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Building the Infrastructure: The Effects of Role Identification Behaviors on Team Cognition Development and Performance

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Abstract

The primary purpose of this study was to extend theory and research regarding the emergence of mental models and transactive memory in teams. Utilizing Kozlowski et al.'s (1999) model of team compilation, we examine the effect of role identification behaviors and argue that such behaviors represent the initial building blocks of team cognition during the role compilation phase of team development. We then hypothesized that team mental models and transactive memory would convey the effects of these behaviors onto team performance in the team compilation phase of development. Results from 60 teams working on a command and control simulation supported our hypotheses.

KEYWORDS: Transactive Memory; Mental Models; Team Development

Organizations are increasingly relying on cross-functional action and decision-making teams, made up of members possessing highly developed and distinct areas of expertise, for completing complex tasks (see Sundstrom, 1999). These teams are highly adaptable and allow organizations to take advantage of the diverse knowledge of skilled team members (Cohen & Bailey, 1997; Keller, 2001; Smith-Jentsch, Mathieu, & Kraiger, 2005). However, in order to successfully integrate their distributed skills and expertise, teams must first develop cognitive structures built upon a shared conception of one another's expertise (Espinosa, Lerch & Kraut, 2004; Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Kozlowski & Bell, 2003). Such shared cognitions allow team members to efficiently process information, plan complex actions, and quickly anticipate, and respond to, the behaviors and needs of their teammates (Cannon-Bowers, Salas, & Converse, 1993; Kozlowski & Ilgen, 2006).

Two related cognitive structures have dominated the team cognition literature: mental models and transactive memory (Ilgen et al., 2005). Mental models are “team members’ shared, organized understanding and mental representation of knowledge about key elements of the team’s task environment” (Kozlowski & Bell, 2003, p. 347) that allow team members to coordinate their actions and respond to evolving demands. Transactive memory represents a “group level shared system for encoding, storing and retrieving information - a set of individual memory systems that combine knowledge possessed by particular members with shared awareness of who knows what” (Kozlowski & Bell, 2003, p. 348) that allows team members to “specialize in different aspects of the cognitive space that the team is required to cover” (Ilgen et al., 2005 p. 525-526). While mental models benefit teams by allowing them to synchronize their actions based on a clear understanding each other’s roles and behaviors, transactive memory enables team members to develop deep, specialized areas of expertise while still maintaining easy access to each other’s knowledge.

Although significant research has focused on exploring the potential benefits of these two cognitions on outcomes such as team performance and satisfaction (e.g., Austin, 2003; Edwards, Day, Arthur, & Bell, 2006; Ellis, 2006; Lewis, 2003; Pearsall & Ellis, 2006) as well as identifying their potential antecedents (e.g., Marks, Zaccaro, & Mathieu, 2000; Marks, Sabella, Burke, & Zaccaro, 2002), the processes and developmental phases underlying their emergence in newly formed teams have yet to be explored (e.g., Ilgen et al., 2005; Kozlowski & Bell, 2003; Lim & Klein, 2006; Mohammed & Dumville, 2001). It is clear that shared cognition does not develop automatically; it requires team members to engage in purposeful interpersonal interactions directed towards understanding their teammates' roles and capabilities (see Kozlowski, Gully, Nason & Smith, 1999; Lewis, Lange, & Gillis, 2005). Kozlowski et al. (1999) refer to these communications as role identification behaviors, through which team members share information regarding their specialized knowledge, skills, and abilities with the rest of the team. Therefore, the purpose of this study is to examine how role identification behaviors influence team mental model and transactive memory development to enhance team performance.

Based on Kozlowski et al.'s (1999) model of team compilation, we argue that role identification behaviors, which occur during the initial stages of team development, act as building blocks for team cognition and influence the success or failure of teams in subsequent developmental stages. Because these behaviors act to enhance both team members' knowledge of one another's responsibilities and capabilities, as well as their understanding of how expertise is distributed within the team, we argue that role identification behaviors lead to both team mental model and transactive memory development, which in turn benefit team performance.

