THE RATE OF TEAM PERFORMANCE CHANGE OVER TIME

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TABLE OF CONTENTS

LIST OF TABLES

SUMMARY

This study examined the growth patterns of action teams over time. Cognitive and non-cognitive (i.e., motivational) team composition variables were hypothesized to differentially predict initial levels of and changes over time in team performance. In order to test the hypotheses 78 two-person teams flew three equivalent missions on a low-fidelity computer-based Apache helicopter simulator. Random Coefficient Modeling analyses indicated that, as expected, team composition of general cognitive ability positively predicted initial team performance, whereas team composition of motivational traits did not. However, none of the team composition variables predicted team performance change. Implications, limitations and directions for future research are discussed.

INTRODUCTION

Copious research has been done on work teams and team processes, but there is a void in the literature regarding the effectiveness of teams over time. Researchers have gained a good understanding of the way in which teams perform, but the theories have been primarily static. For example, the widely accepted input-process-output framework only explains the variables included in task performance and gives no indication as to what happens to "output" over extended time periods. The model calls for the ability to comprehend future team effectiveness, viewed as the team's viability or its ability to continue working together, but gives no indication of the manner in which this will occur (Hackman, 1987). The study of teams over multiple performance episodes has allowed for a thorough understanding of the way in which teams perform and the processes involved during sequential tasks (Marks, Mathieu, Zaccaro, 2001)*,* yet it does not explain the nature in which teams change their performance. In addition, many researchers have viewed team performance over time via developmental models, but again these models are unable to explain the changing criterion (i.e., McGrath, 1964). Consequently, many researchers have called for the inclusion of time in the study of team effectiveness (Kozlowski & Bell, 2001; Landis, 2001). This paper will address team effectiveness and viability through the framework of performance changes over time.

In order to understand team effectiveness, it is necessary to look at teams' rate of change (changes in output) and the predictors of that change. There is evidence that team performance is dynamic (Landis, 2001*)*; so it is time to try and understand what constitutes the changing criterion and the ways in which it changes. From a team staffing standpoint, the study of team processes is not enough because organizations are unaware of future team process variables during selection periods (Stevens & Campion, 1994). It is necessary to extend research done at the individual level on performance in order to determine the composition of certain individual differences that will allow for productive and viable teams throughout the job. Because team performance follows a simplex pattern in which more distal episodes are less related to one another than adjacent episodes (Landis, 2001*)*, there may be unique traits or abilities predictive of future performance that will be important to organizations during selection periods, as was seen at the individual level.

It is possible team inputs will be the most beneficial tool in understanding performance changes over time. Individual differences, such as general mental ability and certain personality traits are already shown to be linked to better team performance. It is expected that team composition of individuals concerning these characteristics will be predictive of team performance in a similar fashion to that of the individual. Therefore, composition levels of general mental ability should be highly related to team performance on initial performance episodes (Ackerman, 1989; Ployhart &Hakel, 1998) while team members' personality characteristics concerned with perseverance should be more predictive of changes over time (Kanfer & Heggestad, 1997). The present study will use action teams, teams that "conduct complex, time-limited engagements with audiences, adversaries, or challenging environments in 'performance events' for which teams maintain specialized, collective skill" (Sundstrom, 1999, p. 20-21), in order to assess and attempt to explain performance changes in teams over multiple performance episodes.

TEAM PERFORMANCE

In today's workplace much of the work being done is through team work (Devine, Clayton, Philips, Dunford, & Melner, 1999). Therefore, it is essential to understand team performance and effectiveness in order to create and maintain productive teams. The most ubiquitous paradigm used in the study of teams is the input-process-output (I-P-O) framework developed by Hackman (1987). This model is used in order to understand the different stages that construct team performance. It was built on the assumption that "input states affect group outputs via the interaction that takes place among members" (Hackman, 1987, p. 317). Hackman's model depicted three different levels of inputs. These consisted of individual-level factors, group-level factors, and environment-level factors. Individual-level factors were defined as variables that are unique to team members such as personality, attitudes, and other traits or characteristics. Group-level factors move from the individual to the team and were described as factors that derive from the group that in return affect the team, such as structure or levels of cohesion. Finally, the input level also included environmental factors. These were viewed as broad variables, such as environmental stress, that influence the team. All of these variables combine and influence the way in which the team interacts in the process phase. The input-process section of the framework has been thoroughly investigated since the rise of the model (Hackman, 1987). The final level of Hackman's model consisted of the output, which was broken into either performance or other outcomes. Other outcomes included things such as attitude change or member satisfaction. Performance outcomes included variables concerned with effectiveness and productivity. The research done on this original model of team performance did not give substantial theory applicable to performance over time; therefore, Hackman (1987) readdressed the model in order to look at performance changes and the ways in which they can transpire.

The lack of research including both teams and time has led other researchers to address issues such as team viability and team effectiveness over time. Marks, Mathieu, and Zaccaro (2001) developed a temporally based framework of team processes referred to as the recurring phase model of team processes in order to systematically view team effectiveness over multiple performance episodes. They defined episodes as "distinguishable periods of time over which performance accrues and feedback is available" (Marks, et al., 2001, p. 359). They determined team performance could be viewed as a series of co-occurring I-P-O episodes, assuming outcomes from one episode will become inputs for the next episode. The model included both action phases (engaging in the actual task) and transition phases (evaluation and planning for the task), with I-P-O frameworks occurring at each phase. The authors believed that the transition and action phases would rotate, in which the output of a transition phase would lead to the input of the subsequent action phase. In addition, the model placed great emphasis on team processes. A list of team processes was developed and divided among transition, action, and interpersonal categories. The interpersonal processes were thought to occur at both the transition and action phases of the model. Although the model advanced the way in which team effectiveness was being studied, its focus was more on process than team performance growth over time. Mark's et al. framework provides a way to look at team processes and their changes over different performance episodes.

Another way in which team effectiveness over time has been conceptualized is through team viability, or the team's ability to continue working together (Hackman, 1987; see also Barrick, Stewart, Neubert, & Mount, 1998). Barrick et al. (1998) examined team viability through supervisors' ratings of the teams' capability to continue working together effectively in the future. They found that personality variables such as agreeableness, extraversion, and emotional stability were predictive of team performance and team viability. The results of this study suggest that the composition of certain individual-level traits can serve as a strong predictor of team effectiveness, both in the present and in the future. Although the findings suggest a way to assess predictors of team viability and effectiveness, there is still a lot missing in the understanding of the nature of team performance over the course of a job. The ratings of team viability used may have been somewhat subjective and the method did not allow for the examination of the way in which effectiveness changes will occur. Many researchers have called for the further understanding of team performance through the inclusion of time (Kozlowski & Bell, in press; Landis, 2001). In order to appropriately include time, it will be necessary to go back to the foundations of performance change. The next section will review the individual performance literature over time in order to build a framework for a new way to look at team viability, which will include the teams' performance growth over time.

INDIVIDUAL PERFORMANCE

The study of individual performance and the changes that occur over time has been debated throughout the last century (Barrett, Caldwell, & Alexander, 1985). The way in which it has been investigated has varied, so it is important to distinguish between the different kinds of improvements or changes that can occur. The literature sometimes blends learning a job or task with improvements in performance over the normal course of the job. Although the two are conceptually similar, making the distinction is important because they are two different constructs. In many cases, individuals will still be learning in early phases of their jobs, but this is different from acquiring a skill (Ackerman, 1989). This paper will focus on performance over time and not skill acquisition, considering the task being used in the current study will require that the necessary skills are already learned during training prior to the first performance episode.

The Criterion

When dealing with performance prediction, the issue of dynamic criteria has been a problem for I/O psychologists. Basically, individual performance (the criterion) changes over time making it harder to predict performance using certain abilities or traits. Dynamic criteria have been conceptualized differently throughout the research. This body of research is strongly tied to the research done on the simplex pattern. The simplex pattern is a decline in the within task intercorrelations. This pattern of correlations is seen throughout the sciences. It is easier to predict criteria closer to the current measurement period than those further in the future (Humphreys, 1960). In terms of performance, performance periods more distal from each other are less related than performance periods closer in time. The simplex pattern deals solely with the criterion and does not indicate that there must be a decline in predictive validity over time (Ackerman, 1989). Although, one would assume that if performances become less related to each other, then predictors of the original performances will not necessarily serve as predictors of later performances. Nonetheless, this does not mean it is impossible to find predictors for more distal performances.

