Cognitive Ability and Objective and Subjective Task Complexity: Unique and Differential Effects on Performance, Self-Efficacy, and Cognitive Appraisals

Debra Steele-Johnson
Wright State University

Julie Steinke
Wright State University

Zach Kalinoski
Wright State University

We proposed a multi-level model examining the differential effects of ability and task complexity (objective and subjective) on performance, self-efficacy, and the cognitive appraisals of threat and challenge. For individuals (N = 183) performing a class scheduling task simulation, results indicated that cognitive ability and objective and subjective task complexity accounted for unique variance in performance and self-efficacy and that subjective task complexity accounted for unique variance in cognitive appraisals. Results highlight the importance of distinguishing between objective and subjective task complexity and examining effects on factors related to emotion such as cognitive appraisals.

INTRODUCTION

Our ongoing quest to improve employee productivity in increasingly dynamic and complex workplaces has resulted in a long and rich history of attempts to better understand human task performance. These attempts have been embodied in research on selection, training, and motivation among other topics (e.g., Cascio & Aguinis, 2005). One direction taken in this research is a focus on the influence of employee capabilities (resources) and objective task demands on motivation and performance. However, to gain a more complete understanding of task performance, researchers' focuses have shifted in two directions. One is a closer examination of the nature of task demands (e.g., Maynard & Hakel, 1997), and a second is an examination of the nature of other, emotion-related outcomes (Desai, 2001). The purpose of the current study is to integrate these research directions by examining the unique effects of abilities and different types of task demands on not only motivation and performance but an affect-related outcome, i.e., cognitive appraisals of threat and challenge. Thus, in this study, we will examine the unique effects of cognitive ability and objective and subjective task complexity on performance, self-efficacy, and cognitive appraisals, suggesting that objective factors will account for more unique variance in performance, subjective factors will account for more unique variance in the affect-related outcomes of challenge and threat appraisals, and both objective and subjective factors will account for unique variance in motivation, i.e., self-efficacy.

Task Complexity

Task complexity continues to receive attention in various research domains (e.g., goal setting, Locke & Latham, 1990), although little research has examined the unique effects of different types of complexity (i.e., objective and subjective). Task complexity can refer to both objective and subjective characteristics of the task (Campbell, 1988). Campbell (1988) provided a classification scheme to organize approaches to research on task complexity and suggested that complexity is a) a psychological experience (i.e., subjective task complexity), b) an interaction between person and task characteristics, and c) a function of objective task characteristics. Increases in information load, the type of information provided, and the rate of change in information contribute to objective task complexity (Campbell, 1988). Subjective task complexity is a reaction to the characteristics of the task (which may stem from non-task characteristics as well; Campbell, 1988). Familiarity with the task, short-term memory, aspects of cognitive ability such as the availability of resources, time constraints, and other factors influence the relationship between objective and subjective task complexity (Campbell, 1988). For example, individuals higher in cognitive ability tend to perceive objectively complex tasks as less complex than individuals lower in cognitive ability (e.g., Campbell, 1988).

Thus, objective and subjective task complexity appear to be non-redundant constructs. It is possible for individuals completing the same task to experience the task in different ways. However, little research has examined the unique contributions of objective versus subjective task complexity. Further, little research has examined the unique contributions of cognitive ability and task complexity. Therefore, one main goal of this study is to examine the unique effects of objective and subjective task complexity and cognitive ability on motivation and performance.

Cognitive Appraisals

Lazarus and Folkman (1984) defined cognitive appraisal as a "process of categorizing an encounter, and its various facets, with respect to its significance for well-being." They distinguished between primary and secondary appraisals. The primary appraisal is an assessment of whether an aspect of the environment has implications for one's well-being. The secondary appraisal addresses whether an encounter with the environment has resulted in some damage to the person (harm/loss) or has the potential to cause harm or loss (threat) or the potential to provide benefit (challenge) to the person in the future. Blascovich and Mendes (2000) further elaborated the appraisal process by suggesting that appraisals of threat versus challenge relate to the perceived sufficiency of resources to meet primary demands. However, Lazarus' (1999) formulation suggests that the individuals can perceive both challenge and threat, that these appraisals reflect two distinct dimensions. Lazarus and Folkman (1984) originally discussed cognitive appraisals in relation to stress and coping. However, more recently Lazarus (1999, 2001) suggested that cognitive appraisals are important precursors to emotion, e.g., anger, fear, anxiety, excitement. That is, cognitive appraisals influence coping processes that shape the emotions aroused (Lazarus, 1999, p. 37).

