $\kappa = .86$, which indicated that the two experimenters evidenced acceptable levels of inter rater agreement (see Landis & Koch, 1977). As a result, the remaining 55 teams were divided between the two experimenters.

Results

Means, standard deviations, and intercorrelations among the variables examined in the hypotheses tests are reported in Table 2. Our first hypothesis suggested that task- and team-generic training would positively affect trainees' declarative knowledge of teamwork competencies. We found that teams in the training condition evidenced significantly higher KSA scores ($M = .24, SD = .30$) than teams in the control condition ($M = -.22, SD = .38$), $t(64) = 5.35$, $p < .01$. These results were consistent across all four team members (see Table 3). Thus, Hypothesis 1 was supported.

We also examined the effects of our training program on conflict resolution and goal setting and performance management scores, which were not addressed by our training program. We found that teams' scores in the training condition ($M = .06, SD = .29$) were not significantly different than teams' scores in the control condition ($M = -.05, SD = .41$), $t(64) = 1.28$,

TABLE 2

Means, Standard Deviations, and Intercorrelations

Variable	M	SD	1	2	3	4	5	6	7	8	9
1. Training	.48	.50	–								
2. Knowledge—Team avg.	.00	.42	.56**	–							
3. Knowledge—Most critical team member	.00	.69	.37**	.58**	–						
4. Knowledge—2nd Most critical team member	.00	.71	.22*	.50**	−.01	–					
5. Knowledge—3rd Most critical team member	.00	.72	.47**	.77**	.45**	.17†	–				
6. Knowledge—Least critical team member	.00	.72	.26*	.49**	−.06	.01	.16†	–			
7. Planning and task coordination skills	15.41	2.93	.42**	.36**	.38**	.26*	.29**	−.09	–		
8. Collaborative problem-solving skills	24.49	14.64	.35**	.20†	−.18†	.27*	.14	.23*	−.06	–	
9. Communication skills	89.75	36.77	.44**	.49**	.37**	.37**	.37**	.04	.32**	.28*	–

Note. $N = 65$. Task- and team-generic teamwork skills training was coded 0 for no training and 1 for training. Significance values are based on 1-tailed tests. $^{\dagger}p < .10$ $^{*}p < .05$ $^{**}p < .01$.

TABLE 3

Effects of Training on Declarative Knowledge of Individual Team Members

Team member	Training condition Mean	Training condition *SD*	Control condition Mean	Control condition *SD*	*t*
Most critical member	0.24	0.30	−0.22	0.38	1.75*
2nd most critical member	0.35	0.56	−0.32	0.70	4.22**
3rd most critical member	0.19	0.73	−0.17	0.68	2.10*
Least critical member	0.26	0.63	−0.24	0.67	3.13**

Note. $N = 65$. Significance values are based on 1-tailed t-tests. $^{*}p < .05$ $^{**}p < .01$.

ns. These results were consistent across all four team members,[1] further supporting the validity of our training program in the sense that the differential effects for various criteria meet the definition on successful application of a non equivalent dependent variable design (Cook & Campbell, 1979; Frese et al., 2003; Klein & Weaver, 2000).

Hypothesis 2 proposed that task- and team-generic training would positively affect planning and task coordination, collaborative problem solving, and communication skills. Teams in the training condition exhibited significantly higher levels of planning and task coordination skill ($M = 16.70$, $SD = 3.47$) than teams in the control condition ($M = 14.24$, $SD = 1.62$), $t(64) = 3.70$, $p < .01$. Teams in the training condition exhibited significantly higher levels of collaborative problem-solving skill ($M = 29.76$, $SD = 11.79$) than teams in the control condition ($M = 19.69$, $SD = 15.48$), $t(64) = 2.93$, $p < .01$. Teams in the training condition exhibited significantly higher levels of communication skill ($M = 106.51$, $SD = 27.49$) than teams in the control condition ($M = 74.47$, $SD = 37.82$), $t(64) = 3.87$, $p < .01$. These results support Hypothesis 2.

Hypothesis 3 proposed that the team's average level of declarative knowledge of teamwork competencies would positively affect planning and task coordination, collaborative problem solving, and communication skills. Table 2 indicates that team's declarative knowledge significantly and positively affected planning and task coordination skills ($r = .36$, $p < .01$), collaborative problem-solving skills ($r = .20$, $p < .10$), and communication skills ($r = .49$, $p < .01$). Thus, Hypothesis 3 was supported.

Hypothesis 4 proposed that communication skills would partially mediate the relationship between declarative knowledge and planning and task coordination and collaborative problem- solving skills. In order to test for partial mediation, it is necessary to demonstrate that (a) the independent variable is correlated with the dependent variable, (b) the independent

[1]These results are available from the first author upon request.

