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Building Team Adaptive Capacity: The Roles of Sensegiving and Team Composition

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The current study draws on motivated information processing in groups theory to propose that leadership functions and composition characteristics provide teams with the epistemic and social motivation needed for collective information processing and strategy adaptation. Three-person teams performed a city management decision-making simulation ($N = 74$ teams; 222 individuals). Teams first managed a simulated city that was newly formed and required growth strategies and were then abruptly switched to a second simulated city that was established and required revitalization strategies. Consistent with hypotheses, external sensegiving and team composition enabled distinct aspects of collective information processing. Sensegiving prompted the emergence of team strategy mental models (i.e., cognitive information processing); psychological collectivism facilitated information sharing (i.e., behavioral information processing); and cognitive ability provided the capacity for both the cognitive and behavioral aspects of collective information processing. In turn, team mental models and information sharing enabled reactive strategy adaptation.

Keywords: information sharing, mental models, sensegiving, team adaptation, team composition

Teams are a basic building block of modern organizations charged with making high-impact decisions in settings as varied as corporate boardrooms; hospital operating rooms; research laboratories; and military stability, security, transition, and reconstruction operations. Modern teams frequently operate in dynamic contexts that require teams to recognize critical changes, understand cause–effect linkages that underlie decisions, and adapt their strategies accordingly (Kozlowski, Gully, Nason, & Smith, 1999). For example, new product sales depend on design teams recognizing and adapting product features in response to new information about market conditions. Thus, building effective teams means creating teams with adaptive capacity (Burke, Stagl, Salas, Pierce, & Kendall, 2006; Kozlowski et al., 1999). Team science currently supports three central ideas about the mechanics of team adaptive capacity. First, both cognitive states and behavioral processes enable teams to adapt effectively (Burke et al., 2006). Second, team leadership plays a pivotal role in fostering team adaptability (Kozlowski et al., 1999; Kozlowski, Watola, Jensen,

Kim, & Botero, 2009). And third, team composition is an important consideration for designing teams with adaptive capacity (LePine, 2003, 2005).

In the current study, we examine the adaptive capacity of information-driven project teams. As decision making and the communication, collective processing, and integration of relevant information are core activities of information-driven teams (De Dreu, 2007; De Dreu, Nijstad, & van Knippenberg, 2008; Hinsz, Tindale, & Vollrath, 1997), strategy adaptation is likely a critical form of adaptation for such teams. However, research is needed to provide empirical insights into the importance of strategy adaptation for project team success, along with the factors that create adaptive capacity. The purpose of the current study is to address this need. We draw on motivated information processing in groups theory (MIP–G; De Dreu et al., 2008) to test a model of leadership functions and composition characteristics that provide the motivation for collective information processing and strategy adaptation. We further propose that cognitive (i.e., team strategy mental models) and behavioral (i.e., information sharing) aspects of collective information processing foster strategy adaptation.

The first contribution of this study is the extension of MIP–G theory to team adaptability. MIP–G theory contends that motivation is a driving factor in the depth of collective information processing, the types of information processed, and quality of team decision making (see De Dreu & Carnevale, 2003; De Dreu et al., 2008). We argue that the team leadership sensegiving function supplies teams with motivation to engage in collective information processing and provide evidence that the enactment of the sensegiving function from external sources fosters the emergence of structured team cognition in project teams. We argue that psycho-

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logical collectivism composition also supplies teams with motivation and provide evidence that psychological collectivism fosters information sharing behaviors. Finally, we propose that cognitive ability composition supplies teams with the cognitive capacity to process information complexly and with the motivation to recognize the importance of collective effort; we demonstrate the importance of cognitive ability for structured cognition and information exchange.

The second contribution of this study is the empirical testing of overarching aspects of Burke et al.'s (2006) conceptual model of team adaptability. We provide evidence that structured cognition (i.e., team mental models) and behavioral processes (i.e., informational sharing) are psychological mechanisms through which team composition and the enactment of team leadership functions enable adaptability after taking into account the effects of prior performance. Figure 1 presents an overview of the relationships examined in the current study.

Team Adaptive Capacity and Motivated Information Processing

Team adaptation describes the capacity of teams to gather information from the performance environment and use it to make functional adjustments to team strategies, behaviors, role structures, and resource allocations (Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995; LePine, 2003). Burke et al. (2006) formally defined *team adaptation* as

a change in team performance, in response to a salient cue or cue stream, that leads to a functional outcome for the entire team. Team adaptation is manifested in the innovation of new or modification of existing structures, capacities, and/or behavioral or cognitive goal-directed actions. (p. 1190)

Adaptation, from this perspective, is a function of behavioral processes and cognitive emergent states that enable the team to evaluate the situation and adjust operations accordingly. This focus

on behavioral and cognitive mediating mechanisms is rooted in more general team performance models (e.g., Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Kozlowski & Ilgen, 2006; Mathieu, Maynard, Rapp, & Gilson, 2008), which explain performance outcomes as determined by the processes and states through which members interact to combine their expertise and tasks. A recent meta-analysis further underscored the unique contributions of behavior and cognition to team performance (DeChurch & Mesmer-Magnus, 2010a).

As the primary tasks of project teams involve information utilization and decision making (Devine, Clayton, Philips, Dunford, & Melner, 1999), reactive strategy adaptation (RSA) is likely to be an important form of adaptation for project teams. RSA involves the alteration of existing strategies or plans in response to unanticipated changes in the performance environment and/or performance feedback (Marks, Mathieu, & Zaccaro, 2001). Those teams that are able to recognize changes, adjust priorities, and implement adjusted strategies are more likely to perform successfully in environments with unforeseen changes (Kozlowski et al., 1999).

We draw on MIP-G theory to elucidate the cognitive and behavioral mechanisms that enable adaptation in project teams above the effects of the team's performance history. De Dreu et al.'s (2008) MIP-G theory is an extension of groups as information processors theory (Hinsz et al., 1997), proposing that two forms of motivation, epistemic and social, provide the motivational underpinnings for collective information processing. It contends that each form affects different aspects of collective information processing. Epistemic motivation, which is "the desire to develop and hold accurate and well-informed conclusions about the world" (De Dreu, Beersma, Stroebe, & Euwema, 2006, p. 929), is thought to influence the depth of deliberate and systematic processing (De Dreu & Carnevale, 2003). Prosocial forms of social motivation, which are preferences for joint outcomes, cooperation, and fairness, are thought to influence information search and exchange

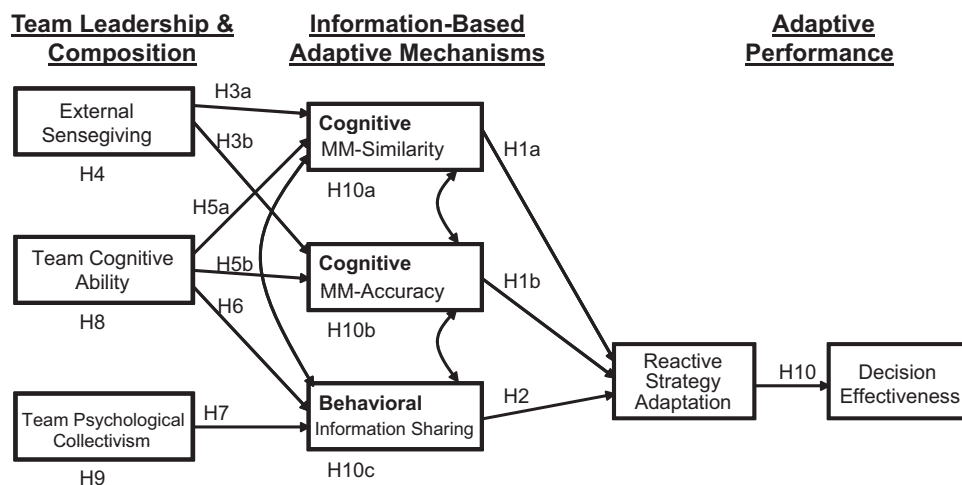


Figure 1. Hypothesized model of relationships between external sensegiving, team composition, cognitive and behavioral adaptive mechanisms, and adaptive performance. Sensegiving and team composition are intercorrelated; paths are not listed to reduce clutter. MM = mental model; decision effectiveness = population of City 2 after 24 simulated months; H = hypothesis.