Indeed, researchers have observed that cognitive appraisals precede emotional, physiological, and behavioral responses to stressful events (Tomaka, Blascovich, Kelsey, & Leitten, 1993; Tomaka, Blascovich, Kibler, & Ernst, 1997). Moreover, researchers have found that cognitive appraisals influence performance and emotion (i.e., anxiety, excitement) in sport contexts (e.g., Adie, Duda, & Ntoumanis, 2008, see also Skinner & Brewer, 2002, for a review) and influence coping responses in health contexts (e.g., Franks & Roesch, 2006; Major, Richards, Cooper, Cozzarelli, & Zubek, 1998). Less research has examined cognitive appraisals in work contexts although research has found that cognitive appraisals influence task performance for undergraduates in a lab setting (Drach-Zahavy & Erez, 2002).

Because they are a precursor to emotional, physiological, and behavioral responses, examining cognitive appraisals can enhance our understanding of human task performance. Moreover, Lazarus (1999, 2001) has identified situational and personal antecedents that might influence the extent to which individuals experience threat and challenge. Specifically, Lazarus suggested that situational antecedents include demands, constraints, opportunities, and culture, and personal antecedents include goals, beliefs, and personal resources (e.g., intelligence, social support). Given the ongoing focus of researchers on the effects of task complexity and cognitive ability on performance and motivation and the potential influence of these predictors on emotion, an examination of the unique effects of task complexity and ability also on cognitive appraisals provides a useful contribution to our understanding of human task performance. Therefore, a second goal of this study was to examine the unique effects of objective and subjective task complexity and cognitive ability on cognitive appraisals of challenge and threat. Moreover, we posited differential effects for these predictors, depending on the nature of the outcome examined. We turn now to a discussion of the posited differential effects of cognitive ability and objective and subjective task complexity on performance, self-efficacy, and cognitive appraisals.

Task Complexity, Cognitive Ability, and Performance

Cognitive ability is one of the best, general predictors of performance (Schmidt & Hunter, 1998). Individuals with higher cognitive ability are typically more efficient in terms of memory capacity and reasoning, leading to higher levels of knowledge (Hunter, 1993). Thus, across tasks varying in objective complexity, those with higher cognitive ability generally perform better than individuals with lower cognitive ability because they are more likely to access different resources that help them perform the task. Moreover, individuals with higher cognitive ability show greater gains in performance with practice (e.g., Kanfer & Ackerman, 1989).

Researchers also have found task complexity (both objective and subjective) to predict task performance (e.g., Earley, 1985; Maynard & Hakel, 1997; Scott, Fahr & Podsakoff, 1988; Taylor, 1981). Specifically, researchers have observed that objective task complexity is negatively related to performance (Campbell, 1984; Earley, 1985; Kernan, Bruning & Miller-Guhde, 1994; Steele-Johnson, Beauregard, Hoover, & Schmidt, 2000). However, only a handful of studies have examined the unique effects of objective and subjective task complexity on performance (Maynard & Hakel, 1997; Mangos & Steele-Johnson, 2001). Although tasks high in objective task complexity are perceived generally as more difficult (e.g., Kernan et al., 1994), subjective and objective task complexity can have unique effects. For example, Mangos and Steele-Johnson (2001) observed that subjective task complexity was related to performance when holding objective task complexity constant. Further, Maynard and Hakel (1997) found that objective and subjective task complexity accounted for unique variance in performance.

In sum, we posited that cognitive ability and objective and subjective task complexity will have effects consistent with the nature of performance. That is, we expect that performance reflects a complex construct that is influenced by both objective and subjective factors. As such, we expected that all three predictors would account for unique variance in performance.

Hypothesis 1: Cognitive ability and objective and subjective task complexity will account for unique variance in task performance.

Task Complexity, Cognitive Ability, and Self-Efficacy

Self-efficacy (Bandura, 1977) reflects one of the most researched motivation constructs. Substantial research has shown the beneficial effects of self-efficacy on task performance (e.g., Bandura, 1986, 1997; Stajkovic & Luthans, 1998). Bandura (1986; 1997) suggested that self-efficacy reflects personal perceptions of competence, self-assessments of one's ability to successfully perform a task. As such, one would expect that self-efficacy should be influenced both by objective factors, including one's cognitive ability and objective task demands, as well as by subjective factors, including one's perceptions of task demands. Other research has shown that both cognitive ability and objective task complexity are related to self-efficacy (e.g., Gist & Mitchell, 1992; see also Bandura, 1997, for a review). Less clear is whether subjective task complexity will account for unique variance in self-efficacy after controlling for ability and objective task complexity although initial research suggests subjective task complexity will also have an effect (Mangos & Steele-Johnson, 2001; Maynard & Hakel, 1997). In sum, we posit that cognitive ability and subjective and objective task complexity will account for unique variance in self-efficacy.

Hypothesis 2: Cognitive ability and objective and subjective task complexity will account for unique variance in self-efficacy.