Performance Changes over Time

There are four main approaches used in the study of individual performance changes. The first three views address the changing criterion, while the other deals with the changes of single individuals and how they compare to other individuals over a given time interval (Ployhart & Hakel, 1998). Barrett et al. (1985) helped to clarify the different criterion approaches by organizing dynamic performance as changes in average group performance, validities, and rank-order. However, changes in validities and changes in rank-orders go hand in hand and can not always be distinguished from each other in the literature because they are so highly interdependent, as will be seen in the next few sections.

Average Performance Changes. The first criterion analysis refers to the changes in mean performance over time. It does not consider specific individual changes, because it examines changes in the group averages. Ghiselli (1956) published an article that looked at average changes of individuals over time on the job. He found significant changes in the group performance over the course of the longitudinal study. Overall, changes in average performance were an important starting ground in order to address issues concerned with the changing criterion, but by no means was this evaluation comprehensive.

Rank Order Changes. Ghiselli and Haire (1960) again addressed the criterion issue in another paper that looked at taxicab driver performance over 18 weeks. They looked at the changes in average performance, as well as the two other ways to analyze dynamic criteria, changes in rank order of individuals and predictor validities. Changes in rank order imply that individuals that start on the top may be low performers in the end and vice versa. The results do not have to be as extreme as this example. Individuals could switch positions from second to fourth best, or any other change in rank. This presented a problem for I/O psychologists. Predictors of initial performance may not serve as good predictors later in time because factors other than the original abilities or traits influence individuals' final standing on a job. Ghiselli and Haire (1960) demonstrated this difficulty with their findings. They found changes in average performance, as well as changes in the individuals' rankings after 18 weeks. Because individuals performances were changing in different ways over time, the authors saw changes in the performance predictors' validities as well, which pushed researchers to realize the importance of looking at validities. If certain predictors become less valid with time they may need to be rethought or not used in performance prediction.

Predictor Validity Changes. Ackerman (1989) addressed the issue of decreasing validity coefficients and the prediction of performance. It is important to recognize, however, that his studies are not of average performance over time but rather of training or skill acquisition. Also, the tasks that he used were differentiated by automatic or controlled processing. Automatic processing is developed in tasks that are "fast, effortless (from a standpoint of allocation of cognitive resources), and unitized (or proceduralized) such that they may not easily be altered by a subject's conscious control" (Ackerman, 1987, p. 4). An example of a task that is done through this type of processing would be riding a bicycle. On the other hand, controlled processing occurs when "no constituent processing rules, consistent sequences of information processing components, and so forth are present in the experimental paradigm" (Ackerman, 1987, p. 4). Tasks relating to this component are continuously under a subject's conscious control due to their novelty or lack of internalization of the task (Ackerman, 1987).

Ackerman also delineated two different forms of tasks, with different resource dependencies. Inconsistent tasks are described as tasks in which "no automatic processing development can occur" (Ackerman, 1987, p. 5). Ackerman described these in a resource-allocation framework as being resource dependent throughout different phases of the task. Consistent tasks were viewed as tasks in which automatic processing could develop over practice such that performance becomes "less resource dependent and more resource insensitive" (Ackerman, 1987, p. 5). Consistent tasks allow for an individual to become familiar with the processes involved in performance, and eventually require no cognitive resources from the individual in order to maintain their performance.

Ackerman (1988) empirically tested a model of skill acquisition determined from information-processing concepts in order to test the ability-performance relationship for both consistent and inconsistent tasks. The tasks used in his studies primarily consisted of motor behaviors. He found that consistent tasks showed distinct results from inconsistent tasks. Inconsistent tasks did not become automatic, so general abilities remained predictive of performance throughout the task and were actually more predictive of performance later on in the skill acquisition phases. On the other hand, consistent tasks allowed him to address issues concerning the degradation of predictor validities. He found that there was an increase in certain abilities predictive validity over time on a consistent task, and a decrease in other predictor validities. Results from the studies demonstrated that for initial performances general abilities were most predictive of performance for consistent tasks. This stage of skill acquisition was referred to as the cognitive stage. As the task became more consistent for the individual he/she entered the intermediate or associative phase where perceptual speed became the strongest predictor of performance. Perceptual speed referred to individual differences in processing speed. Finally, as the task became automatic and performance reached asymptotic levels, psychomotor abilities began to predict performance over other abilities during the autonomous stage. This ability is concerned with the accuracy and speed of responses for motor behaviors.

Findings from Ackerman's studies are extremely important to Applied Psychologists and the study of performance changes. The results gave preliminary explanations for the degradation of predictive validities and evidence for predictors in which validities increase over time. In addition, the studies showed cognitive ability as the strongest initial predictor of performance and confirmed that it maintained a strong relationship with performance throughout training or learning (Ackerman, 1989; Ackerman & Cianciolo, 2000). These results can be generalized to transfer of training situations in which the environment is novel and the individual is forced to rely on his/her general intelligence due to the inconsistent nature of the task.

Keil and Cortina (2001) did a review on the literature concerned with decreasing validity coefficients over time. They found that predictors for performance all showed a universal decline in validity over performance episodes. This finding differs from those previously discussed (Ackerman, 1989; Ackerman & Cianciolo, 2000). Keil and Cortina's results suggest a decline in validity for predictors, criteria, and time periods. They believed that this was because of the individuals' changing abilities. Their results suggested that skills are developed over time at different rates due to differing abilities. Although, other studies have shown that individuals with differing general ability maintain their relationship to one another over time on the job so there is no need to be concerned with the decline of predictor validity (Schmidt, Hunter, Outerbridge, & Goff, 1988). The focus thus far has been on changing criteria, yet this is not the only way in which performance change can be interpreted or studied. When looking at changes in performance, it is important that the nature of the individuals' changes and the differences between these change patterns is also examined.

Interindividual Differences in Intraindividual Change. Intraindividual change can be defined as changes in performance within an individual over time. When addressing intraindividual changes, interindividual differences are recognized through the comparison of intraindividual changes across individuals, which is the difference in the way in which individuals change over time (Ployhart & Hakel, 1998). This way of looking at performance change evaluates the growth of a single individual and determines what the growth pattern looks like in comparison to other individuals' growth patterns (Ployhart & Hakel, 1998). It is concerned with whether individuals perform better over time, stay the same, or get worse. Researchers such as Hofmann, Jacobs, and Baratta

(1993) have argued that looking at this type of performance change is necessary in order to fully understand performance because this approach incorporates all three of the changes addressed in the criterion issue as well as changes in absolute performance.

This technique allows for the assessment of predictors for individual growth on the job. Certain traits can be determined to be associated with faster or higher performance growth, which in turn influences the selection of employees. Hofmann et al. (1993) used insurance sales personnel over 36 months in order to look at individual performance changes and dynamic criteria. They found the simplex pattern discussed earlier which indicated decreasing validity coefficients as well as changes in the rank order of individuals over time. In addition, the individual growth curves were investigated to determine the form of the changes for the individuals. They found that there was significant variance between individuals' growth curve estimates. The authors were able to group the individuals' change in performance into three clusters with different systematic patterns. High performers steadily increased their performance over time similar to a learning curve. The middle group increased at first, but then began a slight decline. Finally, the low performing cluster improved initially, but then declined to almost original levels of performance. These results demonstrated systematic differences between individuals in the way they change over time. Notably, the study suggested that different individual dispositions or abilities may be predictors of different performance trajectories. For example, the authors believed that a certain personality trait, such as goal orientation, may play a role in predicting the individuals' performance trajectories. It is possible that the poor performers over time had negative reactions to failure, which in turn hurt their motivation and performance. These findings led to the further exploration of predictors for interindividual differences.

