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THE RELATIONSHIP BETWEEN WORK EXPERIENCE AND JOB KNOWLEDGE: A THEORETICAL AND EMPIRICAL REEXAMINATION

by

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A THESIS SUBMITTED FOR PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE DOCTOR OF PHILOSOPHY

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ABSTRACT

The Relationship Between Work Experience and Job Knowledge:
A Theoretical and Empirical Reexamination

by

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A study was conducted to examine the relationship between work experience and job knowledge. The data used came from the United States Air Force job performance measurement system (JPMS) database. Data on the cognitive ability and job tenure for two hundred seventy-two aerospace ground equipment specialists (AGE) were used. In addition two measures of task experience were obtained for a sample of 24 AGE tasks. These tasks were subsequently quantified in terms of their difficulty. Hypotheses that work experience predicts job knowledge, and that a task-level measure of work experience, as compared to a job level measure, would be more predictive of job knowledge were supported. In addition, it was shown that both cognitive ability and the difficulty of the task moderates the task experience - job knowledge relationship. Theoretical and practical implications of the findings are discussed.
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The Relationship Between Work Experience and Job Knowledge: 
A Theoretical and Empirical Reexamination

Introduction

Traditionally, the work experience construct has been one of the most heavily used pieces of information in making personnel decisions. Job position ads typically ask for a specified number of years of related previous work experience. Job applications not only ask for whom an applicant has worked, but for how long. There seems to be a commonly held assumption surrounding the potential benefits of experience. It is assumed that with work experience, knowledge, skills, and abilities are gained by virtue of having had the opportunity to participate in the activities of a work setting (Rowe, 1988). However, for a construct that has such widespread practical and theoretically potential use, only relatively recently has this assumption been addressed empirically.

There has been some research that has looked at the relationship between experience and performance. One aspect of experience that has been demonstrated to increase performance on some types of tasks is practice (Welford, 1968; Anderson, 1982). Other researchers have specifically examined the relationship between work experience and performance (Fiedler, 1970; Giniger, Dispenzieri & Eisenberg, 1983; Lance, Hedge & Alley, 1989; McDaniel, Schmidt & Hunter, 1988; Schmidt, Hunter, Outerbridge & Goff, 1988). Quiñones, Ford, and Teachout’s (1995) meta-analysis on the work experience - work performance relationship reported that the relationship was positive using a number of different measures of work experience.
It has been suggested that experience may lead to better performance because subjects develop new strategies for performing tasks (Eysenck & Keane, 1990). For instance, one thing that differentiates experts from novices is a difference in the organization of knowledge (Chase & Simon, 1973). Indeed, it has been demonstrated that the relationship between work experience and performance is mediated by the acquisition of job knowledge (Hunter, 1983,1986; Schmidt, Hunter & Outerbridge, 1986; Borman, Hanson, Oppler, Pulakos & White, 1993). In other words, performance on the job is not merely a function of how long an incumbent has been working, but rather how much job related knowledge has been acquired during that time.

The relationship between experience and knowledge may vary given various task characteristics. Cognitive psychology research on choice reaction tasks has shown that the consistency between stimuli and responses, or between identification targets and their distracters, influence the relationship between practice and performance (Dutta & Proctor, 1992; Shiffrin & Schneider, 1977). Others have found that task difficulty and job complexity influence the experience - performance relationship in a work setting (Lance, et al.,1989; McDaniel, et al.,1988).

The direct effect of cognitive ability on performance has been well documented (Hunter & Hunter, 1984; Rees & Earles, 1991). Others have explored the direct effect of cognitive ability on experience (Schmidt, et al., 1986; Hunter, 1983, 1986). Generally, this relationship has been relatively low or non-significant, although there are a few exceptions (Borman, et al., 1993). In contrast, significant direct effects of cognitive ability on job knowledge have been reported (Schmidt, et al.,1986; Hunter, 1983,1986). The effect that cognitive ability has on the relationship between experience
and performance has also been explored, but results are mixed (Schmidt, et al., 1988; Lance, et al., 1989). However, the moderation that cognitive ability may have on the experience-job knowledge relationship is yet unexplored.