Task Complexity, Cognitive Ability, and Challenge Appraisals

Personal and situational influences both can influence perceptions of threat and challenge (Lazarus, 1999, 2001). Indeed, Lazarus mentioned cognitive ability as an antecedent to cognitive appraisals. That is, individuals higher in cognitive ability are likely to possess more knowledge and have access to a greater amount of resources than individuals with low cognitive ability. Thus, an individual higher in cognitive ability should feel less threatened and less challenged on a particular task than would an individual lower in cognitive ability. Further, Lazarus identified task demands as reflecting a situational antecedent of cognitive appraisals. That is, greater task demands, e.g., objective task complexity, should be associated with greater experienced threat and challenge. Finally, individuals' perceptions of task demands, i.e., subjective task complexity, are likely to influence cognitive appraisals of threat and challenge.

However, because of the nature of cognitive appraisals, we expect subjective task complexity to have the strongest effects. That is, cognitive appraisals reflect appraisals, evaluations of whether one has the resources needed to cope with the environmental demands. As such, cognitive appraisals are likely to be most influenced by subjective factors, evaluations of resources and demands. Thus, we expected that perceptions of task complexity would be most strongly associated with one's appraisals of threat and challenge and would be related to appraisals after controlling for ability and objective task complexity.

Hypothesis 3: Subjective task complexity will account for unique variance in cognitive appraisals of threat and challenge, controlling for the effects of cognitive ability and objective task complexity.

Patterns of Change in Performance, Self-Efficacy, and Cognitive Appraisals

The main objective of this study was to examine the unique contributions of ability and task complexity. However, we had the opportunity to examine also patterns of change over time in performance, self efficacy, and cognitive appraisals. Although little research exists to support specific predictions regarding patterns of change, using a multilevel modeling approach provided us an opportunity to examine research questions relating to whether our predictors differentially affected change in our outcomes.

Research Question 1: Do cognitive ability and objective and subjective task complexity relate to change in performance?

Research Question 2: Do cognitive ability and objective and subjective task complexity relate to change in self-efficacy?

Research Question 3: Do cognitive ability and objective and subjective task complexity relate to change in cognitive appraisals of threat and challenge?

METHOD

Participants

Participants were 183 undergraduate students who were enrolled in an introductory psychology course at a Midwestern university. The sample was comprised of 80 men (44%) and 103 females (56%). Participants were randomly assigned to either a simple or complex objective task complexity condition. Participants received extra credit for their course in exchange for their participation.

Task Description and Objective Task Complexity Manipulation

Participants performed a moderately difficult, computerized simulation of a class scheduling task, similar to the one used in Mangos and Steele-Johnson (2001). Participants chose courses from a database to develop schedules for college students that conformed to pre-specified rules (examples are below). The task window was divided into four quadrants. The upper left quadrant was the Course Schedule Window. In this quadrant, participants could view different courses and different sections within each course by using the PAGE UP and PAGE DOWN functions and the UP and DOWN arrows, respectively. The upper right quadrant was the Planning Window. Here, participants viewed the courses that they had selected from the course schedule window for a particular student. "Students" were identified using 9-digits identification numbers. Participants could switch from one student to another within this quandrant at their own discretion. In the lower right quadrant, participants looked at the Review Window. This quadrant displayed completed schedules that participants could review as needed. Finally, in the lower left quadrant, participants could view the Information Window. In this quadrant, the number of errors and number of completed schedules were displayed in this portion of the screen. Also, when a rule was violated, the exact rule would be highlighted in red in this quadrant. A rule violation would be displayed for as long as the rule was still violated (based on current or submitted schedules). Also, participants could view any task rule by hitting the F1-F7 keys that corresponded to the rule of choice.

We manipulated task complexity by altering the number of rules constraining task performance. Five rules constrained task performance in the simple task version, and seven rules constrained performance in the complex task version. Example rules are "You must assign a lab section for any course in which a lab is required" and "Some students prefer classes on certain days (i.e., MWF or TTH)."

Measures

Cognitive ability

We used the Wonderlic Personnel Test (Wonderlic, 2003) to assess cognitive ability. This measure consists of a 12-minute timed test of math, verbal, and analytical abilities. The range of test-retest reliabilities for this measure ranges from $\alpha = .82$ to $\alpha = .94$ (Wonderlic, 2003).

Subjective task complexity

We assessed subjective task complexity using a six-item measure (Steele-Johnson et al., 2000). Participants responded using a 7-point Likert-type scale (1 = not at all, 7 = very; $\alpha = .82$). An example item is "How difficult is performing this task?"

Cognitive appraisals

We used McGregor and Elliot's (2002) challenge and threat construal measure to assess cognitive appraisals. Both subscales consisted of five items, and participants responded using a seven-point Likert-type scale (1 = not at all true of me, 7 = very true of me; $\alpha = .86$ for challenge, $\alpha = .78$ for threat). An example challenge item is "I view the task as a positive challenge." An example threat item is "I view the task as a threat."

Task-specific self-efficacy

We used a five-item measure of task specific self-efficacy adapted from Riggs, Warka, Babasa, Betancourt, et al. (1994). Participants responded using a seven-point Likert-type scale (1 = strongly disagree, 7 = strongly agree, $\alpha = 78$). An example item is "I am confident that I can do well on this task."

