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Team Adaptation and Postchange Performance: Effects of Team Composition in Terms of Members' Cognitive Ability and Personality

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The present study extended research on relationships between individual differences and individual-level adaptation (J. A. LePine, J. A. Colquitt, & A. Erez, 2000). This study focused on team-level relationships ($N = 73$ teams) and demonstrated that after an unforeseen change in the task context, performance was superior for teams with members who had higher cognitive ability, achievement, and openness and who had lower dependability. These relationships were mediated by a measure of role structure adaptation (i.e., the effectiveness with which teams adapted their role structure when faced with an unforeseen change in their task context). Members' individual differences did not explain variance in team performance prior to the unforeseen change in the task context. Overall, results suggest differential relationships for team composition across routine and changing task contexts.

Technological, economic, and demographic trends are changing the structure of work in organizations (Howard, 1995). Advances in information-processing technologies have increased the pace at which new products are developed and brought to market. Increased globalization and advances in communications technologies have increased technological transfer and shortened product lifecycles even further. To remain competitive in this environment, organizations must often change what they do or how they do it. Among the most popular means of achieving this type of increased flexibility has been to structure work around teams rather than individual jobs (Cascio, 1995; Ilgen, 1999). The increasing prevalence of teams has been well documented (e.g., Devine, Clayton, Philips, Dunford, & Melner, 1999; Lawler, Mohrman, & Ledford, 1995; Gordon, 1992). Some have estimated that in the next few years, up to half of the U.S. workforce will be working in teams of some form or another (Stewart, Manz, & Sims, 1999).

With experience, and as in all organizational systems (Katz & Kahn, 1978; Miller, 1978; von Bertalnffy, 1968), teams develop habitual patterns of behavior that are sometimes called *routines* (Gersick & Hackman, 1990; Weiss & Ilgen, 1985). Routines are functional in that they provide a mechanism whereby members can anticipate other members' actions. Routines also allow for increased efficiency because ways of transforming inputs to outputs need not be actively managed. Finally, routines reduce the uncertainty members have regarding their role responsibilities. However, among the most critical aspects of teams is the occasional need to change their routines to respond to changes in their task environment. Routine behavior has been characterized as mindless or heedless and thus has a high likelihood of being inappropriately applied in a changing situation (Cohen & Bacdayan, 1996; Weick & Roberts, 1993). As Argote and McGrath (1993) noted, teams must be able to deal with unanticipated change and modify their routines, or team effectiveness will suffer. Thus, recognizing that routines are often desirable and probably inevitable (Gersick & Hackman, 1990; Hackman & Morris, 1975), several critical questions emerge. For example, what variables predict the extent to which teams adjust their routines in response to unforeseen change? Do the same factors predict team performance prior to and after unforeseen change? Is it possible that some of these factors might be controllable by those responsible for managing teams?

To date and despite the growing literature on teams as documented in numerous scholarly reviews (e.g., Bettenhausen, 1991; Guzzo & Shea, 1992; Ilgen, 1999; Levine & Moreland, 1990; Sundstrom, DeMeuse, & Futrell, 1990), there has not been much empirical research aimed at these questions (Waller, 1999). This shortcoming in the teams literature is even more disconcerting given that Behling, Coady, and Hopple (1967) noted over 30 years ago that "one of the least understood phenomena in task-oriented team performance is the manner of adjustment to unprogrammed changes" (Behling et al., 1967, p. 73).

Thus, the purpose of this article is to report a study intended to increase our understanding of the factors that allow teams to effectively adapt their routines (systems of member roles) in response to unforeseen changes in their work environment. The conceptual framework for the study appears in Figure 1. The study extends recent research focusing on the linkages between certain individual differences (in cognitive ability and personality characteristics) and individual-level decision-making performance prior to and immediately following an unforeseen change in the task context (LePine, Colquitt, & Erez, 2000).

The most obvious extension of the previous research is the team-level focus. First, the focal independent variables in this study are members' individual differences aggregated to the team level (general cognitive ability, dependability, achievement, and

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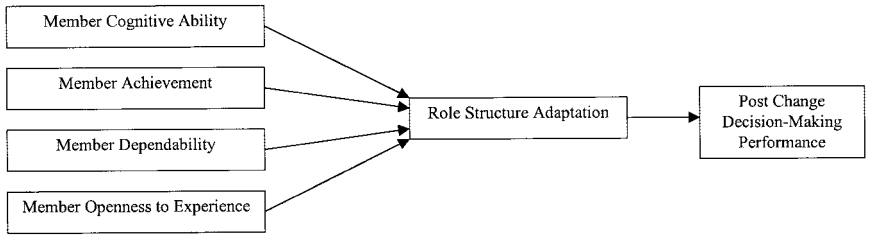

Figure 1. Conceptual model of team composition and team adaptation.

openness to experience). This focus on team composition with respect to team members' individual differences is consistent with the need to conduct research that can be applied by those responsible for managing and, in particular, staffing teams (e.g., Guzzo & Shea, 1992; Klimoski & Jones, 1995; LePine, Hanson, Borman, & Motowidlo, 2000). Second, the focal outcome variable in this study is team decision-making performance following an unforeseen change in the task context. The focus on team decision making as the focus of performance is consistent with the increasing emphasis on cognitive aspects of performance and knowledge work in teams (Beyerlein, Johnson, & Beyerlein, 1995; Howard, 1995; Ilgen & Pulakos, 1999).

A more important extension of the previous research, however, is that the focus of the adaptation in this study is *team-level behavior* rather than *individual-level cognition.* More specifically, the present study focuses on role structure adaptation as the mediator of the relationship between team composition and postchange performance. Role structure adaptation is defined here as *reactive and nonscripted adjustments to a team's system of member roles that contribute to team effectiveness.* Considering mediating processes such as these are important to the extent that they provide insight into the "black box" through which team inputs (such as team composition) influence team outcomes (such as decision-making performance; Lawrence, 1997). The focus on role structure adaptation is consistent with research demonstrating that team effectiveness after an unanticipated change in the task context may depend on the effectiveness with which members collectively adapt their roles (Hutchins, 1996).

Role Structure Adaptation and Performance

As the definition in the previous paragraph suggests, role structure adaptation is a fairly specific type of adaptation. The first element of the definition, *reactive,* implies change in team activity in response to something: a problem, error, or discrepancy. Accordingly, the focus in this article is not on proactive behavior that anticipates the need for change (e.g., innovation). The second element of the definition of role structure adaptation, *nonscripted,* implies that the focus is not on reactions to problems by implementing intact procedures learned in the past. Role structure adaptation, therefore, is different from constructs such as transfer of training that address proficiency regarding when to implement lessons from the past.

The third element in the definition of role structure adaptation is the word *adjustment,* which implies activity or behavior. The team activity or behavior reflected by a team's role structure is the cyclical pattern of activity among members who compose a team. However, the term *role structure* more explicitly reflects the cyclical pattern of behavior directed toward the transformation of resources to outputs within the boundary of the set of events that return upon themselves to complete a new cycle of task-related activity (Katz & Kahn, 1978). Thus, role structure adaptation is distinct from *learning,* which can mean a change in knowledge without any change in activity or behavior. The element *team* in the definition stresses that team-level behavior is the focus of the present research. That is, the focus is on changes in the patterns of activity among interdependent individuals who, as part of an identifiable team with a common purpose, transform resources to outputs.

The final element of the definition, *contributes to team effectiveness,* implies that patterns of team behavior can be judged with respect to how well they contribute to team functioning. Role structure adaptation is effective when the pattern of team activity is judged to be consistent or congruent with the demands of the new situation. Thus, role structure adaptation is defined in a manner that is consistent with how other behavioral performance constructs are defined (e.g., Motowidlo, Borman, & Schmit, 1997) that is, the aggregated value of those activities contributing (either positively or negatively) to the effectiveness of the group or organization.

Although role structure adaptation may be important across different team settings, it should be particularly important for teams that must integrate information to make a series of decisions over a defined span of time. These types of teams exist in many different types of organizations, and the nature of their task often places a premium on the team's ability to adapt their established role structure *in the course of performing the task.* For example, production teams involved in long linked and continuous flow processes, surgical teams, flight crews, and command and control teams do not have the time to stop and plan a rational response to an unexpected change that makes their established role structure inappropriate (e.g., an equipment failure). Instead, in the face of an unforeseen change, these teams must be capable of "adapting on the fly" to be effective, and quite often, to avoid disaster.