Although there has been research which has examined factors that lead to the acquisition of work experience, as well as investigations of the relationship between experience and performance, there has been relatively little research which has systematically investigated the nature of the work experience construct and its relationship with the acquisition of job knowledge. The present paper draws upon the work experience literature, as well as that from cognitive and human factors psychology, and examines the relationship between a multi-level definition of experience and job knowledge. Specifically, this paper investigates (1) the relationship between various measures of work experience and job knowledge, (2) the extent to which this relationship is influenced by task difficulty, (3) whether this relationship varies as a function of cognitive ability, and (4) the joint interaction of cognitive ability, task difficulty, and work experience in predicting job knowledge. Empirical results are presented, and the implications of this research is discussed.

Work Experience

Fiedler (1970) discussed a methodological issue regarding the nature of work experience. Failing to find a significant relationship between leadership experience (measured in years) and leadership performance, he questioned the measurement of the experience construct. Recent literature still calls for a common language and refined definitions to be developed so research findings can be used to make general conclusions about the effects
of work experience (Quiñones, et al., 1995; Lance, et al., 1989). Some progress in defining the construct of work experience has been made from several sources, and it has been demonstrated that a variable's relationship with work experience may depend on how experience is measured (Lance et al., 1989; Ford, Quiñones, Sego, & Sorra, 1992; Quiñones et al., 1995; Quiñones, Longoria, & Barlow, 1996).

A conceptual framework for defining the work experience construct was developed by Quiñones, et al. (1995). They conducted a meta analysis which reported that the relationship between experience and performance was moderated by the method of measuring experience. From the literature, they categorized the various measures of work experience into two dimensions. These were the measurement mode and the level of specificity. There were three measurement modes: (1) time, (2) amount, and (3) type. Each of these measurement modes can, in turn, be applied at three levels of specificity: (1) task, (2) job, (3) organization. At the task level of specificity, a time-based measure of experience would indicate how long an incumbent has been performing the task. An amount-based measure of experience would indicate the number of times the task has been performed. And a type-based measure of experience would indicate the difficulty or criticality of the tasks being performed. These methods of measuring work experience are theoretically independent. An incumbent may be given the opportunity to gain experience on few or many different tasks, these tasks may be performed few or many times, and further, these tasks may be challenging or non-challenging for the incumbent.

Theoretically, each method of measuring experience can provide a different perspective of the job in which one has been working. For example, a time-based, job-level measure of work experience simply
represents how long an incumbent has held a particular position. What it does not quantify is exactly what the incumbent has been doing during that time. This is especially true when one considers incumbents are not always given similar opportunities to perform tasks on the job (Ford, et al., 1992). Depending on what variables are jointly examined with work experience, another method of measurement may be warranted. For example, it has been argued that predictors and criteria should be examined at similar levels of analyses (Ajzen & Fishbein, 1977; Binning & Barrett, 1989). Anderson (1982) showed that task performance is related to the log transformation of how many times the task had been performed. Therefore, when predicting task performance on the job, it makes more theoretical sense to measure work experience using a method that quantifies the number of times a particular task has been performed. Quiñones, et al.(1995), as well as others (Lance, et al., 1989; Ford, et al., 1992; Quiñones, et al., 1996) have empirically demonstrated that how one measures work experience does indeed influence subsequently reported relationships.

Quiñones, et al. (1995) found that the majority of work experience studies have used a time-based measurement of experience. In addition, a majority of the studies have measured experience at the job level of specificity. Of the measurement modes used in the literature, 79.5% of the studies used a time-based measure of experience. This was followed by an amount-based, and then a type-based measurement mode. In regards to the levels of specificity, 68% of the studies used the job level, followed by an organization level, and then a task level. The results of their meta-analysis reveal differences in the mean estimated population correlation (M ρ) for the three measurement modes and for the three levels of specificity. The relationship between experience and performance was positive regardless of
how it was measured (M $\hat{\rho} = .27$). However, when experience was
measured in terms of amount, the strongest relationship with performance
was demonstrated (M $\hat{\rho} = .41$). This was followed by time (M $\hat{\rho} = .27$) and
type (M $\hat{\rho} = .21$), respectively. In addition, when experience was specified
at the task level, the strongest relationship with performance was observed
(M $\hat{\rho} = .41$). This was followed by the job level (M $\hat{\rho} = .27$) and the
organization level (M $\hat{\rho} = .16$). Thus, although the experience dimensions
of time and job level were the most common, the amount and task level
dimensions had the highest validities and represent the best measure of what
individuals actually do on the job (Quiñones, et al., 1995).