Task performance

Task performance was operationalized as the average number of class schedules completed in each of three performance blocks (see below).

Procedure

Participants completed the cognitive ability measure prior to performing two 10-minute practice trials of the scheduling task. Then, participants completed three blocks of two 10-minute trials of the scheduling task. Participants completed measures of subjective task complexity, self-efficacy, and cognitive appraisals prior to each block.

Analyses

The main objective of this study was to examine the unique contributions of ability and task complexity. However, we had the opportunity to examine also patterns of change over time in performance, self efficacy, and cognitive appraisals. As these data were collected from individuals over multiple time periods, there is likely some degree of nonindependence in the responses. Additionally, responses might be temporally related, and the variability in responses might change over time. To account for the above methodological factors, growth modeling using a random coefficient model (RCM) framework as described by Bliese and Ployhart (2002) was used to build appropriate models for the data. We used the Nonlinear and Linear Mixed Effects program (Pinheiro & Bates, 2000) in the statistical program R (Bliese & Ployhart, 2002). This analysis allowed us to model fixed effects (i.e., average effects for initial performance and rate of performance change) as well as random effects (i.e., between person variance in the intercept and slope). Analyses at Level 1 (within-person) used time as a predictor. Time was coded as 0, 1, and 2 and was modeled as an uncentered predictor of performance, self-efficacy, and cognitive appraisals scores. Level 2 analyses (between-persons) modeled cognitive and both objective and subjective task complexity as centered predictors of intercept and slope variance.

RESULTS

Influences on Performance

Level 1 model

Following the Bliese and Ployhart (2002) approach, we first estimated the intraclass correlation coefficient (ICC). The ICC of the sample was .79, indicating substantial nonindependence in the performance data, i.e., substantial between-person differences. At Step 2, Level 1 results revealed a positive, linear trend in performance across the three time periods, $t(549) = 5.38$, $p < .0001$. Participants demonstrated substantial improvements in performance over time (i.e., completed more class schedules, see Table 1). (Given that we had only three trials, we restricted our analysis to a test of the linear trend although we had the additional degree of freedom to test for the quadratic; however, we note that exploratory tests of the quadratic trend did not alter the conclusions we would draw regarding this or the other three outcomes.)

In Step 3, we tested for significant variance in intercepts (mean between-person differences in performance across the three blocks) and slope parameters (growth trajectories). Using Bliese and Ployhart's (2002) approach for model comparisons, we evaluated competing models by comparing log-likelihood ratios using chi-square difference tests. Results indicated that allowing intercepts to vary provided significant improvement in model fit, $\chi^2_{diff}(1) = 534.670$, $p < .0001$. We then tested a model allowing variation in the linear slope parameter. Likelihood contrasts between these two models suggested that model fit was improved by allowing between-person variation in slope, $\chi^2_{diff}(2) = 142.828$, $p < .0001$. Subsequently, we attempted to specify a model for the error-covariance structure of the data (Step 4). Results indicated the presence of heteroscedasticity, $\chi^2_{diff}(1) = 21.391$, $p < .0001$. We included this error term specification in subsequent models. Thus, the model that best fit revealed significant variance in the intercept and linear slope parameters, suggesting an overall linear increase in performance over time, with individuals differing in initial levels of performance (intercept) and rate of change (slope) over time. Estimates for the final Level 1 model are shown in Table 2.

TABLE 2
RANDOM COEFFICIENT MODELS PREDICTING PERFORMANCE, SELF-EFFICACY, AND COGNITIVE APPRAISALS

MODEL AND PARAMETER	PARAMETER ESTIMATE	SE	*t*	*p*
Performance:				
Final Level 1 Model[1]				
Intercept	11.014	.453	24.317	< .0001
Time	2.627	.198	13.286	< .0001
Final Level 2 Model				
Cognitive Ability	.304	.064	4.736	< .0001
Objective Task Complexity	-6.200	.722	-8.588	< .0001
Subjective Task Complexity	.031	.398	.079	.9372
Cognitive Ability X Time	.091	.036	2.506	.0126
Objective Task Complexity X Time	-2.290	.358	-6.403	< .0001
Subjective Task Complexity X Time	-.415	.214	-1.941	.0531
Self-efficacy:				
Final Level 1 Model[1]				
Intercept	4.663	.072	64.424	< .0001
Time	-0.042	.049	-0.859	.3907
Final Level 2 Model				
Cognitive Ability	.012	.012	1.005	.3162
Objective Task Complexity	-0.467	.133	-3.519	.0005
Subjective Task Complexity	.230	.073	3.147	.0019
Cognitive Ability X Time	.024	.009	2.634	.0088
Objective Task Complexity X Time	.151	.098	1.548	.1224
Subjective Task Complexity X Time	.050	.054	.919	.3586
Challenge Appraisals:				
Final Level 1 Model[1]				
Intercept	3.697	.098	37.824	< .0001
Time	-0.097	.044	-2.200	.0285
Final Level 2 Model				
Cognitive Ability	-0.027	.015	-1.797	.0740
Objective Task Complexity	.110	.172	.643	.5210
Subjective Task Complexity	.697	.095	7.370	< .0001
Cognitive Ability X Time	-0.014	.008	-1.661	.0976
Objective Task Complexity X Time	-0.016	.089	-0.184	.8538
Subjective Task Complexity X Time	.009	.049	.187	.8518
Threat Appraisals:				
Final Level 1 Model[1]				
Intercept	2.530	.080	31.478	< .0001
Time	.158	.051	3.107	.0020
Final Level 2 Model				
Cognitive Ability	-0.026	.013	-1.939	.0541
Objective Task Complexity	.103	.151	.683	.4957
Subjective Task Complexity	.379	.083	4.542	< .0001
Cognitive Ability X Time	-0.018	.010	-1.863	.0633
Objective Task Complexity X Time	.034	.102	.337	.7361
Subjective Task Complexity X Time	.081	.056	1.438	.1512