TABLE 4

The Mediating Effects of Communication Skills on the Relationship Between Declarative Knowledge of Teamwork Competencies and Planning and Task Coordination and Collaborative Problem-Solving Skills

		Planning and task coord. skills			Collaborative problem-solving skills		
Step	Independent variable	β	Total R^2	ΔR^2	β	Total R^2	ΔR^2
1	Knowledge—Team avg.	.36**	.13**	.13**	.20†	.04†	.04†
1	Communication skills	.20	.10**	.10**	.24†	.08*	.08*
2	Knowledge—Team avg.	.26†	.16**	.05†	.09	.08*	.00
1	Knowledge—Most critical team member	.26*	.07*	.07*	.27*	.07*	.07*
1	Communication skills	.26*	.10**	.10**	.21	.08*	.08*
2	Knowledge—Most critical team member	.17	.13**	.02	.19	.11**	.03

Note. $N = 65$. †$p < .10$ *$p < .05$. **$p < .01$. *Avg*. = average.

variable is correlated with the mediating variable, (c) the mediating variable affects the dependent variable when controlling for the independent variable, and (d) relationship between the independent variable and the dependent variable becomes negligible or is reduced significantly when controlling for the mediating variable (Baron & Kenny, 1986; Kenny, Kashy, & Bolger, 1998).

Because the team's average level of declarative knowledge significantly affected planning and task coordination and collaborative problem-solving skills, the first requirement for mediation was satisfied. The second requirement for mediation was also supported as declarative knowledge acquired during training affected demonstrated communication skills. The third requirement for mediation was tested by first regressing planning and task coordination skills on the team's declarative knowledge and communication skills. Communication was not significantly related to planning and task coordination skill when controlling for declarative knowledge ($\beta = .20$, *ns*). This violated the third requirement for mediation, even though the variance in planning and task coordination skill accounted for by declarative knowledge was reduced from 13% to 5% when controlling for communication skill (see Table 4).

We then regressed collaborative problem-solving skill on declarative knowledge. Communication skill was significantly related to collaborative problem-solving skill when controlling for declarative knowledge ($\beta = .24$, $p < .10$), passing the third requirement for mediation. Regarding the fourth requirement for mediation, regression analyses indicated that, after controlling for communication skill, the variance in collaborative problem-solving skill accounted for by declarative knowledge was reduced from 4% to 0% (see Table 4). This reduction was determined to be marginally significant by Sobel's (1982) test, $Z = 1.67$, $p < .10$. Thus, Hypothesis 4 was partially supported.

Hypothesis 5 proposed that the most critical action team member's declarative knowledge of teamwork competencies would have a significant impact on the team's planning and task coordination, collaborative problem solving, and communication skills. As shown in Table 5, the declarative knowledge held by the most critical team member positively affected planning and task coordination skill ($\beta = .25$, $p < .05$), collaborative problem-solving skill ($\beta = .23$, $p < .10$), and communication skill ($\beta = .33$, $p < .01$). Interestingly, Table 5 also indicates that the declarative knowledge held by the least critical team member exhibited unique effects on planning and task coordination behavior ($\beta = .32$, $p < .05$), collaborative problem-solving behavior ($\beta = -.25$, $p < .10$), and communication skill ($\beta = .30$, $p < .05$); findings that are discussed further in the discussion section. The remaining two team members' scores did not have a significant effect on the team-level, skill-based outcomes. Thus, partial support was found for Hypothesis 5.

Hypothesis 6 proposed that communication skills would partially mediate the effects of the most critical action-team member's declarative knowledge on planning and task coordination and collaborative problem-solving skills. Because the most critical action-team member's declarative knowledge significantly affected planning and task coordination and collaborative problem-solving skills, the first requirement for mediation was satisfied. The second requirement for mediation was also supported as the most critical action team member's declarative knowledge significantly affected communication skill. The third requirement for mediation was tested by first regressing planning and task coordination skill on the most critical action team member's declarative knowledge and communication skill. Communication was significantly related to planning and task coordination when controlling for the most critical action team member's declarative knowledge ($\beta = .26$, $p < .05$), passing the third requirement for mediation. Regarding the fourth requirement for mediation, regression analyses indicated that, after controlling for communication skill, the variance in planning and task coordination accounted for by the most critical action-team member's declarative knowledge was reduced from 7% to 2% (see Table 4). This reduction was determined to be marginally significant by Sobel's (1982) test, $Z = 1.73$, $p < .10$.