(De Dreu et al., 2008). We propose that external sensegiving provides epistemic motivation to teams, facilitating the structuring of knowledge in the form of similar and accurate mental models. We propose that psychological collectivism composition provides teams with prosocial motivation, facilitating the sharing of information. We also extend MIP-G theory by arguing that cognitive ability composition provides teams with the capacity to process information complexly and the epistemic and prosocial motivation to process information collectively. In turn, we propose that team mental models and information sharing equip project teams with the capacity to adapt strategies effectively.

Cognitive Mechanism: Strategy Mental Models

Team cognition encompasses three features: *form of cognition*, *form of similarity*, and *form of content* (Rentsch, Small, & Hanges, 2008). Mental models are the form of cognition we examine. Mental models are a type of structured knowledge (Kraiger & Wenzel, 1997; Rumelhart & Ortony, 1977) that people use in a “computationally dynamic manner” (Wilson & Rutherford, 1989, p. 624) to interpret situations, understand the role of various activities in accomplishing objectives, make inferences and predictions, and determine appropriate actions (Johnson-Laird, 1983; Rouse & Morris, 1986). Team mental models are an emergent state (Marks et al., 2001) that enables members to integrate efforts and perform effectively as a unit (Cannon-Bowers & Salas, 1990; Cannon-Bowers, Salas, & Converse, 1993; Mohammed, Ferzandi, & Hamilton, 2010).

Two important forms of similarity are mental model similarity (MM-similarity) and mental model accuracy (MM-accuracy). MM-similarity refers to the degree of congruence among members’ mental models. MM-accuracy refers to the degree to which members’ mental models adequately represent a given performance domain (e.g., Edwards, Day, Arthur, & Bell, 2006; Marks, Zaccaro, & Mathieu, 2000). Although MM-similarity and MM-accuracy are both compositional team properties (see DeChurch & Mesmer-Magnus, 2010a), different composition models are used to operationalize each form (Kozlowski & Klein, 2000). MM-similarity is a dispersion construct (see Chan, 1998) reflecting the degree of congruence among members’ mental models, whereas MM-accuracy is an additive construct (see Chan, 1998) reflecting the averaging of members’ mental model accuracy regardless of agreement. Both forms have been linked to team effectiveness (DeChurch & Mesmer-Magnus, 2010b) and contribute to a holistic understanding of the importance of team mental models (Smith-Jentsch, 2009).

For the content of cognition, we examine strategy mental models, which represent an understanding of strategic priorities, the trade-offs and relationships among strategic alternatives, and the implications of strategic decisions. Mental model research has traditionally focused on task and team interaction content (see Mohammed et al., 2010). However, because the primary tasks of project teams involve utilizing information to make decisions and solve problems, we argue that strategy mental models are a particularly important type of team mental model. This form of collective, structured knowledge of strategic priorities and implications should enable project teams to effectively execute and adapt strategies.

Team mental models provide a collective, systematic, and structured understanding of performance objectives and the environment that enables teams to adapt to disruptive events or shifting demands (Burke et al., 2006; Cannon-Bowers et al., 1993). Both the similarity and accuracy of team mental models have been shown to predict team performance (DeChurch & Mesmer-Magnus, 2010b). When teams hold accurate mental models, members are able to effectively decipher how change impacts their goals and renders certain strategies more or less effective toward achieving them. As such, MM-accuracy fosters adaptability by enabling teams to evaluate the usefulness of possible strategy adjustments in light of new circumstances. Regardless of the degree of MM-similarity among members, the level of MM-accuracy should ultimately help the team to develop and implement high-quality revised strategies.

MM-similarity has been shown to be critical for team success, particularly when teams face dynamic performance environments (Marks et al., 2000). Burke et al. (2006) even contended that “adaptive team performance is not possible” when teams do not hold similar mental models because their disparate interpretations of their environment will impede coordination (p. 1194). MM-similarity makes implicit, nonverbal coordination among members possible regardless of the level of MM-accuracy (Rico, Sánchez-Manzanares, Gil, & Gibson, 2008). As such, the similarity among members’ mental models fosters adaptation by enabling members to quickly reach consensus and determine a new course of action. Even if a project team has a history of successful performance, the team will need to develop both accurate and similar strategy mental models of the new demands to enable them to reprioritize issues, understand strategic implications, reach consensus efficiently, and make quality decisions.

Hypothesis 1: Team strategy MM-similarity (H1a) and MM-accuracy (H1b) will be positively related to RSA.

Behavioral Mechanism: Information Sharing

Information sharing is a communication process whereby team members discuss their tasks, feelings, opinions, or ideas (Henry, 1995; Hinsz et al., 1997; Jehn & Shah, 1997; Stasser, 1992). Sharing information between team members has been linked to enhanced team performance (see Mesmer-Magnus & DeChurch, 2009). Information sharing is believed to improve performance by bringing the full range of members’ uniquely held expertise to bear on the task (Larson, Christensen, Abbott, & Franz, 1996), highlighting members’ awareness of opportunities, clarifying key issues, and raising alternative problem-solving approaches (Van de Ven, 1986).

Information sharing is thought to be especially important for teams performing cognitive tasks (e.g., Stasser & Stewart, 1992), complex tasks (e.g., Volpe, Cannon-Bowers, Salas, & Spector, 1996), and those tasks that require a high degree of interdependence (e.g., Alge, Wiethoff, & Klein, 2003). In these situations, members of a team frequently possess different and unique knowledge and skills, and the sharing of information adds to the collective pool of knowledge. Solving complex cognitive problems requires team members to have access to as much situationally relevant information as possible. When teams face changing situations, the relative importance of various sets of information

changes; information that was previously irrelevant can take on new importance, whereas previously essential information can become much less relevant under new task conditions. Information sharing facilitates team learning (De Dreu, 2007) by increasing the availability and salience of informational resources relevant to current performance demands, which enhances the likelihood of adaptive performance during the current performance episode (Larson et al., 1996). Therefore, we expect information sharing will enable project teams to effectively adapt their strategies.

Hypothesis 2: Team information sharing will be positively related to RSA.

Burke et al. (2006) argued that team mental models and processes coevolve over phases of performance in the formulation and execution of plans that enable adaptability. Ilgen et al. (2005) further argued that processes and emergent states can simultaneously serve as team mediating mechanisms. Some prior studies have found that processes (e.g., role identification behaviors) facilitate the emergence of team cognition (e.g., Pearsall, Ellis, & Bell, 2010), whereas others have found that team cognition (e.g., shared task representations) facilitates information elaboration processes (e.g., van Ginkel & van Knippenberg, 2008). On the basis of prior theory and research, we do not specify a temporal ordering of the information sharing and mental model mediators and instead focus on their coevolution as project team members work together.

Sensegiving and Motivated Information Processing

Team leadership plays a critical role in the development of adaptive capacity, particularly for teams operating in complex environments (D. V. Day, Gronn, & Salas, 2006; Kozlowski, Gully, McHugh, Salas, & Cannon-Bowers, 1996). Team leadership is the “process of team need satisfaction” that can be enacted by numerous individuals internal or external to the team in positions of formal or informal authority (Morgeson, DeRue, & Karam, 2010, p. 8). Team leadership functions provide direction, foster integration, and shape emergent cognition and behavioral processes that enable team effectiveness (Kozlowski et al., 2009; Zaccaro, Rittman, & Marks, 2001). We expect that sensegiving enacted by external sources of leadership will facilitate epistemic motivation and foster the emergence of strategy mental models in project teams.