[1]For Level 1 parameter estimates, $df = 365$. For parameters predicting intercept variations in Level 2 analyses, $df = 179$; for cross-level interaction parameters in Level 2 analyses, $df = 364$.

Level 2 model

In Step 5, we attempted to account for intercept and slope variance in performance identified at Level 1 with between-subject variables (i.e., ability and task complexity). We first examined whether ability and task complexity accounted for variance in performance intercepts. Results indicated that cognitive ability and objective task complexity were significantly related to performance (see Table 2). However, subjective task complexity was not significantly related to performance. Individuals higher in cognitive ability had higher levels of initial performance, and individuals who performed the complex task had lower initial performance. These results provided partial support for Hypothesis 1.

Next, we examined whether ability and task complexity were related to variance in performance slope. These analyses provided information relating to cross-level interactions and indicate the role of each Level 2 predictor in performance change. Ability was significantly and positively associated with variance in the slope (see Table 2). Objective task complexity was significantly and negatively associated with variance in the slope. Finally, subjective task complexity revealed a marginal, negative association with variance in performance slope. Thus, greater performance gains were observed for higher ability individuals and for those performing the task lower in objective and subjective task complexity, providing information related to Research Question 1.

Influences on Self-Efficacy

Level 1 model

Using the analysis approach described above, we observed that the ICC of the sample was .42, indicating substantial nonindependence in the self-efficacy data. In Step 2, results from a test of fixed effects failed to reveal significant change in self-efficacy across the three performance blocks, $t(549) = -.634$, $p = .5266$.

In Step 3, we tested for variance in intercepts (mean between-person differences in self-efficacy across the three blocks) and slope parameters (growth trajectories). We evaluated competing models by comparing log-likelihood ratios using chi-square difference tests. Results indicated that allowing intercepts to vary provided significant improvement in model fit, $\chi^2_{diff}(1) = 87.273$, $p < .0001$. Further, log-likelihood contrasts suggested that model fit was improved also by allowing between-person variation in slope, $\chi^2_{diff}(2) = 15.213$, $p < .0001$. Subsequently, we attempted to specify a model for the error-covariance structure of the data (Step 4). Results failed to indicate any significant effects. Thus, the model that best fit revealed significant variance in the intercept and linear slope parameters, suggesting that self-efficacy was significantly different from zero but changing little over time, with individuals differing in initial levels of performance (intercept) and rate of change (slope) over time. Estimates for the final Level 1 model are shown in Table 2.

Level 2 model

We attempted to account for intercept and slope variance in self-efficacy identified at Level 1 with cognitive ability and task complexity. We first examined whether ability and task complexity accounted for variance in self-efficacy intercepts. Results indicated that ability was not significantly related to self-efficacy. However, both objective and subjective task complexity were significantly related to self-efficacy, providing partial support for Hypothesis 2. Thus, individuals performing the objectively complex task reported lower levels of initial self-efficacy than those performing the simple task. However, individuals who perceived the task as more complex reported higher initial self-efficacy.

Next, we examined whether ability and task complexity accounted for variance in self-efficacy slopes. Ability was significantly and positively associated with variance in self-efficacy slope. Individuals higher in cognitive ability demonstrated greater gains in self-efficacy over time, providing information related to Research Question 2. However, significant cross-level interactions were not observed found for objective or subjective task complexity.

Influences on Threat Appraisals

Level 1 model

The observed ICC of the sample was .53, indicating a substantial amount of nonindependence in the data. At Step 2, a test of fixed effects revealed a positive, linear trend in threat appraisals over the three time periods, $t(549) = 2.385$, $p = .0174$.