We then regressed collaborative problem-solving skill on the most critical action-team member's declarative knowledge and communication skill. Communication was not significantly related to collaborative

TABLE 5

The Effects of Each Team Member's Declarative Knowledge on Planning and Task Coordination, Collaborative Problem Solving, and Communication Skills

		Planning and task coord. skills			Collaborative prob. solving skills			Communication skills		
Step	Independent variable	β	Total R^2	ΔR^2	β	Total R^2	ΔR^2	β	Total R^2	ΔR^2
1	Knowledge—Most critical team member	$.25^{*}$	$.23^{**}$	$.23^{**}$	$.23^{\dagger}$	$.17^{*}$	$.17^{*}$	$.33^{**}$	$.29^{**}$	$.29^{**}$
	Knowledge—2nd Most critical team member	.12			.18			.17		
	Knowledge—3rd Most critical team member	−.09			.19			.03		
	Knowledge—Least critical team member	$.32^{*}$			$-.25^{\dagger}$			$.30^{*}$		

Note. $N = 65$. $^{\dagger}p < .10$ $^{*}p < .05$. $^{**}p < .01$.

problem solving when controlling for the most critical action team member's declarative knowledge ($\beta = .21$, *ns*), which violated the third requirement for mediation, even though the variance in collaborative problem solving accounted for by the most critical action team member's declarative knowledge was reduced from 7% to 3% (see Table 4). Thus, Hypothesis 6 was partially supported.

Discussion

The purpose of this study was to utilize established training design principles to examine the effectiveness of a task- and team-generic training program for the members of action teams. Results indicated that training significantly increased declarative knowledge within the team as evidenced by improved scores on Stevens and Campion's Teamwork KSA Test. Trained teams also demonstrated significantly greater proficiency than untrained teams in the areas of planning and task coordination, collaborative problem solving, and communication in a novel team and task environment.

These findings suggest that task- and team-generic training represents one viable approach organizations can take to enhance the level of teamwork skills among employees. One benefit of task- and team-generic training is that it is not tailored to a specific team or task and, therefore, can be used to develop training programs that are offered simultaneously to a broad range of employees. In addition, task- and team-generic training reduces the need for organizations to retrain employees before each new team assignment (Salas et al., 2002). These two benefits should not only reduce training costs but also enhance organizational flexibility by making it possible for individuals to transition more quickly and effectively from one team environment to another.

Our results also provide some insight into how task- and team-generic training has its effects. Consistent with cognitive theories of skill-development (e.g., Anderson, 1982), we found that declarative knowledge gathered through training led to the development of several skills important in action team environments. Not only was the average level of declarative knowledge within the team positively related to team performance, but we also found that the relationship between cognitive and skill-based outcomes was influenced by team members' roles within the team. In particular, our results suggest that the knowledge held by critical team members is particularly important for team effectiveness. This extends research on social networks (e.g., Brass, 1984) and suggests that criticality can play an important role in team settings. Critical team members who possess strong teamwork skills may serve as a conduit for effective team functioning.

The results regarding criticality are also practically interesting because they offer organizations with more specific prescriptive advice regarding who should be targeted for task- and team-generic training programs. If organizations possess limited training resources (e.g., time, money), as is frequently the case, our results indicate that it would be beneficial to focus on training team members whose roles are extremely low in substitutability first. There may be particular individuals who, because of the nature of their expertise or position, are more likely to assume a highly critical role within various teams in an organization. Our results suggest that training these individuals on generic teamwork skills may offer the greatest return on an organization's training investment.

The criticality results also suggest an alternative form of aggregation to researchers. Studies have traditionally used Steiner's (1972) taxonomy to identify the type of team task before deciding upon an aggregation method (e.g., Barrick et al., 1998; Ellis et al., 2003; Porter et al., 2003). Using Steiner's taxonomy, we found that mean levels of declarative knowledge influenced planning and task coordination, collaborative problem solving, and communication skills. However, we found it was also informative to examine the roles and responsibilities of team members themselves instead of simply focusing on the type of task. Although researchers have examined the effects of team leader characteristics on team behaviors (LePine et al., 1997), this study suggests that critical team members may play a significant role in non hierarchical teams as well. Our results support Hinsz, Tindale, and Vollrath (1997), who note that "the cognitive resources a member brings to a group need to relate to the task and interaction demands to achieve group effectiveness" (p. 56) and suggest that new aggregation methods are needed to reflect this idea.