Hutchins (1996), for example, described how a ship's navigation team adapted its role structure in response to an unexpected loss of power that disabled the instruments necessary to navigate the ship while entering a harbor. Prior to the power loss, members of the team had preestablished role responsibilities and interdependencies. Bearing takers read the bearings of landmarks on the shore and reported them to bearing timers, who logged them and reported them to the plotter, who kept track of the ship's position and who estimated where the ship was going. Hutchins described

how the navigation team responded to the power loss and how the team eventually arrived at a new stable pattern of activity among members that was appropriate given the nature of the situation. As a result, the ship was brought to dock safely. This was a study of an effective instance of role structure adaptation. However, it is easy to see how the navigation team's failure to develop a new system of behavior could have lead to disastrous consequences.

In the context of decision-making teams, such as the type considered here, members share information with one another and use this information to make judgments and recommendations about an appropriate course of action. Thus, unexpected changes in the team's task context that hinder the smooth flow of information among members should result in less effective judgments and recommendations and ultimately less effective decisions. With this reasoning in mind, team decision-making performance should be positively associated with the extent to which a team can adapt its role structure after an unforeseen change. Thus, I propose the following:

> *Hypothesis 1:* Role structure adaptation is positively associated with team decision-making performance after an unforeseen change in the task context.

Individual Differences and Adaptation

In a recent study, LePine, Colquitt, and Erez (2000) identified several characteristics of individuals that predicted their ability to make accurate decisions after unforeseen changes in their task context. In this study, participants worked independently at a personal computer and made decisions on a series of 75 problems on the basis of the values of nine cues they were presented. After the 25th and 50th problem, the rules used in calculating correct decisions changed (i.e., the weights that needed to be applied to the vector of cues). These changes came with no warning to participants because they only received feedback reflecting the accuracy of each decision immediately following each problem. The focus of this study was on predicting the decision-making performance of individuals within each decision context (i.e., prechange task context, 1st postchange task context, 2nd postchange task context) with individual differences that could be used in personnel selection contexts. After each change, while performing the task, participants needed to recognize that the weights they were applying to the cues were no longer optimal. They had to unlearn an old set of cue weights and relearn a new one. The choice of individual differences in this study reflected three proposed requirements of adaptation: ability (cognitive ability), motivation (conscientiousness), and creativity (openness to experience).

Cognitive Ability

Cognitive ability refers to differences between individuals in their capacity to process information and learn (Hunter, 1986; Kanfer & Ackerman, 1989). Cognitive ability relates positively to job performance, especially in jobs that require the mental representation and manipulation of information obtained from the environment and long-term memory (Hunter, 1986; Ree, Earles, & Teachout, 1994). LePine, Colquitt, and Erez (2000) hypothesized that cognitive ability would be related to individual adaptation because, after some unexpected change, unlearning and learning would be required, and this would increase the information-processing requirements of individuals. In other words, individuals with superior information-processing capacities should be more capable of unlearning and learning while simultaneously engaged in the more mundane elements of the task. This expectation is consistent with research demonstrating stronger relationships between cognitive ability and performance for tasks that are novel and complex than for tasks that are routine and simple (Hartigan & Wigdor, 1989; Hunter & Hunter, 1984). LePine, Colquitt, and Erez's expectations were confirmed in that individuals with higher cognitive ability made better decisions prior to the change, and this effect became significantly stronger after the two unexpected changes in the cue values.

Conscientiousness

Conscientiousness is a personality characteristic that includes a achievement component related to feelings of competence, achievement striving, and being self-disciplined in addition to a dependability component related to orderliness, dutifulness, and deliberation (Costa & McCrae, 1992; Costa, McCrae, & Dye, 1991). Highly conscientious individuals tend to set difficult goals for themselves, and they are more perseverant and committed to those goals (Barrick, Mount, & Strauss, 1993; Hollenbeck, Klein, O'Leary, & Wright, 1989; Hollenbeck & Williams, 1987). Moreover, highly conscientious individuals have high self-efficacy and expectancy motivation (Judge & Ilies, 2002). Perhaps these are the reasons why conscientiousness is positively related to job performance across contexts (Barrick & Mount, 1991).

LePine, Colquitt, et al. (2000) hypothesized that conscientiousness should be positively associated with individual adaptation. They suggested that perseverance and feelings of self-confidence are critical for effectiveness when individuals first acquire information regarding the performance decrements that normally accompany unexpected change. Additionally, they felt that a methodical, careful, and deliberate consideration of available contextual information is necessary to promote effectiveness in the new context. Unexpectedly, although the effect for conscientiousness was stronger for performance after the changes, the direction of the effect was negative. Specifically, participants with high conscientiousness made *worse* decisions after the changes than individuals with low conscientiousness. A post hoc analysis revealed that the negative relationship for conscientiousness and adaptation was due to the aspects of conscientiousness reflecting dependability (i.e., order, dutifulness, deliberation) rather than achievement (i.e., competence, achievement striving, self-discipline).

Openness to Experience

Openness to experience is a personality characteristic that reflects characteristics such as imaginativeness, curiosity, originality, and broadmindedness (Costa & McCrae, 1992). Although there is no evidence that openness relates to normal job performance, it has been found to predict training proficiency (Barrick & Mount, 1991). Perhaps this is because open individuals tend to engage in the type of self-monitoring that is necessary for learning in novel situations (Blickle, 1996; Busato, Prins, Elshout, & Hamaker, 1999). LePine, Colquitt, and Erez (2000) hypothesized that

openness would be positively associated with individual adaptation not only because of this self-monitoring effect but also because open people tend to be more creative and receptive to change. Open people also tend to enjoy intellectual problems and are more willing to try new things (Costa & McCrae, 1992; King, Walker, & Broyles, 1996; McCrae, 1987). These tendencies are important for effectiveness in a changed task context because adaptation requires the development of creative and perhaps counterintuitive ways of doing things. LePine et al. found that the effects for openness on decision-making performance became significantly stronger after the two changes in the task context. Participants with high openness made better decisions when adaptation was required.

Team Composition and Team Adaptability

As described above, LePine, Colquitt, and Erez (2000) used individual differences to predict an individual-level cognitive adaptation—specifically, individuals' ability to unlearn and relearn cue values after the ecological value of the cues changed unexpectedly. Because behavioral adjustments (either directly in response to changes in the situation or indirectly in response to changes in interactions with others) also require unlearning and relearning, it is possible that these same individual differences are important in predicting the extent to which a team restructures its system of roles. Team outcomes, however, are a product of the interaction of team members, not simply the aggregated outputs of individuals who perform tasks independently. Similarly, team processes such as role structure adaptation reflect the characteristic pattern of behavior among team members who participate jointly, and usually reciprocally, in transforming inputs to outcomes (LePine, Hanson, et al., 2000). Accordingly, because the focus of this study is on predicting team effectiveness with respect to team-level processes and outcomes, the appropriate unit of theory and analysis is the team. Because the purpose of this study is to predict team-level processes and outcomes with the composition of the teams, there is a need to consider how the attributes of the members need to be represented at the team level (Chan, 1998; Roberts, Hulin, & Rousseau, 1978; Rousseau, 1985).

The present research is consistent with other researchers who viewed the aggregated attributes of individuals as characteristics of the team (e.g., Barrick, Stewart, Neubert, & Mount, 1998; LePine, Hollenbeck, Ilgen, & Hedlund, 1997; Taggar, Hackett, & Saha, 1999). That is, teams can be characterized as having members with a certain set or combination of attributes, and aggregation is simply necessary to account for those attributes (LePine et al., 1997). What follows next is a conceptual description related to how aggregated characteristics of individuals influence role structure adaptation and postchange team performance.

Member Cognitive Ability

In an early narrative review, Heslin (1964) concluded that group members' ability promoted group performance in most of the studies he reviewed, and although the results were somewhat equivocal, in no study did higher member ability detract from group performance. More recently, Devine and Philips (2000) found a moderate relationship between aggregated team member ability and team performance across studies (sample weighted mean $r = .19$) by using meta-analysis. The explanation for this relationship is that members who have high cognitive ability tend to be more effective in their roles, and as long as the members are competent at integrating their roles, their effectiveness translates to higher team-level performance (Hackman, 1987; LePine, Hanson, et al., 2000; Steiner, 1972).

When the task context changes, and the team needs to adapt its role structure, team composition with respect to cognitive ability (henceforth *member cognitive ability*) should become even more important with respect to predicting team performance. This expectation is consistent with Devine and Philips's (2000) meta-analysis that demonstrated that task familiarity moderates the relationship between team cognitive ability and team performance such that the relationship is much stronger for unfamiliar tasks ($r = .36$) than for familiar tasks ($r = .12$). Certainly, a changed task context is less familiar than the routine task context.