Thus, we hope to extend research on team mental models and transactive memory by delineating team processes through which these cognitive constructs emerge. Further, by examining the developmental phases within Kozlowski et al.'s (1999) model of team compilation, we hope to identify the specific period through which these processes occur and cognitions develop, and describe how they influence future phases of task performance.

Team-Interaction Mental Models

A mental model is an organized knowledge structure, or psychological map, that depicts how the characteristics, duties, and needs of teammates fit with one another (e.g., Mohammed, Klimoski, & Rentsch, 2000). Mental models provide team members with a heuristic that can help them interpret information in a similar manner (Hinsz, Tindale, & Vollrath, 1997), enabling them to coordinate their diverse skills and to “describe, explain, and predict events” (Burke, Stagl, Salas, Pierce, & Kendall, 2006, p. 1199) when completing complex tasks. Teams with well-developed models are able to anticipate each other’s actions, accurately assess a situation, and quickly integrate their behaviors (e.g., Edwards et al., 2006; Marks et al., 2002).

Cannon-Bowers, Salas, and Converse (1993) have identified four types of team mental models: technology/equipment mental models, task mental models, team mental models, and team-interaction mental models. While other types of mental models deal with factors such as equipment functioning, environmental constraints, and general team processes, team-interaction mental models focus on “the content and organization of interrole knowledge held by team members within a performance setting. Team-interaction mental models contain procedural knowledge about how team members should work together on a task within a given task domain, including information about who should do what at particular points in time” (Marks et al., 2002, p. 5). Given our focus on team member roles and interdependencies in the effective coordination of team capabilities and behavior, we examine team-interaction mental models in this study.

While models can vary in their level of accuracy and similarity across team members (e.g., Marks et al., 2000), these two dimensions do not necessarily affect team performance in the same manner. For example, teams may exhibit highly similar mental models that are highly inaccurate. Additionally, for tasks that entail a discrete set of information or optimal strategies, accuracy may serve as a better predictor of team performance than similarity (e.g., Edwards et al., 2006; Ellis, 2006). Therefore, because we are interested in how members' understanding of their teammates' roles develops and acts to positively influence team performance, we focus on the accuracy of team members' team-interaction mental models.

Transactive Memory

Organizational researchers examining transactive memory have defined it as the shared division of cognitive labor regarding group members' encoding, storing, and retrieving of relevant team knowledge (e.g., Hollingshead, 2001; Lewis, 2004; Zhang, Han, Hempel, Tjolsvold, 2007). Wegner, Giuliano, and Hertel (1985) first introduced transactive memory theory to explain the way couples in close relationships divided responsibility for information. Wegner (1987) later extended this theory to explain how knowledge develops in groups, suggesting that a shared system for processing information deepens the development of expertise, reduces cognitive load, and enhances performance. For instance, a fully developed transactive memory system allows team members to allocate new information to the responsible team member without having to store it themselves, freeing them to focus on their own areas while confident they can retrieve the information if needed (e.g., Wegner, 1987).

Transactive memory consists of three dimensions: *specialization, credibility,* and *coordination* (e.g., Lewis, 2003; Liang, Moreland, & Argote, 1995; Moreland & Myaskovsky, 2000). Specialization refers to the level of memory differentiation within the team, credibility refers to team members' beliefs about the reliability of other members' knowledge, and coordination refers to the ability of the team members to work together efficiently (e.g., Ellis & Bell, 2005; Lewis, 2003; Moreland & Myaskovsky, 2000). As each of these three dimensions represents an indicator of the underlying latent construct, they are viewed collectively and together reflect perceptions regarding the level of transactive memory system functioning within the team (e.g., Lewis, 2003).

While these two team cognitions overlap with one another, they benefit the team in different ways. Whereas team-interaction mental models reflect team members' knowledge and understanding of their teammates' roles and responsibilities that allow them to synchronize their actions, transactive memory represents the development of a differentiated memory structure within the team that allows team members to coordinate knowledge with one another and trust in each other's expertise (e.g., Ilegen et al., 2005; Kozlowski & Ilgen, 2006).