Many of the problems teams face originate in the external environment (Ancona & Caldwell, 1988); sensemaking and sensegiving are core leadership functions that enable teams to respond to complex problems, particularly in disruptive or novel environments (Dunford & Jones, 2000; Maitlis & Lawrence, 2007; Morgeson, 2005; Morgeson et al., 2010; Morgeson, Lindoerfer, & Loring, 2009; Zaccaro et al., 2001). Gioia and Chittipeddi (1991) differentiated two strategic change processes: sensemaking and sensegiving. Whereas sensemaking involves scanning the environment for important changes and reconstructing meaning around these changes, sensegiving is the “process of attempting to influence the sensemaking and meaning construction of others toward a preferred redefinition of organizational reality” (Gioia & Chittipeddi, 1991, p. 442). Sensegiving is enacted when information and environmental cues are identified and placed into a framework that

influences how staff interpret meaning and form cue–response contingencies (Bartunek, Krim, Necochea, & Humphries, 1999; Dunford & Jones, 2000; Weick, 1995; Zaccaro et al., 2001).

Storytelling or narratives are a set of techniques that leadership may use to enact sensegiving functions. These techniques involve telling a story in which events are compiled together around common themes and “configured into temporal unity by means of a plot” (Polkinghorne, 1995, p. 5) to influence a group decision (Dunford & Jones, 2000). These narratives are especially important in times of change (Dunford & Jones, 2000) because they help team members to understand the current environment and structure information in a systematic and useful manner.

A critical responsibility of external team leadership is to manage meaning for their staff by identifying critical pieces of information, determining cause and effect associations among those pieces of information, and then placing them into a common framework for team members to utilize (Smircich & Morgan, 1982; Weick, 1995). Zaccaro et al. (2001) submitted that the sensegiving function enhances team performance by impacting the accuracy and similarity of team mental models. When teams have a source of external team leadership that (a) interprets the situation and (b) imparts a common frame of reference for understanding how key decision alternatives are related to one another and influence goal accomplishment, the mental models that emerge among members should be more accurate. Team members should also interpret decisions similarly, resulting in more congruent mental models. Project teams often have an external advisor (formal) or champion (informal) who provides a source of leadership guidance and direction. We expect that sensegiving enacted by these external sources will help teams to adjust mental models to represent the current performance context, thereby increasing MM-accuracy and MM-similarity.

Hypothesis 3: Teams exposed to external sensegiving will possess more similar (H3a) and more accurate (H3b) strategy mental models than teams not exposed to external sensegiving do.

We expect that external sensegiving will enable teams to effectively adapt strategies in response to new goal contingencies and propose that strategy MM-similarity and MM-accuracy mediate this relationship. Marks et al. (2000) provided initial empirical support for this assertion, as they found that leader communication prompted more similar and more accurate team mental models, which in turn enhanced team performance in novel environments. As such, we propose that external sensegiving will be indirectly related to RSA by creating a common frame of reference through which team members form accurate and similar mental models.

Hypothesis 4: The relationship between external sensegiving and team RSA will be mediated by MM-similarity (H4a) and MM-accuracy (H4b).

Team Composition and Motivated Information Processing

Deep-level team composition characteristics, such as abilities, personality traits, and values, have important implications for effective team interactions and performance (Barrick, Stewart,

Neubert, & Mount, 1998; Bell, 2007; Harrison, Price, Gavin, & Florey, 2002; Hollenbeck, DeRue, & Guzzo, 2004) and epistemic and prosocial motivation (De Dreu et al., 2008). The compositional characteristics of team members represent configural team properties (Klein & Kozlowski, 2000), which are operationalized using additive composition models that combine the scores on a trait from individuals without concern for the congruence among individuals (see Chan, 1998). Composition has been represented using the mean, minimum, maximum, and standard deviation across members, often on the basis of the level of interdependence among team members (e.g., Barrick et al., 1998; Bell, 2007). The team-level mean has been identified as a robust indicator of the distribution of traits and abilities among members and the extent to which a particular characteristic reflects the composition of the team (Bell, 2007; E. A. Day et al., 2004; Devine & Philips, 2001; LePine, 2003). Therefore, in the current article we operationalize team-level compositional characteristics using the mean across members. For project teams, we propose that mean levels of cognitive ability and psychological collectivism are important composition considerations for creating teams motivated to process information collectively and to build the capacity to break from strategies and routines used in prior performance episodes.

Cognitive Ability

Cognitive ability is “the capacity to understand complex ideas, learn from experience, reason, problem solve, and adapt” (Devine & Philips, 2001, p. 507). Hunter (1986) suggested that cognitive ability determines how much and how quickly a person is able to learn, as well as one’s ability “to react in innovative ways to situations where knowledge does not specify exactly what to do” (p. 342). Cognitive ability is also associated with the structuring of information and the desire to seek out large amounts of information rapidly (Schmidt & Hunter, 1998; Schmidt, Hunter, & Outerbridge, 1986). High cognitive ability individuals adapt to new situations better than do lower cognitive ability individuals because they learn more quickly and recognize and understand problems more easily (LePine, Colquitt, & Erez, 2000).

Meta-analytic findings indicate that cognitive ability composition has a moderate direct relationship with team performance (Bell, 2007). Further, team cognitive ability may be most important when teams face a novel environment (Devine & Philips, 2001). For example, LePine (2003) found that mean levels of cognitive ability were most strongly related to team decision accuracy following a disruptive event, as high cognitive ability teams were able to adapt their roles to meet the demands of the environment. Burke et al. (2006) further contended that cognitive ability facilitates adaptive team performance by enhancing processes and emergent states. As mental models represent structured knowledge, the emergence of both similarity and accuracy should be impacted by team cognitive ability composition. Prior research has provided some empirical support for a link between team cognitive ability composition and task-focused mental models (Edwards et al., 2006; Resick, Dickson, Mitchelson, Allison, & Clark, 2010).

Teams with higher mean levels of cognitive ability have a greater capacity to process information complexly and desire to process new information. We therefore contend that cognitive ability composition will provide the capacity for motivated infor-

mation processing in teams. We further expect that cognitive ability will provide the epistemic motivation to form well-developed and accurate views of the performance context. As a result, teams should form strategy mental models that accurately reflect their strategic priorities. We also expect team members to recognize the need for their team to agree upon a strategy and work toward a collective understanding of strategic priorities and the implications of their strategic options.

Hypothesis 5: Team cognitive ability composition will be positively related to the similarity (H5a) and accuracy (H5b) of team strategy mental models.

Information sharing is critical to the success of project teams with distributed expertise (Mesmer-Magnus & DeChurch, 2009). Motivated information sharing theory posits that team information sharing is a function of “deliberate processes in the interest of members’ goal attainment” (Wittenbaum, Hollingshead, & Botero, 2004, p. 298). Factors that deepen the processing of information translate into greater information sharing (Mesmer-Magnus & DeChurch, 2009). We contend that team cognitive ability composition is important for information sharing for two reasons. First, cognitive ability involves a desire to seek out information and the capacity to learn by acquiring and using information efficiently (Hunter, 1986; Schmidt et al., 1986). Second, we expect that teams composed of high cognitive ability members will recognize interdependencies and the need to cooperate, providing a basis for prosocial motivation. Further, cognitive ability composition has been linked with information sharing (Devine, 1999), in part because it provides the capacity to process information complexly and recognize the need to exchange information. We expect that teams with high mean levels of cognitive ability should actively share information.

Hypothesis 6: Team cognitive ability composition will be positively related to team information sharing.

Psychological Collectivism

Psychological collectivism composition provides teams with a compositional basis for prosocial motivation and information sharing. Values determine what is and what is not personally rewarding (Locke, 1991), which in turn motivates decisions and actions (Meglino & Ravlin, 1998; Rokeach, 1973). Collectivistic values reflect preferences for working in groups, a motivation to cooperate, and tendencies to prioritize group goals ahead of personal goals (C. C. Chen, Chen, & Meindl, 1998; Cox, Lobel, & McLeod, 1991; Wagner, 1995). At the team level, psychological collectivism composition has been found to have a direct link with team performance (see Bell, 2007) and citizenship behavior (Jackson, Colquitt, Wesson, & Zapata-Phelan, 2006) and may be a particularly important motivational driver of information exchange and adaptive capacity.