In Step 3, we tested for variance in intercepts (mean between-person differences in self-efficacy across the three blocks) and slope parameters (growth trajectories). We evaluated competing models by comparing log-likelihood ratios using chi-square difference tests. Results indicated that allowing intercepts to vary provided significant improvement in model fit, $\chi^2_{diff}(1) = 147.092$, $p < .0001$. Further, model fit was improved also by allowing slopes to vary, $\chi^2_{diff}(2) = 26.760$, $p < .0001$. Subsequently, we attempted to specify a model for the error-covariance structure of the data (Step 4). Results failed to indicate a significant effect. However, the effect for heteroscedasticity, $\chi^2_{diff}(2) = 2.318$, $p < .1279$, was of sufficient size that we corrected for this effect to provide a more conservative test of subsequent relationships. Thus, the model that best fit revealed significant variance in the intercept and linear slope parameters, suggesting an overall linear increase in threat appraisals over time, with individuals differing in initial levels of performance (intercept) and rate of change (slope) over time. Estimates for the final Level 1 model are shown in Table 2.

Level 2 Model

We attempted to account for variance in threat appraisal intercepts and slopes with cognitive ability and task complexity. We examined first whether ability and task complexity accounted for variance in intercepts. Results indicated that subjective task complexity was significantly related to threat appraisals, providing support for Hypothesis 3. Objective task complexity was unrelated to threat appraisals, and cognitive ability revealed a marginal effect (see Table 2). In sum, individuals who perceived the task as more complex also reported greater threat.

Next, we examined cognitive ability and task complexity as predictors of slope variance. However, neither cognitive ability nor complexity accounted for significant variance in threat appraisal slopes.

Influences on Challenge Appraisals

Level 1 model

The ICC of the sample was .71, indicating a substantial amount of nonindependence in the data. At Step 2, a test of fixed effects failed to reveal significant change in challenge appraisals over time, $t(549) = -1.302$, $p = .1936$.

In Step 3, we tested for variance in intercepts (mean between-person differences in self-efficacy across the three blocks) and slope parameters (growth trajectories). We evaluated competing models by comparing log-likelihood ratios using chi-square difference tests. Results indicated that allowing intercepts to vary provided significant improvement in model fit, $\chi^2_{diff}(1) = 298.974$, $p < .0001$. Further, log-likelihood contrasts suggested that model fit was improved also by allowing slopes to vary, $\chi^2_{diff}(2) = 16.500$, $p < .0001$. Subsequently, we attempted to specify a model for the error-covariance structure of the data (Step 4). Results failed to indicate any significant effects. Thus, the model that best fit revealed significant variance in the intercept and linear slope parameters, suggesting that challenge appraisals were significantly different from zero but changing little over time, with individuals differing in initial levels of performance (intercept) and rate of change (slope) over time. Estimates for the final Level 1 model are shown in Table 2.

Level 2 model

Using the same between-subject variables (i.e., ability and task complexity), we attempted to account for variance in challenge appraisal intercepts and slopes. We first examined whether ability and task complexity accounted for intercept variance. Results indicated that neither ability nor objective task complexity accounted for variance in intercepts. Only subjective task complexity was significantly related to challenge appraisals, providing support for Hypothesis 3. Individuals who perceived the task as more complex had higher levels of initial challenge appraisals than those individuals who perceived the task as simpler.

Finally, we examined predictors of slope variance. Neither ability nor task complexity (objective or subjective) accounted for variance in challenge appraisal slopes.

DISCUSSION

Results provided support for our predictions and contributed to our understanding of human task performance by demonstrating the unique and differential effects of cognitive ability and objective and subjective task complexity on performance, self-efficacy, and cognitive appraisals. Hypothesis 1 stated that cognitive ability and task complexity would account for unique variance in performance. Cognitive ability and objective task complexity both accounted for variance in performance, controlling for the effects of subjective task complexity. Individuals higher in cognitive ability or performing the simpler task had higher levels of initial performance. Additionally, cross-level interactions revealed that the effect of cognitive ability increased over time and the effect of objective task complexity decreased over time as well as a tendency for the subjective task complexity effect to decrease over time. Hypothesis 2 stated that all three predictors would account for unique variance in self-efficacy. Similar to the results for performance, objective and subjective task complexity accounted for unique variance in self-efficacy and the third predictor, cognitive ability, had an effect on change in self-efficacy. That is, individuals higher in cognitive ability also showed greater gains in self-efficacy, relative to individuals lower in cognitive ability. Thus, all three predictors accounted for unique variance in self-efficacy. Finally, results for cognitive appraisals clearly supported Hypothesis 3. That is, only subjective task complexity accounted for unique variance in challenge and threat appraisals after controlling for the effects of cognitive ability and objective task complexity.

Theoretical Implications and Future Research

This study extends prior research on task complexity. One might expect objective and subjective task complexity to be interchangeable in terms of their effects on outcomes. However, our results highlight the importance and value of distinguishing between these constructs. For example, subjective task complexity had a stronger effect on the affect-related outcomes, i.e., cognitive appraisals, relative to objective task complexity and ability. Moreover, objective and subjective task complexity had differential effects on self-efficacy. Indeed, objective task complexity had a negative effect on self-efficacy, but subjective task complexity was positively related to self-efficacy. Thus, our results suggest that perceiving a task as complex can have beneficial effects on motivation even when a task is objectively complex.