The Effects of Role Identification Behaviors

Although team-interaction mental models and transactive memory provide unique benefits to teams, researchers suggest that they develop simultaneously and from similar sources (e.g., Espinosa et al., 2004; Ilgen et al., 2005; Kozlowski & Bell, 2003; Lewis et al., 2005). Kozlowski et al.'s (1999) model of team compilation proposes that these types of cognitive structures develop through specific behaviors in the early stages of team development. Their model views the process of team compilation as occurring over four phases during the initial period of team interaction and adaptation. In the first phase, team formation, team members come together and begin the socialization process, developing an understanding of their collective purpose and coming to think of themselves as a team. In the second phase, task compilation, members focus on individual task mastery, developing the skills necessary for task completion and self-regulation.

In the third phase, role compilation, team members engage in dyadic exchanges, sharing and seeking out information related to their own and their teammates' capabilities and responsibilities within the team. Kozlowski et al. (1999) refer to these interactions as *role identification behaviors*, through which team members develop a deeper understanding of their own role and an awareness of the responsibilities of the other team members. Through these communications, members navigate the role expectations of their teammates and begin using their knowledge of one another to integrate their efforts, resulting in the development of routinized processes and the emergence of cognitive structures.

For mental models, which focus on team members' understanding of the roles and interdependencies within the team, role identification behaviors lead to the development of accurate expectations of teammate behaviors (Mohammed & Dumville, 2001). As team members engage in dyadic exchanges with their teammates, they become aware of both the nature and scope of each team member's roles and capabilities, and begin to understand the patterns of behavior and interaction that are emerging within the team.

These behaviors similarly lay the groundwork for transactive memory development, as an understanding of the underlying memory differentiation within the system begins to emerge through sharing information about members' domains of expertise**.** These early interactions lead to the development of "elaborated knowledge structures that represent how a member's own knowledge fits with and builds on other members' task-related knowledge" (Lewis et al., 2005, p. 584), which act as an organizing scheme connecting each individual's knowledge to the knowledge held by the others in the team (Wegner et al., 1985). As team members share information about their roles and expertise, they begin to understand the distributed, specialized nature of the team's "directory of directories" and are able to retrieve knowledge from their shared memory system.

Role identification behaviors, therefore, build part of the infrastructure of team cognition. As team members attempt to figure out who they need to work with to perform their tasks and what information they will need to share (Katz & Kahn, 1978), they develop a clear picture of how their knowledge, skills, and abilities can help the team achieve its goals and objectives. By describing their qualifications and the extent of their domains, as well as soliciting information from their teammates, team members develop the understanding of "who does what" and "who knows what" that lies at the heart of both team-interaction mental models and transactive memory (Hollingshead, 1998; Marks et al., 2002). Therefore, we hypothesize that:

Hypothesis 1: Role identification behaviors will be positively related to a) team-interaction mental model accuracy and b) transactive memory.

Because team-interaction mental models and transactive memory emerge during the role compilation phase, team members are then able to employ their cognitive structures to assist them in performing a variety of complex tasks in the fourth phase, team compilation. During team compilation, teams turn their focus to task completion, adaptation, and process improvement, relying on their cognitions to smoothly coordinate their efforts and knowledge, refine the flow of work, and continuously improve performance. Teams that have developed accurate mental models through role identification behaviors are better able to communicate and integrate their efforts, performing their shared task more quickly and effectively (e.g., Edwards et al., 2006; Marks et al., 2000). Similarly, as a team's transactive memory system emerges through role identification exchanges, it enhances team performance by allowing members to efficiently divide responsibility and reduce their cognitive load, while remaining able to coordinate the sharing of expertise (e.g., Austin, 2003; Ellis, 2006; Lewis, 2003; Moreland & Myaskovsky, 2000). Therefore, we argue that team-interaction mental models and transactive memory act to convey the effects of role identification behaviors onto team performance, leading to the following hypothesis:

Hypothesis 2: The effects of role identification behaviors on team performance will be mediated by a) team-interaction mental model accuracy and b) transactive memory.