Ford, et al. (1992) examined the relationship between various
measures of experience and individual and environmental characteristics.
They also investigated which incumbents, and under what work
environment conditions, received the greatest opportunity to perform tasks
(i.e., gain experience). Instead of measuring experience in terms of how
long a position had been held (time), this framework categorized work
experience in terms of breadth, activity level, and type. Breadth referred to
the quantity of different tasks an incumbent had the opportunity to perform
in his/her job. Activity level quantified the number of times a particular
task had been performed. The type category referred to the relative
importance and criticality of the tasks that an incumbent had the opportunity
to perform. Different patterns of results were found depending on which
measure of experience was used. For example, there was a significant
positive relationship between a supervisor's perceptions of an incumbent's
capability, skill, and likeability when experience was measured as breadth
and type, and a non-significant relationship when experience was measured as activity level.

It has also been demonstrated that the relationship between work experience and employee turnover decisions depends on how experience is measured. Similar to Ford, et al., (1992), Quiñones, Longoria, and Barlow (1996) measured work experience in terms of breadth, amount, task type. In a study of 255 Air Force recruits, they reported a significant correlation between experience measured as task type and intentions to re-enlist (r = .25). The correlations between intentions to remain in the Air Force with an activity level or breadth measure of experience were both non-significant (both r = .07). Those incumbents who were given challenging tasks on which to work maintained high levels of career motivation and wanted to remain in the service. Incumbents who were not given challenging tasks wanted to leave, even though they may have had high breadth experience (many non-challenging tasks) and high activity level (did non-challenging tasks many number of times). Finally, Ford, et al. (1993) reported different patterns of correlations between breadth and activity level measures of experience with training emphasis ratings.

It is apparent that when conducting work experience research one needs to be explicit about the method with which one quantifies experience. This level of specificity should not depend on the available data, but on a theoretical relationship of interest (Quiñones, et al., 1995). The theoretical relationship of interest for the present paper is that between work experience and job knowledge. Various methods of measuring work experience have been shown to predict performance differently. In audition, job knowledge meditates the experience - performance relationship. The present paper incorporates a multi-level approach in
investigating how different methods of measuring work experience influence the relationship between experience and the acquisition of job knowledge.

**Job knowledge**

Sternberg, Wagner, Williams, and Horvath (1995) distinguished between two types of knowledge, academic versus tacit knowledge. Academic knowledge comes from formal education or training and is the kind of knowledge sampled in achievement tests. Tacit knowledge, on the other hand, refers to "action-oriented" knowledge and appears to be uniquely important to competent performance in real world settings. Tacit knowledge is procedural in nature and is usually acquired on one's own. This distinction is similar to the declarative versus procedural knowledge (Sternberg, et al., 1995). Declarative knowledge is fact oriented, while procedural knowledge is action or skill oriented (Anderson, 1982).

Job knowledge has both declarative and procedural components. Job knowledge is defined as technical information about objects and concepts required to do the job and the knowledge of processes and judgmental criteria necessary for efficient and correct action on the job (Hunter, 1983). Both declarative and procedural job knowledge may come from formal education or training programs, or may be derived from experiences on the job.

A variety of research has investigated the job knowledge construct. Job knowledge is usually assessed and tested in written form (Schmidt, et al., 1986), and both Hunter and Hunter (1984) and Dye, Reck, and McDaniel (1993), in separate meta-analyses, conclude that the validity of written job knowledge tests generalizes in predicting performance. The
relationship between work experience and job knowledge has also been explored. It has been demonstrated that the relationship between work experience and performance is mediated through the acquisition of job knowledge (Hunter1983,1986; Schmidt, et al.,1986; Borman, et al. 1993, Williams and Sternberg, in press, as reported in Sternberg, et al.,1995). For example, Schmidt et al. (1986) reported no direct relationship between job experience (measured in years) and performance ratings. On the other hand, the relationship between job experience and job knowledge was quite strong (.53), as was the subsequent relationship between job knowledge and performance ratings (.34). This suggests that it is not simply experience that matters in predicting job performance, but what a worker learns as a consequence of that experience.

Other research have provided similar findings (Sternberg, et al., 1995; McCall, Lombardo & Morrison, 1988). Although these studies have helped clarify how job specific knowledge mediates the experience - performance relationship, very little is known as to how job knowledge is acquired through work experience. Sternberg et al. (1995) argue that tacit, or procedural, job specific knowledge is “acquired on one’s own” and “under conditions of minimal environmental support” (pp.916-917); however, just how this acquisition takes place has not been addressed.