As “values motivate action” (Locke, 1991, p. 291), we expect that teams with a high mean level of psychological collectivism among members will be motivated to work together and engage in behaviors that maximize the potential for team success. For project teams, these behaviors primarily involve exchanging and integrating knowledge and information, and social motivation is a critical

factor in the sharing and exchange of information in teams (De Dreu et al., 2006, 2008; Wittenbaum et al., 2004). We do not expect that psychological collectivism composition will have a direct relationship with team mental models; however, an indirect relationship may exist through the engagement in cooperation or negotiation behaviors. However, these behaviors are not addressed in this study.

Hypothesis 7: Team psychological collectivism composition will be positively related to team information sharing.

Prior research has linked team cognitive ability composition to team adaptation (LePine, 2003, 2005), and Burke et al.'s (2006) conceptual model further details the important role of cognitive ability in team adaptation. Essentially, Burke et al. proposed that cognitive ability enables all of the subprocesses required for successful adaptation, including cue recognition, meaning ascription, and plan formulation; teams with greater levels of cognitive ability are at an advantage in processing information about changes in the environment and developing new strategies. Furthermore, the Burke et al. model posits that member characteristics translate into team adaptation through cognitive emergent states and effective behaviors such as communication. Thus, we expect that team cognitive ability composition will be indirectly related to RSA by facilitating the emergence of similar and accurate strategy mental models and by prompting the sharing of information among project team members.

Hypothesis 8: The relationship between team cognitive ability composition and team RSA will be mediated by MM-similarity (H8a), MM-accuracy (H8b), and information sharing (H8c).

Similarly, prosocial motivation provides a compositional basis for effective strategy adaptation. We expect that project teams with a high mean level of psychological collectivism will be efficient at recognizing and adapting to changing circumstances because of their tendencies to engage in greater information sharing. That is, we expect that team psychological collectivism composition will be indirectly related to RSA through the sharing of unique information that is relevant to problem solving in light of an unforeseen change.

Hypothesis 9: The relationship between team psychological collectivism composition and team RSA will be mediated by information sharing.

Reactive Strategy Adaptation and Decision Effectiveness

Marks et al. (2001) submitted that RSA is an important process for teams facing changing task circumstances requiring in vivo adjustments. Supporting this idea, DeChurch and Haas (2008) found that RSA predicted team performance better than either deliberate or contingency planning did. The adjustment of strategies is vital for teams because it determines their course of action following an unforeseen change. When teams face an unexpected event, teams that recognize relevant task and contextual changes, reprioritize issues, and make decisions that fit the demands of the situation are likely to make more effective decisions. We also

expect that the capacity to adapt their strategies effectively will function as a mediator linking team strategy mental models and information sharing to decision effectiveness.

Hypothesis 10: RSA will be positively related to team decision effectiveness and will mediate the relationships between (a) MM-similarity, (b) MM-accuracy, and (c) information sharing and team decision effectiveness.

Method

Participants and Design

Participants included 222 undergraduate psychology students from a large Southeastern university. Participants formed 74 three-person teams; each team was tested in a separate session. Participants were randomly assigned to one of three team roles, and teams were randomly assigned to the external sensegiving experimental ($n = 38$) or control ($n = 36$) condition. Teams performed a strategic decision-making task requiring the integration of distributed expertise from each member. Teams first performed a decision-making task requiring a certain set of strategies and were then presented with a new task requiring a different set of strategies. Sensegiving was manipulated through a videotaped address by a confederate leader that was shown to participants in between the first and second tasks.

Simulation

The strategic decision-making task was created using the computer game SimCity 4 Deluxe Edition (EA Games, 2004). SimCity is a simulated city-building game in which users design, build, and govern a metropolitan city. Teams were provided with two partially developed cities containing all of the normal amenities available in real-life cities, such as public safety systems, educational systems, public utilities, transportation systems and arteries, and land zoned for residential and commercial use. Teams were responsible for city management, including development, infrastructure design, resource allocation, and taxation. Teams were charged with the goal of increasing each city's long-term desirability, as indicated by increases in population.

Each team consisted of three participants who served as the city mayor's cabinet. Roles were created on the basis of a task analysis; each role represented unique functional expertise required for making decisions in SimCity (Kramer, 2003). Participants in the Director of City Planning and Environment role were trained to identify the relative desirability of land for various uses, zone and develop land, and reduce air and water pollution levels. Participants in the Director of Transportation and Finance role were trained to manage city budgets, tax revenues, and city expenditures, and to improve traffic patterns throughout the city. Participants in the Director of Welfare and Public Works role were trained to build and manage power, water, and sanitation facilities, as well as schools, hospitals, police stations, and fire houses. Knowledge distributed across the three roles was needed to successfully accomplish the team goal of increasing the city's population by making the city as desirable a place to live and work as possible.

Each team worked on two separate tasks (i.e., cities). The two cities were designed to require different strategies to achieve the same overall goal of increasing city population. First, teams managed City 1, named Centreville, which was landlocked and designed so that all zones were intermixed and connected throughout the city. The city center was highly congested but surrounded by vast amounts of unzoned and undeveloped land. The congestion created demands for city expansion and improvements to the transportation, public utility, and public service systems to entice residents to move into the city.

Next, teams governed City 2, named Pantherville, which required different strategic decisions to attract residents. City 2 was developed along a coastline with residential and commercial properties located in the southern portion of the city and noisy, pollution-producing factories and industrial buildings located to the north. There was very little undeveloped land, which necessitated the rezoning of existing space and vertical rather than horizontal expansion. Also, the developed nature of City 2's infrastructure and economic market required teams to offer tax incentives to entice residents to move into the city.

To ensure that different strategies were important for increasing the population in each city, we conducted an analysis of the impact of nine possible strategies on each city's population. Beginning with City 1, we implemented a single strategy and examined its impact on the city's population, documented in 6-month increments for a simulated 36-month period of time. The process was repeated three times for each strategy in each city. The three strategies that had the strongest average influence on City 1 population included (a) developing and zoning the land outside of the congested city center, (b) building additional roads and increasing the capacity of existing thoroughfares, and (c) constructing additional power plants. The three strategies that had the greatest average influence on City 2 were (a) de-zoning all existing low-density zones and rezoning them into high-density areas to increase capacity, (b) decreasing all property taxes, and (c) increasing funding for all city departments. As teams moved from City 1 to City 2 they needed to recognize important differences, reprioritize issues, and develop and implement new strategies to effectively accomplish their goal of increasing city population.

Procedure

Experimental sessions lasted approximately 3 hr. Upon arrival, participants provided informed consent and completed measures of cognitive ability and psychological collectivism. Next, participants completed two computer-based training modules that lasted approximately 30 min. The first training module was identical across the three roles; it provided a general introduction to SimCity, outlining the operations in the game, major decisions to be made, and the location of key information. The second training module identified how to retrieve role-specific information from the simulation, monitor the status of each functional area, consult city opinion polls regarding each functional area, and adjust resource allocation. Participants also received a handout of the costs and benefits of various decision options that were specific to their area of expertise. Upon completion of the two training modules, an experimenter asked each participant to demonstrate a series of tasks associated with his or her respective role. All participants

performed all tasks correctly, thereby demonstrating the acquisition of a basic level of knowledge necessary for the task.

After a 5-min break, participants convened in a conference room where they were seated at a round table and viewed the simulation on a 32-in. television. Participants were then shown a short video where the leader (i.e., Mayor Woodward) introduced himself to the team. The mayor told a story outlining the characteristics of City 1, discussed general strategies that were said to be effective in increasing the population of similar cities, and informed teams that their ultimate goal was to increase the city's population. Teams were then given 7 min to acquire information about the city, determine their strategy, and implement changes with the simulation paused. After 7 min the simulation was started and allowed to progress for 6 simulated months (approximately 90 s). Teams could observe the impact of their decisions on the living conditions and population of their city and make plans for the next set of decisions. The simulation was then paused, and teams were given 4 min to make decisions and implement changes to the city. The simulation was then resumed and allowed to progress for another 6 simulated months. This process of making and implementing decisions and then monitoring their impact occurred for four cycles, totaling 24 simulated months (approximately 25 min total).