Ployhart & Hakel (1998) looked at interindividual differences in intraindividual change using the same paradigm as Hofmann et al. (1993), but they employed a statistical technique called the Latent Growth Model. They analyzed sales performance in order to look at the individual changes in performance. The statistical technique used allowed them to extend the Hofmann studies and test predictors of interindividual differences in sales performance and determine which predictors were most valid. The Latent Growth Model evaluates which growth pattern (intercept, linear, quadratic, or cubic) is the best fit for describing performance change and applies predictors to the models (Ployhart and Hakel, 1998). It is possible for more than one growth pattern to describe individual performance changes, but there will always be one that serves as the best fit for the individual.

Ployhart and Hakel found that the performance criterion was dynamic. All that this implies is that performance changes over time. But, they also saw that the individuals' performances followed a quadratic pattern similar to trends seen in the literatures where individuals enter new environments and are still learning. Similar to Ackerman's (1989) model of skill acquisition, individuals placed in new situations show quadratic performance patterns as they became familiar with the tasks involved for the job. These performance trends have also been seen in domains where the individual or team members are forced to learn or adapt on the job, such as newcomers to an organization (Chen, 2003). Chen found newcomers in teams had greater rates of performance improvement during early socialization periods than in later periods due to learning done in these spans. Ployhart & Hakel's study showed a similar pattern because the salesmen were new to the job and still adapting and learning during the measurement periods. Also, interindividual differences were seen in the intraindividual performance changes.

Ployhart and Hakel's most important finding was that the predictors were able to provide information about the interindividual differences. The PSCSP (past sales commission and salary potential) was related to initial status (the intercept). The measure can be viewed as an ability assessment because it is based on past performance, a behavioral measure of ability. This finding provided further evidence for general ability as the strongest predictor of initial periods on a complex task or job. Both persuasion and empathy were slightly related to the intercept and the rate of improvement. The predictability of these individual differences implies that certain motivational or interpersonal traits will be more applicable to performance once an individual is on the job, because with-in person improvement is dependent on persistence and perseverance. This finding had strong implications for the individual performance research. Non-ability individual characteristics were found to be predictive of different rates of performance change, which can be considered during selection periods.

Thus far the focus has been on individual performance because the literature in this area has been centered on one level of analysis. It is essential to build on the individual performance literature and extend the known paradigms to the next level of analysis, that of the team.

TEAM PERFORMANCE OVER TIME

Landis (2001) conducted a study on professional basketball teams' performance records over a 10 year period. He found that the simplex pattern that was found in individual performance also existed for teams. Basically, performance episodes that were close in time were more related than performance episodes further from each other. The pattern was actually so extreme that there were negative correlations found between early and later performances. This serves as evidence for dynamic criteria at the team level. It can be inferred that teams will have changing rank orders and decreasing validity coefficients. Therefore, predictors of initial performance periods may not serve as good predictors in the future.

In addition, research on group development has suggested that teams change in a predictable nature over time, but there is a lack of research that accounts for this change (Gersick, 1988). Early research on group development viewed team performance over time via phase models, which outlined the various stages groups went through in order to perform (Tuckman, 1965). Recent research in this area has been able to mark transitional periods and view performance efforts more specifically (i.e., Gersick, 1988); but these theories still deal primarily with performance on one task and do not address or explain performance changes over multiple performance episodes. In order to gain a better understanding of team effectiveness and viability, it will be necessary to look at team growth patterns, inter-team differences, and predictors of those differences.

Action teams are useful in the study of changes in team performance. The team enters a novel environment in which they are forced to adapt over multiple performance episodes. These teams are usually short term, requiring the team to adjust quickly (Sundstrom, 1999). In order for this adjustment to be efficient, the team must have a rapid rate of improvement due to the brief nature of the team's lifespan. Therefore, it is beneficial to evaluate different predictors of action teams' rate of change. Research has shown that certain individual abilities affect the performance and effectiveness in action teams such as command-and-control teams. Command-and-control teams are characterized by their highly coordinated actions and role definitions that allow the team to quickly respond to external stimuli (Klimoski & Jones, 1995). Consequently, individual-level characteristics will be important in selecting individuals that will create effective action teams over multiple performance episodes.

PREDICTORS OF TEAM PERFORMANCE

Research on team staffing has identified a person-in-team model in which individuals are selected into teams for optimal team/group effectiveness (Klimoski & Zukin, 1999). Work group effectiveness has been described as including team performance and other factors such as viability (Sundstrom, McIntrye, Halfhill, & Richards, 2000). Therefore, there have been certain categories determined in which teams can differ; all of which influence the effectiveness of teams. One of the categories described is individual position requirements, which includes qualities such as ability and conscientiousness (Klimoski & Zukin, 1999). This way of viewing team staffing is concerned with the composition of the team. A team's composition is the makeup of the different individual characteristics such as ability and values that are shown to be jointly important to the team (Klimoski & Jones, 1995). Research has called for a greater understanding of teams in terms of individual level traits such as ability, conscientiousness, and agreeableness. The literature is sparse on these traits at the group or team level of analysis (Sundstrom et al., 2000). Individual-level characteristics, concerned with ability or desirable personality traits, should show similar patterns of predictive validity for team performance to that of the individual, but much is unknown about their ability to predict team effectiveness and viability.

Conjunctive Model

In order to represent these individual-level traits at the team-level of analysis Steiner's (1972) typology of group task types can be used in order to determine the proper representation of the individual-level traits. Action teams, such as simulated combat flight teams, are highly interdependent teams that perform conjunctive tasks given Steiner's typology. Therefore, the performance of these teams is dependent on the team's weakest link, which is the lowest member's level of a certain advantageous trait. Moynihan and Peterson (2001) argue that these teams are best represented by the minimum individual score in a team, because the team can be no better than its worst member. This way of viewing team performance is a natural broadening of the individual performance literature. It results in the most straight forward extension of individual traits in which the constructs are not changed. Also, it allows the generalizability of individual level theories to be tested at the team level. Predictors of individual performance have been primarily concerned with individual abilities, motivation, and role expectations. Therefore, when individuals are selected they are chosen using these characteristics, which would naturally extend to the team level (Klimoski & Jones, 1995).

General Mental Ability

General mental ability has been shown to have widespread validity in the prediction of performance across a variety of different jobs and tasks (Barrick et al., 1998). This is seen at both the individual and team level of analyses (Barrick et al., 1998; Klimoski & Jones, 1995). Research suggests that general mental ability allows for the selection of individuals into teams that will perform efficiently. In addition, team members with high levels of general mental ability are also more capable of developing systems of interaction that will allow for the most effective use of information (Lepine, Hollenbeck, Ilgen, & Hedlund, 1997). Organizations are looking for the brightest individuals to perform the job, regardless of the context in which the job will be performed. However, general mental ability has shown the strongest predictive validity with initial performance episodes and a less significant relationship with more distal episodes (Ackerman, 1989; Barrick et al., 1998). Ackerman's (1987, 1988) studies of skill acquisition investigated this relationship between cognitive ability and performance. He found that initial performance on consistent tasks was predicted by general mental ability, and other facets of abilities were predictive of performance later in the acquisition phase. The results of these studies can be generalized to transfer of training situations or to performance periods in which the environment is novel and the individual or team has not become familiar with the task.

The validity of general mental ability-performance relationship has been debated in the performance literature. While it is largely agreed that general mental ability is predictive of initial performance on complex jobs or tasks, researchers have disagreed about what happens to the validity coefficients over time. Schmidt et al. (1988) argued for a noninteractive hypothesis in which general mental ability maintains its relationship with performance over time. They found that individuals with high levels of cognitive ability kept the same advantage over individuals with low levels of cognitive ability over many months on the job, which implied that the validity of mental ability with performance remained constant. Although, there is another body of research which views changes in the criterion (performance) over time in a very different manner. For instance, the simplex pattern demonstrated that performance is not stable over time (Humphreys, 1960), and general mental ability was known to be a stable trait, therefore it seemed unlikely that the validity of mental ability with performance maintains its relationship over time (Murphy, 1989).

Murphy (1989) proposed a model that accounted for the instability of performance. He examined both transitional and maintenance stages of job performance. Transitional phases occur when the job or task is novel and an individual is forced to make decisions about unfamiliar stimuli. Maintenance stages include phases where the task is well-learned and requires minimal mental effort, similar to Ackerman's autonomous stage. The model proposed that during transition stages performance depends on cognitive ability because new information is acquired and the individual can not rely on past experience. On the other hand, the maintenance stage is not affected by cognitive ability, but rather personality and motivational factors. The model demonstrated that ability predicts performance early on the job, but practice on tasks results in the degradation of cognitive ability-performance validity coefficients, as was seen in Ackerman's (1987,1988) studies.