In addition to the most critical team member, we unexpectedly found that the declarative knowledge of the least critical team member exhibited unique effects on planning and task coordination ($\beta = .32, p < .05$), collaborative problem solving ($\beta = -.25, p < .10$), and communication ($\beta = .30, p < .05$). Given the way we conceptually and operationally defined criticality, these results were definitely counter intuitive. Although this is a post hoc speculation that deserves a direct a priori confirmation from future research, what this may suggest is that there may be a curvilinear relationship between criticality and the need for generic teamwork skills. That is, given the redundant nature of the least critical team member with respect to taskwork, perhaps the only way this person can have an influence on team functioning is when their generic teamwork's skills are very strong. That is, only a person armed with strong teamwork skills can find a way to move from being a non critical contributor to a more critical figure (e.g., by taking responsibility for lower level team operations so that critical members can devote their capabilities to those operations for which only they are equipped to perform). However, a non critical figure who lacks generic teamwork skills may simply become a non factor, turning a four-person team into what is effectively a three-person team, with the predictable effects on team's overall effectiveness.

Finally, our results examined communication skills as a critical mechanism by which declarative knowledge at the individual-level drives the development of skills at the team-level. Researchers have suggested that communication underlies a number of other skills, such as coordination, in teams (e.g., Kozlowski & Bell, 2003). Our results partly supported the operation of a "skill hierarchy," which has implications for the sequencing of generic teamwork skills training modules. Organizations may want to initially focus on training more fundamental skills such as communication before progressing to more complex skills such as planning and task coordination and collaborative problem solving.

However, the fact that our results did not completely support the mediating effects of communication skills was not surprising. The literature on teams has repeatedly noted the difficulties surrounding measurement of the communication. Generally, the literature has traditionally treated communication as a "more is better" construct (e.g., Campion, Medsker, & Higgs, 1993; Campion, Papper, & Medsker, 1996; Gladstein & Reilly, 1985). However, several researchers have found that more communication does not necessarily translate into positive outcomes (e.g., Tesluk & Mathieu, 1999), and indeed, too much communication can be an indicator of lack of implicit coordination and shared understanding. For example, in this study, rather than routinely getting into the habit of patrolling other team members' quadrants and then helping spontaneously without a direct request, poorly performing teams may have to repeatedly make direct verbal requests for help—perhaps even to multiple team members before getting assistance. This type of communication would actually be indicative of ineffective planning and task coordination.

Limitations and Directions for Future Research

A few limitations of the current study should be highlighted. First, we employed lecture-based training, which is only one of a number of techniques that organizations can utilize when training generic teamwork skills. A recent meta-analysis by Arthur, Bennett, Edens, and Bell (2003) revealed that, despite their poor image, lectures are one of the more effective organizational training methods, particularly for achieving cognitive outcomes. Researchers have also suggested that a lecture format may be a particularly effective and efficient means of conducting generic teamwork skills training (Cannon-Bowers et al., 1995), and our results provide support for this argument. Yet, methods that are more interactive or experiential, such as those that incorporate role playing or guided practice may be equally or more effective for developing generic teamwork skills (Beard, Salas, & Prince, 1995; Salas, Burke, & Cannon-Bowers, 2002). Salas and Cannon-Bowers (1997) note that multimedia technology may also serve as an effective team training method, particularly for information-based team training that is designed to impart knowledge. Thus, we believe that future research would benefit from an examination of different training techniques and their utility for developing generic teamwork KSAs.

In addition to exploring alternative training methods, future research is needed to examine other considerations in the design and delivery of generic teamwork skills training. For example, Salas et al. (2002) recommend developing team members' taskwork skills to a threshold level before focusing on the acquisition of teamwork skills. Our results suggest that developing generic teamwork competencies prior to the acquisition of taskwork skills can enhance team performance. Thus, it may be that generic teamwork skills can serve as a valuable foundation for the development of more team- and task-contingent competencies. Team training design must take into account principles of human learning (Salas et al., 2002). Transfer of generic teamwork skills training across various team and task contexts may be enhanced through the utilization of instructional strategies that facilitate the development of flexible and adaptive skills. For example, providing individuals with opportunities to practice their skills in a variety of situations (Schmidt & Bjork, 1992), allowing individuals to experience and learn from errors (Ivancic & Hesketh, 1995/1996), and supplementing training with meta cognitive instruction or guidance (Bell & Kozlowski, 2002; Schmidt & Ford, 2003) have all been shown facilitate the transfer of skills to related tasks and altered contexts. Future research that examines these and other issues surrounding the design and delivery of generic teamwork skills training will provide valuable insight into how to enhance the impact of this approach on team performance.