One explanation for a positive relationship between member cognitive ability and postchange team performance is that teams composed of members with higher cognitive ability should be more capable of redeveloping effective systems of activity than teams composed of members with lower cognitive ability. Members with high cognitive ability are more capable of learning from their experience than are members with low cognitive ability. In a changing situation, individuals with high cognitive ability can draw from their superior base of knowledge, and once this knowledge is integrated with other members' knowledge, an accurate understanding of the new situation can emerge. Moreover, the larger pool of task knowledge should be useful to a team with respect to developing a system of activity that is consistent with the demands of the new situation. Having members with higher cognitive ability gives a team the potential to be flexible because members acquire knowledge that may ultimately be useful in a variety of situations.

With the logic contained in these paragraphs in mind, it is reasonable to expect that teams composed of members who have high cognitive ability will perform well after an unforeseen change because these teams will tend to effectively adapt their role structure.

Hypothesis 2a: Member cognitive ability is positively associated with role structure adaptation.

Hypothesis 2b: Member cognitive ability is positively associated with team decision-making performance after an unforeseen change in the task context.

Hypothesis 2c: The relationships between member cognitive ability and team decision-making performance after an unforeseen change in the task context is mediated by role structure adaptation.

Member Achievement

In the present study, achievement and dependability aspects of conscientiousness are considered instead of the broader construct. The bifurcation of conscientiousness into components reflecting achievement and dependability is consistent with recent research demonstrating meaningful differences in relationships for these aspects of conscientiousness and important job-relevant criteria

(e.g., Hough, 1992; LePine & Van Dyne, 2001b; Moon, 2001; Mount & Barrick, 1995). This approach is also consistent with those scholars who have suggested that increased theoretical understanding can result from consideration of aspects of personality that are more narrow and behaviorally specific than the Big Five characteristics (e.g., Ashton, 1998; Hough, 1992; Paunonen, Rothstein, & Jackson, 1999; Schneider, Hough, & Dunnette, 1996).

Although LePine, Colquitt, and Erez (2000) failed to find a significant relationship between the achievement aspects of conscientiousness and *individuals'* postchange decision-making performance, there are many reasons to believe that *member achievement* may be a valuable resource for *teams* that confront an unexpected change. Individuals who score high on achievement are valuable to organizations because they tend to exert high levels of effort to achieve goals (Costa & McCrae, 1992). Thus, in the context of a decision-making team, high levels of member achievement should translate into high levels of effort in obtaining, considering, and sharing information to make effective individual recommendations and team decisions. High achievement should be particularly important to a team after there is an unforeseen change in the task context that will likely cause a decrement in performance. Because achievement relates to perseverance and self-efficacy (Costa & McCrae, 1992), it is less likely that high achievement members will reduce or abandon their drive to achieve team and personal goals as they see their level of effectiveness decrease. Instead, after an unexpected change, high-achievement members will work harder and will encourage each other to work harder to find an alternative work arrangement that will allow the team to function effectively. Although high achievement among members might manifest itself in a number of different ways after unforeseen change, another likely response is that members will share ideas about alternative ways of going about the task. This expectation is supported indirectly in that the achievement components of conscientiousness have been linked to voice behavior—the extent to which individuals speak up and make constructive suggestions aimed at improving group effectiveness (LePine & Van Dyne, 2001b).

Overall, therefore, it is reasonable to expect that teams composed of members who have high levels of achievement will perform well after an unforeseen change because these teams will tend to effectively adapt their role structure.

Hypothesis 3a: Member achievement is positively associated with role structure adaptation.

Hypothesis 3b: Member achievement is positively associated with team decision-making performance after an unforeseen change in the task context.

Hypothesis 3c: The relationships between member achievement and decision-making performance after an unforeseen change in the task context is mediated by role structure adaptation.

Member Dependability

Although the negative relationship between the dependability components of conscientiousness and individual adaptation was unexpected by LePine, Colquitt, and Erez (2000), this relationship is consistent with logic. Individuals who score high on the dependability components have a high need for order and tend not to do anything without careful consideration first. They tend to be more punctilious with respect to behaving reliably, and they are not spontaneous with respect to decision making. In fact, as Costa and McCrae (1992) noted, scoring highly on the dependability aspect of conscientiousness might contribute to annoying fastidiousness and even obsessive-compulsive personality disorder. Essentially, those who score high on dependability are less likely to abandon old habits after an unexpected change and therefore are more likely to "go down with the sinking ship."

With the results of the previous research in mind, it is reasonable to expect that a team with highly dependable members will perform poorly after some unexpected change in the task. In the face of change, members who score high on dependability should be less willing to abandon old patterns of behavior, even after it is apparent that the behavior is inappropriate. Teams composed of highly dependable members will likely have problems in the type of trial-and-error learning that may be necessary in novel situations. Highly dependable members will feel the need to gather additional information and deliberate before acting, and this is likely to be especially problematic when the path to effectiveness is unclear and the team has to adapt in the course of performing its task. Highly dependable members are likely to feel anxiety in the face of change and to feel uncomfortable about engaging in new patterns of interpersonal behavior. Moreover, a team composed primarily of highly dependable members is likely to apply pressure to "deviants" who engage in behavior that seems too different, spontaneous, or untested (Hackman, 1992). With this logic in mind, it is reasonable to expect that teams composed of members who score high on dependability will perform poorly after an unforeseen change because these teams will tend not to effectively adapt their role structure.

Hypothesis 4a: Member dependability is negatively associated with role structure adaptation.

Hypothesis 4b: Member dependability is negatively associated with team decision-making performance after an unforeseen change in the task context.

Hypothesis 4c: The relationships between member dependability and team decision-making performance after an unforeseen change in the task context are mediated by role structure adaptation.

Member Openness to Experience

As noted earlier, the personality characteristic openness to experience relates to creativity, broadmindedness, and the willingness to try new things. For these reasons, LePine, Colquitt, and Erez (2000) hypothesized and found that openness to experience was positively related to individual adaptation.

In a team setting, openness to experience should also be important in predicting performance after an unforeseen change. Because open individuals tend to be more imaginative and inventive and to have divergent interests (Costa & McCrae, 1992), teams composed of highly open members should be able to develop a more diverse menu of alternative ways of going about the task

given the new situation. In a team setting, open individuals should not only make more suggestions, but because they tend to be insightful, enthusiastic, and talkative, they should tend to build on the ideas of other members. Finally, teams composed of members who score high on openness should also be more willing to consider and try alternative ways of going about the task. This is because highly open individuals have a willingness to consider unconventional ideas, and at the same time they tend to be versatile (Costa & McCrae, 1992). Given this line of reasoning, teams composed of highly open members will perform well after an unforeseen change because these teams will tend to effectively adapt their role structure.

Hypothesis 5a: Member openness to experience is positively associated with role structure adaptation.

Hypothesis 5b: Member openness to experience is positively associated with team decision-making performance after an unforeseen change in the task context.

Hypothesis 5c: The relationships between member openness to experience and team decision-making performance after an unforeseen change in the task context is mediated by role structure adaptation.

Method

Participants

Research participants included 219 college juniors and seniors arrayed into 73 three-person teams. The mean age for these participants was approximately 21 years ($SD = 2.29$), their self-reported grade-point average was 3.06 out of 4.00 ($SD = 0.43$), and about half of the participants were male. Participation in this study was voluntary, and participants were informed that they could withdraw from the study at any time. Participants who completed the study received course participation credit for their time as well as eligibility for cash bonuses based on team performance. Individuals in top-performing teams shared $60, $45, and $30, respectively.

Research Design

The study took place in a laboratory and used a 3-hr computerized decision-making simulation. Approximately halfway through the simulation, a critical communications link was removed. This treatment, given in the same way to all of the teams in this study, created the opportunity to observe relationships between the team composition variables and the adaptation and postchange performance variables. Because teams were composed randomly (there was no manipulation of team composition) and because the removal of the communications link was not a manipulation in an experimental sense (it was given in the same way to all teams), the study should be thought of as a nonexperimental laboratory study.

The study was conducted in the laboratory for several reasons. First, in field settings it is difficult to anticipate changes that are likely to affect a fairly large number of teams in the same way. Thus, it is not only difficult to find field settings in advance where adaptation is likely to be relevant, but this problem is compounded because adequate statistical conclusion validity necessitates the opportunity to observe a fairly large number of teams prior to and after an unforeseen change. Second, it is difficult to anticipate the nature of a contextual change in field settings. This makes it difficult to anticipate, *a priori,* the set of behaviors that should contribute to team effectiveness after the change. The laboratory allows researchers to control both the timing and the nature of a change. Controlling these aspects of the change is especially crucial when studying adaptation because experience (both in terms of breadth and depth of knowledge) likely plays an important role in strengthening the very routines that must be overcome during times of change. Finally, it would be problematic to create a significant unexpected change in a field setting because these types of changes are going to create a performance decrement across teams. Although creating an unforeseen change would be difficult in most organizational settings, in some contexts (e.g., real-world command and control teams, surgical teams, flight crews) creating such a change would be catastrophic because lives could be lost.