When performance over time is addressed through modeling performance change, general mental ability or constructs similar to this remain the most important predictor for initial performance periods. Ployhart and Hakel (1998) found through modeling individual growth curves that initial performance on a job was predicted by a sales performance ability measure (determined by past sales) over and above certain personality traits. This has held consistent at the team level in the preliminary studies of team performance over time or team viability. Although these studies have not modeled growth patterns, they have found teams with higher mean levels of general mental ability to be more effective (Barrick et al., 1998). Barrick and colleagues suggested that general mental ability was a good predictor of initial team performance, but not predictive of effectiveness over time because it is outside the domain of personality, which they found to be related to team viability. General mental ability should therefore serve as the strongest predictor of initial team performance episodes, but it should have decreasing validity over the course of a job.

Motivational Traits

Studies done by Hofmann et al. (1993) as well as Ployhart and Hakel (1998) have shown individuals' personality traits as predictors of the growth patterns for individuals. Certain personality traits are related to the individuals' rate of change on the job. The Big Five personality variables conscientiousness and openness to experience, both related to motivational traits, have shown predictive validity for performance trends or growth at the individual level of analysis (Thoresen, Bradley, & Bliese, in press). This has also been seen at the team level in a different form of analysis. Barrick et al. (1998) conceptualized team effectiveness or performance over time as ratings of team viability. They found conscientiousness, agreeableness, and emotional stability to predict the team's ability to continue working together effectively in the future; suggesting team performance changes over time may be most strongly predicted by the aggregation of certain individual level personality traits.

Therefore, it is essential to determine the individual traits that will combine to influence the performance changes in teams. A great deal of research has focused on what influences performance changes, and certain traits have been found to influence the ways in which individuals approach performance, which results in perseverance and effort over time. Vandewalle, Brown, Cron, and Slocum (1999) as well as other researchers have used Dweck and colleagues (Elliott & Dweck, 1999) original conceptualization of goal orientation, which includes two unique traits that individuals can differ on that affect the way they approach performance in achievement settings, in order to study performance changes. Dweck discovered two ways that individuals approach achievement situations; they have either performance goals or learning goals. These goal orientations can be seen as traits in which individuals exhibit one of the orientations. They are defined as "(a) *learning* goal orientation, to develop competence by acquiring new skills and mastering new situations, and (b) *performance* goal orientation, to demonstrate and validate one's competence by seeking favorable judgments and avoiding negative judgments" (Vandewalle et al., 1999, p. 249).

These orientations in turn affect the way in which individuals approach tasks and respond to challenges. Individuals with performance goal orientations are afraid of failure and displaying their lack of ability and therefore avoid or withdraw from tough tasks that could bring failure, which results in the formation of maladaptive response patterns. On the other hand, individuals with learning goal orientations approach difficult tasks as an opportunity for growth and development and consequently form adaptive response patterns that allow them to persist and perseverance through exciting challenges (Vandewalle et al., 1999). Vandewalle et al. found that a learning orientation did have a positive impact on sales performance over time, a relationship that has been seen in other areas such as academics, but that this relationship was not direct. Goal orientations influence self-regulation, which are the mechanism or processes that turn motivational energy into actual performance (Kanfer, 1990). Vandewalle et al. found that individuals with learning goal orientations used more self-regulatory processes such as goal setting, effort, and planning, which resulted in better performance for a well-learned job. Although, the relationship between a performance goal orientation and performance remained unclear; it was not significantly related to the self-regulatory practices or performance.

The lack of predictive validity for the performance goal orientation led researchers to breakdown the two-factor goal orientation model into three factors, two of which relate to the performance goal orientation. Vandewalle (1997) determined that the performance goal orientation contained two clear factors in which the individual either has a desire to prove their competence or avoid negative judgments from others. Therefore, there is a body of research that encompasses a three-factor model of goal orientation (learning, proving, and avoiding) and its relationship to performance over time (e.g. Vandewalle, Cron, & Slocum, 2001). In this literature the learning goal orientation maintains its positive relationship with performance over multiple performance episodes. Also, the proving goal orientation has a unique relationship with performance. Vandewalle and colleagues saw that the proving goal orientation had a positive relationship with performance on an initial performance episode, but the relationship became non-significant after the initial performance period. In addition, the avoiding goal orientation showed a distinct relationship to performance over time. At first, it had no relationship to performance, but a negative relationship developed after the first performance period. The study of this three-factor model not only determined that a performance goal orientation does have a relationship to performance, but it also exemplifies the strong need to investigate goal orientations over time. The way in which these traits affect performance is clearly influenced by feedback, experience, and time on the job. Also, it was found that the three orientations have unique effects on self-regulatory processes that influence performance (Vandewalle et al., 2001).

Although the goal orientation framework provides information on the way in which approach/avoidance traits influence performance as well as the motivational process, the taxonomy suffers from problems with the dimensionality of traits and levels of assessment (Kanfer & Ackerman, 2000). In order to appropriately study motivational traits as a whole, a much broader framework was needed. Kanfer and Heggestad (1997) described a taxonomy of motivational traits and skills that combined and clarified all of the previous research in this area. The framework distinguished between achievement and anxiety factors as well as more distal traits and proximal skills. In addition, the model accounts for different environmental and task influences on motivation. The following section will focus only on the distal motivational traits; motivational skills are beyond the scope of this paper.

Kanfer and Heggestad (1997) defined achievement as "differences in the strength of motives to approach, pursue, and attain rewards or incentives" (p. 16). They depict achievement as an approach oriented trait, which can be broken down into two related categories, task mastery and competitive excellence. Research has shown that higher levels of achievement motive lead to increased levels of efficiency and persistence, as opposed to a motive to avoid failure (Atkinson, 1966). It is also believed that one's achievement orientation will affect the way in which an individual approaches a situation and overcome "emotional reactions" (Kanfer & Heggestad, 1997, p. 43), which in turn influences his perseverance over time. This widely accepted view of achievement implies that ones achievement orientation will be related to their effort on a task, which will in turn correlate to their performance over the course of a job. In addition, Kanfer and Heggestad identified a superordinate anxiety trait which encompassed the other half of the motivational taxonomy. They believed that this trait included test anxiety, fear of failure, and general anxiety. As opposed to the approach-oriented achievement trait, this trait was viewed as an avoidance-oriented trait in which individuals evade situations that may result in failure. Therefore, this trait was seen as detrimental to performance.

In later empirical studies the motivational traits were determined to be three separate factors, all of which differently affected performance (e.g. Heggestad & Kanfer, 2000; Kanfer & Ackerman, 2000). The advancement of these traits coincided with the development of Kanfer and Heggestad's Motivational Trait Questionnaire (MTQ). Two of the traits, Personal Mastery and Competitive Excellence, were part of the superordinate achievement trait; while the anxiety trait was composed of Anxiety Motivation. Although, the Competitive Excellence trait actually includes both approach and avoidance dimensions that will be discussed later. Personal Mastery, a trait defined by Heggestad and Kanfer (2000), is a form of self-referent achievement striving in which individuals define standards of excellence in terms of personal improvement. These individuals are concerned with being the best that they are capable of being, and therefore work hard in order to maximize their potential. This trait is similar to the learning goal orientation previously discussed. On the other hand, individuals or team members, high on Heggestad and Kanfer's Competitive Excellence factor, have an other-referent form of achievement striving in which normative standards of excellence are developed. These members' are not necessarily concerned with the quality of their work, as long as they are regarded as high performers. This achievement orientation is similar to a proving goal orientation in which the individual is in quest of favorable judgments from others, but it also captures other approach and avoidance traits. Finally, Anxiety Motivation is the final dimension of Heggestad and Kanfer's motivational traits that includes individuals with anxiety reactions and avoidance of achievement-oriented situations.