Future research may also benefit from different aggregation techniques when examining the effectiveness of generic teamwork skills training. Due to the nature of the task utilized in this study, an additive model was used when aggregating individual-level data (see Barrick et al., 1998). However, in many organizations, teams are faced with tasks that involve more complex combinations of different contributions across team members. When sequential or reciprocal coordination mechanisms are required, emergence may be more discontinuous and nonlinear. In such situations, dispersion or configural models may better capture the emergent characteristics of the team (Kozlowski & Bell, 2003). Treating the effects of training as a multilevel phenomenon will help further our understanding of when, why, and how training conducted at the individual level will vertically transfer to the team level.

Furthermore, due to time constraints, the task- and team-generic training program focused on three specific teamwork KSAs that were deemed as particularly important for action team effectiveness. In many situations, resource constraints will make it impractical to focus on all of the teamwork KSAs in a single training session. In addition, one has to be careful to avoid overloading trainees with information, which can ultimately detract from learning and performance (Paas, Renkl, & Sweller, 2003). Thus, the team task analysis should always serve as the first step in designing any team training program because it will allow organizations to focus generic teamwork skills training on those teamwork KSAs that are likely to have the largest impact for the largest segment of the employee population (Salas & Cannon-Bowers, 1997). Future research is needed to extend our findings to the training of different types of teams on different sets of teamwork competencies.

Finally, because this study was conducted in a laboratory context, future research needs to examine the external validity of these results. Because we were interested in specific learning outcomes, we feel the laboratory setting did not present a significant problem. In fact, Kraiger et al. (1993) note that skill-based outcomes should be measured through role playing exercises or simulations. Furthermore, we were concerned more with developing and evaluating the effects of task- and team-generic training than with the simulation itself. Because there is no reason to think that a task- and team-generic training program could not be evaluated in this context, this context serves as a meaningful venue for testing our hypotheses. We are simply asking the "can it happen" question, which according to Ilgen (1986), is exactly the type of question that bears investigation in this type of a laboratory setting. However, despite our results, we acknowledge that teams in the control condition did not receive any training beyond the declarative and procedural aspects of the simulation. Consequently, we cannot definitively say that our results would have been different with a different type of team training (e.g., cross training). We hope that future research will address these issues and extend our findings by further examining the role of task- and team-generic training in enhancing team effectiveness across a variety of team and task contexts.

REFERENCES

Ackerman PL. (1987). Individual differences in skill learning: An intergration of psychometric and information processing perspectives. *Psychological Bulletin, 102*, 3–27.

Anderson JR. (1982). Acquisition of a cognitive skill. *Psychological Review, 89*, 369–406.

Arthur W, Bennett W, Edens PS, Bell ST. (2003). Effectiveness of training in organizations: A meta-analysis of design and evaluation features. *Journal of Applied Psychology, 88*, 234–245.

Baldwin TT. (1992). Effects of alternative modeling strategies on outcomes of interpersonal-skills training. *Journal of Applied Psychology, 77*, 147–154.

Baron RM, Kenny DA. (1986). The mediator–moderator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173–1182.

Barrick MR, Stewart GL, Neubert MJ, Mount MK. (1998). Relating member ability and personality to work-team processes and team effectiveness. *Journal of Applied Psychology, 83*, 377–391.

Beard RL, Salas E, Prince C. (1995). Enhancing transfer of training: Using role-play to foster teamwork in the cockpit. *The International Journal of Aviation Psychology, 5*, 131–143.

Beersma B, Hollenbeck JR, Humphrey SE, Moon H, Conlon DE, Ilgen DE. (2003). Cooperation, competition, and team performance: Toward a contingency approach. *Academy of Management Journal, 46*, 572–590.

Bell BS, Kozlowski SWJ. (2002). Adaptive guidance: Enhancing self-regulation, knowledge, and performance in technology-based training. PERSONNEL PSYCHOLOGY, *55*, 267–306.

Bowers C, Salas E, Prince C, Brannick M. (1992). Games teams play: A method for investigating team coordination and performance. *Behavior Research Methods, Instruments, & Computers, 24*, 503–506.

Brannick MT, Roach RM, Salas E. (1993). Understanding team performance: A multimethod study. *Human Performance, 6*, 287–308.

Brass DJ. (1984). Being in the right place: A structural analysis of individual influence in an organization. *Administrative Science Quarterly, 29*, 518–539.

Brass DJ. (1985). Men's and women's networks: A study of interaction patterns and influence in an organization. *Academy of Management Journal, 28*, 327–343.

Campion MA, Medsker GJ, Higgs C. (1993). Relations between work group characteristics and efficiency: Implications for designing effective work groups. PERSONNEL PSYCHOLOGY, *46*, 823–850.

Campion MA, Papper EM, Medsker GJ. (1996). Relations between work team characteristics and effectiveness: A replication and extension. PERSONNEL PSYCHOLOGY, *49*, 429–452.