Our results also extend research on cognitive appraisals. Prior research has established the effects of cognitive appraisals on emotional and behavioral outcomes in health and sport contexts (e.g., Skinner & Brewer, 2002; Tomaka et al., 1997). Our results provide further evidence of the importance of cognitive appraisals with undergraduates in a laboratory setting. Although researchers have called for and documented the inclusion of affect-related outcomes in relation to training (e.g., Ford, Kraiger, & Merritt, 2010; Kraiger, Ford, & Salas, 1993), too little research has examined cognitive appraisals and other emotion-related outcomes in the context of work.

In sum, our results suggest the value of distinguishing between types of task complexity and including cognitive appraisals as an affect-related outcome to enhance our understanding of human performance. Moreover, future research would benefit by examining differential effects of our predictors on change over a lengthier period of time and by examining the structure of relationships between performance, motivation, cognitive appraisals, and other affective outcomes. Skinner and Brewer (2004) have begun this examination of the structure of outcomes, including affective outcomes, in the context of college athletes. We would benefit by extending this research to the context of work.

Limitations

Some limitations constrain the conclusions we can draw from our results. The fact that the sample consisted of college students performing a laboratory task simulation might have implications. However, we used a task which was relevant to students and with which students were familiar, i.e., developing class schedules. Further, we observed results for participants for whom the primary reward was a few points assigned to their coursework. Thus, our results might provide a conservative estimate of effects.

Conclusion

Our results indicated that cognitive ability and objective and subjective task complexity account for unique variance in outcomes and have differential effects on performance, motivation, and cognitive appraisals. Moreover, our results highlight the importance of distinguishing between types of task complexity and of including cognitive appraisals of threat and challenge in our research. As we move toward a greater understanding of human task performance, we would benefit by including measures not only of performance and motivation but also of emotion-related outcomes (e.g., anxiety, excitement) and their antecedents such as cognitive appraisals.

REFERENCES

Adie, J. W., Duda, J. L., & Ntoumanis, N. (2008). Achievement goals, competition appraisals, and the psychological and emotional welfare of sport participants. *Journal of Sport and Exercise Psychology, 30,* 302-322.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84,* 191-215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W. H. Freeman.

Blascovich, J., & Mendes, W. B. (2000). Challenge and threat appraisals: The role of affective cues. In Forgas, J. P. (Ed.), *Feeling and thinking: The role of affect in social cognition* (pp. 59-82). Cambridge, UK: Cambridge University Press.

Bliese, P. D., & Ployhart, E. (2002). Growth modeling using random coefficient models: Model building, testing, and illustration. *Organizational Research Methods*, *5*(4), 362-387.

Campbell, D. J. (1988). Task complexity: A review and analysis. *Academy of Management Review, 13,* 40-52.

Desai, M. S. (2001). Computer anxiety and performance: An application of a change model in a pedagogical setting. *Journal of Instructional Psychology, 28,* 70-78.

Drach-Zahavy, A., & Erez, M. (2002). Challenge versus threat effects on the goal-performance relationship. *Organizational Behavior and Human Decision Processes, 88,* 667-682.

Earley, P. C. (1985). Influence of information, choice and task complexity upon goal acceptance, performance, and personal goals. *Journal of Applied Psychology, 70,* 481-491.

Ford, J. K., Kraiger, K., & Merritt, S. M. (2010). An updated review of the multidimensionality of training outcomes: New directions for training evaluation research. In S. W. J. Kozlowski and E. Salas (Eds.), *Learning, training, and development in organizations,* NY: Routledge/Taylor & Francis Group, 135-165.

Franks, H. M., & Roesch, S. C. (2006). Appraisals and coping in people living with cancer: A Meta-Analysis. *Psycho-Oncology, 15,* 1027-1037.

Gist, M. E., & Mitchell, T. R. (1992). Self-efficacy: A theoretical analysis of its determinants and malleability. *Academy of Management Review, 17,* 183-211.

Hunter, J. E. (1993). A causal model of cognitive ability, job knowledge, job performance, and supervisor ratings. In F. J. Landy, S. Zedeck, & J. Cleveland (Eds.), *Performance Measurement and Theory (pp. 257-266).* Hillsdale, NJ: Lawrence Erlbaum Associates.

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

Kernan, M. C., Bruning, N. S., & Miller-Guhde, L. (1994). Individual and group performance: Effects of task complexity and information. *Human Performance, 7,* 273-289.

Kraiger, K., Ford, J. K., & Salas, E. (1993). Application of cognitive, skill-based, and affective theories of learning outcomes to new methods of training evaluation. *Journal of Applied Psychology, 78,* 311-328.

Lazarus, R. S. (1999). *Stress and emotion: A new synthesis.* NY: Springer.