After extensive research on these motivational traits it was illustrated that the three traits described above can be broken down and measured by six scales with two scales representing each trait (Kanfer & Ackerman, 2000). Personal Mastery includes both the "Desire to Learn" scale, which measures a need for achievement in learning new skills, as well as the "Mastery" scale, which reflects a desire towards continual improvement. As was noted earlier this trait is an achievement or approach-oriented motivational trait. The Competitive Excellence trait is measured by an "Other referenced Goals" scales, which reflects and individuals need to compare oneself to others, and a "Competitiveness" scale, which measures a need to be better than coworkers or peers. Interestingly, "Other referenced Goals" is thought to tap both approach and avoidance motivational traits, which differentially affect performance. Yet, the Competitiveness scale is solely measuring an approach-oriented trait. Finally, the Anxiety trait is demonstrated through a "Worry" scale, which deals with evaluation apprehension, and a "Emotionality' scale that measures emotional responses in achievement settings. This trait measures anxiety or avoidance characteristics as was discussed earlier (Kanfer & Ackerman, 2000).

Despite the abundant research on motivational traits at the individual level of analysis, there is far less knowledge of these constructs at the team level. Although, researchers have argued that research findings from an individual level can be applied to a team level due to the "embedding of the constructs in a nomological network across levels" (Gully & Phillips, 1999, p. 34). Gully and Phillips examined goal orientations at the organizational and group levels in order to predict the effects of these constructs at levels other than its traditional level of analysis, the individual. Also, Vandewalle (2001) advocated the use of goal orientation in the selection of team members. He argued a learning goal orientation is beneficial when working in teams because team members with this orientation have a greater tendency to be "open to new experiences, value cooperation, and effectively process feedback" (Vandewalle, 2001, p. 168). Although these studies do not provide any empirical evidence for using goal orientations or motivational traits at the team level, they are a starting ground for further research. In addition, the above multilevel examples are focused on the goal orientation framework. It would make more sense to use the well validated and comprehensive individual-level motivational traits when moving from individual level motivational theories to team-level applications.

Regardless of the minimal exploration of motivational traits and performance at the team level, there is some research on the effects of achievement-oriented traits on team performance. Lepine (2003) found that teams with higher mean levels of achievement were better able to adapt their role structure after a change and in return performed better in uncertain environments. Role structure was defined as "reactive nonscripted adjustments to a teams system of member roles that contribute to team effectiveness" (Lepine, 2003, p. 28). These results imply that motivational traits, in the context of achievement orientation, will be an essential tool when evaluating team adaptation over time. Teams with high mean levels of Personal Mastery will see faster rates of performance change due to the individuals' perseverance and the team's efficient role structure adaptation. Consequently, team members with high levels of Competitive

Excellence and Anxiety Motivation are less resilient and will not adapt as smoothly, which will result in slower rates of team performance change in complex task environments. Team members with Anxiety Motivation are going to avoid a complex task or have negative emotional reactions to stressful environments, and therefore will be of no help to the team. Also, members with the Competitive Excellence trait will show some degree of avoidance and their competitiveness will be a detriment to interdependent teams.

HYPOTHESES

Combining the ideas of motivational traits, cognitive ability, and individual growth patterns; hypotheses were developed in an effort to explain team effectiveness over time in a fashion parallel to the individual performance literature. In order to view this construct it is necessary to gain a thorough understanding of the nature of team performance changes, and what predicts different rates of change. Researchers have described team development as "a process of learning and skill acquisition" (Kozlowski, Gully, Nason, & Smith, 1999, p. 250). Teams are expected to change over time during development or adaptation periods due to the new individual and team knowledge acquired. Therefore, team performance in novel environments should show a positive rate of improvement as was seen in the individual performance literature (Ackerman, 1989; Chen, in press; Ployhart & Hakel, 1998).

Hypothesis 1: In novel environments teams improve their performance over multiple performance episodes.

The strongest predictor of team performance in novel environments will be general mental ability. As was discussed earlier, cognitive ability is the strongest predictor of performance on complex tasks, especially when the environment is novel and individuals or team members are adapting to unfamiliar situations (Murphy, 1989). In attempting to replicate Ployhart and Hakel's (1998) findings at the team level, which will appropriately predict initial team performance, a conjunctive model will be used to predict initial performance. For highly interdependent teams the minimum score of general mental ability should be the strongest predictor of initial performance on complex tasks (Moynihan & Peterson, 2001); especially when teams perform in a post-training environment that is substantially more complex than the environments teams were previously exposed to (i.e., during transitional/ inconsistent phases of work; cf. Murphy, 1989).

Hypothesis 2: Performance on the initial performance episode is predicted by the minimum team member score of general cognitive ability.

In addition, there are two models that explain performance changes, changing-persons or changing-tasks (Keil & Cortina, 2001). The models fundamental differences lie in early research on abilities versus skills. Fleishman (1972) distinguished between abilities and skills in order to lay out a framework for the contribution of abilities to certain tasks. Ability was described as a "more general trait of the individual" (Fleishman, 1972, p. 1018). The definition was in opposition to skills, which were defined as "the level of proficiency on a specific task" (Fleishman, 1972, p. 1018). These definitions have been used to describe the relationship between the two models of performance. A changing-person model is concerned with the changes in individual abilities over time. It assumes that individual abilities change during learning of a task, but the ability put forth to the task is invariable. A changing-task model views individual abilities as contributing differently to the task over time while the individual ability level shows no change (Keil & Cortina, 2001). Keil and Cortina suggested that the changing-person model is actually a representation of increasing skill level and not changes in ability. It is often hard to distinguish between the two models when we are looking at performance changes, because both the individual and the task change over the course of a job.

The present study will not be concerned with the changing-task, because each performance episode is novel and equivalently complex and requires the same skills. Therefore, the task will remain the same throughout time. Consistent with the changing-persons model, the “abilities and characteristics of individuals that determine task performance change over time” (Murphy, 1989, p.187), and therefore performance will rely more heavily on dispositional variables such as Personal Mastery as the team members become familiar with the task and the ability-performance validity decreases. Dispositional variables, such as motivational traits, will predict the rate of team performance change, which has already been seen at the individual level (Ployhart & Hakel, 1998). Team members’ personality characteristics concerned with persistence and perseverance, such as Personal Mastery, will be predictive of changes in team performance over time. Personal Mastery is a form of self-referent achievement striving in which individuals define standards of excellence in terms of personal improvement; as opposed to the other-referent form of achievement striving in which individuals develop normative standards of excellence, Competitive Excellence. Teams consisting of members with high levels of Personal Mastery will aid performance while Competitive Excellence may hinder performance in this complex environment. Also, Anxiety Motivation will inhibit the rate of team performance improvement due to the team member's anxiety reactions and avoidance of achievement-oriented situations (Heggestad & Kanfer, 2000). Therefore, the following hypotheses were developed using a conjunctive model due to the nature of this task.

Hypothesis 3a: The minimum team member score of Personal Mastery positively predicts the teams’ rate of performance change.

Hypothesis 3b: The minimum team member scores of Competitive Excellence and Anxiety Motivation negatively predict the rate of team performance change.

METHOD

Participants

The participants of this study consisted of 156 undergraduates at the Georgia Institute of Technology from which 80 two-member teams were formed. The gender distribution of the sample was similar to the university, 26.9% female and 73.1% male. Also, the mean participant age was close to the typical university student age ($M = 20$, SD = 1.57). Participants received 4.5 extra course credits for participation. In order to ensure participant motivation and adaptive performance, members of the top three scoring teams each received gift certificates ($50 certificates for members of the best scoring team, $25 certificates for members of the second-best scoring team, and $15 certificates for members of the third-best scoring team). Two teams had to be dropped from the study given there was incomplete data due to computer difficulties ($n = 1$), and one team member became sick over the course of the study which drastically influenced the team's performance ($n = 1$).

Task Apparatus

The study was conducted using a computer simulation of a Longbow Apache helicopter. The computer simulation allows for the creation of engaging and highly interactive task environments, paralleling principles encountered by many of today's work teams (Marks, 2000).