Method

Research Participants

Participants included 240 students from introductory management courses at a large Southwestern University in the United States who were arrayed into 60 four-person teams. Out of the 240 students, 147 (61%) were male and 167 (70%) were white, with an average age of 21.2 years. In exchange for their participation, each earned class extra credit and all were eligible for cash prizes (up to $160 per team) based upon the team's performance.

Task

Participants engaged in a modified version of Distributed Dynamic Decision-making (DDD) Simulation (see Miller, Young, Kleinman, & Serfaty, 1998). The DDD is a computerized, dynamic command and control simulation requiring four team members to monitor a geographic region and defend it against invasion from unfriendly tracks, which are radar representations of enemy forces moving through the region. This simulation has been widely used to examine the type of action and decision-making teams we focus on in this study (e.g., Ellis, 2006; Johnson et al., 2006; Porter, 2005). The objective of the task is to maximize the number of team points by identifying tracks, and keeping unfriendly tracks out of the restricted zones by engaging them.

In terms of monitoring the geographic region, each team member is assigned four vehicles that are used to defend the space (i.e., keep unfriendly tracks out of restricted areas). There are four different types of vehicles; (a) AWACS (surveillance planes), (b) tanks, (c) helicopters, and (d) jets. Assets vary on five capabilities: range of vision, speed, duration of operability, identification capacity, and power (see Table 1). When tracks enter the screen and are identified by an AWACS plane, a team member can engage them with a tank, helicopter or jet. If the vehicle has the correct level of power, the track can be disabled. In this study, teams faced four different types of tracks: A, B, C, D. Each track had either a power of 0 (friendly), 1, 3, or 5 depending on whether it appeared in the training or experimental task (see Table 1).

During DDD training, team members worked independently and did not have specific areas of expertise; they each possessed all four types of vehicles and knew the power level of all types of tracks. During the actual experimental task, however, team members *did* have specific areas of expertise. Areas of expertise were created by splitting up vehicle possession and knowledge regarding the tracks. During the experimental task, each team member knew the power level of only one track and possessed only one type of vehicle (see Table 1).

Procedure

Immediately after entering the laboratory, participants were randomly assigned to one of four computer stations and were trained as a team on the declarative and procedural knowledge necessary for successful task completion for approximately 30 minutes. Participants then performed a 30-minute practice task, during which they each learned how to launch and move vehicles, identify tracks, and attack them. Their focus was on skill development, and they did not engage in task-related interactions nor develop strategies for task completion. These two periods mirror the team formation and task compilation phases of Kozlowski et al.'s (1999) framework, in which team members develop a team orientation and develop individual proficiency. After training, each team initially performed a 30-minute experimental task *with* specific areas of expertise, during which role identification behaviors were coded. This task coincides with the role compilation phase of team development, in which team members engage in dyadic exchanges that lead to interrole knowledge. Each team member was given a sheet that illustrated his or her own specific role, which they were able to keep during the experimental task. While they were aware that the vehicles and knowledge about the tracks was divided among the team members, they did not initially know which area of responsibility and expertise the other members possessed. Immediately following this session, team members individually spent approximately ten minutes completing the transactive memory and team-interaction mental model measures. Next, teams performed an additional 10-minute experimental task, during which team performance was assessed. This final task represents the initial team compilation phase where teams employ their cognitive structures to integrate efforts and expertise towards completing complex tasks.

Measures

Role identification behaviors. We employed direct measures of verbal behavior based on the team members' areas of expertise (see Ellis, 2006; Hollingshead, 1998) and used an additive index (i.e., sum) to represent role identification behaviors at the team level (Chan, 1998). Role identification behaviors related to task interdependencies reflect members' attempts to resolve two questions, "Who requires inputs from me?" and "From whom do I require inputs?" (Kozlowski et al., 1999, p. 267). Therefore, role identification behaviors were coded when team members either shared information about their specific roles or requested information about their teammates' areas of responsibility. For example, a role identification behavior for DM2 was coded if he or she told another teammate "I have the tanks" or asked a teammate "What tracks are you responsible for attacking?" Two experimenters were in charge of coding behaviors in real time as they occurred during the task, coding 9 (15%) of the experimental teams together to establish inter-rater agreement. Cohen's (1960) κ provided an index of interrater agreement. In this study, $\kappa = .82$ for role identification behaviors, which indicated acceptable levels of agreement (see Landis & Koch, 1977). Differences between coders were resolved by judgments by the senior author and the remaining 51 teams were then divided between the two experimenters[1].

