The Influence of Team Monitoring on Team Processes and Performance

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We advance the idea that monitoring teammates’ task related behaviors will benefit overall team performance by enhancing team coordination and the provision of feedback. We used 32 3-person teams to conduct a simulated flight combat team exercise and measured monitoring, teamwork processes, and performance. Results offer empirical support for the framework proposed in this study: that team monitoring improves coordination and feedback processes, and that these coordination and feedback processes in turn improve team performance. Conceptual implications regarding team regulation processes and practical implications regarding team monitoring are discussed.

As self-managing teams become increasingly prevalent in today’s workforce, functions traditionally carried out by team leaders are now being delegated to team members. One such function is monitoring. Monitoring has been classified as a leader behavior (Fleishman, Mumford, Zaccaro, & Levin, 1991), yet now it is often left to team members in nonhierarchical team settings. At the team level, monitoring has been defined as “observing the activities and performance of other team members” (Dickinson & McIntyre, 1997, p. 25). This involves a heightened awareness of what others are doing during task execution. Members who monitor effectively should be better able to obtain team situation awareness (Bolman, 1979; Salas, Prince, Baker, & Shrestha, 1995), and to analyze rhythm, timing, and pace of team member activities, which facilitates coordination (Kozlowski, 1998). In addition, monitoring

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should enable individuals to recognize when their team members make mistakes or perform inadequately, which should promote assistance to teammates when needed.

We could not locate any published empirical research on the impact of team monitoring. Therefore, we set out to test the premise that team monitoring benefits overall team effectiveness by enhancing team coordination and the provision of feedback. Teams who monitor should be more adeptly attuned to their teammates’ actions, so they should not only be better suited to synchronize collective activities but also to minimize detrimental behaviors by helping struggling teammates.

Monitoring is likely to be important for most work teams. By definition, teams are composed of multiple individuals working interdependently toward common goals (Ilgen, 1999; Salas, Dickinson, Converse, & Tannenbaum, 1992). The notion that members rely on each other to function effectively implies the need for at least a minimum level of awareness of others, in terms of their actions, timing, and resources. Team monitoring should play a more prominent role in team success for teams with highly interdependent work arrangements (Tesluk, Mathieu, Zaccaro, & Marks, 1997) that depend on superior communication and synchronization to accomplish collective goals.

In this study we concentrated on action teams, a specific type of team that is characterized by highly interdependent work arrangements (Kozlowski, Gully, McHugh, Salas, & Cannon-Bowers, 1996). Essentially, an action team is any “team in which expertise, information, and tasks are distributed across specialized individuals, where team effectiveness depends on rapid, complex, and coordinated task behavior, and the ability to dynamically adapt to the shifting demands of the situation” (Kozlowski et al., 1996, p. 254). To operate successfully in challenging environments, action team members have specialized task-related skill sets as well as honed teamwork abilities to coordinate their activities with teammates (Sundstrom, 1999). Because action teams are highly interdependent, the overall performance is unattainable without task contributions from each member and the successful interaction of the team members (Blickensderfer, Cannon-Bowers, & Salas, 1998; Brannick, Salas, & Prince, 1997; Orasanu, & Salas, 1993). Ongoing monitoring should be particularly important to action teams whose members work together closely to complete stressful, complex, and challenging tasks that cannot be fully planned out ahead of time because of heightened interdependency requirements.

**RESEARCH ON THE CONSTRUCT OF MONITORING**

The construct of monitoring has roots in both leadership and self-regulation literature. In the leadership literature, monitoring has been a central component of leader behavior models and taxonomies (e.g., Mintzberg, 1973; Mumford & Connelly, 1991; Neider & Schriesheim, 1988). These leadership models call attention to the range of monitoring functions leaders undertake, such as environmental
monitoring, systems monitoring, material resources monitoring, and goal monitoring. Mumford and Connelly’s (1991) category of “monitoring personnel resources” leader behaviors is most similar to the type of team monitoring that we examine in this study. This involves leader observation of personnel performance and workloads, assessment of subordinate needs, and provision of feedback.