The software used was a computer-generated low-fidelity Longbow Apache helicopter simulator, LongBow2 (1997). LongBow2 was designed for one two-person team consisting of a pilot and gunner. Each member in the team maintains a specialized role while having a high level of interdependence (Tesluk, Mathieu, Zaccaro, & Marks, 1997). The pilot is primarily responsible for nine roles: (1) maintaining optimal flight altitude, (2) following the waypoint path, (3) crossing over waypoints, (4) maintaining optimal airspeed, (5) using the chain gun (6) monitoring time to next waypoint, (7) monitoring distance to next waypoint, (8) extinguishing engine fire when necessary, and (9) lining up the I-Beam (rocket steering cursor) with cross-hairs to allow the gunner to fire rockets. The gunner has eight central responsibilities: (1) identifying and differentiating targets, (2) selecting weapons appropriately, (3) monitoring weapons' status, (4) prioritizing targets appropriately, (5) monitoring helicopter's systems, (6) informing pilot of aircraft systems' status, (7) using rockets, and (8) using missiles.

In general, the team is tasked with flying to successive waypoints and eliminating primary and secondary enemy targets as outlined in the mission briefing they are given. The missions are created with a mission scripting software named Missioneer Plus (1998). This program allows for the experimenter to control most aspects of the study: (1) mission objectives, (2) location of waypoints, (3) terrain, (4) weather, (5) number of weapons, (6) flight paths and objectives of other friendly vehicles, and (7) number, type, skill-level, and formation of enemies.

Participants were randomly assigned to either the pilot or gunner terminal. Terminals consisted of a: (1) personal computer, (2) monitor, (3) microphone-equipped headphones, and (4) joystick.

Procedure

Upon arrival to the study, participants were provided with an informed consent form containing information on the study. Participants then completed the following tasks in order: (1) 12-minute Wonderlic test, (2) premeasure assessment including the Motivational Trait Questionnaire, (3) task training, (4) practice mission (5) transition phase, (6) transfer mission. Phases five and six were repeated two additional times.

Premeasure assessment. After consent, participants spent 12 minutes completing the Wonderlic and approximately 30 minutes doing a battery of several individual difference measures (e.g. MTQ).

Task training. After completing the measures, the participants were joined as a team for approximately 1.5 hours of task training, including a 5-minute introduction video designed to facilitate the learning process. This video was developed using Microsoft PowerPoint (XP) software and was displayed to the participants on a television.

After the introductory video, participants received approximately 1 hour of scripted task training and, as a team, participated in a practice mission standardized across teams. Task training was hands-on training emphasizing the competencies necessary for task performance in a role, while familiarizing both subjects with the duties of their partner. The training also included instructional cards to clarify and expand upon the computerized training. Experimenters followed a checklist with the script and coached participants to ensure a minimal level of competency. The checklist was standardized such that no participant could continue to the next phase of training without reaching a minimal level of role competency.

Participants then began team training. Following a similar procedure to the role-specific training, experimenters used analogous measures during this training. No team was able to proceed to the next phase of training without first reaching a minimal level of task competency. The teams were then given 10 minutes to plan for the practice mission using practice "intelligence reports." "Intelligence reports" included their mission objectives and enemies as well as a map of the mission. The team training concluded after the team flew a 10-minute team practice mission. Following training, participants spent approximately 30 minutes completing measures unrelated to the current study. Participants then took a ten minute break.

Transfer missions. Teams engaged in a 10 minute transition phase before each transfer mission where they were given an "intelligence report" to aid in planning for the mission. Then, the team flew a 15-minute transfer mission. The transfer mission required teams to be highly adaptive to adjust to the novel (i.e., different terrain) and more complex missions (in comparison to the earlier practice mission). Participants completed the transition and transfer phases consecutively for two more parallel, unique, and complex missions after the original transfer episode. Therefore, there were three equivalent transfer missions that the teams flew. The order in which the teams flew the three transfer missions was randomized in order to account for any differences in the complexity of the missions.

Measures

General mental ability. The Wonderlic test was given to the participants as a premeasure in order to estimate general mental ability. The Wonderlic is a personnel test used for the assessment of cognitive ability. Research has shown that this test is an accurate and efficient tool to use for a quick estimation of college students' general mental ability (McKelvie, 1989). The test is administered as a paper and pencil test and takes 12 minutes to complete. Participants are told to do as many problems as they can in those 12 minutes. An example item from the test reads, “Paper sells for 21 cents per pad. What will 4 pads cost?” The team’s representation of general mental ability was found by using the minimum of the team members’ scores on the Wonderlic.

Motivational Trait Questionnaire (MTQ). A personality measure created by Heggestad and Kanfer (2000) was used to look at the achievement/anxiety personality factor. Scores were determined for the three motivational traits: Personal Mastery, Competitive Excellence, and Anxiety Motivation. The MTQ measures these traits using 48 items that were taken from an original, longer version of the present questionnaire. Cronbach’s _ internal consistency reliability has demonstrated validity for these three motivational factors (a) Personal Mastery (_=.84); (b) Competitive Excellence (_=.90); and (c) Anxiety Motivation (_=.90). Also, discriminant validity has been shown via low correlations between scales representing different motivational constructs (Kanfer & Ackerman, 2000). There are 16 items that compose the Personal Mastery trait. An example item from the Personal Mastery motivational factor reads, “I set high standards for myself and work toward achieving them.” Another example of this factor is, "I prefer activities that provide me the opportunity to learn something new." Also, there are 13 items that compose the Competitive Excellence trait, an item measuring this factor reads, “I would rather cooperate than compete.” [reverse scored] Another item from this trait is, "Whether or not I feel good about my performance depends on how it o compares to performance of others." Finally, are 19 items that tap the Motivation Anxiety factor. Example items in the Anxiety Motivation scale are, “I am able to remain calm and relaxed before I take a test"[reverse scored]; and "Before beginning an important project, I think of the consequences of failing." (Kanfer & Ackerman, 2000). The team’s representation of the motivational traits was determined from the minimum of the team members' scores on each of the 3 factors.

Team performance. Teams had three general objectives: (1) survive; (2) eliminate eight pre-designated assigned targets while avoiding neutral and friendly targets; and (3) eliminate seven pre-designated bonus targets per mission. At the end of the mission Longbow2 (1997) displays a scoreboard with a mission summary, from which, experimenters recorded team point totals. Team performance was the total number of points the teams accumulated during the mission based a variety of criteria. Helicopter status was worth 30 points. The team received 30 points for remaining undamaged, 20 points if they were damaged, and no points if they were destroyed. The assigned target hits (primary targets) were worth 20 points. The bonus target hits (secondary targets) were worth 10 points. Also, the teams were deducted 20 points for every friendly target they hit. Finally, the teams received 2 points for every minute they were alive. Teams that completed the mission in less than the allotted time received the total points available for this criterion, 30 points. Team performance scores for each mission were the combined scores on all of the mission objectives (including deductions), where the maximum score was 410 points. The team performance scores were then standardized by centering the scores according to that mission's mean in order to account for any differences in the difficulty of the missions.

Analysis

Principle component analysis was done on the individual-level MTQ in order to ensure that the questionnaire represented three distinct motivational traits. Then, Random coefficient modeling (RCM) was used in order to test the hypotheses regarding changes over time in team performance (H1) and predictors of initial levels and changes over time in team performance (H2-3) following the framework and steps given by Bliese and Ployhart (2002). The RCM analyses were done using Version 1.6.2 of the *Nonlinear and Linear Mixed Effects* (NLME) program for S-PLUS and R written by The R Development Core Team (2003). The RCM analyses were conducted at both within-team (Level 1) and between-team (Level 2) levels. In the analyses of team performance over time, team performance was the Level 1 outcome and a time variable was created as the Level 1 predictor (including the three performance episodes). Team general mental ability, Personal Mastery, Competitive Excellence, and Anxiety Motivation were then treated as Level 2 predictors of both the team performance intercept (i.e., initial team perf0ormance) and the time*team performance slope (i.e., team performance change).

RESULTS

The results of principle component analysis done on the MTQ are reported in Table 1.