Team-interaction mental model accuracy. While several techniques have been developed to measure team mental models (see Mohammed et al., 2000), this study adapted Ellis' (2006) concept mapping technique that was specifically designed to assess team mental model development in tasks such as this (see Marks et al., 2000). Following the experimental task, team members were given a task scenario accompanied by eight blank spaces (two per team member) that needed to be filled with one of nine concepts that represented different aspects of

[1] Teams engaged in an average of 23.55 role identification behaviors (.79 per minute) during the role compilation phase of the experiment, but only engaged in 1.98 per team (.20 per minute) during the team compilation phase ($t(59) = 15.80$, $p < .01$), supporting the hypothesized developmental phases and causal ordering of our variables.

the task domain. Team members completed the maps by placing concepts that best represented the actions of each team member on the diagram.

The concept map was constructed specifically for this study and based on team members' expertise during the experimental task. Scores were assessed independently by the lead author and another graduate student, both of whom had received extensive training and were experienced in the DDD command and control simulation; a technique adapted from Marks et al. (2000) and Ellis (2006). The judges paid particular attention to (1) the critical DDD functions, (2) the appropriate role assignments for each team member, and (3) the sequence of actions for successful completion of the task. Concept maps were scored from 1 (*inaccurate*) to 7 (*highly accurate*) based on the number of correct responses. To ensure scores were reliable, the lead author and graduate student independently scored the same 72 (30%) concept maps. The two sets of scores were compared and because they were highly correlated ($r = .99$, $p < .01$), the two judges' ratings were averaged and the lead author evaluated the remaining concept maps. Team scores reflect the mean of the team members' scores (ICC(1) = .32, and ICC(2) = .69).

Transactive memory. Transactive memory was measured using the scale developed by Lewis (2003). The scale contains 15 items (5 items per dimension) designed to assess specialization (e.g., "Different team members are responsible for expertise in different areas"), credibility (e.g., "I trusted that other members' knowledge about the project was credible"), and coordination (e.g., "Our team worked together in a well-coordinated fashion"). Each item was scored on a 5-point Likert-type scale ranging from 1 *(strongly disagree)* to 5 *(strongly agree).* Coefficient alpha for the scale reached .78. A mean Rwg(j) of .84, based on an expected uniform variance distribution, provided evidence of acceptable inter-member agreement (James, Demaree, & Wolf, 1984), and ICC(1) = .35 and ICC(2) = .72 provided support for adequate inter-member reliability (Bliese, 2000). Therefore we aggregated the individual responses to a single team score (e.g., Lewis, 2003; 2004).

Team performance. The measure of team performance in this study was adapted from Ellis et al. (2003) and focused on the team's main objective, which was to maximize the number of points represented by offensive and defensive scores. Offensive scores went up by 5 points every time an enemy track was disabled within one of the restricted zones and dropped by 25 points every time an enemy track was disabled in the neutral space or a friendly track was disabled. Defensive scores decreased 1 point for every second an enemy resided within the restricted zone and 2 points for every second an enemy resided within the highly restricted zone. Team performance was assessed by standardizing and combining offensive and defensive scores.

Control variables. Because previous researchers have suggested that team cognitive ability (e.g., Edwards et al., 2006) and learning goal orientation (e.g., Bunderson & Sutcliffe, 2003) may be related to the team learning and adaptation associated with cognitive development in teams, we measured and controlled for both. Team cognitive ability was assessed by participant self-reports of Scholastic Aptitude Test (SAT) scores (e.g., LePine, Hollenbeck, Ilgen, & Hedlund, 1997). The individual members responses were averaged to create a team score, which was standardized for comparison. Team learning goal orientation was measured with Button, Mathieu, & Zajac's (1996) 8-item scale (e.g., "I prefer to work on tasks that force me to learn new things"). Individual responses were scored on a 5-point Likert-type scale ranging from 1 *(strongly disagree)* to 5 *(strongly agree).* Coefficient alpha for the scale reached .84 and the team level score was calculated by taking the within team average of the member scores (e.g., LePine, 2005).