Self-monitoring describes the manner whereby individuals gather information about their existing performance levels and strategies and then compare results with the desired performance goals\(^1\) (Weldon, Jehn, & Pradhan, 1991). DeShon, Brown, and Greenis (1996) referred to self-monitoring as a proximal motivational process that “occurs when individuals allocate attention to the actions and consequences of their behavior” (p. 596). Individuals who self-monitor are more aware of their own performance strategies and are able to modify their behaviors to better reach performance goals (Delchos & Harrington, 1991). Self-monitoring has been found to increase performance across a number of tasks, including mathematics, reading comprehension, and motor tasks (Ghatala, 1986; Gourgey, 1998; Malone & Mastropieri, 1992; Martin & Anshel, 1995). Kanfer and Ackerman (1989) have shown that self-regulatory processes such as self-monitoring improve goal accomplishment because they channel individuals’ attentional resources toward goal attainment.

Similar to leader and self-monitoring, team monitoring is primarily a cognitive operation in which team members observe actions of their teammates and watch for errors or performance discrepancies. Team monitoring differs from both leader monitoring and self-monitoring in that individuals monitor teammates’ actions as well as those of subordinates or their own. We argue that team monitoring serves an important function for team regulation. Effective team monitoring involves channeling attention to other member behaviors and evaluating whether member behaviors are instrumental to goal accomplishment. In this manner, team members monitor their teammates’ execution of critically interdependent roles to reach team goals and/or sustain acceptable levels of team performance (Dickinson & McIntyre, 1997; Salas & Cannon-Bowers, 1997).

When team members identify the need to provide help, feedback in the form of verbal suggestions (i.e., coaching) or corrective behaviors (i.e., backup) assists team members in getting performance back on track (Dickinson & McIntyre, 1997). Simply acquiring familiarity with teammates’ responsibilities does not constitute monitoring. Successful team monitoring involves regular observation and concern with the performance of teammates (Serfaty, Entin, & Johnston, 1998). To effectively monitor teammates, individuals need to be sufficiently informed of members’ roles as well as their own roles in goal accomplishment. In addition, to the extent that tasks force members to work interdependently to achieve success,

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\(^1\)Self-monitoring also refers to an individual difference characteristic, defined as the extent to which one observes and controls his or her expressive behaviors and self-presentation (Snyder & Gangestad, 1986). However, this is not the focus of this article.
team members need to have some idea about how members should sequence their activities to meet task demands.

Tasks with moderate levels of interdependency benefit from team members who watch out for one another, render assistance when required, and warn each other of possible problems. For example, in an airplane cockpit, copilots must stay abreast of pilots’ actions to detect or compensate for critical lapses in judgment or oversight. Nuclear power plant operator teams work much the same way. Individuals are responsible for their own set of tasks, but also monitoring others’ responses (or lack thereof) to abnormal events. In both cases, a failure to monitor teammates renders the entire team susceptible to a single shortcoming because, in this type of environment, the entire team fails if any one member fails.

Tasks requiring high levels of interdependency cannot be completed without the joint contributions and sequential or simultaneous activities of multiple people (Tesluk et al., 1997). For highly interdependent teams, team monitoring functions not only as a process to detect member errors or misjudgments, but also as a mechanism to help individuals regulate their own actions in concert with those of their teammates. For example, firefighters depend on simultaneous, coordinated efforts of multiple team members to extinguish burning structures. This study examines team performance in such an intensely interdependent context, where effective task execution depended on the ability of three team members to align role-based activities in a conjunctive manner to accomplish the task.

In this study, we expected that teams whose members were better able to monitor each others’ task performance would be more likely to attain team performance goals via the improvement of two teamwork processes: coordination and intra-team feedback. Improved monitoring processes should provide team members with a more accurate assessment of the current state and needs of team members (e.g., a component of situation awareness; Endsley, 1998) as they work to achieve their goals. Researchers in crew resource management have argued team monitoring is critical for situation awareness, which is arguably the single most important factor in aviation performance (Endsley, 1998). Salas et al. (1995) advanced a model that directly links team situation awareness with improvement in coordination and feedback. This supposition is consistent with Dickinson and McIntyre’s (1997) model of teamwork, which suggests team monitoring positively impacts coordination and the provision of feedback that, in turn, leads to team performance.