We set the initial decision-making time frame at 7 min to enable teams to gather enough information about the city to make appropriate decisions. Subsequent cycles were shortened to 4 min, because teams now possessed the requisite understanding of the structure and needs of the city. We set progression at 6 simulated months because pilot testing revealed that sufficient changes would occur within 6 months to enable teams to recognize the effects of their decisions, while making the cycle short enough to keep participants engaged.

Next, the external sensegiving manipulation was introduced. All participants watched a video in which the mayor indicated that they had been asked to take over the neighboring city of Pantherville (City 2) and were then provided information consistent with either the control or experimental condition. Teams were given 7 min to review City 2 and to make and implement any changes they deemed appropriate while the simulation was paused. The simulation was then allowed to progress for 6 simulated months. Teams completed three more decision cycles that followed the same format as the decision cycles in City 1 (i.e., 4 min to make and implement decisions and 6 simulated months to watch the impact) for a total of four cycles (24 simulated months or approximately 25 min total).

Mental models were assessed after the third decision cycle in City 2. Trained raters assessed information sharing by watching videotaped recordings of the first three decision cycles in City 2. RSA was assessed during the session by trained observers who recorded the amount of time it took for teams to implement the three most important strategies for City 2. Decision effectiveness was the population of City 2 at the end of the simulation. A manipulation check was administered at the end of the session.

External Sensegiving

As noted, external sensegiving was manipulated through the use of videotaped instructions from the city's mayor between City 1 and City 2. In both conditions, the video began with the mayor (a) discussing why the team would now be governing a different city;

(b) describing the new city's general structure, organization, and history; and (c) reinforcing the team's goal of increasing the city's population. Next, the mayor told a story about a meeting he had attended with mayors from other cities in the area. In both conditions, the mayor discussed six strategies that other city councils had implemented to help develop their cities and spur population growth; three of the six strategies were the three strategies most important for increasing City 2's population presented earlier.

Sensegiving involves "extracting important environmental cues, placing these cues in a team's performance context, and embellishing the meaning of these cues into a coherent framework," which enables teams to form cue-response contingencies (Zaccaro et al., 2001, p. 462). The manipulation was designed to extract the same environmental cues and place these cues within the team's performance context; the mayor discussed the same six strategies other mayors used to grow their city in each condition. However, only in the sensegiving condition did the leader explain the underlying rationale and cause-effect logic for why each of the six strategies had been implemented in the other neighboring cities. For example, in both the control and experimental conditions, the mayor said, "One of the other mayors focused on the city's layout. They zoned a large percentage of the city into higher density zones." In the experimental sensegiving condition, the mayor went on to say, "This decision created new and more available housing and more job opportunities throughout the city." That is, the mayor provided a rationale for why the strategy could be effective. Teams ultimately had to decide which strategies would be effective in their city. Importantly, the manipulation did not discuss which strategies should be used or their direct impact on city population. The key distinction between the two conditions was the imparting of a framework for thinking about why a particular strategy may or may not be effective. In the experimental group, the mayor imparted a framework for teams to use to determine the appropriateness of each strategy, whereas in the control group, no such framework was imparted.

Manipulation checks. To verify that the manipulation impacted sensegiving perceptions and did not have unintended effects, we asked participants to respond to four questions using a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The first two questions assessed perceptions of sensegiving (sample item: "To what extent did Mayor Woodward provide information that helped you to make sense of the existing layout of Pantherville?"). The second set of questions assessed the perceived difficulty of the task and relevance of information (sample item: "To what extent did Mayor Woodward provide information that made the simulation more difficult?").

Measures

Cognitive ability. Cognitive ability was measured using the 50-item Wonderlic Personnel Test Form IV. Participants had 12 min to complete the measure. Reported test-retest reliabilities range from .82 to .94 across forms (see Wonderlic & Associates, 1992).

Psychological collectivism. Psychological collectivism was measured using Jackson et al.'s (2006) 15-item questionnaire. Participants responded using a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). An acceptable internal consistency reliability was found with $\alpha = .87$. We

aggregated cognitive ability and psychological collectivism to the team level using the mean score across members.

Mental models. Strategy MM-accuracy and MM-similarity were elicited using pairwise ratings of 10 important strategic decisions (see the Appendix) identified through a task analysis. Our measure reflects team members' understanding of the relationships among key city management decisions associated with achieving the team's goals. Participants read each pair of strategic decisions and rated the relationship on a 9-point scale ranging from 1 (*totally unrelated*) to 9 (*strongly related*). In all, each team member made a total of 45 ratings, which represent their structured knowledge regarding how governing decisions are related to one another in achieving the team's goal. Mental model structure was represented using Pathfinder networks (PFNET; [Schvaneveldt, 1990](#)). The Pathfinder algorithm calculates a network of direct and indirect links between concepts, with related concepts separated by fewer links (and being closer in proximity) and unrelated concepts separated by greater distance.

Team MM-similarity was determined using Pathfinder's metric of closeness (C), which calculates the degree of similarity between two PFNETs. For each team, three strategy C scores were calculated by comparing members' PFNETs to one another. Two networks without any common links would have a $C = 0$, and two networks that have identical network structures would have a $C = 1$. The three scores were then averaged together to create the team's MM-similarity score. To calculate MM-accuracy, an expert mental model was constructed. Three members of the research team who were highly familiar the SimCity game and the strategies for success in City 2 (Pantherville) independently completed the mental model questionnaire. The experts then met to review their ratings, discuss any differences, and incorporate any changes. The average C score between the experts' PFNETs was .814. An expert mental model was calculated by averaging the ratings for the three researchers. For each team, three C scores were calculated by comparing each member's PFNET to the expert PFNET. These scores were then averaged together to create the team's MM-accuracy score.

Information sharing. Information sharing was rated by observers who watched video recordings of the first three decision-making cycles of City 2. We developed a six-item scale capturing the amount and frequency of the information shared among teammates (sample items: "Members of the team shared information/knowledge from their specific area of responsibility" and "Members of the team shared a large amount of information/ideas") based on definitions of information sharing ([Devine, 1999](#); [Jehn & Shah, 1997](#)) and elaboration of information ([van Knippenberg, De Dreu, & Homan, 2004](#)). We trained a pool of four raters on the use of the measure and responsibilities specific to each role. To ensure that raters were not exposed to either the manipulation or the performance of the team in Cities 1 or 2, videos presented only a specific part of each session and were structured so that all three members of the team were visible on the tapes but the simulation screen was not. Raters responded to each item using a 5-point frequency scale (1 = *never*, 2 = *rarely*, 3 = *sometimes*, 4 = *often*, and 5 = *constantly*). All teams were evaluated by two raters; we calculated interrater agreement using index r_{wg} ([James, Demaree, & Wolf, 1984](#)) and interrater reliability using intraclass correlation coefficients ($ICC[1]$ and $ICC[2]$). We followed procedures outlined by [Kozlowski and Hults \(1987\)](#) to assess interrater agree-

ment. We calculated r_{wg} using the expected variance of a 5-point scale with a uniform null distribution ($\sigma_{EU}^2 = 2$), which assumes no systematic responses biases among raters, and then we calculated r_{wg} using the expected variance of a 5-point scale with a moderately skewed distribution ($\sigma_{EMS}^2 = .90$; LeBreton & Senter, 2008), which assumes some systematic responses bias in the item variances (James et al., 1984). The mean r_{wg} values ranged from .79 (moderately skewed distribution) to .87 (uniform null distribution), indicating acceptable levels of interrater agreement. For interrater reliability, intraclass correlation coefficients ($ICC[1] = .24$ and $ICC[2] = .72$) were found to be within acceptable levels (see Bliese, 2000). Ratings were aggregated across raters at the item level and then combined to create an index of team information sharing ($\alpha = .90$).