Task

Research participants worked on a team-based version of the Team Interactive Decision Exercise for Teams Incorporating Distributed Expertise computer task ($TIDE^2$; see Hollenbeck et al., 1995, for a more complete description). $TIDE^2$ is a simulation that presents participants with values on a number of attributes of a problem or object. Participants are asked to make decisions about the state of that object on the basis of these attributes. $TIDE^2$ was programmed to simulate a military command and control team. As stated earlier, command and control teams are particularly vulnerable to unexpected changes in their task context. They must continue to perform missions despite changes that necessitate adaptation. The participants in this study were seated at networked computer terminals and were responsible for communicating over this network to make classification decisions about aircraft within a simulated airspace. Each team member was assigned the job of an officer in one of three command and control stations: Alpha, Bravo, or Charlie. Each team member was trained so as to possess unique expertise regarding aspects of the task. Alpha was trained on how to interpret information related to location (number of aircraft, range, and position relative to commercial air corridors) of the aircraft (the location rule). Bravo was trained on how to interpret information regarding the motion (heading crossing angle, altitude, and speed) of the aircraft (the motion rule). Finally, Charlie was trained on how to interpret information regarding the category (electronic security measure, radar cross section, and rate change altitude) of the aircraft (the category rule).

The instructions were such that participants knew that their area of expertise included only one decision rule and that making a recommendation on the basis of their rule required knowledge of all three attributes. This is because a value of nonthreatening for any attribute in a rule makes the correct decision for the rule nonthreatening (ignore). Alpha, who was responsible for making the final team decision, was taught that the final correct decision for each aircraft is an additive combination of the three rules. In monitoring the assigned airspace, teams had to assess a series of aircraft in terms of their level of threat. Judgments on rules and final decisions were rendered on a 7-point continuum anchored by 1 = *ignore* (lowest level of threat) and 7 = *defend* (highest level of threat). Intermediate responses on this scale in increasing level of threat included 2 = *review,* 3 = *monitor,* 4 = *warn,* 5 = *ready,* and 6 = *lock-on.*

The task was programmed so that there was interdependence among staff members. Although the three rules involved combinations of three distinct cues, no team member was able to measure all of the necessary components of any one rule. Specifically, Alpha needed to transmit "speed" to Bravo, Bravo needed to transmit "rate change altitude" (RCA) to Charlie, and Charlie needed to transmit "corridor status" to Alpha. The contextual change in this study was the failure of the transmit mechanism between Bravo and Charlie. Bravo was able to execute the "Transmit RCA" command; however, the attribute RCA did not reach Charlie.

The computers began to beep when there was 30 s remaining to make a team decision. Recommendations regarding each decision object were forwarded from Bravo and Charlie to Alpha who then considered his or her information along with these recommendations and made a final decision for the team. In the course of the experiment (which lasted 3 hr), participants made decisions on a series of 83 aircraft (including 5 for training and practice).

Procedure

Participants were randomly assigned to teams and roles (Alpha, Bravo, or Charlie). Participants received instruction and hands-on training during the first trial, after which there were four trials for practice. During the initial training trial, participants were instructed about the mechanics involved in gathering and sharing information about target attributes. These actions included (a) measuring attribute values, (b) querying others for attribute values, (c) directly transmitting attribute values to others (only permitted on values that could be measured by the station), and (d) communicating via sentence-long free-form text messages (not permitted between Bravo and Charlie). The hands-on training also involved instruction on individuals' responsibilities. This information was provided on a responsibility sheet that participants kept throughout the study. The information included (a) the specific attributes the participants needed for their role, (b) how to translate raw data on targets into judgments about how threatening the target is likely to be on a specific attribute, and also (c) how to combine information on attributes into judgments about rules. Alpha was also shown how to combine judgments on rules into a final team decision. During the 1st trial, participants were also encouraged to practice using the equipment and communicating with each other. During the next 2 trials participants practiced the task. A research assistant stood by to answer questions and to clarify misunderstandings. After the 3rd trial, the research assistant instructed participants on how to exchange information most efficiently (i.e., transmitting information directly to the person needing it without having to be asked first). This was done to ensure that teams established routines prior to the change manipulation and also to ensure that teams' routines were equally efficient. During the last 2 training trials, participants practiced using this structure. A pilot study confirmed that teams quickly developed proficiency with this structure. If left alone, the pilot teams used this structure until the simulation ended. After the 5th trial, the simulation was paused and any final questions were answered. On the 54th trial, the communications breakdown occurred (the removal of the transmit link between Bravo and Charlie) and remained this way for the remaining trials.

Core Study Variables

Postchange decision-making performance. Consistent with other recent research, decision-making performance was measured by using the mean squared error, that is, the mean of the squared differences between teams' decisions and the correct decisions (e.g., Gigone & Hastie, 1997; Hollenbeck, Colquitt, Ilgen, LePine, & Hedlund, 1998; LePine, Hollenbeck, Ilgen, Colquitt, & Ellis, 2002). These values were reversed; thus, high scores represented high performance. The postchange measure included trials after the communications breakdown. The difficulties and range of correct decisions were balanced across pre- and postchange periods.

Role structure adaptation: A count measure. Role structures are the recurring task-focused actions of individuals interrelated with the recurring task-focused actions of others (Katz & Kahn, 1978). Although somewhat arbitrary in the context of the present study, it is reasonable to suggest that a team that repeats the same pattern of activity for three consecutive trials, after which the remaining trials use that same pattern of activity, is not likely to be acting randomly. Such a team can be said to have developed a recognizable recurring pattern of task-related activity (role structure). Because all aircraft attribute values were important and because Charlie was the only member who could interpret RCA values, any adaptation required the team learning how to get the RCA value to Charlie after the communications breakdown. With all of this in mind, the primary measure of role structure adaptation was number of postchange trials in which the team used a newly developed role structure to get the RCA value to Charlie.

Before continuing, it is important to note that the most efficient adapted role structure involved Bravo directly transmitting the RCA value to Alpha and then Alpha sending a text message with the RCA value to Charlie. This was because Bravo and Charlie could not communicate with each other using text messages, and only the station that originally measured the attribute value could directly transmit the attribute value to another station. The task was structured this way so that an effective adaptation would not be overly obvious to participants and would necessarily involve the entire team. Specifically, it was very important that an adaptation would require more than Bravo simply realizing that he or she needed to send the RCA value to Charlie by text message rather than by direct transmission. However, teams did vary with respect to the efficiency of their adaptations. For example, some teams' role structures involved the following sequence: Charlie queries Alpha for the RCA value, Alpha queries Bravo for the RCA value, Bravo transmits the RCA value to Alpha, Alpha sends the RCA value to Charlie using a text message. This sequence was less efficient because there are unnecessary communications. Thus, because there are a variety of possible adapted role structures, each differing with respect to their efficiency, it might be important to model adaptation efficiency because it could influence team performance. However, a pilot study suggested that the efficiency of the adapted role structure was not important in terms of influencing team decision accuracy. Additionally, in no case did a team settle into a new routine that did not result in Charlie receiving the value for RCA. Overall, therefore, teams adapted their communications structure a number of different ways, and the particular sequence they used did not influence the quality of decisions. This was reconfirmed in the present study.

A second measure of adaptation: A rated measure. In addition to the count measure of role structure adaptation described above, this study also included a rated measure. Two raters, who were unaware of the study conditions, read transcripts of each teams' communications following the unforeseen communications breakdown. These raters then independently rated each team on eight items designed to capture the elements of role-structure adaptation. Items from the measure were (a) members of this team developed a routine that accomplished the team's work, (b) members of this team were NOT hesitant about changing the way they did the task, (c) members of this team adjusted what they did to accommodate other members' needs, (d) members of this team coordinated the exchange of required information, (e) members of this team settled into a smooth pattern of communicating necessary information, (f) members of this team found a way to get information to the right member, (g) members of this team relearned how to perform their part of the team's task, and (h) members of this team found a way to accomplish their responsibilities. Several of the items were adapted from those listed on Oser, McCallum, Salas, and Morgan's (1989) technical report on critical teamwork behaviors. Internal consistency reliability of this scale averaged .90 for the two raters. There was acceptable interrater agreement (two-way fixed effects intraclass correlation [ICC] = .75) so the raters' scores were averaged to form a composite.

Team cognitive ability and personality. Cognitive ability was measured by scores on the Wonderlic Personnel Test (Form IV) obtained when participants signed up for the experiment. This 50-item test has support in the literature as a reliable and valid measure of cognitive ability. Reliabilities have ranged from .88 to .94 (Wonderlic & Associates, 1983). Individuals' conscientiousness (dependability and achievement) and openness scores came from the Revised NEO Personality Inventory (NEO-PI-R; Costa & McCrae, 1992), administered when participants signed up for the study. Reliabilities for these measures ranged from the low .80s to the low .90s. For the current study, internal consistency reliabilities for achievement (24 items), dependability (24 items), and openness (48 items) were .86, .79, and .87, respectively.