Coordination

Coordination has been defined as “orchestrating the sequence and timing of interdependent actions” (Marks, Mathieu, & Zaccaro, 2001). This refers to management of synchronous and/or simultaneous activities and involves information exchange and mutual adjustment of action (Brannick, Roach, & Salas, 1993) to align the pace and sequencing of team member contributions with goal accomplishment. The more interdependent the tasks, the more teams rely on coordination as a central process for
effective functioning (Tesluk et al., 1997). Teams experiencing “communication breakdowns” and those that get “out of sync” are likely to be experiencing coordination problems. This is what Steiner (1972) referred to as “process loss” due to coordination, when teams fall below their estimated productivity level.

We expect that teams that monitor well will enhance their coordination by focusing member attention on the flow and timing of member actions, which provides them with information on how and when to act in an interdependent task situation. Effective monitoring should prompt team members to analyze the rhythm and the pace of team members’ activities that are critical to interdependent action, enabling team members to better regulate the timing and execution of their own activities in concert with the rest of the team.

Intra-Team Feedback

Intra-team feedback involves team members providing information regarding other members’ performance and/or requesting input or guidance about their own performance (Dickinson & McIntyre, 1997). Rasker, Post, and Schraagen (2000) distinguished between two types of intra-team feedback: that which occurs during task execution and that which occurs after task execution. They found teams having the opportunity to participate in intra-team feedback perform better, possibly because feedback was linked directly to task behaviors and prevented errors.

Here, we focus on intra-team feedback occurring during task execution. By relying on each other to provide feedback assistance during task execution, team members can prevent mishaps and take advantage of opportunities by adjusting their actions immediately when necessary. It should be noted that our use of the term feedback is different from the way it has typically been defined in other team studies. It has often referred to the provision of feedback by someone external to the team (e.g., a leader, an experimenter), and involves feedback solely at the team level (e.g., Conlon & Barr, 1989). Several studies have manipulated aspects of feedback (e.g., interdependence, content, timing, delivery method) by providing teams with different types of external feedback and examining the effects on team processes and performance.

Ultimately, we are interested in how team monitoring impacts team performance. When individuals monitor their own team performance environments, we expect better intra-team feedback to be provided for teammates. As a team-regulation process, monitoring functions by shifting attentional resources to the examination of others’ actions and to evaluating the gap between what members are doing and what they should be doing to accomplish team goals. The provision of feedback is likely to occur when gaps are detected via team monitoring.

We consider two types of inter-team feedback in this study: verbal and behavioral. Intra-team feedback can occur verbally when one person asks for or gives task-clarifying assistance during task execution (Rasker et al., 2000). In addition, we consider backup behavior a behavioral form of intra-team feedback. When
team members have difficulties performing tasks, feedback may be in the form of backup behavior or assisting team members to perform their tasks (Dickinson & McIntrye, 1997). Thus, in this study, intra-team feedback includes (a) providing a teammate verbal feedback or coaching, (b) assisting a teammate behaviorally in carrying out actions, or (c) assuming and completing a task for a teammate.

In sum, we believe that team monitoring is a necessary and critical team-regulation process for interdependent team-performance contexts. We expect that monitoring team members' actions in an interdependent performance context will promote the provision of intra-team feedback, help teams coordinate their actions, and ultimately boost overall team goal accomplishment. Teams whose members monitor are more likely to provide better feedback when errors in performance are identified. When a team member recognizes that another teammate is in need of help, s/he provides coaching or feedback on how to improve performance. We also expect teams that monitor to coordinate better because they are more aware of their own and others' timing and the sequence of interdependent events. Figure 1 illustrates the framework tested in this study. We hypothesized that

H1. Team monitoring will be positively related to team feedback and backup behavior.

H2. Team monitoring will be positively related to team coordination.