Cannon-Bowers JA, Salas E. (1997). Teamwork competencies: The intersection of team member knowledge, skills, and attitudes. In O'Neil HF (Ed.), *Workforce readiness: Competencies and assessment* (pp. 151–174). Hillsdale, NJ: Erlbaum.

Cannon-Bowers JA, Tannenbaum SI, Salas E, Volpe CE. (1995). Defining competencies and establishing team training requirements. In Guzzo RA, Salas E (Eds.), *Team effectiveness and decision making in organizations* (pp. 333–380). San Francisco: Jossey-Bass.

Chen G, Donahue LM, Klimoski RJ. (2004). Training undergraduates to work in organizational teams. *Academy of Management Learning and Education, 3*, 27–40.

Cohen J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20*, 37–46.

Cook TD, Campbell JP. (1979). Quasi-experimentation: Design analysis issues for field settings. Boston, MA: Houghton Mifflin Company.

Cooper CL, Dewe PJ, O'Driscoll MP. (2001). *Organizational stress: A review and critique of theory, research, and applications*. Thousand Oaks, CA: Sage.

Ellis APJ, Bell BS. (in press). Capacity, collaboration, and commonality: A framework for understanding team learning. In Schrieshiem C, Neider LL (Eds.), *Research in Management*, (vol. 4).

Ellis APJ, Hollenbeck JR, Ilgen DR, Porter COLH, West BJ, Moon HK. (2003). Team learning: Collectively connecting the dots. *Journal of Applied Psychology, 88*(5), 821–835.

Erez A, LePine JA, Elms H. (2002). Effects of rotated leadership and peer evaluation on the functioning and effectiveness of self-managed teams: A quasi-experiment. PERSONNEL PSYCHOLOGY, *55*, 929–948.

Fleishman EA, Zaccaro WJ. (1992). Toward a taxonomy of team performance functions. In Swezey RW, Salas E (Eds.), *Teams: Their training and performance* (pp. 31–56). Norwood, NJ: Ablex.

Frese M, Beimel S, Schoenborn S. (2003). Action training for charismatic leaders: Two evaluations of studies of a commercial training module on inspirational communication for a vision. PERSONNEL PSYCHOLOGY, *56*, 671–697.

Gladstein DL, Reilly NP. (1985). Group decision making under threat: The tycoon game. *Academy of Management Journal, 28*, 613–627.

Guzzo RA. (1995). Introduction: At the intersection of team effectiveness and decision making. In Guzzo RA, Salas E (Eds.), *Team effectiveness and decision making in organizations* (pp. 1–8). San Francisco: Jossey-Bass.

Hinsz VB, Tindale RS, Vollrath DA. (1997). The emerging conceptualization of groups as information processors. *Psychological Bulletin, 121*, 43–64.

Hollenbeck JR, DeRue DS, Guzzo R. (2004). Bridging the gap between I/O research and HR practice: Improving team composition, team training and team task design. *Human Resource Management, 43*, 353–366.

Hollenbeck JR, Moon H, Ellis A, West B, Ilgen DR, Sheppard L, et al. (2002). Structural contingency theory and individual differences: Examination of external and internal person-team fit. *Journal of Applied Psychology, 87*, 599–606.

Ilgen DR. (1986). Laboratory research: A question of when, not if. In Locke EA (Ed.), *Generalizing from lab to field settings* (pp. 257–267). Lexington, MA: Heath.

Ilgen DR, Major DA, Hollenbeck JR, Sego DJ. (1993). Team research in the 1990s. In Chemers MM, Ayman R (Eds.), *Leadership theory and research* (pp. 245–270). New York: Academic Press.

Ivancic K, Hesketh B. (1995/1996). Making the best of errors during training. *Training Research Journal, 1*, 103–125.

Kanter RM. (1983). *The change masters*. New York: Simon & Schuster.

Kanter RM. (1988). When a thousand flowers bloom: Structural, collective, and social conditions for innovation in organizations. In Staw BM, Cummings LL (Eds.), *Research in organizational behavior* (pp. 169–211). Greenwich, CT: JAI Press.

Kenny DA, Kashy DA, Bolger N. (1998). Data analysis in social psychology. In Gilbert D, Fiske S, Lindzey G (Eds.), *The handbook of social psychology* (pp. 233–265). Boston: McGraw-Hill.

Kimberly JR. (1981). Managerial innovation. In Starbuck WH (Ed.), *Handbook of organizational design* (pp. 84–104). New York: Oxford University Press.

Klein HJ, Weaver NA. (2000). The effectiveness of an organizational-level orientation training program in the socialization of new hires. PERSONNEL PSYCHOLOGY, *53*, 47–66.