Reactive strategy adaptation. RSA was measured as the time it took a team to initiate implementing the three strategies identified as having the strongest average influence on City 2 population as measured in 6-month increments over 36 simulated months. As noted previously, these strategies included (a) de-zoning existing low-density zones and rezoning them into high-density zones, (b) decreasing taxes, and (c) increasing the funding for city departments. As these strategies were not critical to success in City 1, their utilization during City 2 represented strategy adaptation. During each session two trained observers recorded, in 15-s increments, the time that had elapsed when each of the three strategies was implemented by the team. Acceptable interrater reliability was found between the observers ($ICC[1] = .62$ and $ICC[2] = .93$; Bliese, 2000). The mean time to initiate implementation across the three strategies was then calculated. We then recoded the scores by subtracting each team’s score from 20 so that higher scores indicated more effective RSA. We measured RSA with three, as opposed to two or four, strategies, as it enabled us to include one third of the strategies examined, cover a range of the most influential strategies, account for variability in the influence of any single strategy, and provide a manageable number of strategies for coders to rate.

Prechange decision effectiveness. We controlled for effectiveness in City 1 to remove the effects of the team’s prior performance on their ability to adapt and perform successfully in City 2. Decision effectiveness in City 1 was the population after 24

simulated months. The final mean population of City 1 was 40,151, ranging from 35,358 to 46,291.

Decision effectiveness. Final decision effectiveness was the population of City 2 after 24 simulated months. The mean population of City 2 was 43,869, ranging from 36,840 to 58,959.

Analytical Approach

We used an approach similar to G. Chen and Klimoski (2003) and tested the model of hypothesized relationships using path analyses conducted in LISREL 8.7. With path analyses, we tested the model using observed variables as single indicators of latent constructs (Raykov & Marcoulides, 2000). We assessed model fit using the chi-square goodness-of-fit statistic, the root-mean-square error of approximation (RMSEA), and the comparative fit index (CFI). For RMSEA, values below .05 are considered an excellent fit (MacCallum, Browne, & Sugawara, 1996). For CFI, values above .95 are considered an excellent fit (Hu & Bentler, 1999). Given our directional hypotheses, we tested the significance of path coefficients using one-tailed *t* tests. Additionally, we followed James, Mulaik, and Brett’s (2006) procedures for testing mediation hypotheses; they argued that mediation is found using structural equation modeling when (a) the mediation model demonstrates acceptable fit, (b) path coefficients from predictor to the mediator are significant, and (c) path coefficients from the mediator to the outcome variable are significant. We also conducted Sobel tests (Sobel, 1982) using path coefficients and their respective standard errors from the path analyses to determine the significance of the mediating effects.

Results

Table 1 summarizes the descriptive statistics and zero-order correlations. Results of the manipulation checks indicated that teams in the external sensegiving condition perceived the information as helping them to understand their responsibilities ($M_{exp} = 3.68, SD_{exp} = 0.45$ vs. $M_{control} = 3.36, SD_{control} = 0.49$), $t(72) = 2.96, p < .01$, and make sense of the situation ($M_{exp} = 3.80, SD_{exp} = 0.46$ vs. $M_{control} = 3.44, SD_{control} = 0.68$), $t(72) = 2.69, p < .01$, to a greater extent than teams in the control

Table 1
Zero-Order Correlations Among Key Study Variables

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9
1. City 1 decision effectiveness	4.02	0.18	—								
2. External sensegiving	0.51	0.50	.17	—							
3. Cognitive ability	21.02	2.46	.27*	.11	—						
4. Psychological collectivism	3.43	0.34	.20*	.24*	-.12	—					
5. MM-similarity	0.26	0.08	.09	.27**	.23*	.11	—				
6. MM-accuracy	0.26	0.05	.10	.38**	.32**	.03	.25*	—			
7. Information sharing	3.31	0.87	.09	.27*	.24*	.29**	.29**	.37**	—		
8. RSA	4.12	5.40	.19	.28**	.21*	.09	.36**	.41**	.38**	—	
9. Decision effectiveness	4.39	0.44	-.09	.07	-.05	.19	-.03	.11	.21*	.24*	—

Note. *N* = 74. City 1 decision effectiveness = population of City 1 after 24 simulated months (in 10,000s); decision effectiveness = population of City 2 after 24 simulated months (in 10,000s); sensegiving was coded (0 = control, 1 = sensegiving); cognitive ability and psychological collectivism reflect the team-level mean; MM = mental model; RSA = reactive strategy adaptation.
* *p* < .05 (one-tailed). ** *p* < .01 (one-tailed).

condition. At the same time, teams in both conditions perceived a similar level of task difficulty ($M_{\text{exp}} = 2.48$, $SD_{\text{exp}} = 0.41$ vs. $M_{\text{control}} = 2.58$, $SD_{\text{control}} = 0.58$), $t(72) = 0.87$, *ns*, and information relevance ($M_{\text{exp}} = 2.32$, $SD_{\text{exp}} = 0.55$ vs. $M_{\text{control}} = 2.31$, $SD_{\text{control}} = 0.55$), $t(72) = 0.15$, *ns*. Results indicate that the manipulation helped teams in the experimental condition to make sense of the city without impacting task difficulty or the perceived relevance of information.

Next, we examined the extent to which teams changed strategies from City 1 to City 2 by comparing the first two strategies implemented. Across all teams, 22% implemented the same two initial strategies, 54% changed one strategy, and 24% changed both strategies. However, as shown in Figure 2, among the worst performing teams, 48% implemented the same strategies, 44% changed one strategy, and 8% changed both strategies. In contrast, all of the top performing teams used different initial strategies, with 46% changing both. Results indicate that teams tended to change strategies, and better performing teams adapted more strategies.

Next, we fit the hypothesized path model to the data and found that the model fit the data well, $\chi^2(12, N = 74) = 8.43$, *ns*; $CFI = 1.00$, $RMSEA = .00$. Standardized path coefficients are depicted in Figure 3. We intercorrelated the error terms associated with the exogenous external sensegiving, composition, and City 1 decision effectiveness variables; paths are not listed to reduce clutter. Interestingly, City 1 decision effectiveness was not significantly related to the adaptive mechanisms or adaptive performance.

Next, we examined the path coefficients to determine if specific hypotheses were supported. Results indicate that Hypotheses 1a, 1b, and 2 were supported, as MM-similarity ($\beta = .23$, $t = 2.19$, $p < .05$), MM-accuracy ($\beta = .26$, $t = 2.43$, $p < .01$), and information sharing ($\beta = .21$, $t = 1.97$, $p < .05$) were positively and significantly related to RSA.

Turning to external sensegiving and team composition, results indicate that sensegiving was significantly related to MM-similarity ($\beta = .22$, $t = 1.97$, $p < .05$) and accuracy ($\beta = .32$, $t = 3.08$, $p < .01$), supporting Hypotheses 3a and 3b, respectively. In addition, support for Hypotheses 1 and 3 provides initial support for the hypothesized mediation effect (Hypotheses 4a and 4b). However, Sobel tests indicated a significant mediation effect for

MM-accuracy ($Z = 1.89$, $p < .05$) but not similarity ($Z = 1.48$, *ns*). An alternative model including a direct path from sensegiving to RSA fit the data well but not better than the hypothesized model, $\Delta\chi^2(1) = 0.19$, and the added path coefficient was nonsignificant ($\beta = .05$, $t = 0.43$, *ns*). Hypothesis 4a was supported, whereas H4b was not; MM-accuracy mediated the relationship between sensegiving and RSA.