H3. Coordination and feedback processes will mediate the relationship between team monitoring and team performance.

METHOD

Participants and Design

Participants were 37 male and 59 female undergraduate students enrolled in psychology classes at a large southeastern university. Their ages ranged from 17 to 41 years ($M = 19.13$, $SD = 3.18$). They participated in the experiment in exchange for course credit and were assigned to 32 three-person teams. Teams were generally mixed gender (53.1%) with all-male teams making up 12.5% and all-female teams 34.4%. We measured monitoring, coordination, feedback, and team performance. Individuals were randomly assigned to positions within teams.²

²This study originally intended to examine the influence of a training program to teach team members about the importance of the monitoring process. However, reviewers correctly pointed out that there were two alternative explanations regarding why the training program may have been effective: (a) The training program increased teams’ monitoring skills, or (b) the training program increased clarity that monitoring should be a part of team members’ roles. Thus, it was impossible to pinpoint why the manipulation worked. Because we had measured monitoring behavior as well, we refocused this article more specifically on monitoring as a measured variable, examining relationships between the team-monitoring skill level, teamwork coordination and feedback processes, and feedback, rather than on the development of monitoring skills.
Task

The task was a commercially available, PC-based Apache helicopter flight simulator called Longbow2 (Janes Combat Simulations, 1998). Longbow2 was originally designed as a two-player simulation, but the task was modified for this study to create a three-person interdependent team. Three team members worked together as pilot, gunner, and radar specialist to operate an Apache helicopter and were charged with conducting attack missions in challenging battlefields. Team members worked together using networked computers at individual computer stations equipped with keyboards (gunner and radar specialist) and joysticks (pilot). Roles were divided as follows: (a) Pilots were in charge of flying the aircraft; (b) gunners operated the weapons systems, which included selecting and shooting various ammunition; and (c) radar specialists were responsible for interpreting radar systems containing critical enemy information. Roles were configured such that only pilots were able to fly the aircraft, only radar specialists had access to the radar intelligence (via a different screen with more information), and only gunners were able to load and fire weapons. Team members were given 12 min to destroy enemy targets on the battlefield (e.g., surface-to-air missiles (SAMs), antiaircraft artillery (AAA), tanks, helicopters). Teammates communicated with each other during the simulation through an aircraft cockpit system consisting of interconnected microphone equipped headphones. There was no redundancy in role functions (i.e., only the pilot could fly the helicopter; only the gunner could select and shoot ammunition; only the radar specialist had access to enemy radar and waypoint information).

This task was highly interdependent, such that to perform it effectively, team members had to work together closely. Because all members’ roles were imperative for mission success, there was no way to complete the task effectively without the integrated contributions of all three members. A good plan of attack aided team performance, although it was impossible to plan completely for the precise nature and timing of the challenges teams faced on the battlefield. Successful performance on this task depended on team members’ ability to coordinate their activities, primarily via the exchange of mission-critical information, to kill enemy targets and avoid being killed by enemy forces.

All teams completed two parallel missions designed specifically for this study using the simulation’s mission scripting function. The goal of each mission was to fly into enemy territory, destroy enemy targets, and return safely to friendly territory. To accomplish the mission, teams had to navigate a fixed course of waypoints (i.e., flight markers that aid teams in navigation), identify and destroy all enemy targets they encountered, and, at the same time, evade enemy attacks on their helicopter. Missions concluded three different ways: (a) when a team reached the last waypoint, (b) when a team was destroyed by enemy fire, or (c) when the 12-min time limit expired.
Procedure

Experimental sessions lasted for approximately 3 hr. First, participants completed a background information questionnaire and a timed test of spatial ability. Next, participants were taken to separate rooms to receive training on their given roles. These training sessions consisted of a videotaped slide show describing the roles and responsibilities of the participant's position as well as some individual practice time. In this way, pilots learned to fly the helicopter; radar specialists were taught navigation, surveillance, and radar detection; and gunners were trained in the use of several types of ordnance to destroy enemies. Videotaped training modules were followed by a practice exercise serving to reinforce information received during individual role training. An experimenter was available to answer participant questions and physically demonstrate maneuvers if necessary.