Kozlowski SJW, Bell BS. (2003). Work groups and teams in organizations. In Borman WC, Ilgen DR, Klimoski R (Eds.), *Handbook of psychology: Industrial and organizational psychology* (vol. 12, pp. 333–376). New York: Wiley.

Kraiger K. (2002). Decision-based evaluation. In Kraiger K (Ed.), *Creating, implementing, and maintaining effective training and development: State-of-the-art lessons for practice* (pp. 331–375). San Francisco: Jossey-Bass.

Kraiger K. (2003). Perspectives in training and development. In Borman WC, Ilgen DR, Klimoski R (Eds.), *Handbook of psychology: Industrial and organizational psychology* (vol. 12, pp. 171–192). New York: Wiley.

Kraiger K, Ford JK, Salas E. (1993). Application of cognitive, skill-based, and affective theories of learning outcomes to new methods of training evaluation. *Journal of Applied Psychology, 78*, 311–328.

Landis J, Koch GG. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*, 159–174.

Laughlin PR. (1988). Collective induction: Group performance, social combination processes, and mutual majority and minority influence. *Journal of Personality and Social Psychology, 54*, 254–267.

Laughlin PR, Ellis AL. (1986). Demonstrability and social combination processes on mathematical intellective tasks. *Journal of Experimental Social Psychology, 22*, 177–189.

Laughlin PR, McGlynn RP. (1986). Collective induction: Mutual group and individual influence by exchange of hypotheses and evidence. *Journal of Experimental Social Psychology, 22*, 567–589.

LePine JA, Hollenbeck JR, Ilgen DR. (1997). Effects of individual differences on the performance of hierarchical decision-making groups: Much more than *g*. *Journal of Applied Psychology, 82*, 803–811.

Liang DW, Moreland RL, Argote L. (1995). Group versus individual training and group performance: The mediating role of transactive memory. *Personality and Social Psychology Bulletin, 21*, 384–393.

Marks MA, Mathieu JE, Zaccaro SJ. (2001). A temporally based framework and taxonomy of team processes. *The Academy of Management Review, 26*, 356–376.

Marks MA, Sabella MJ, Burke CS, Zaccaro SJ. (2002). The impact of cross training on team effectiveness. *Journal of Applied Psychology, 87*, 3–13.

Marks MA, Zaccaro SJ, Mathieu JE. (2000). Performance implications of leader briefings and team-interaction training for team adaptation to novel environments. *Journal of Applied Psychology, 85*, 971–986.

Mathieu JE, Heffner TS, Goodwin GF, Salas E, Cannon-Bowers JA. (2000). The influence of shared mental models on team process and performance. *Journal of Applied Psychology, 85*, 273–283.

McClough AC, Rogelberg SG. (April, 1998). *An exploration of Stevens and Campion's teamwork knowledge, skill, and ability instrument*. Paper presented at the 13th Annual Conference for the Society for Industrial and Organizational Psychology, Dallas, TX.

Mechanic D. (1962). Sources of power of lower participants in complex organizations. *Administrative Science Quarterly, 7*, 349–364.

Mehra A, Kilduff M, Brass DJ. (2001). The social networks of high and low self-monitors: Implications for workplace performance. *Administrative Science Quarterly, 46*, 121–146.

Miller DL, Young P, Kleinman D, Serfaty D. (1998). *Distributed dynamic decision-making simulation phase I: Release notes and user's manual*. Woburn, MA: Aptima, Inc.

Mintzberg H. (1983). *Power in and around organizations*. Englewood Cliffs, NJ: Prentice-Hall.

Mohrman SA, Cohen SG, Mohrman AM, Jr. (1995). *Designing team-based organizations*. San Francisco: Jossey-Bass.

Neves DM, Anderson JR. (1981). Knowledge compilation: Mechanisms for the automatization of cognitive skills. In Anderson JR (Ed.), *Cognitive skills and their acquisition* (pp. 335–359). Hillsdale, NJ: Erlbaum.

Paas F, Renkl A, Sweller J. (2003). Cognitive load theory and instructional design: Recent developments. *Educational Psychologist, 38*, 1–4.

Pfeffer J. (1981). *Power in organizations*. Marshfield, MA: Pitman.

Porter COLH, Hollenbeck JR, Ilgen DR, Ellis APJ, West BJ, Moon HK. (2003). Backing up behaviors in teams: The role of personality and the legitimacy of need. *Journal of Applied Psychology, 88*, 391–403.

Prince C, Salas E. (1993). Training and research for teamwork in the military aircrew. In Weiner EL, Kanki BG, Hlemreich RL (Eds.), *Cockpit resource management* (pp. 337–366). San Diego, CA: Academic.