Team-level variables were formed for each predictor by taking the average of the members' scores. This has been called the additive form of aggregation and is appropriate when team members can compensate for one another with respect to task-focused contributions (LePine et al., 1997; Steiner, 1972). Other forms of aggregation include the conjunctive (the score for the lowest scoring member) and the disjunctive (the score for the

highest scoring member) models. The conjunctive model is thought to be appropriate when members cannot compensate for one another or when there is low substitutability with respect to task-relevant knowledge, skills, and abilities. These teams are as strong as their weakest links. The disjunctive model is thought to be most appropriate when between team variability in a task is likely to be driven by the member who scores the highest on the requisite knowledge, skills, and abilities.

Although elements of the task may have conjunctive elements (members possess unique role responsibilities) as well as disjunctive elements (a highly competent member may be able to suggest an adapted role structure), the additive model was used for a number of related reasons. First, the mean scores (additive model) were highly correlated with the lowest (conjunctive) and highest (disjunctive) scores, and therefore the alternative measures were largely redundant with one another. On average across traits, the correlation between the mean score and the lowest score was .77, and the average correlation between the mean score and the highest score was .79. Second, past research has demonstrated that the additive model predicts outcomes across different types of task contexts. For example, although Tziner and Eden (1985) found nonadditive effects for ability on tank crew performance, the strongest effects in their study were the additive effects for ability and motivation (p. 90). They further stated that their results were consistent with previous research and that "for tasks where coordination is high, group productivity is likely to relate positively to the summed abilities of all group members." As another example, in their meta-analysis of team cognitive ability, Devine and Philips (2000) demonstrated that the additive model has higher criterion-related validity relative to the conjunctive and disjunctive models. Third, the present study is the first to link these specific individual differences to adaptive team performance, and therefore it was difficult to confidently assert that the task would be more conjunctive or disjunctive than additive. With these reasons in mind, the additive model was used to test the hypotheses.

Results

Table 1 shows the descriptive statistics and correlations for the variables included in the study. Overall, relationships between the team composition variables were consistent with what one would expect. Specifically, there were nonsignificant relationships among the composition variables reflecting different traits (except for team achievement and dependability). There was also a moderately strong relationship between the two measures of role structure adaptation ($r = .45$, $p < .05$). This provides initial evidence of convergence across the two measures.

Performance and Role Structure Adaptation

In support of Hypothesis 1, Table 1 shows significant positive correlations between both measures of role structure adaptation and postchange decision-making performance ($r = .54$, $p < .05$; $r = .35$, $p < .05$ respectively). Teams that adapted their role structure in response to the communications breakdown performed better than teams that failed to adapt their role structure.

Predicting Role Structure Adaptation and Postchange Decision-Making Performance

Table 2 summarizes the regression results that test Hypotheses 2–5. The team composition variables were entered hierarchically. Team cognitive ability was entered first because cognitive ability is generally believed to be the best individual difference predictor of performance. The personality variables were entered as a block in the next step. The first column of statistics in Table 2 is relevant to Hypotheses 2a, 3a, 4a, and 5a, and also provides the first test of the linkages of the mediation hypotheses (Baron & Kenny, 1986). Specifically, the ΔR^2's and β's listed in this column are the result of the regression of the count measure of role structure adaptation (the mediator) on the team composition variables (the independent variables). Column 2 shows the statistics for the rated measure of role structure adaptation and therefore provides another assessment of Hypotheses 2a, 3a, 4a, and 5a, as well as another assessment of the first test of the mediation hypotheses. Column 3 shows the regression results relevant to Hypotheses 2b, 3b, 4b, and 5b. These results also provide the second test of linkages of the mediation hypotheses (Baron & Kenny, 1986). Specifically, these results are for the regression of postchange decision-making performance (the dependent variable) on the team composition variables (the independent variables). In columns 4 and 5, the statistics for the third and final test of mediation are presented (Baron & Kenny, 1986). Here, the results are for the regression of postchange performance on the team composition variables, controlling for role structure adaptation (the count measure in column 4 and the rated measure in column 5). According to Baron and Kenny (1986, p. 1177), mediation (Hypotheses 2c, 3c, 4c, and 5c) is supported if the relationship with the independent variable is less than in the previous model (column 3) and if the mediator remains

Table 1
Team Level Descriptive Statistics and Correlations

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Member cognitive ability	24.31	3.19	—						
2. Member achievement	3.61	0.25	.07	—					
3. Member dependability	3.35	0.22	−.17	.62*	—				
4. Member openness	3.48	0.21	−.06	.00	.00	—			
5. Role structure adaptation, (objective)	9.10	8.12	.47*	.16	−.15	.26*	—		
6. Role structure adaptation (rated)	3.31	0.77	.25*	.18	−.12	.25*	.45*	—	
7. Postchange decision-making accuracy	5.39	1.13	.38*	.12	−.19	.19	.54*	.35*	—

Note. $N = 73$ teams.
* $p < .05$.

Table 2
Hierarchical Regression Results

	Role structure adaptation (count)		Role structure adaptation (rated)		Postchange decision-making performance		Postchange performance controlling for adaptation (count)		Postchange performance controlling for adaptation (rated)		Prechange decision-making performance	
Independent variable	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Role structure adaptation	—	—	—	—	—	—	.29*	.53*	.13*	.36*	—	—
Member cognitive ability	.23*	.48*	.06*	.25*	.14*	.39*	.02	.17	.09*	.32*	.05	.21
Member personality	.14*		.16*		.12*		.04		.06		.03	
Member achievement		.30*		.38*		.31*		.19		.24		−.19
Member dependability		−.26*		−.33*		−.33*		−.23		−.27		.02
Member openness		.29*		.26*		.21*		.10		.16		−.07
Total R^2 (F)	.37*	(9.90)[a]	.22*	(4.93)[a]	.26*	(6.07)[a]	.35*	(7.17)[b]	.28*	(5.31)[b]	.08	(1.56)[a]

Note. Dashes indicate that the variable was not included in the regression.
[a] $df = 4, 72$. [b] $df = 5, 72$.
* $p < .05$.

statistically significant when the independent variables are also considered. Baron and Kenny suggested also assessing the significance of the indirect relationships by using a formula for the standard error of an indirect relationship provided by Sobel (1982).

In support of Hypothesis 2a, the relationship of cognitive ability with both measures of role structure adaptation was significant in the expected direction ($\Delta R^2 = .23$, $p < .05$; $\Delta R^2 = .06$, $p < .05$). Overall, teams with members with higher cognitive ability tended to be effective at adapting their role structure after an unforeseen change in their task context. Hypothesis 2b was also supported. Team cognitive ability predicted postchange decision-making performance ($\Delta R^2 = .14$, $p < .05$). Teams with members who scored high on cognitive ability tended to make more accurate decisions after an unforeseen change in their task context than did teams with members who scored low on cognitive ability.

The mediation hypothesis (2c) also received support; however, the degree of support depended on the nature of the adaptation measure. On the one hand, the count measure of role structure adaptation appeared to be a "perfect" mediator (Baron & Kenny, 1986) of the relationship between team cognitive ability and team performance. First, the relationships with member cognitive ability was reduced substantially and was no longer statistically significant when controlling for role structure adaptation measured as a count ($\Delta R^2 = .02$, $p > .10$). Second, the mediator (i.e., the count measure of adaptation) remained statistically significant even when cognitive ability was entered in the regression ($\beta = .46$, $p < .05$). Finally, the indirect relationship of member cognitive ability and team performance through the count measure of adaptation was statistically significant ($B_{g * \text{count adapt}} = .08$, $p < .05$). On the other hand, the results suggest partial mediation for the rated measure of role structure adaptation. First, the amount of variance explained in team performance was reduced by only one third and remained statistically significant when controlling for the rated measure of adaptation ($\Delta R^2 = .09$, $p < .05$). Second, the mediator (i.e., the rated measure of adaptation) remained statistically significant even when cognitive ability was entered into the regression ($\beta = .28$, $p < .05$). Finally, the total indirect relationship for member cognitive ability through the rated measures of adaptation was statistically significant ($B_{g * \text{rated adapt}} = .03$, $p < .05$).

Table 2 shows that as a block and after the relationship with team cognitive ability was accounted for the personality variables explained 14% of the variance in the count measure of role structure adaptation, and 16% of the variance in the rated measure. Hypotheses 3a, 4a, and 5a were supported in that the regression coefficients for each of the personality-based composition variables were statistically significant in the expected directions. Regardless of how it was measured, role structure adaptation was higher for teams with members scoring higher on achievement, lower on dependability, and higher on openness to experience.