Basic training was originally developed according to the results of a task analysis. All critical role functions were included in basic training, and pilot testing ensured participants were able to comprehend training and learn requisite role-based skills. To guarantee a minimum level of individual ability at each position during the experiment, participants completed a 14-item, position-specific proficiency test at the end of the individual training module. These tests were scored immediately. On average, scores on the proficiency test were high ($M = 11.87$ out of a possible $14$, $SD = 1.78$). Experimenter reviewed the content of all incorrect items with participants.

Following individual role-based training, all participants were brought together as a team to receive training on the critical tasks for every position. Via videotape, members watched a narrated videotape of a team successfully working together to complete a mission. Each player's critical activities were highlighted. Participants then completed two 12-min team practice missions on the simulator. An experimenter was available during the practice missions to answer questions.

Measures

Monitoring. Monitoring was defined, operationally, as observing the activities and performance of other team members (Dickinson & McIntyre, 1997). Recognition of others' performance errors would be an example of well-executed monitoring behavior. For instance, pilots who detect enemy targets first (this is the role of the radar specialist) would adjust speed accordingly, an indication of their awareness of the enemy targets (and their ability to monitor radar specialist functions). Another example of effective monitoring is when weapons and radar specialists monitor the helicopter's power level (pilot function). Conversely, an example of poor monitoring behavior is when members failed to notice teammates' performance.
Two subject matter experts (SMEs) completed ratings of monitoring quality based on the extent to which monitoring occurred (if no monitoring occurred, the lowest rating was given because in this case, the lack of monitoring was an example of poor monitoring) and how well monitoring was executed (interrater correlation = .88_{mission 1}, .83_{mission 2}). Because monitoring is primarily a cognitive process, SMEs based ratings on more indirect but observable indicators of monitoring, such as behaviors and verbal comments associated with monitoring team member functions. Using the previous example of good monitoring behavior, a pilot that detects enemy presence before the radar specialist might increase speed and exclaim "enemy at three o'clock."

Ratings were completed for both experimental missions, and averaged together (r_{monitoring mission 1} * mission 2 = .51). Monitoring quantity ratings ranged from 1 (very poor monitoring) to 7 (very good monitoring).

**Coordination.** Operationally, coordination was defined as team members interacting while performing tasks requiring at least two team members to work interdependently. This included both verbally communicating and behaviorally working together. For instance, following waypoints is an interdependent action requiring joint activities of both pilots and radar specialists. Other examples of tasks requiring coordination included targeting enemies (requiring radar and weapon specialist dialogue) and avoiding enemy attacks (requiring communication from radar specialists and related actions from pilots). Coordination processes differed from monitoring processes in that teams were rated higher when team members worked together to sequence and orchestrate their actions. Monitoring involved a single member's actions or statements that indicated awareness of important team member actions (or inactions). Two SMEs completed ratings of coordination quality based on the extent to which coordination occurred (if no coordination occurred among teams, the lowest score was given) and how well coordination was executed (interrater correlation = .83_{mission 1}, .84_{mission 2}). Ratings were completed for both experimental missions, and averaged together (r_{coordination mission 1} * mission 2 = .73). Coordination quantity ratings ranged from 1 (very poor coordination) to 7 (very strong coordination).

**Feedback.** SMEs also rated quality of feedback provided to and by team members. Feedback was operationalized as a team member providing a teammate with verbal coaching or backup behavior to improve performance. An example of good feedback is the gunner instructing the pilot to slow the helicopter and lower altitude because an enemy was targeting their plane. If the gunner instructs the pilot to continue at his or her current speed and/or increase altitude, it is considered poor feedback. SMEs distinguished feedback from coordination and monitoring in that feedback ratings were based upon verbal communication or behavior actions intended to correct inappropriate teammate role-based behavior rather than plan-
ning integrated actions to achieve the mission (coordination) or actions indicating simply awareness of others’ actions. Monitoring SME ratings for the quantity of feedback was recorded for both missions (intrate correlation = .91mission 1, .87mission 2). Feedback quality ratings ranged from 1 (very poor feedback) to 7 (very good feedback). Ratings were completed for both experimental missions and averaged together (rfeedback mission 1*mission 2 = .64).