Table 1. Principle Components Analysis of MTQ (N=156)

	Varimax-rotated factor		
Item Description	Motivation Anxiety	Competitive Excellence	Personal Mastery
WOR8	**.79**	.18	-.02
WOR6	**.77**	.07	.00
WOR7	**.76**	-.10	-.11
WOR9	**.74**	.20	.01
WOR1	**.68**	.14	.04
EMOT1	**.68**	-.10	.00
EMOT9	**.66**	.011	-.05
WOR2	**.61**	-.10	.02
WOR5	**.61**	.22	-.02
EMOT3	**.57**	-.10	-.06
EMOT7	**.56**	-.03	.04
EMOT8	**.55**	.08	.10
WOR10	**.54**	-.07	-.20
EMOT2	**.53**	.10	.03
EMOT4	**.52**	-.14	-.20
WOR4	**.50**	.09	.03
EMOT5	**.42**	-.04	-.02
ORG4	**.41**	.38	-.06
EMOT6	**.34**	.03	-.17
WOR3	**.33**	-.02	.01
CS5	-.13	**.85**	-.08
CS6	-.02	**.82**	-.02
CS2	-.07	**.81**	-.01
CS1	-.08	**.77**	-.09
ORG2	-.01	**.77**	.04
ORG5	.17	**.66**	.37
CS3	-.42	**.63**	.00
ORG3	.28	**.62**	.11
ORG6	.22	**.60**	.22
ORG1	.35	**.58**	.02
CS4	-.26	**.57**	-.08
ORG7	.28	**.56**	-.06
DL4	-.09	-.02	**.69**

MG4	-.11	.09	**.68**
MG7	-.13	.17	**.67**
MG8	-.03	.17	**.67**
DL7	-.14	-.13	**.66**
MG5	-.01	.10	**.64**
DL8	-.16	-.09	**.59**
MG1	.11	.03	**.56**
DL5	-.15	-.05	**.48**
MG2	-.21	.11	**.47**
DL1	.10	.02	**.46**
MG3	.06	.15	**.44**
DL2	.04	-.13	**.43**
DL3	.26	-.23	**.42**
MG6	.08	-.03	**.42**
DL6	-.03	-.05	**.39**
Eigenvalues	7.92	6.36	5.26
% of Variance	16.50	13.25	10.96

The factor loadings provide sufficient evidence for the three motivational traits. Descriptive statistics and correlations for the individual-level variables are reported in Table 2. The internal consistencies (alphas) are given on the diagonal.

Table 2. Means, Standard Deviations, Reliability, and Correlations among Individual-Level Variables

Variable	*M*	*SD*	1	2	3	4
1. Wonderlic	28.17	4.25	--	--	--	--
2. Personal Mastery	4.33	.55	.05	.84	--	--
3. Competitive Excellence	3.99	.79	-.09	.05	.90	--
4. Motivation Anxiety	3.33	.75	-.11	-.09	.09	.90

Note. Analyses were conducted at the individual-level: *N* = 156. Internal consistency reliability coefficients (alpha) are on the diagonal.

Descriptive statistics and correlations for the team-level variables are provided in Table 3. There is a mean improvement of 24.05 performance points for all teams between Mission 1 and Mission 3. Note that the team-level scores for the individual-level variables are represented by the minimum score of the team, and therefore descriptive statistics are on the teams' minimum member score. Interestingly, team's ability composition did not relate to performance on the first or second mission, but it did relate to performance on the third mission. Also, none of the motivational team composition variables related to any of the team performance scores. However, the correlations do not appropriately reflect relationships between the predictors and the within-team patterns of performance change, which was the main focus of the study. Therefore, these correlations should not be interpreted because they do not consider the multilevel nature of the relationship, which will be reported as the cross-level effect of the Level 2 predictors on the Level 1 intercept and slope.

Table 3. Means Standard Deviations, and Correlations among Team-Level Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Wonderlic	25.74	3.53	--						
2. Motivation Anxiety	2.88	.62	-.05	--					
3. Competitive Excellence	3.57	.71	.08	.18	--				
4. Personal Mastery	4.04	.46	-.02	-.20	-.13	--			
5. Mission 1	-9.06	85.50	.17	.00	-.03	-.14	--		
6. Mission 2	-5.93	97.29	.17	-.08	.08	-.12	.28*	--	
7. Mission 3	14.99	94.17	.37**	-.10	.10	-.10	.29**	.22	--

*$p < .05$. **$p < .01$.

Note. Analyses were conducted at the team-level: $N = 78$. Minimum scores used to represent teams for individual-level variables.

Analysis of Team Performance Change

In accordance to Bliese and Ployhart (2002), an "intercept-only" model was examined using RCM in order to determine the variance in team performance existing between and within teams. The intraclass correlation (ICC1) acquired from this model demonstrated that 26% of the total performance variance was accounted for by team membership (i.e., 26% of the variance was between teams), and 74% of the variance was within teams. Then, a second model was tested in RCM in order to evaluate H1 in which a linear time factor (designated as 0, 1, & 2 for Missions 1, 2, & 3) was set to predict the three mission performance scores. In other words, this model was regressing team performance on time and the time parameter estimate represents the extent to which, on average, team performance improved. Partial support for H1 was detected given there was a marginally significant positive effect of the time variable on team performance (parameter estimate = 12.02, $p < .06$); demonstrating that on average team performance improved by 12.02 points at each successive time period. Finally, a third model was tested using RCM in which team performance intercepts and slopes were allowed to vary across teams. In order to test for team differences in performance slopes the fit of the second model (where performance slopes were set to be equal across teams) and the fit of the third model were compared, which gave a log likelihood ratio of .009 (*ns*) indicating no significant differences in performance slopes. This was further reinforced by descriptive statistics done on the performance slopes indicating a range of only 11.05 to 13.03 in the performance–time slopes across teams. Therefore, team performance improvement did not significantly differ across teams, which limited the ability to support H3 (prediction of slope differences).

Predictors of Team Performance

To examine H2-H3 RCM analyses were done using general mental ability, Personal Mastery, Competitive Excellence, and Motivation Anxiety as Level 2 predictors of the team intercept (i.e., initial team performance) and team performance change/improvement (i.e., the time-performance slope), the Level 1 outcomes (see Bliese & Ployhart, 2002). These analyses allowed for the investigation of the predictors' direct effects on the intercept, initial team performance; and tested the predictors' relationships with team performance improvement via the cross-level interaction between the predictors and the Level 1 time variable.

As shown in Table 4, the teams' general mental ability positively predicted initial team performance, but the motivational traits did not. These results support H2.

Table 4. Growth Model Parameter Estimates of Predictors of Initial Team Performance

Variable	Estimate	*SE*	*Df*	*t*	*p*
Intercept	-41.37	101.11	155	-.41	.68
Time	12.02	6.36	155	1.89	.06
Wonderlic	5.95	2.02	73	2.94	.00
Motivation Anxiety	-12.41	11.88	73	-1.04	.30
Competitive Excellence	4.77	10.28	73	.46	.64
Personal Mastery	-25.97	15.74	73	-1.65	.10

Note. N = 234 performance observations nested in 78 teams.

As seen in Table 5, H3a was not supported because there was no significant effect of the teams' Personal Mastery on the time*team performance slope (evidence for the predictor's effect on changes over time in team performance). Also, H3b was not demonstrated given there were no significant effects of the teams' Competitive Excellence on the time*team performance slope and the team's Anxiety Motivation on the time*team performance slope. The lack of support for H3 is not a surprise given there was little variability in the ways in which teams changed over time.

Table 5. Growth Model Parameter Estimates of Predictors of Team Performance Intercept and Slope

Variable	Estimate	*SE*	*df*	*t*	*p*
Intercept	44.80	135.87	151	.33	.74
Time	-74.14	90.98	151	-.81	.42
Wonderlic	3.30	2.72	73	1.21	.23
Motivation Anxiety	-4.12	16.00	73	-.26	.80
Competitive Excellence	-4.20	13.84	73	-.30	.76
Personal Mastery	-28.38	21.19	73	-1.34	.18
Wonderlic * Time	2.65	1.82	151	1.46	.15
Motivation Anxiety * Time	-8.28	10.71	151	-.77	.44
Competitive Excellence * Time	8.96	9.26	151	.97	.34
Personal Mastery * Time	2.40	14.19	151	.17	.87

Note. N = 234 performance observations nested in 78 teams.