Hypotheses 3b, 4b, and 5b were also supported because team achievement, team dependability, and team openness all predicted postchange decision-making performance after the relationship with team cognitive ability was taken into account. Again, the directions of these relationships were consistent with expectations. After the unforeseen communications breakdown, teams made better decisions when they were composed with members who scored higher on achievement, lower on dependability, and higher on openness.

Relationships with the personality composition variables discussed in the two previous paragraphs provided support for the first two conditions needed for support of mediation. Specifically, there were significant relationships between each of the independent variables and the mediator and dependent variables. As shown in columns 4 and 5 of Table 2, mediation was further supported in that the personality composition variables did not explain a statistically significant amount of variance in postchange decision-making accuracy after either measure of role structure adaptation was entered into the equation. The count measure of adaptation remained statistically significant when the team composition variables were included in the model ($\beta = .37$, $p < .05$). The rated measure of adaptation, however, did not remain statistically significant in the model including the team composition variables ($\beta = .17$, $p = .15$). Strictly speaking, therefore, mediation was not supported for the rated measure of role structure adaptation when examining the full model by using Baron and Kenny's (1986) criteria. However, the rated measure of role structure adaptation remained statistically significant in reduced models that considered fewer team composition variables. Furthermore, the indirect

relationships for each of the personality composition variables on team decision-making performance was statistically significant regardless of whether adaptation was measured by using the count or the rating ($B_{\text{achievement * count adapt}} = .72$, $p < .05$; $B_{\text{achievement * rate adapt}} = .62$, $p < .05$; $B_{\text{dependability * count adapt}} = .72$, $p < .05$; $B_{\text{dependability * rate adapt}} = .61$, $p < .05$; $B_{\text{openness * count adapt}} = .82$, $p < .05$; $B_{\text{openness * rate adapt}} = .49$, $p < .05$). Overall, the mediation hypotheses (Hypotheses 2c, 3c, 4c, and 5c) received strong support for the count measure of role structure adaptation and equivocal support for the rated measure of role structure adaptation.

Although there were no hypotheses for relationships with prechange performance, this analysis was included for comparison purposes and is shown in column 6 of Table 2. Team cognitive ability explained 5% of the variance in prechange decision-making performance. However, this relationship was not statistically significant. The team personality variables also failed to explain variance in prechange decision-making performance.

Discussion

The present study extended past research on adaptation by focusing on the team level of analysis and by examining an adaptation that was more behavioral and less cognitive. Previous research by LePine, Colquitt, et al. (2000) examined the extent to which individuals could unlearn and relearn a set of cue values after the ecological validities of these cue values changed unexpectedly. Although the adaptation manifested itself in terms of decision accuracy, this was a purely cognitive adaptation that took place within the mind of the individual. In the present study, teams were confronted with an unforeseen change in available communications, and the teams then had to unlearn and relearn how members needed to communicate with each other to cope with the change. Although there were cognitive aspects of this adaptation, it was much more behavioral in the sense that members had to work together and share knowledge to develop an appropriate system of communication given the unforeseen change.

One implication of studying a behavioral form of adaptation is that it was possible to actually observe the adaptation, and this allows for greater insight into the mechanism or "black box" through which team composition influenced team performance. This is a contribution in that there are very few studies in the literature in which team inputs, processes, and outputs are considered together. Perhaps just as important, this study is among the first to measure adaptation as behavior after unforeseen change (a process variable) rather than performance in a novel or complex situation (an outcome variable).

Although the present study and the LePine, Colquitt, et al. (2000) study differ with respect to the nature of the unforeseen change, mode of adaptation, and level of theory and analysis, relationships with the individual differences are quite similar. Certainly research needs to be conducted in other settings before practical recommendations can be made. However, the results of the two studies together support the notion that cognitive ability, dependability, achievement, and openness may be crucial elements of adaptation. Moreover, in both studies, relationships with these individual differences and prechange performance were quite distinct from relationships with postchange performance. Thus, the results of these studies support the notion that unforeseen change places demands on people that are quite distinct from the demands placed on individuals performing in a routine task context. These results also support the notion that performance is a multidimensional construct and that personality may be important in predicting some dimensions but not others (e.g., LePine & Van Dyne, 2001b; Motowidlo et al., 1997).

Comparing the Measures of Role Structure Adaptation

Although evidence of mediation was stronger for the count measure of role structure adaptation, the overall pattern of results in this study remained fairly consistent regardless of how role structure adaptation was measured. The convergence of results across the two measures not only provides support for the validity of the measures, but also for the validity of the findings. Moreover, because it is often impractical to assess role structure adaptation objectively (e.g., by using a count) in the field (all interpersonal communications must be recorded and coded), the externally rated measure may be useful to those who wish to study team adaptation in the future.

Considering the Narrower Aspects of Conscientiousness

The results in this study regarding the differential relations for components of conscientiousness are consistent with a growing body of literature (e.g., Brinkmeyer & McDaniel, 1998; Colquitt, LePine, & Noe, 2000; Feist, 1998; LePine & Van Dyne, 2001b; Martocchio & Judge, 1997; Moon, 2001; Tett, 1998; Tett, Jackson, Rothstein, & Reddon, 1999). Given the accumulation of findings, it seems reasonable to urge scholars to be heedful when making predictions relating the overall conscientiousness to performance criteria. Scholars should ensure that the breadth of the predictor and criterion construct are congruent (Hogan & Roberts, 1996).

Limitations

The first limitation of the present research relates to the focus on a fairly specific type of adaptation. Specifically, the focus here was on adaptation that requires unlearning and relearning in the course of performing a task. Although there are many instances in which this happens, the extent to which the results would generalize to settings where teams have the chance to stop what they are doing and plan a response to the change is open to question. Future research should explore whether the results reported here generalize to these settings.

A second limitation of this study relates to the focus on team composition as the sole predictor of team adaptation. Certainly, there are a host of other potential predictors that deserve research attention. For example, Behling et al. (1967) examined the effect of the strength of the prior routines (number of successful applications of a decision rule) on the ability of teams ($N = 54$ teams) to adjust to an unexpected change in their task. As another example, Arrow (1997) studied the influence of communications media on influence patterns over 13 weeks in student groups ($N = 20$ teams) after changes in operating conditions and group membership. In a study of airline crew flight simulations ($N = 10$ teams), Waller (1999) examined the influence of the frequency and timing of adaptive behaviors (information collection and transfer, task prioritization, and task distribution) on the extent to which groups adapted to nonroutine events. Finally, in a laboratory study using

a personal-computer–based tank war game simulation ($N = 79$ teams), Marks, Zaccaro, and Mathieu (2000) assessed how leader briefings and team interaction training influenced team mental models, communications processes, and team performance in routine and novel task environments. Although all of this research on team adaptation is important and interesting, none of it has examined the role of team composition as an antecedent, and such research is needed if we are to understand how to staff teams in environments characterized by change and uncertainly. Nevertheless, future research needs to integrate the small but growing literature on team adaptation to develop a more comprehensive model of this phenomenon.

Related to the previous point, a third limitation of this research is that by only considering the additive model, the treatment of team composition was relatively simplistic. Indeed, by relying on the mean of members' scores on characteristics to represent the team, it was impossible to detect any synergies created by the complex interactions of individuals, each of whom possesses a unique configuration of characteristics. Given that such relationships may be theoretically and practically important, scholars should begin to focus their attention on developing theory about more complex composition models. As one example, LePine and Van Dyne (2001a) used attributional theory to develop a model that described how the characteristics of a low-performing group member (i.e., *g* and conscientiousness) are likely to influence the behavior of his or her peers. Research could extend this model by considering the joint effects of the low-performer characteristics together with the characteristics of his or her peers.

A fourth limitation is that the present research did not assess variables that could potentially mediate the relationship between the team composition variables and role structure adaptation. Certainly it would have been worthwhile to measure a host of team processes to gain insight into the mechanisms underlying the predictor–criterion relationship. However, for several practical reasons, this was not done in the present study. First, because prechange processes and routine strength could influence subsequent adaptation, the study was intentionally designed to control these factors (e.g., all teams used the same communications structure prior to the communications breakdown). Thus, there would be little variation between teams for process measures to capture, even if they were measured. Second, there was concern that measuring team processes (e.g., coordination, flexibility, experimentation) at some point prior to the communications breakdown by using self-reports might unintentionally prime participants about the manipulation or the purpose of the study.