Robbins SP. (2003). *Organizational Behavior*. Upper Saddle River, NJ: Prentice-Hall.

Salancik GR, Pfeffer J. (1977). Who gets power—and how they hold on to it: A strategic contingency model of power. *Organizational Dynamics, 5*, 3–21.

Salas E, Cannon-Bowers JA. (1997). Methods, tools, and strategies for team training. In Quinones MA, Ehrenstein A (Eds.), *Training for a rapidly changing workplace: Applications of psychological research* (pp. 249–280). Washington, DC: American Psychological Association.

Salas E, Burke CS, Cannon-Bowers JA. (2002). What we know about designing and delivering team training. In Kraiger K (Ed.), *Creating, implementing, and managing effective training and development: State-of-the-art lessons for practice* (pp. 234–259). San Francisco: Jossey-Bass.

Salas E, Cannon-Bowers JA, Blickensderfer EL. (1993). Team performance and training research: Emerging principles. *Journal of the Washington Academy of Sciences, 83*, 81–106.

Schmidt RA, Bjork RA. (1992). New conceptualizations of practice: Common principles in three paradigms suggest new concepts for training. *Psychological Science, 3*, 207–217.

Schmidt AA, Ford JK. (2003). Learning within a learner control training environment: The interactive effects of goal orientation and metacognitive instruction on learning outcomes. PERSONNEL PSYCHOLOGY, *56*, 405–429.

Smith-Jentsch K, Salas E, Baker DP. (1996). Training team performance-related assertiveness. PERSONNEL PSYCHOLOGY, *49*, 909–936.

Sobel ME. (1982). Asymptotic confidence intervals for indirect effects in structural equations models. In Leinhart S (Ed.), *Sociological methodology 1982* (pp. 290–312). San Francisco: Jossey-Bass.

Steiner ID. (1972). *Group process and productivity*. New York: Academic Press.

Stevens MJ, Campion MA. (1994). The knowledge, skill, and ability requirements for teamwork: Implications for human resource management. *Journal of Management, 20*, 503–530.

Stevens MJ, Campion MA. (1999). Staffing work teams: Development and validation of a selection test for teamwork settings. *Journal of Management, 25*, 207–228.

Stevens MJ, Yarish ME. (1999). Training for team effectiveness. In Sundstrom E, Associates (Eds.), *Supporting work team effectiveness* (pp. 126–156). San Francisco: Jossey-Bass.

Sundstrom E. (1999). The challenges of supporting work team effectiveness. In Sundstrom E, Associates (Eds.), *Supporting work team effectiveness* (pp. 3–23). San Francisco: Jossey-Bass.

Swezey RW, Salas E. (1992). Guidelines for use in team-training development. In Swezey RW, Salas E (Eds.), *Teams: Their training and performance* (pp. 219–245). Norwood, NJ: Ablex.

Tesluk PE, Mathieu JE. (1999). Overcoming roadblocks to effectiveness: Incorporating management of performance barriers into models of work group effectiveness. *Journal of Applied Psychology, 84*, 200–217.

Van de Ven AH. (1986). Central problems in the management of innovation. *Management Science, 32*, 590–607.

Waller MJ. (1999). The timing of adaptive group responses to nonroutine events. *Academy of Management Journal, 42*, 127–137.

Zalesny MD, Salas E, Prince C. (1995). Conceptual and measurement issues in coordination: Implications for team behavior and performance. *Research in Personnel and Human Resources Management, 13*, 81–115.

APPENDIX

You have just graduated with a bachelor's degree in engineering. To find a job, you send your resume around to various organizations in the area. Fortunately, Titan Motor Company is looking for engineers and they set up an interview. At the interview, you impress them with your charm and they hire you on the spot to help them design the new Titan Comet Coupe in Iowa City, Iowa.

Upon starting your job, you are immediately faced with an issue that your design team needs to resolve. You must decide what type of fabric to use for the interior of the car. You, along with two of your three teammates, want to use polyester. However, your fourth team member is adamantly against polyester and opts for suede instead. His voice gives the impression that he is certain that suede is the best choice and no one is going to change his mind. He thinks he has given the impression that he is a confident decision maker. But, by refusing to discuss the issue, he ends up creating a situation where you and the other teammates feel hesitant to open up to him. You want to be part of a team where everyone has a chance to participate. Everyone should be able to communicate openly and supportively with each other. What do you think leads to the most open and supportive environment?

1. Positioning yourself properly in the communication network.
2. Learning how to communicate non verbally with your teammates.
3. Paying attention to where you are on the social ladder within the team.
4. Improving the quality of your interpersonal relationships with your teammates.