Performance measures. The primary team objective was to destroy enemy targets without being “killed,” while simultaneously following the waypoints as closely as possible to return to base within the 12-min time limit. Thus, two performance variables were used to capture the team performance domain: amount of time needed to complete the mission and number of targets destroyed.

If a team completed a mission (landed at the last waypoint) in less than 12 min, it was given a time score of 12 min. This time adjustment was performed to avoid penalizing teams that were skilled enough to destroy all enemy targets within the given time limit. The performance variable of time (needed to complete a mission) could range from 0 to 12 (min).

A maximum of 12 enemy targets could be destroyed during each performance mission. Teams were required to follow the waypoints to locate and destroy all 12 targets within the 12-min time limit. Consequently, the number of targets destroyed per mission was measured on a scale ranging from 0 to 12.

Both performance criteria were important to the overall effectiveness of a team; however, it was difficult to interpret these variables individually and get a sense of how well the team performed. For example, Team A was able to destroy six targets but was shot down only 8 min into a mission; Team B killed only three targets but managed to follow all the waypoints and return home safely (15 min). Team A destroyed twice as many targets as Team B; however, Team B was able to survive the mission, whereas Team A was killed approximately half-way through. To accurately describe a team’s overall effectiveness, both time and targets killed were summed to form a single, composite criterion signifying overall team performance that ranged from 0 to 24.

It was possible to sum the performance variables without standardizing the scores because both variables were measured on similar scales ranging from 0 to 12. The correlation between the performance scores for mission 1 and mission 2 was .38 (p < .05). A paired t test was also conducted to determine whether teams’ scores differed across missions. The results indicated that the mean total performance score for mission 1 (M = 11.19, SD = 8.32) was not significantly different from the mean total performance score for mission 2, t(31) = 1.35, p = .19 (M = 13.44, SD = 8.70). Thus, we averaged performance scores across missions to compose the final performance score used in subsequent analyses.
RESULTS

Means, standard deviations, intrarater reliability correlations, and key variable intercorrelations are reported in Table 1. Correlations between background variables and key study variables indicated that average team age, computer experience, flight simulator experience, mean Stanford Achievement Test performance, college grade point average, and mean spatial orientation were not significantly correlated with any key study variables. Team gender composition was significantly correlated with coordination (teams with more male members coordinated better) and average time per week spent playing electronic games (PC or console games) was significantly correlated with task knowledge (teams with greater average member PC game experience had greater task knowledge). Therefore, these two variables were included in Table 1.

Intercorrelations Between Coordination and Feedback Processes

Coordination and feedback processes were highly intercorrelated (.75). Though conceptually we argue for the distinctive nature of each construct, we were unable to empirically discriminate among the three constructs. We believe that, in part, high correlations were caused by common method variance, and more specifically halo effects. Despite extensive rater training, we suspect that raters may have been unable to distinguish operationally between these two constructs. In addition, conceptually, we would expect these two constructs to be highly related (though not as high as .75). Because we were not able to show empirical divergence between feedback and coordination, we analyzed them together in the test for mediation later.