In order to compare the results with alternative aggregation methods or ways to conceptualize the team that are often seen in the literature (see Barrick et al., 1998; Neuman, Wagner, Christiansen, 1999); the above analyses were also done using the team's mean, standard deviation, and maximum scores as predictors of both the initial performance and slope. These results can be seen in Appendixes. Using the mean or average of the team member scores demonstrated the same findings regarding the hypotheses as the minimum score, which can be seen in Appendix A and B. On the other hand, the standard deviation of the team member scores, which is often used when researchers are concerned with the heterogeneity of member characteristics (Neuman et al., 1999), failed to support both H2 and H3 as is seen in Appendix C and D. The maximum scores used as predictors also failed to confirm H2 and H3, which is shown in Appendix E and F. Although the alternative analyses were not drastically different, using the minimum score for these highly interdependent teams is the most consistent with the data and theoretically sound.

DISCUSSION

This study was the first to extend Ployhart and Hakel's (1998) findings to the team level in order to investigate team performance longitudinally and examine predictors of initial team performance as well as team performance changes. This framework allowed for the first empirical validation of team performance improvement over time, and demonstrated that the strongest predictor of initial performance was general mental ability, as was hypothesized. The most important contribution of this study was its extension of individual-level theories and statistical applications to the team-level.

As was demonstrated at the individual level and the few studies done on teams, initial team performance was most strongly predicted by the teams' general mental ability and the motivational traits investigated did not have a relationship with this performance episode. These results support Barrick et al.'s (1998) findings demonstrating that initial team performance is most strongly predicted by mental ability over other personality or motivational traits. However, Barrick et al. (1998) found that mental ability was not predictive of team viability using ratings of the team's ability to continue working together. These findings were empirically validated in the current study using team growth models indicating that mental ability does not predict the way in which teams improve over time, an alternative way to conceptualize team viability.

These findings have important implications for theoretical models of teams. The results suggest that some of the individual level theories will also be appropriate in the context of teams, given teams demonstrated similar growth patterns and predictors for initial performance periods. For highly interdependent teams the minimum team member score for general mental ability is highly predictive of initial performance periods, but not for the way in which the team changes. Therefore, this attribute is seen as very important when the focus is on original performances, but as the team becomes familiar with the task they are no longer dependent on the cognitive ability of their weakest member. In practical terms, when staffing teams it will be important for managers to select team members that all have high levels of general mental ability if they are concerned with initial performance episodes. On the other hand, if teams are given time to adapt it will not be as important for managers to consider this attribute.

Limitations and Future Research

Although, this study was not without limitations given the lack of support for H3 and possible sample issues. The motivational traits were unable to predict the teams' rate of performance improvement as was hypothesized. Although it is possible that these traits do not impact the rate of team performance change, the more obvious explanation for the lack of prediction is the little variability seen between the teams' slopes in the study. There were not enough differences in the ways in which teams changed in order to appropriately predict these changes. It is worth noting that the direction of the effects in team performance change for the motivational traits, Personal Mastery and Motivation Anxiety, was in the expected direction (see Table 3). Therefore, they may serve as important predictors in contexts that allow for more variability between teams. Future research should investigate larger samples over more extended time periods in order for more substantial differences in improvement to arise. Then, motivational traits could be applied to this framework to determine whether or not they are the key contributors to team improvement.

In addition, this study suffered from the widely seen issues associated with student samples and laboratory investigations. Along with these issues, there were some problems with the complexity of each of the missions. The missions were randomized and their scores were centered to account for differences in mission difficulty, but these differences may have been influential given one mission was significantly more difficult than the other two. In addition, there were only three performance episodes used in this study. Future studies should use this framework in other laboratory settings with more performance episodes, and apply this model of team performance and predictors of team performance to organizational contexts in order to determine the generalizability of the findings. Hopefully, this environment would also allow for more variation in performance improvement as was discussed earlier. Overall, this was a preliminary study and extension of individual-level theories to that of the team. Future research should continue in this fashion in other settings in order to further investigate the ways in which teams change their performance, and what abilities/traits impact that change.

APPENDIX A

Growth Model Parameter Estimates of Predictors' Means of Initial Performance

Variable	Estimate	*SE*	*df*	*t*	*p*
Intercept	-30.96	136.52	155	-.23	.82
Time	12.02	6.36	155	1.89	.06
Wonderlic	6.02	2.52	73	2.39	.02
Motivation Anxiety	-17.92	14.05	73	-1.27	.21
Competitive Excellence	8.22	13.28	73	.62	.54
Personal Mastery	-28.53	17.40	73	-1.64	.11

Note. *N* = 234 performance observations nested in 78 teams.

APPENDIX B

Growth Model Parameter Estimates of Predictors' Means of Team Performance Intercept and Slope

Variable	Estimate	*SE*	*df*	*t*	*p*
Intercept	100.25	183.23	151	.55	.59
Time	-119.40	122.59	151	-.97	.33
Wonderlic	3.99	3.39	73	1.18	.24
Motivation Anxiety	-13.16	18.88	73	-.70	.49
Competitive Excellence	-7.60	17.85	73	-.43	.67
Personal Mastery	-34.69	23.38	73	-1.48	.14
Wonderlic * Time	2.03	2.27	151	.89	.37
Motivation Anxiety * Time	-4.77	12.63	151	-.38	.71
Competitive Excellence * Time	15.85	11.94	151	1.32	.19
Personal Mastery * Time	6.16	15.64	151	.39	.69

Note. *N* = 234 performance observations nested in 78 teams.

APPENDIX C

Growth Model Parameter Estimates of Predictors Standard Deviations of Initial Performance

Variable	Estimate	*SE*	*df*	*t*	*p*
Intercept	12.28	20.43	155	.60	.55
Time	12.02	6.36	155	1.89	.06
Wonderlic	-3.76	2.81	73	-1.34	.19
Motivation Anxiety	-6.58	16.98	73	-.39	.70
Competitive Excellence	-9.38	14.03	73	-.67	.51
Personal Mastery	-3.94	25.59	73	-.16	.87

Note. *N* = 234 performance observations nested in 78 teams.

APPENDIX D

Growth Model Parameter Estimates of Predictors' Standard Deviations of Team Performance Intercept and Slope

Variable	Estimate	*SE*	*df*	*t*	*p*
Intercept	10.64	25.43	151	.42	.68
Time	13.67	16.45	151	.83	.41
Wonderlic	.58	3.67	73	.16	.88
Motivation Anxiety	-18.34	22.23	73	-.82	.41
Competitive Excellence	-10.33	18.37	73	-.56	.58
Personal Mastery	-16.71	32.20	73	-.52	.61
Wonderlic * Time	-4.34	2.38	151	-1.83	.07
Motivation Anxiety * Time	11.78	14.38	151	.81	.41
Competitive Excellence * Time	.94	11.88	151	.08	.94
Personal Mastery * Time	12.80	20.83	151	.61	.54

Note. N = 234 performance observations nested in 78 teams.

APPENDIX E

Growth Model Parameter Estimates of Predictors' Maximums of Initial Performance

Variable	Estimate	*SE*	*df*	*t*	*p*
Intercept	78.79	123.88	155	.64	.53
Time	12.02	6.37	155	1.89	.06
Wonderlic	2.47	2.17	73	1.14	.26
Motivation Anxiety	-13.85	12.84	73	-1.08	.28
Competitive Excellence	1.30	12.38	73	.10	.92
Personal Mastery	-25.92	15.66	73	-1.65	.10

Note. N = 234 performance observations nested in 78 teams.

APPENDIX F

Growth Model Parameter Estimates of Predictors' Maximums of Team Performance Intercept and Slope

Variable	Estimate	*SE*	*df*	*t*	*p*
Intercept	130.00	163.37	151	.80	.43
Time	-39.71	108.29	151	-.37	.71
Wonderlic	2.85	2.87	73	.99	.32
Motivation Anxiety	-16.44	16.95	73	-.97	.34
Competitive Excellence	-9.71	16.34	73	-.59	.55
Personal Mastery	-26.84	20.68	73	-1.30	.20
Wonderlic * Time	-.38	1.90	151	-.20	.84
Motivation Anxiety * Time	2.62	11.24	151	.23	.82
Competitive Excellence * Time	11.12	10.83	151	1.03	.31
Personal Mastery * Time	.93	13.71	151	.07	.95

Note. N = 234 performance observations nested in 78 teams.

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