Team cognitive ability was related to MM-similarity ($\beta = .21$, $t = 1.80$, $p < .05$) and accuracy ($\beta = .30$, $t = 2.77$, $p < .01$), supporting Hypotheses 5a and 5b, respectively. Team cognitive ability ($\beta = .29$, $t = 2.52$, $p < .01$) and psychological collectivism ($\beta = .32$, $t = 3.00$, $p < .01$) were related to information sharing, supporting Hypotheses 6 and 7, respectively. These results, combined with support for Hypotheses 1 and 2, provide initial support for the mediation effect in Hypotheses 8 and 9. Sobel tests indicated that MM-accuracy ($Z = 2.43$, $p < .01$) and MM-similarity ($Z = 2.19$, $p < .05$) mediated the relationship between team cognitive ability and RSA but that information sharing did not ($Z = 1.55$, *ns*). An alternative model adding a direct path from team cognitive ability to RSA fit the data well, but not significantly better than the hypothesized model, $\Delta\chi^2(1) = 0.02$, and the additional path coefficient was not significant ($\beta = -.01$, $t = 0.14$, *ns*). Finally, Sobel tests also indicated that information sharing mediated the relationship between team psychological collectivism and RSA ($Z = 1.65$, $p < .05$). An alternative model including a direct path from psychological collectivism to RSA also fit the data well but not significantly better than the hypothesized model, $\Delta\chi^2(1) = 0.11$, and the additional path coefficient was not significant ($\beta = -.03$, $t = 0.32$, *ns*). Therefore, Hypotheses 8a and 8b were supported, with MM-accuracy and MM-similarity operating as mediators, whereas 8c was not supported (information sharing as a mediator). Hypothesis 9 was supported.

Finally, RSA was positively related to decision effectiveness in City 2 ($\beta = .26$, $t = 2.26$, $p < .05$), supporting Hypothesis 10. We conducted Sobel tests and fit a series of alternative models to the data to test for mediation effects in Hypotheses 10a–10c. Sobel test results indicated that RSA did not mediate the relationship between decision effectiveness and MM-similarity ($Z = 1.48$, *ns*), MM-accuracy ($Z = 1.54$, *ns*), or information sharing ($Z = 1.40$, *ns*). An alternative model adding a direct path from MM-similarity to effectiveness fit the data well but not better than the hypothesized model, $\Delta\chi^2(1) = 0.63$, and the additional path coefficient was not significant ($\beta = -.13$, $t = 1.05$, *ns*). An alternative model adding a direct path from MM-accuracy to effectiveness also fit the data well but not better than the hypothesized model, $\Delta\chi^2(1) = 0.03$, and the added path coefficient was nonsignificant ($\beta = .02$, $t = 0.15$, *ns*). A final alternative model including a direct path from information sharing to effectiveness fit the data well but not better than the hypothesized model, $\Delta\chi^2(1) = 1.15$, and the additional path coefficient was not significant ($\beta = .14$, $t = 1.16$, *ns*). Hypotheses 10a, 10b, and 10c were not supported.

Discussion

The current study contributes new insights to the team science literature by (a) identifying the strategy-focused cognitive states and information exchange behaviors important for adaptive performance in information-based project teams and (b) identifying the motivational drivers of information-based adaptive mecha-

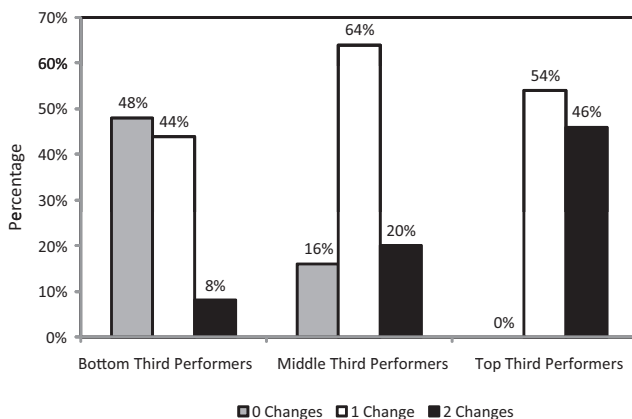


Figure 2. Percentage of teams changing zero, one, or two initial strategies from City 1 to City 2.

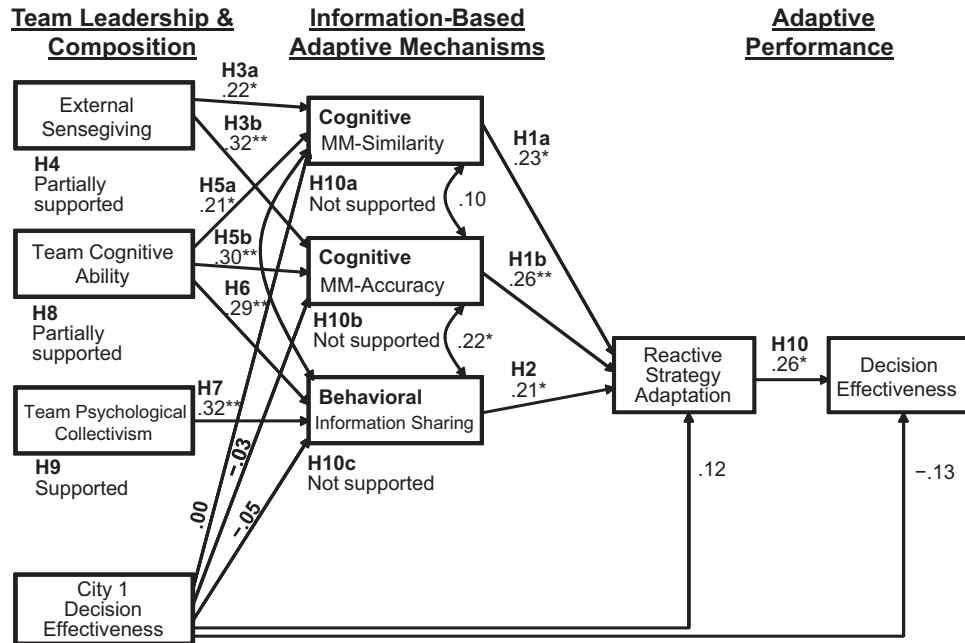


Figure 3. Hypothesized model with standardized path coefficients. Sensegiving, team composition, and City 1 decision effectiveness are intercorrelated; paths are not listed to reduce clutter. MM = mental model; City 1 decision effectiveness = population of City 1 after 24 simulated months (in 10,000s); decision effectiveness = population of City 2 after 24 simulated months (in 10,000s); H = hypothesis. * $p < .05$ (one-tailed). ** $p < .01$ (one-tailed).

nisms and adaptive capacity. We now discuss the theoretical and practical implications of these findings.

Theoretical and Practical Implications

In line with conceptual models of team adaptation (e.g., Burke et al., 2006; Kozlowski et al., 2009), our results indicate that structured strategy-focused knowledge and the exchange of information enable project teams to effectively adapt strategies in response to disruptive events. As such, these findings also demonstrate the importance of De Dreu et al.'s (2008) MIP-G theory for understanding team adaptive capacity. Further, these findings make two important contributions to the team mental model literature. First, our results indicate that strategy-focused mental models are a third type of mental model, apart from task-focused and team interaction-focused mental models (see DeChurch & Mesmer-Magnus, 2010b; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000; Mohammed et al., 2010), that is relevant for understanding structured knowledge in information-driven teams. Second, our results provide further evidence that both similarity and accuracy are important facets of mental models and uniquely contribute to a team's ability to make adaptive decisions.

Turning now to the motivational drivers of collective information processing, we found that external sensegiving played a strong role in creating adaptive capacity by enhancing MM-accuracy and MM-similarity. This finding supports Kozlowski et al.'s (2009) theory of dynamic team leadership, that "leaders should help members construct a *mental model* to organize their cognitions" (p. 14). These results also build on Morgeson's (2005) finding of the importance of external leader sensemaking for perceived leader

effectiveness during disruptive events and directly support Zaccaro et al.'s (2001) proposition that the sensegiving function helps teams to form accurate and similar team mental models. By placing information and stimuli into a common framework (Weick, 1995), external sensegiving provides a source of epistemic motivation to teams, facilitating the formation of similar and accurate structured knowledge of the implications of strategic decision options. In turn, these collective knowledge structures enable teams to determine strategic needs and make adaptive decisions.