Hypothesis Testing

We used bivariate correlations to assess the relations between monitoring, feedback and coordination (H1 and H2), and hierarchical regression analysis to examine mediation (H3). Supporting H1 and H2, monitoring was significantly and positively correlated with both feedback ($r = .42, p < .05$) and coordination ($r = .43, p < .01$). Because coordination and feedback were highly correlated ($r = .75$), we conducted analyses to test them jointly to control for possible multicollinearity effects as well as to examine their cooperative impact as mediators in H3. To satisfy a precondition for mediation, we tested for a significant relationship between monitoring behavior and performance by regressing performance on monitoring behavior ($\beta_{\text{monitoring\ behavior}} = .55, t = 3.61, p < .01$), and by regressing coordination ($\beta = .42, t = 3.11, p < .01$), and feedback ($\beta = .43, t = 3.15, p < .01$), on monitoring behavior.
<table>
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<th>Variables</th>
<th>M</th>
<th>SD</th>
<th>n</th>
<th>Reliability</th>
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<th>2</th>
<th>3</th>
<th>4</th>
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<td>32</td>
<td>.86**</td>
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<td>—</td>
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<td>1.08</td>
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<td>.83**</td>
<td>.42*</td>
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<td>32</td>
<td>.91**</td>
<td>.43**</td>
<td>.75**</td>
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<td>.67**</td>
<td>.61**</td>
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<td>.76</td>
<td>32</td>
<td>n/a</td>
<td>.25</td>
<td>.33</td>
<td>.09</td>
<td>-.08</td>
</tr>
</tbody>
</table>

aGender composition of the teams: 0 = all male teammates; 1 = two male teammates, one female teammate; 2 = one male teammate, two female teammates, 3 = all female teammates.

bAverage number of hours per week spent playing electronic games (e.g., PC or console), averaged across team members.
Next, we regressed performance onto both coordination and feedback simultaneously. Results indicated that, though the set significantly predicted team performance—$R^2 = .44, F(2, 29) = 13.26, p < .01$—coordination was the stronger predictor ($\beta_{\text{coordination}} = .50, t = 2.46, p < .05$; $\beta_{\text{feedback}} = .23, t = 1.15, p = .26$). Once these initial preconditions for mediation had been satisfied, we tested the joint impact of coordination and feedback as mediators. Monitoring behavior was entered into the regression equation after controlling for both coordination and feedback (James & Brett, 1984). Monitoring behavior did not produce an increment in variance after controlling for both coordination feedback—$R^2_{\text{change}} = .00, F_{\text{change}}(1, 28) = .00, ns$. The beta for coordination remained significant ($\beta = .51), t(1, 28) = 2.24$, whereas both the betas for feedback ($\beta = .24), t(1, 28) = 1.04, p = .31$, and monitoring ($\beta = -.02), t(1, 28) = -.10, p = .93$, were nonsignificant. These results indicated the impact of monitoring behavior on team performance was completely mediated by the coordination and feedback processes, with particular emphasis on coordination.

**DISCUSSION**

This study examined the relationships between monitoring, feedback and coordination processes, and team performance. We found support for the hypothesis that monitoring enhances the quality of coordination, and that the relationship between monitoring behavior and more distal team performance is fully mediated by coordination and feedback processes.

Teams that monitored appeared to be better prepared to evaluate the pace of their teammates’ actions and adjust their own timing to facilitate the completion of their interdependent tasks in a timely manner. For example, during the simulation, coordination was required for targeting and destroying enemies. Coordination improved when radar specialists observed gunners had destroyed current targets. By monitoring this behavior, radar specialists were able to quickly target the next enemy. At the same time, pilots monitored radar specialists and were able to turn their helicopters in the direction of new targets. In situations such as these, team monitoring facilitated teammates’ ability to remain closely “in sync” with one another, improving their level of coordination. This example describes a case in which monitoring facilitated coordination without necessarily triggering the provision of intra-feedback. Yet we often observed members providing verbal feedback and backup behavior to assist struggling teammates. For instance, radar specialists often reminded pilots to fly at lower altitudes. Here, we believe that team monitoring serves to detect problems or errors in team activities and triggered assistance from teammates.

Coordination and feedback were highly correlated in this study. While we view them as conceptually distinct teamwork processes, there are two primary reasons for their intercorrelation. First, teams that coordinated more also provided more
feedback, both as a function of increased member knowledge of the team monitoring process. Second, both coordination and feedback measures tap into the amount of communication between team members, and the same SMEs rated coordination and feedback processes. This raises the likelihood of at least some covariance due to halo or common rater variance. We analyzed both coordination and feedback as joint mediators, and both mediation models were fully supported. Interestingly a simultaneous regression analysis indicated that, when entered together, coordination still remained the sole unique predictor of team performance. This finding reconfirms the primary role of coordination in fostering collective performance in interdependent task settings (Entin & Serfaty, 1999; Marks, Zaccaro, & Mathieu, 2000; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000).