Anderson’s (1983) model of skill acquisition provides an insight to the experience - knowledge relationship. The model suggests that the learning of a skill develops first from a repertoire of declarative knowledge. Individuals first obtain a set of facts relevant to performing a task. With practice (an amount-based, task level measure of experience), skill learning enters the second stage, in which the declarative knowledge develops into successful procedures for performing the task, although not
all declarative knowledge is transformed. Finally, with enough experience, procedural knowledge is strengthen and develops into automatized behaviors.

Further conceptual understanding of the development, organization, and use of job knowledge can be gleaned from studies on the differences between experts and novices from various domains. Greater experience gives individuals the opportunity to develop, test, and restructure existing work related knowledge. Chi, Glaser, and Rees (1983) demonstrated that problem solving schemas (or mental models) employed by novices focus on the obvious, surface features of the problem, while experts have deeper knowledge structures. Memory research shows that experts are able to chunk greater amounts of task-specific information into meaningful bits (Chase & Simon, 1973) and have higher recall of task-based memory (Soloway & Erlick, 1984, in Esyenck & Keane, 1992). It has also been argued that experience gives an individual the opportunity to use and test task related schemas, and to refine them when necessary (Rumelhart & Norman, 1981, in Esyenck & Keane, 1992).

Anecdotal evidence from work situations supports this claim. McCall, et al. (1988) surveyed corporate executives about the job related experiences that had the greatest impact on the development of their careers and successes as managers. Interviewed executives emphasized that their managerial knowledge and repertoire of skills had developed from a variety of experiences. These experiences include working in particular organizational and political structures, working on various job assignments, and handling crises.

Applying these concepts empirically to a work setting, it is hypothesized that greater work experience will lead to the acquisition of job
knowledge. However, as previously discussed, how one measures work experience may influence this relationship. Schmidt, et al. (1986) quantified work experience in terms of months on the job. Using the Quiñones, et al. (1995) framework, this constitutes a time based, job level measurement of experience. The pattern of the relationships found can differ when a different measure of experience is used. As mentioned earlier, the time-based, job level measure of experience may be the most frequently used, however, it is the amount-based, task level measure of experience that has the highest validity on performance (Quiñones, et al., 1995). As Ajzen and Fishbein (1977) noted, a lack of measurement correspondence between criterion and predictor can have a strong impact on the observed relationship. One can therefore argue that quantifying work experience in terms of an amount-based, task level measure would have greater correspondence with job knowledge, than when work experience is quantified in terms of simply how long one had been on the job (job tenure).

Hypothesis 1: The relationship between work experience and job knowledge will be positive. Those subjects with more work experience will have higher levels of job knowledge.

Hypothesis 2: An amount-based, task level measurement of work experience will have a higher validity in predicting job knowledge than a time-based, job-level measurement.

While, Schmidt, et al. (1986) showed that job knowledge mediates the experience - performance relationship, job complexity was held constant. All jobs studied were of “intermediate levels of complexity”
(Schmidt, et al., 1986, p. 439). The absence of variance makes it impossible to infer any possible interactions that job complexity may have with the work experience - job knowledge relationship. Stemberg, et al. (1995) argue that the lack of a correlation between tacit knowledge and years of experience suggests that it is not simply the experience that matters but what is learned from the experience. While they may have found a different pattern of results if they had used a different method for measuring experience, this brings up the question as to what variables may condition the relationship between work experience and the acquisition of job knowledge. That is, are there any individual differences or task characteristics that may influence the extent to which work experience is related to job knowledge? To address these issues, this paper investigates the moderating role that task difficulty and cognitive ability has in this relationship.

Task Difficulty

The difficulty of a task has been shown to be proportional to the length of training it takes to perform the tasks effectively (Burch, Lipschitz, & Wissman, 1982). Various task factors contribute to its difficulty. According to Anderson's (1982) model, one factor that contributes to the performance of a skill is the amount of task relevant knowledge. It seems intuitive, therefore, that the more task knowledge an individual must acquire, the longer it would take to learn how to perform a task effectively. Understanding the differences in the amount of knowledge required to perform certain tasks is therefore a cornerstone to explaining differences in task difficulties.
One task characteristic that can influence the level of difficulty is the complexity of the task. Wood (1986) provides a framework for task complexity, which establishes the relative amount of knowledge inherent in a task. Wood defined task complexity in terms of component, coordinative, and dynamic complexity. Component complexity is a function of how many distinct acts are necessary to accomplish a task. Each act would require a distinct set of knowledge. As the number of acts increases, the knowledge required to accomplish the whole task also increases. Coordinative complexity considers the extent to which the relationship between task inputs (behaviors) or information cues at one stage of the task are contingent upon acts performed at another stage, or if multiple acts must be performed in parallel. More dependent relationships between task components would require a more detailed, system-level understanding (greater knowledge) of the nature of the task for proper performance. Finally, dynamic complexity refers to the predictability of the relationships between task inputs and products. For instance, a task in which the stimulus-response relationships change would be more complex than a task in which the relationship was constant, with all else being equal. A more dynamic task would not only require a greater amount of task schemas (one for each relationship), but would also require knowing when it is appropriate to shift schemas (Wood, 1986).