Results

Means, standard deviations, and intercorrelations among the variables are included in Table 2. We controlled for cognitive ability and learning goal orientation in all of our regressions (see Table 3).

Hypothesis 1 proposed that role identification behaviors would lead to the development of team-interaction mental models and transactive memory. As shown in Table 3, role identification behaviors were positively related to the emergence of both team mental models (ß = .38, $p < .01$) and transactive memory (ß = .32, $p < .05$), supporting Hypothesis 1.

Hypothesis 2 proposed that the team mental models and transactive memory would convey the effects of role identification behaviors onto team performance. As described in Baron and Kenny (1986), to demonstrate mediation the independent variable must first significantly predict the dependent variable. As shown in Table 3, role identification behaviors were positively related to team performance (ß = .34, $p < .01$), satisfying the first mediational requirement. Second, as shown in Table 2, the mediators were both significantly related to team performance in the presence of the independent variable (team-interaction mental models: $\beta = .33$, $p < .01$; transactive memory: $\beta = .24$, $p < .05$). Finally, when controlling for transactive memory and team-interaction mental model accuracy, the variance in team performance accounted for by role identification behaviors was reduced, with the main effect becoming non-significant (ß = .14, ns). In terms of the indirect path for team-interaction mental models, the reduction in variance explained by role identification behaviors was significant by Sobel's (1982) test ($Z = 2.06$, $p < .05$). For the indirect path through transactive memory, the reduction was also significant ($Z = 1.87$, $p < .05$, one-tailed). These results provide support for Hypothesis 2.

Discussion

Organizations’ continued reliance on work teams with distributed expertise highlights the importance of understanding the emergence of cognitive mechanisms that allow them to effectively integrate their varied skills and domains of knowledge to accomplish their goals. The purpose of this study was to examine the development of shared team cognitions by identifying their generative behavioral processes and temporally fixing their development within a specific phase of team compilation. Results clearly indicated that the degree to which team members engaged in role identification behaviors predicted the development of team-interaction mental models and transactive memory in the role compilation phase of team development. Further, these emergent cognitions mediated the effects of role identification behaviors on team performance during team compilation, as the coordination gained through the exchange of role based information lead to more effective, and efficient, teamwork.

By focusing on the "role compilation" and “team compilation” phases of team development, these results add to our understanding of the interplay between behaviors, emergent states, and performance as team members shift their attention from themselves, to dyadic relationships within the team, and then to the team itself (Kozlowski et al., 1999). The learning and development of each phase sets the stage for successful performance and adaptation in the next. As cognitive structures emerge from role identification behaviors, they improve the team’s ability to plan and decide on an appropriate course of action when faced with evolving demands. Further, they allow team members to dynamically adjust their own behaviors, accounting for the actions and expertise of their teammates when handling changes to the task environment (Burke et al., 2006; Marks et al., 2000). This collective role knowledge also leads to enhanced information processing routines, which enable cycles of continuous learning and improvement over later performance phases (Kozlowski et al., 1999; Lewis et al., 2005).

This study also extends the team cognition literature by pinpointing role identification as a specific behavioral process that has been more broadly suggested in other conceptions of cognitive development (e.g., Lewis et al., 2005; Wegner, 1995), which propose that team cognition develops through the self-disclosure of knowledge and experience. Further, by isolating the role compilation phase as the transitional period associated with cognitive development, we more specifically place the behavioral processes that underlie team cognition emergence within new teams. Identifying the correct focal phase is crucial for timing interventions aimed at enhancing team effectiveness. For example, certain types of skills training or leader briefings may be most beneficial before the role compilation phase, when team members begin working together and roles become fixed (e.g., Marks et al., 2000). Similarly, strategy and planning sessions (e.g., Mathieu & Schulze, 2006) may be most useful in a transitional period after role compilation, but before team compilation, when team members fully comprehend the structure of the team's mental model and transactive memory system and can use them to more effectively synchronize their actions and utilize their expertise.