Team composition also provides an important basis for motivating collective information processing and building adaptive capacity. Teams with high levels of cognitive ability composition likely had the capacity to quickly determine cause-and-effect linkages among their strategic decision alternatives and the motivation to form accurate views of the performance context, facilitating the emergence of similar and accurate strategy mental models. Likewise, these teams may have been able to recognize information dispersion and the need to engage in cooperative information exchange. As such, we suggest that cognitive ability is an important factor in the motivated information processing in teams. Turning to psychological collectivism composition, results confirm Jackson et al.'s (2006) assertion that collectivistic values provide a foundation for effective performance in interdependent work settings. As such, the findings provide empirical support for MIP-G theory (De Dreu et al., 2008) and extend models of team adaptability (e.g., Burke et al., 2006) by indicating that psychological collectivism composition provides prosocial motivation to engage in information sharing behaviors that enable adaptive performance in project teams.

Importantly, the strategic decisions most important for success in City 1 (i.e., zoning undeveloped areas, building additional roads, and constructing additional power plants) were not the same strategic decisions most important for success in City 2 (i.e., rezoning low-density areas to be high-density areas, decreasing property taxes, and increasing funding for public departments). In fact, City 1 decision effectiveness had a small negative, though nonsignificant, relationship with City 2 decision effectiveness and a small positive, though nonsignificant, relationship with City 2 RSA. Some teams who achieved some level of success in City 1 may have become entrained in their decision routines (Ancona & Chong, 1996), causing a spillover effect to City 2, which ultimately led to weaker performance. In contrast, those teams that formed similar and accurate strategy mental models and who shared goal-relevant information were able to quickly adapt their strategies to match the needs of the new city and make effective decisions. Together these findings suggest that, although entrainment effects could have hindered decision quality in the changing environment, strategy-focused team cognition and information sharing behaviors created adaptive capacity that enabled teams to succeed.

The current study offers several practical implications for staffing and developing knowledge-based project teams with the capacity to adapt to environmental complexities. First, staffing teams with members who have high levels of cognitive ability likely facilitates the emergence of accurate and similar strategy mental models and promotes effective information sharing. Staffing teams with members who have high levels of psychological collectivism likely enhances cooperative information exchange. Second, training team leaders to engage in sensegiving processes that involve presenting information to the team in a manner that helps them to form cue–response contingencies will aid the emergence of structured cognition among members. Additionally, as training interventions have been found to be important for developing adaptive performance in teams (G. Chen, Thomas, & Wallace, 2005), training content should be aimed at building structured cognition and promoting information sharing among team members.

Limitations and Future Directions

This study has several limitations that should be noted. First, as with most laboratory studies, external validity may be a concern. Findings were obtained from undergraduate students performing a simulated task. The participants lacked the depth of knowledge and personal consequences associated with project teams in the field. In addition, the simulation did not replicate the contextual pressures (e.g., political, financial, etc.) that project teams in the field would face, nor did the teams face real consequences for their decisions; thus, the simulation had limited mundane realism. However, the scenario was designed to capture the structure of cross-functional teams, and the simulation provided a platform for teams to make strategic decisions, receive real-time feedback on the consequences of their decisions, and model the nomological network among constructs of interest. As such, the task contained a relatively high level of psychological realism, which is an especially important design consideration for laboratory research (Berkowitz & Donnerstein, 1982; Marks, 2000).

A second limitation is the short-term nature of the study, which may have impacted the magnitude of relationships. For example,

sensegiving and composition factors may have their strongest effects during initial stages of team development and become less pronounced over time. Alternatively, the effects of team composition may be stronger over time as members adjust to each other's working styles.

A third concern is the limited scope of the decision effectiveness criterion and the timing of measurements. Population growth may not have fully captured the impact of decision making and strategy adaptation, which in turn may explain the moderate magnitude of the relationship between RSA and decision effectiveness and the lack of a mediated relationship with mental models and information sharing. Alternatively, the magnitude of the RSA–effectiveness relationship may reflect the reality of organizational settings where strategy development and adaptation may be necessary but insufficient drivers of team effectiveness, as internal processes and external forces also impact performance (see Marks et al., 2001). Also, the sample of 74 teams may have yielded insufficient statistical power to fully identify the effects. A related concern is the timing of the measurement of mental models, information sharing, and RSA. Although the constructs were measured by different sources, they were captured at similar time intervals during the simulation. Although a temporal ordering of constructs is implied, the study design does not allow for a test of this causal order, and relationships are best interpreted as reflecting a correlational pattern. Research is needed that models the pattern of relationships in intact teams using more comprehensive performance criteria over an extended period of time.

A fourth limitation is the videotaped sensegiving manipulation, as our approach did not capture the interpersonal dynamics between leaders and team members, such as the quality of relationships (i.e., leader–member exchange; Dansereau, Graen, & Haga, 1975) or leader consideration (Stogdill, 1950), to name a few. Each of these factors could impact the relationship between the leadership sensegiving function and mental models. Therefore, we suggest that the current findings most closely capture more informal and external sources of team leadership as opposed to internal or formal team leaders. Finally, the manipulation check results indicated that, although sensegiving perceptions of teams in the experimental and control condition differed, the overall effect of the manipulation was not particularly strong. Perhaps the short duration of the study attenuated the effects. Alternatively, sensegiving may have a stronger effect when delivered by an actual leader who can interact with the team and clarify unresolved questions.

Fifth, this study focused exclusively on cross-functional, information-driven project teams; the pattern of relationships may not extend to production-focused or action-oriented teams. Although strategy mental models were found to be an important adaptive mechanism for project teams, task- or team-interaction mental models may be more useful adaptive mechanisms for action teams where action processes such as coordination are important for effective performance. In addition, the correlation between MM-similarity and MM-accuracy ($r = .25$) in the current study was considerably lower than correlations reported in prior studies of task (e.g., $r_s = .61-.67$; Edwards et al., 2006) or team-interaction mental models (e.g., $r = .85$; Ellis, 2006), which raises some questions about the similarities and differences between strategy, task, and team-interaction content. Last, the simulation modeled external changes; adaptation to internal changes to structure (e.g., Moon et al., 2004) and downsizing (DeRue,

Hollenbeck, Johnson, Ilgen, & Jundt, 2008) have also been shown to be critical for team success. It is unclear whether the current set of leadership, composition, and adaptive mechanism will also promote project team adaptation to internal changes. These issues should be examined in future research.

Additional team leader functions, such as those outlined by Morgeson et al. (2010), may also create adaptive capacity in teams. For instance, prior research has found that a positive leadership climate is an important enabler of team empowerment (e.g., G. Chen, Kirkman, Kanfer, Allen, & Rosen, 2007), which in turn has been linked with team motivation to perform well (e.g., Kirkman & Rosen, 1999). We expect that empowerment is likely to be another important motivational component of adaptive performance. Additional motivational and interpersonal processes may also be important mechanisms for adaptation in project teams, as motivational processes have been found to be an important link between training interventions and adaptive performance (G. Chen et al., 2005). Leadership functions such as establishing goals or building a supportive climate should help to build empowered, motivated, and adaptive project teams.

In conclusion, modern organizations are faced with the challenge of not only how to design and develop effective teams but also how to design and develop teams that adapt effectively. Findings from the current study indicate that external sensegiving, cognitive ability, and psychological collectivism are key drivers of the cognitive and behavioral information-based adaptive mechanisms that enable project teams to make adaptive strategic decisions.

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Appendix

Strategic Decisions in the Mental Model Measure

1. Cut spending
2. Build schools, clinics, and public safety buildings
3. Zone undeveloped areas
4. Increase taxes
5. Increase capacity of roads
6. Dezone developed areas and rezone into higher density
7. Build power plants
8. Decrease taxes
9. Reduce air and water pollution
10. Increase funding for city departments

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