As a whole, our results support Dickinson and McIntyre's (1997) teamwork model suggesting that monitoring affects other components of teamwork; namely, verbal feedback, backup behavior, and coordination. In addition, this study highlights the role of team monitoring as a critical process in team regulation. Regulation of one's own contributions toward team performance is no longer sufficient in an interdependent team context, not only because individuals' actions are dependent on others, but also because success resides at the level of the team. Simply being concerned with one’s own activities will not ensure goal attainment.

Practical Implications

With the shift toward process-based organizations (Cascio, 1995), accountability is being taken away from individuals and placed on teams with diverse roles and skill sets. To gain competitive advantages, organizations need to focus on ways to transfer teamwork skills to individuals, enabling them to optimize team efforts and create synergy among individual contributors working collectively. Of course, these issues have broader human resource implications, but one obvious upshot is the need to shift from an individual orientation toward preparing individuals to work effectively in team settings (Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995). This includes training teamwork processes that facilitate interdependent working relationships and teach team regulation tactics, such as team monitoring.

In a very practical sense, team monitoring processes have an important role in improving safety conditions within a variety of team work settings, including firefighting, police work, the military, nuclear power plants, and even space exploration. This study supports the idea that monitoring improves coordination and increases the likelihood that team members will discover others' mistakes, which left undetected could jeopardize collective performance or lives in some cases. By recognizing errors quickly and then providing appropriate feedback, teams can minimize some risks involved with working in challenging interdependent environments.
This study explored the role of monitoring in action teams, though team monitoring may also play a vital role in less interdependent settings. Many work teams (e.g., assembly teams or sales teams) have pooled or disjunctive workflow arrangements (Tesluk et al., 1997). These teams require less interdependence to perform effectively and probably would not benefit from allocating a large amount of resources to continuous team monitoring. However, preparing teams to periodically execute team monitoring processes (e.g., once per day, during critical events) could help team members discover broader disconnects and synchronize larger scale contributions to collective goals.

Limitations and Future Directions

This study provided an initial test of the relationship between monitoring, coordination and feedback, and effectiveness. We provided support for the important role of team monitoring in action team performance; however, at this point, we cannot offer evidence that these findings generalize directly to specific workplace contexts. Future research could provide stronger tests of external validity by investigating the role of monitoring in existing action teams (e.g., airline crews) operating in real environments. In addition, we conducted the study using leaderless teams; however, action teams more typically are arranged hierarchically. Especially because monitoring has been viewed as a critical leader behavior (Mumford & Connelly, 1991), future studies should explore the role of monitoring in action teams with formalized leaders.

Because team monitoring is largely cognitive and unobservable, we were not able to directly measure this process in this study. As other authors have noted (e.g., Salas et al., 1995), measurement of cognitive states poses a challenging problem for researchers. The slow progress of empirical research on team monitoring, as with other cognitive variables (e.g., mental model literature, situation awareness literature), may be attributed to the difficulties regarding measurement of cognitive processes. As others have done, we have focused on more indirect, behaviorally based observational assessment of the monitoring process that is likely to be representative of effective and ineffective monitoring. Future studies should consider further development of a more direct measure of monitoring for use. These measures might include self-report indexes or more micromasurement techniques such as eye-tracking methodology; however, there are disadvantages to these types of measures as well (e.g., self-report biases, disruption of cognitive processes).

This study has provided initial support for the idea that team monitoring has benefits for coordination, the provision of feedback, and ultimately, collective goal accomplishment. Furthermore, it has enhanced our understanding of the importance of team regulation within an overall model of team performance by suggesting that monitoring teammates’ actions may help teams develop their coordination skills as
well as responsive feedback techniques by promoting the provision of feedback. We hope this study sparks future research on monitoring in applied team settings.

REFERENCES