In terms of diagnosing problems within teams, it is often difficult to isolate when the root cause occurred. Our results suggest that process loss during initial phases of team development may be compounded in later stages by team members' inability to fully develop cognitions such as transactive memory and team-interaction mental models. If the team is not effectively utilizing its distributed skills and expertise, the root cause may lie in a poor understanding of teammates' roles and responsibilities due to a failure to share role information during role compilation. Further, while Lewis et al. (2005) suggest higher order, detailed knowledge between team members will emerge through extended interactions over time, if members do not recognize that they have attained an inadequate degree of cognitive development at the end of role compilation, they may prematurely transition away from dyadic exchanges and neglect to engage in further role identification behaviors.

In teams where role identification behaviors are lacking or difficult to engage in (e.g., virtual teams, large complex organizations), one option for ensuring accurate knowledge of interdependent responsibilities may be formal training. Because of the differentiated nature of teams requiring cognitive mechanisms to enhance coordination, one specific form of team training, cross-training, might be especially beneficial as it increases interpositional knowledge regarding team members' roles and responsibilities. Moreland and his colleagues (e.g., Liang et al., 1995; Moreland et al., 1998) found that teams that trained together developed a stronger transactive memory system, while Cannon-Bowers, Salas, Blickensderfer, and Bowers (1998) found that cross-training was positively related to mental model development. Cross-training may therefore act as a partial substitute for initial role identification behaviors, providing teams with a basic understanding of each other's domains and jump-starting the development of team cognition (Marks et al., 2002).

Limitations and Directions for Future Research

Despite our findings, there are several limitations that need to be addressed in future research. First, this study was conducted in a laboratory context with undergraduate students as participants. While this potentially limits the generalizability of the findings, the computer simulation allowed us to examine behaviors within a specific phase of team compilation, closely observe team members' behaviors, and precisely map those behaviors onto the team's cognitive states and performance, thereby serving as a meaningful venue for testing our hypotheses and extending theory (Driskell & Salas, 1992). While our results suggest that role identification behaviors have important implications for the development of team cognition, we hope that future research will extend our findings by further examining the developmental process of team cognition across a variety of team and task contexts.

For example, the teams examined in this study are akin to self-managed action or decision-making teams, where members are brought together for a relatively short period of time and possess distinct areas of expertise. Examples of such teams include rescue units, cockpit crews, military units, engineering teams, and programming teams (see Sundstrom, 1999). While Sundstrom notes that these types of teams are increasingly common, role identification behaviors may occur much less frequently, and play a less critical function, in teams with lower levels of expertise differentiation or interdependence. Further, while the potential benefits of transactive memory and mental models in action and decision-making teams are clear, for many types of teams shared cognitive development may not be necessary, or even advantageous. For example, creative teams may capitalize on informational and experiential diversity rather than the role and memory differentiation associated with stratified domains of expertise.

Because of our interest in the emergence of team cognition, we focus on newly formed teams, in which team members must negotiate their role interactions. Although our methodology was designed to align with the phases of team development as described by Kozlowski et al. (1999), in organizational settings it may be more challenging to definitively isolate the beginning and end of each phase of team compilation. As Kozlowski et al. note, team development is a “continuous series of phases, with partial overlap at transitions” (1999, p. 248). In some types of teams, these phase transitions may be unclear and it would be beneficial to explore how teams shift from one phase to the next. For example, in teams with extensive experience working together in other task environments, members may be able to more quickly and accurately develop shared cognition, as they are able to transfer their teamwork skills and immediately turn their focus to communications related to building their cognitive awareness (Cooke et al., 2007).