Lazarus, R. S. (2001). Relational meaning and discrete emotions. In K. R. Scherer, A. Schorr, and T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research.* NY: Oxford University Press.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping.* NY: Springer.

Locke, E. A., & Latham, G. P. (1990). A theory of goal setting and task performance. Englewood Cliffs, NJ: Prentice Hall.

Mangos, P. M., & Steele-Johnson, D. (2001). The role of subjective task complexity in goal orientation, self-efficacy, and performance relations. *Human Performance, 14,* 169-186.

Major, B., Richards, C., Cooper, M. L., Cozzarelli, C., & Zubek, J. (1998). Personal resilience, cognitive appraisals, and coping: An integrative model of adjustment to abortion. *Journal of Personality and Social Psychology, 74,* 735-752.

Maynard, D. C., & Hakel, M. D. (1997). Effects of objective and subjective task complexity on performance. *Human Performance, 10,* 303-330.

McGregor, H. A., & Elliot, A. J. (2002). Achievement goals as predictors of achievement-relevant processes prior to task engagement. *Journal of Educational Psychology, 94,* 381-395.

Pinheiro, J. C., & Bates, D. M. (2000). *Mixed-effects models in S and S-PLUS.* NY: Springer-Verlag.

Riggs, M. L., Warka, J., Babasa, B., Betancourt, R., et al. (1994). Development and validation of self-efficacy and outcome expectancy scales for job-related applications. *Educational & Psychological Measurement*, *54,* 793-802.

Schmidt, F. L. & Hunter. J. E. (1998). The validity and utility of selection methods in personnel psychology: Practical and theoretical implications of 85 years of research findings. *Psychological Bulletin, 124,* 262-274.

Skinner, N. & Brewer, N. (2004). Adaptive approaches to competition: Challenge appraisals and positive emotion. *Journal of Sport and Exercise Psychology, 26,* 283-305.

Stajkovic, A. D., & Luthans, F. (1998). Self-efficacy and work-related performance: A meta-analysis. *Psychological Bulletin*, *124,* 240-261.

Steele-Johnson, D., Beauregard, R.S., Hoover, P. B., & Schmidt, A. M. (2002). Goal orientation and task demand effects on motivation, affect, and performance. *Journal of Applied Psychology, 85,* 724-738.

Tomaka, J., Blascovich, J., Kelsey, R. M., & Leitten, C. L. (1993). Subjective, physiological, and behavioral effects of threat and challenge appraisal. *Journal of Personality and Social Psychology, 65,* 248-260.

Tomaka, J., Blascovich, J., Kibler, J., & Ernst, J. M. (1997). Cognitive and physiological antecedents of threat and challenge appraisal. *Journal of Personality and Social Psychology, 73,* 63-72.

Wonderlic, C. (2003). *Wonderlic Personnel Test Manual.* Northfield, IL: E. F. Wonderlic and Associates.

TABLE 1
MEANS, STANDARD DEVIATIONS, AND INTERCORRELATIONS FOR STUDY VARIABLES

Variable	Time	*M*	*SD*	1	2	3	4_{Time0}	4_{Time1}	4_{Time2}	5_{Time0}	5_{Time1}	5_{Time2}	6_{Time0}	6_{Time1}	6_{Time2}	7_{Time0}	7_{Time1}
1 Cog. Abil.		20.50	5.30														
2 OTC		0.50	0.50	.09													
3 STC		3.73	0.91	-.06	.35												
4 Threat	0	2.54	1.10	-.10	.13	.29											
	1	2.67	1.29	-.13	.14	.32	.57										
	2	2.86	1.47	-.20	.12	.32	.45	.61									
5 Challenge	0	3.70	1.35	-.12	.22	.50	.35	.24	.22								
	1	3.59	1.40	-.10	.15	.45	.27	.48	.33	.73							
	2	3.51	1.54	-.20	.18	.45	.22	.35	.51	.66	.77						
6 Self-Efficacy	0	4.69	1.00	-.07	-.24	.09	-.13	-.14	-.19	.13	.04	-.04					
	1	4.56	1.14	.08	-.06	.13	-.14	.02	-.02	.12	.24	.14	.44				
	2	4.61	1.26	.15	-.07	.14	-.04	-.02	.03	.15	.21	.29	.33	.50			
7 Performance	0	10.62	5.99	.26	-.57	-.22	-.17	-.09	-.12	-.23	-.13	-.20	.28	.10	.16		
	1	14.17	8.57	.25	-.59	-.22	-.15	-.13	-.13	-.25	-.20	-.23	.23	.06	.18	.94	
	2	15.18	9.43	.27	-.57	-.20	-.19	-.14	-.19	-.20	-.14	-.20	.23	.11	.23	.87	.93

Note: $N = 183$. For $|r| \geq .20$, $p < .01$. For $|r| \geq .15$, $p < .05$. Cog. Abil. indicates cognitive ability. OTC indicates objective task complexity. STC indicates subjective task complexity.