The fifth limitation of this study relates to the objective measure of role structure adaptation. Specifically, because the measure was the aggregate of adapted trials, it ignored the efficiency of the adaptation. However, any concern about this should be tempered because, as mentioned previously, the efficiency of an adaptation was unrelated to the accuracy of decisions. Thus, in this particular study, communications efficiency was not a relevant issue. Moreover, although it would be worthwhile to focus more on adaptation efficiency in the future (perhaps by constraining the time teams had to make decisions), the count measure in the present study was consistent with the definition of role structure adaptation. This is because the measure captured the aggregated value of team behaviors that contributed to the team over a defined time period. Finally, any limitations of the count measure should be less of a concern because there was convergence of results using a more general, externally rated measure of adaptation.

The task used in this study was structured such that team members' communications were computer-mediated, and therefore, it is unclear whether the findings will generalize to face-to-face situations or to situations in which communications are merely computer-assisted (e.g., Colquitt, Hollenbeck, Ilgen, LePine, & Sheppard, 2002). Although this aspect of the study is a limitation with respect to external validity, the study may be very relevant to virtual teams. These teams are increasingly being used by organizations and are structured such that physically or organizationally separated individuals work interdependently on a task using e-mail, chat systems, videoconferencing, shared white boards, and other technologies (Cascio, 2000).

Finally, the study has limitations in terms of internal validity. Although the hypotheses imply causality, the independent variables were not manipulated, and therefore one cannot say with certainly that the independent variables "caused" changes in the dependent variables. Temporal precedence (e.g., teams were composed prior to performing the simulation) and the control afforded by the laboratory (e.g., teams experienced the same stimuli) helped to rule out many threats to internal validity; however, the lack of manipulated independent variables precludes any firm conclusions regarding causality. In future theory testing research, it might be worthwhile to conduct experiments in which the researcher assigns participants to groups in such a manner so as to create different compositions (e.g., Tziner & Eden, 1985). By composing teams this way, internal validity would be increased because researchers could be more certain that it was the compositions that "caused" the outcomes.

Conclusion

This study suggests that the set of individual differences that predict performance in a changing situation may be quite distinct from the set that predicts performance in a more routine situation. One implication of this is that staffing teams may require much more than just taking into consideration the obvious technical and interpersonal demands of the teams' work. Specifically, effective team staffing may require knowledge of the degree to which members are likely to experience unexpected change. Given today's increasingly dynamic organizational environments, future research on this topic may be worthwhile.

References

Argote, L., & McGrath, J. E. (1993). Group processes in organizations: Continuity and change. In C. L. Cooper & I. T. Robertson (Eds.), *International review of industrial and organizational psychology* (pp. 333–389). Chichester, United Kingdom: Wiley.

Arrow, H. (1997). Stability, bistability, and instability in small group influence patterns. *Journal of Personality and Social Psychology, 72,* 75–85.

Ashton, M. C. (1998). Personality and job performance. The importance of narrow traits. *Journal of Organizational Behavior, 19,* 289–303.

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

Barrick, M. R., & Mount, M. K. (1991). The Big Five personality dimen-

sions and job performance: A meta-analysis. *Personnel Psychology, 44,* 1–26.

Barrick, M. R., Mount, M. K., & Strauss, J. P. (1993). Conscientiousness and performance of sales representatives: Test of the mediating effects of goal setting. *Journal of Applied Psychology, 78,* 715–722.

Barrick, M. R., Stewart, G. L., Neubert, M. J., & Mount, M. K. (1998). Relating member ability and personality to work–team processes and team effectiveness. *Journal of Applied Psychology, 83,* 377–391.

Behling, O., Coady, N., & Hopple, T. G. (1967). Small group adaptation to unprogrammed change. *Organizational Behavior and Human Performance, 2,* 73–83.

Bettenhausen, K. L. (1991). Five years of group research: What we have learned and what needs to be addressed. *Journal of Management, 17,* 345–381.

Beyerlein, M. M., Johnson, D. A., & Beyerlein, S. T. (1995). *Advances in interdisciplinary studies of work teams.* Greenwich, CT: JAI Press.

Blickle, G. (1996). Personality traits, learning strategies, and performance. *European Journal of Personality, 10,* 337–352.

Brinkmeyer, K. R., & McDaniel, S. L. (1998, August). *The dark-side of normal personality: New perspectives for workplace decisions.* Paper presented at the 106th Annual Convention of the American Psychological Association, San Francisco.

Busato, V. V., Prins, F. J., Elshout, J. J., & Hamaker, C. (1999). The relation between learning styles, the Big Five personality traits, and achievement motivation in higher education. *Personality and Individual Differences, 26,* 129–140.

Cascio, W. F. (1995). Whither industrial and organizational psychology in a changing world of work. *American Psychologist, 50,* 928–939.

Cascio, W. F. (2000). Managing a virtual workplace. *Academy of Management Executive, 14,* 81–90.

Chan, D. (1998). Functional relations among constructs in the same content domain at different levels of analysis: A typology of composition models. *Journal of Applied Psychology, 83,* 234–246.

Cohen, M. D., & Bacdayan, P. (1996). Organizational routines are stored as procedural memory: Evidence from a laboratory study. In M. D. Cohen & L. S. Sproull (Eds.), *Organizational learning* (pp. 403–429). Thousand Oaks, CA: Sage.

Colquitt, J. A., Hollenbeck, J. R., Ilgen, D. R., LePine, J. A., & Sheppard, L. (2002). Computer-assisted communication and team decision-making performance: The moderating effect of openness to experience. *Journal of Applied Psychology, 87,* 402–410.

Colquitt, J. A., LePine, J. A., & Noe, R. A. (2000). Toward an integrative theory of training motivation: A meta-analytic path analysis of 20 years of research. *Journal of Applied Psychology, 85,* 678–707.

Costa, P. T., Jr., & McCrae, R. R. (1992). *Revised NEO Personality Inventory.* Odessa, FL: Psychological Assessment Resources.

Costa, P. T., Jr., McCrae, R. R., & Dye, D. A. (1991). Facet scales for Agreeableness and Conscientiousness: A revision of the NEO Personality Inventory. *Personality and Individual Differences, 12,* 887–898.

Devine, D. J., Clayton, L. D., Philips, J. L., Dunford, B. B., & Melner, S. B. (1999). Teams in organizations: Prevalence, characteristics, and effectiveness. *Small Group Research, 30,* 678–711.

Devine, D. J., & Philips, J. L. (2000). *Do smarter teams do better? A meta-analysis of team level cognitive ability and team performance.* Poster session presented at the 15th annual conference of the Society for Industrial and Organizational Psychology, New Orleans, LA.

Feist, G. J. (1998). A meta-analysis of personality in scientific and artistic creativity. *Personality and Social Psychology Review, 2,* 290–309.

Gersick, C. J. G., & Hackman, J. R. (1990). Habitual routines in task-performing groups: *Organizational Behavior and Human Decision Processes, 47,* 65–97.

Gigone, D., & Hastie, R. (1997). Proper analysis of the accuracy of group judgments. *Psychological Bulletin, 121,* 149–167.

Gordon, J. (1992, October). Work teams: How far have they come? *Training, 29,* 59–65.

Guzzo, R. A., & Shea, G. P. (1992). Group performance and intergroup relations in organizations. In M. D. Dunnette & L. M. Hough (Eds.), *Handbook of industrial and organizational psychology* (Vol. 3, pp. 269–313). Palo Alto, CA: Consulting Psychologists Press.

Hackman, J. R. (1987). The design of work teams. In J. W. Lorsch (Ed.), *Handbook of organizational behavior* (pp. 315–342). Englewood Cliffs, NJ: Prentice Hall.

Hackman, J. R. (1992). Group influences on individuals in organizations. In M. D. Dunnette & L. M. Hough (Eds.), *Handbook of industrial and organizational psychology* (2nd ed., Vol. 3, pp. 199–267). Palo Alto, CA: Consulting Psychologists Press.

Hackman, J. R., & Morris, C. G. (1975). Group tasks, group interaction process, and group performance effectiveness: A review and proposed integration. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 9, pp. 45–99). New York: Academic Press.

Hartigan, J. A., & Wigdor, A. K. (1989). *Fairness in employment testing: Validity generalization, minority issues, and the general aptitude test battery.* Washington, DC: National Academy Press.

Heslin, R. (1964). Predicting group task effectiveness from member characteristics. *Psychological Bulletin, 62,* 248–256.

Hogan, J., & Roberts, B. W. (1996). Issues and non-issues in the fidelity-bandwidth trade-off. *Journal of Organizational Behavior, 17,* 627–637.

Hollenbeck, J. R., Colquitt, J. A., Ilgen, D. R., LePine, J. A., & Hedlund, J. (1998). Accuracy decomposition and team decision making: Testing theoretical boundary conditions. *Journal of Applied Psychology, 83,* 494–500.