It is also important to examine how this developmental process plays out over time. While our results suggest that certain behaviors are important for early team cognition development, shared cognitive structures may continue to coalesce and deepen through multiple episodes of interaction. Further, as we only focused on the initial emergence of team mental models and transactive memory, it remains an open question whether these two cognitive states converge or diverge over time and if they require different inputs at different stages of development. Although our findings suggest that certain types of role identification behaviors lead to the initial emergence of both cognitions, other aspects of role identification may be required for continued development. For example, transactive memory systems continue to benefit from the exchange of “higher order information” (Lewis et al., 2005, p. 584) as teams engage in performance and feedback cycles and the depths and boundaries of expertise are explored and extended. On the other hand, because team mental models have a tendency to lead to habitual routines, models may not be updated to reflect changes to the team or task (Rico et al., 2008). Therefore, it is possible that mental model development may plateau much more quickly than transactive memory or that different forms of communication are necessary for its continued development. Further, researchers have suggested that actions and emergent states influence each other, with the product of one performance episode leading to behaviors in the next (Ilgen et al., 2005; Marks et al., 2001), and the emergence of these two cognitive structures may result in different behaviors, with different effects, in future performance episodes.

Finally, because this study focused on examining the initial emergence of team cognition through role identification behaviors, we did not explore limits and boundaries to its development. Many factors may influence the initial and continued development of team mental models and transactive memory. For example, research on reward structures in teams has found that cooperative incentives positively affect members' willingness to communicate and share information with teammates (Johnson et al., 2006). In teams where individual performance is more heavily rewarded, however, reduced levels of communication may restrict the role identification behaviors that lead to the emergence of team cognition.

The proximity of team members and the nature of their interactions may also influence cognitive development. For example, transactive memory is particularly susceptible to influences such as communication medium (Hollingshead, 1998). It may be that virtual teams, which rely heavily on email as a principal medium of communication, may engage in fewer role identification behaviors and therefore attempt to proceed without a clear understanding of the roles and expertise of their teammates. On the other hand, though less frequent, written communications between members regarding role identification may contain greater detail and provide a resource that can be easily referred to as a reminder of the roles and expertise of their teammates.

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Table 1

Summary of Vehicles and Tracks

Vehicles	Duration (in min.)	Speed	Vision	Power	Identify Tracks	Tracks	Power (**Task**)	Nature (**Task**)
AWACS	6:00	Fast	Very far	None	Yes	**A**	Low(1)	Enemy
Tank	8:00	Slow	Very limited	High(5)	No	**B**	High(5)	Enemy
Helicopter	4:00	Med	Limited	Med(3)	No	**C**	Med(3)	Enemy
Jet	2:00	Very fast	Far	Low(1)	No	**D**	None	Friendly

Note: For vehicles: *duration* = amount of time a vehicle may stay away from base before refueling, *speed* = how fast the vehicle travels across the task screen, *vision* refers to the range of vision the vehicle has to see and/or identify tracks, *power* = the ability of the vehicle to engage enemy tracks, *identify tracks* = the ability to identify the power level and nature of tracks. For tracks: *power* = the level of power needed to successfully engage the track for either the training session or experimental task, *nature* = whether the track is friendly or enemy during the task. All tracks move at the same speed.

Table 2

Means, Standard Deviations, and Intercorrelations Among Variables of Interest

Variable	Mean	SD	1	2	3	4	5	6
1. Role Identification Behaviors	23.55	9.12	--					
2. Team Cognitive Ability	0.00	.62	.22					
3. Learning Goal Orientation	3.99	.30	.11	.02	--			
4. Team Mental Models	5.14	.51	.44**	.28*	.16	--		
5. Transactive Memory	3.87	.26	.34**	.13	.12	.28*	--	
6. Team Performance	0.00	.75	.38**	.18	.09	.43**	.34**	--

Note: N = 60 teams.

*p < .05, ** p < .01.

Table 3

Mediation Regression Results for the Effects of Role Identification Behaviors on Team Cognition and Performance

Predictor	Team Mental Models	Transactive Memory	Team Performance		
			Control	Main Effect	Mediated Effects
Team Cognitive Ability	.19	.05	.19	.10	.03
Learning Goal Orientation	.11	.08	.10	.06	.01
Role Identification Behaviors	.38**	.32**		.34**	.14
Team Mental Models					.33**
Transactive Memory					.24*
Total R^2			.04	.15	.28
ΔR^2				.11**	.13**

Note: N = 60 teams.

*p < .05; ** p < .01.