Hollenbeck, J. R., Ilgen, D. R., Sego, D., Hedlund, J., Major, D. A., & Phillips, J. (1995). The multilevel theory of team decision-making: Decision performance in teams incorporating distributed expertise. *Journal of Applied Psychology, 80,* 292–316.

Hollenbeck, J. R., Klein, H. J., O'Leary, A. M., & Wright, P. M. (1989). Investigation of the construct validity of a self-report measure of goal commitment. *Journal of Applied Psychology, 74,* 951–956.

Hollenbeck, J. R., & Williams, C. R. (1987). Goal importance, self-focus, and the goal setting process. *Journal of Applied Psychology, 72,* 204–211.

Hough, L. M. (1992). The Big Five personality variables—construct confusion: Description versus prediction. *Human Performance, 5,* 139–155.

Howard, A. (1995). A framework for work change. In A. Howard (Ed.), *The changing nature of work* (pp. 3–44). San Francisco: Jossey-Bass.

Hunter, J. E. (1986). Cognitive ability, cognitive aptitudes, job knowledge, and job performance. *Journal of Vocational Behavior, 29,* 340–362.

Hunter, J. E., & Hunter, R. F. (1984). Validity and utility of alternate predictors of performance. *Psychological Bulletin, 96,* 72–98.

Hutchins, E. (1996). Organizing work by adaptation. In M. D. Cohen & L. S. Sproull (Eds.), *Organizational learning* (pp. 20–57). Thousand Oaks, CA: Sage.

Ilgen, D. R. (1999). Teams embedded in organizations: Some implications. *American Psychologist, 54,* 129–139.

Ilgen, D. R., & Pulakos, E. D. (1999). *The changing nature of performance: Implications for staffing, motivation, and development.* San Francisco: Jossey-Bass.

Judge, T. A., & Ilies, R. (2002). Relationship of personality to performance motivation: A meta-analytic review. *Journal of Applied Psychology, 87,* 797–807.

Kanfer, R., & Ackerman, P. L. (1989). Motivation and cognitive abilities: An integrative/aptitude-treatment interaction approach to skill acquisition. *Journal of Applied Psychology, 74,* 657–690.

Katz, D., & Kahn, R. L. (1978). *The social psychology of organizations.* New York: Wiley.

King, L. A., Walker, L. M., & Broyles, S. J. (1996). Creativity and the five-factor model. *Journal of Research in Personality, 30,* 189–203.

Klimoski, R., & Jones, R. G. (1995). Staffing for effective group decision making: Key issues in matching people in teams. In R. Guzzo & E. Salas (Eds.), *Team effectiveness and decision making in organizations* (pp. 291–332). San Francisco: Jossey-Bass.

Lawler, E. E., III, Mohrman, S. A., & Ledford, G. E., Jr. (1995). *Creating high performance organizations: Practices and results of employee involvement and total quality management in Fortune 1000 companies.* San Francisco: Jossey-Bass.

Lawrence, B. S. (1997). The black box of organizational demography. *Organizational Science, 8,* 1–21.

LePine, J. A., Colquitt, J. A., & Erez, A. (2000). Adaptability to changing task contexts: Effects of general cognitive ability, conscientiousness, and openness to experience. *Personnel Psychology, 53,* 563–593.

LePine, J. A., Hanson, M. A., Borman, W. C., & Motowidlo, S. J. (2000). Contextual performance and teamwork: Implications for staffing. In G. R. Ferris & K. M. Rowland (Eds.), *Research in Personnel and Human Resources Management* (Vol. 19, pp. 53–90). Stanford, CT: JAI Press.

LePine, J. A., Hollenbeck, J. R., Ilgen, D. R., Colquitt, J. A., & Ellis, A. (2002). Gender composition, situational strength, and team decision-making accuracy: A criterion decomposition approach. *Organizational Behavior and Human Decision Processes, 88,* 445–475.

LePine, J. A., Hollenbeck, J. R., Ilgen, D. R., & Hedlund, J. (1997). Effects of individual differences on the performance of hierarchical decision-making teams: Much more than *g. Journal of Applied Psychology, 82,* 803–811.

LePine, J. A., & Van Dyne, L. (2001a). An attributional model of helping in the context of work groups. *Academy of Management Review, 26,* 67–84.

LePine, J. A., & Van Dyne, L. (2001b). Voice and cooperative behavior as contrasting forms of contextual performance. Evidence of differential relationships with personality characteristics and cognitive ability. *Journal of Applied Psychology, 86,* 326–336.

Levine, J. M., & Moreland, R. L. (1990). Progress in small group research. *Annual Review of Psychology, 41,* 585–634.

Marks, M. A., Zaccaro, S. J., & Mathieu, J. E. (2000). Performance implications of leader briefings and team-interaction training for team adaptation to novel environments. *Journal of Applied Psychology, 85,* 971–986.

Martocchio, J. J., & Judge, T. A. (1997). Relationship between conscientiousness and learning in employee training: Mediating influences of self-deception and self-efficacy. *Journal of Applied Psychology, 82,* 746–773.

McCrae, R. R. (1987). Creativity, divergent thinking, and openness to experience. *Journal of Personality and Social Psychology, 52,* 1258–1265.

Miller, J. G. (1978). *Living systems.* New York: McGraw-Hill.

Moon, H. (2001). The two faces of conscientiousness: Duty and achievement striving in escalation of commitment dilemmas. *Journal of Applied Psychology, 86,* 535–540.

Motowidlo, S. J., Borman, W. C., & Schmit, M. J. (1997). A theory of individual differences in task and contextual performance. *Human Performance, 10,* 71–83.

Mount, M. K., & Barrick, M. R. (1995). The Big Five personality dimensions: Implications for research and practice in human resources management. In G. R. Ferris & K. M. Rowland (Eds.), *Research in personnel and human resources management* (Vol. 13, pp. 153–200). Stamford, CT: JAI Press.

Oser, R., McCallum, G. A., Salas, E., & Morgan, B. B. (1989). *Toward a definition of teamwork: An analysis of critical team behaviors* (Tech. Rep. No. 89–004). Orlando, FL: Human Factors Division, Naval Training Systems Center.

Paunonen, S. V., Rothstein, M. G., & Jackson, D. N. (1999). Narrow reasoning about the use of broad personality measures for personnel selection. *Journal of Organizational Behavior, 20,* 389–405.

Ree, M. J., Earles, J. A., & Teachout, M. S. (1994). Predicting job performance: Not much more than g. *Journal of Applied Psychology, 79,* 518–524.

Roberts, K. H., Hulin, C. L., & Rousseau, D. M. (1978). *Developing an interdisciplinary science of organizations.* San Francisco: Jossey Bass.

Rousseau, D. M. (1985). Issues of level in organizational research: Multi-level and cross-level perspectives. In L. L. Cummings & B. M. Staw (Eds.), *Research in organizational behavior* (Vol. 7, pp. 1–37). Greenwich, CT: JAI Press.

Schneider, R. J., Hough, L. M., & Dunnette, M. D. (1996). Broadsided by broad traits: How to sink science in five dimensions or less. *Journal of Organizational Behavior, 17,* 639–655.

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

Steiner, I. D. (1972). *Group process and productivity.* New York: Academic Press.

Stewart, G. L., Manz, C. C., & Sims, H. P., Jr. (1999). *Teamwork and group dynamics.* New York: Wiley.

Sundstrom, E., DeMeuse, K. P., & Futrell, D. (1990). Work teams: Applications and effectiveness. *American Psychologist, 45,* 120–123.

Taggar, S., Hackett, R., & Saha, S. (1999). Leadership emergence in autonomous work teams: Antecedents and outcomes. *Personnel Psychology, 52,* 899–926.

Tett, R. P. (1998). Is conscientiousness ALWAYS positively related to job performance? *The Industrial–Organizational Psychologist, 36,* 24–29.

Tett, R. P., Jackson, D. N., Rothstein, M., & Reddon, J. R. (1999). Meta-analysis of bidirectional relations in personality–job performance research. *Human Performance, 12,* 1–29.

Tziner, A., & Eden, D. (1985). Effects of crew composition on crew performance: Does the whole equal the sum of its parts? *Journal of Applied Psychology, 70,* 85–93.

von Bertalnffy, L. (1968). *General systems theory.* New York: Braziller.

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

Weick, K. E., & Roberts, K. H. (1993). Collective mind in organizations: Heedful interrelating on flight decks. *Administrative Science Quarterly, 38,* 357–381.

Weiss, H. M., & Ilgen, D. R. (1985). Routinized behavior in organizations. *The Journal of Behavioral Economics, 24,* 57–67.

Wonderlic & Associates. (1983). *Wonderlic personnel test manual.* Northfield, IL: Author.

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