It is clear that performance on difficult tasks benefit from experience (Anderson, 1982; Spelke, et al., 1976). However, since tasks differ in the amount of knowledge required to accomplish the task, the relationship between experience and performance may also differ. Spelke, et al. (1976) found that although there are stronger initial practice effects for single versus dual tasks performance, enough practice on the dual tasks can
decrease this discrepancy. However, others have found that for tasks with characteristics that vary in complexity, there are continual differences in the experience - performance relationship.

Practice has a stronger effect on performance when tasks have consistent versus inconsistent stimulus - response mappings (Dutta & Proctor, 1992), and this performance discrepancy can not be practiced away (Dutta, Walker, Czerwinski, & Feldman, in press). One explanation for this is that for the less difficult, consistently mapped tasks, there is less task-relevant knowledge to acquire over practice trials. Thus, higher levels of performance are obtained relatively quickly. This is not true for the more difficult, inconsistently mapped tasks. In this case, tasks require a greater amount of task-relevant knowledge to be obtained before high performance can be reached.

A few studies have looked at the role that job complexity or task difficulty plays in the work experience - performance relationship. Reviews of the literature indicate that indeed more complex tasks take longer to learn and are often allocated more time for training (Fleishman & Mumford, 1989; Mumford, Weeks, Harding, & Fleishman, 1988). McDaniel et al. (1988) performed a meta-analysis which reports that the validity of job experience in predicting performance varies as a function of job complexity. Using a time-based, job level measure of experience, they found that the relationship between work experience and performance was higher for lower complexity jobs. They postulate that this may be due to the greater impact that job experience may have on job knowledge for less complex jobs. For high complexity jobs, one can gain job knowledge through formal education and other job experiences. Low complexity jobs
may be more dependent on skills which are specifically developed through on the job training (McDaniel et al., 1989).

Dye, et al.'s (1993) meta-analysis on the job knowledge literature indicates that job complexity moderates validities for predicting both job performance and training success. Studies used in their meta-analysis were dichotomized as being either high or low complexity. Both job performance and training validities were higher for more complex jobs. The authors conclude that more complex jobs demand greater levels of knowledge and require greater judgement and synthesis of that knowledge (Dye, et al., 1993). Both Dye, et al. (1993) and McDaniel et al. (1989) conducted job level investigations. The present paper extends these findings by examining the importance of task difficulty in the task experience - job knowledge relationship.

One possibility is that task difficulty and experience may interact in their effects on the acquisition of job knowledge. For example, to perform a task at a desired level, a specific level of knowledge is needed. For simple tasks, that knowledge level may be reached somewhat quickly, because there is less knowledge that one needs to obtain. However, for difficult tasks, the necessary knowledge level would require more experience to achieve.

Lance, et al. (1989) studied 23 tasks conducted by 255 U.S. Air Force jet mechanics. The tasks varied in terms of “learning difficulty”, a measure derived from subject matter experts which reflect the time required for each task to be effectively learned by an average incumbent. A longer learning time is indicative of the amount of task relevant knowledge that must be obtained, and thus is partly a function of task complexity. Lance, et al. used both a time-based, job level (job tenure) as well as an amount-based, task level measure of experience (NTP). At the task level of
specificity, the relationship between task experience and performance varied as a function of the learning difficulty of the task. Task experience had a stronger relationship with task performance when task difficulty was high. When task difficulty was low, experience had no effect on performance. Given that knowledge mediates the relationship between task experience and performance, one could argue that given enough experience, the mechanics mastered the knowledge required to achieve similar performance levels for both difficult and simple tasks. No task difficulty - work experience interactions were found with the job level measure of experience, again showing that this type of experience measure is inappropriate given the criterion of interest.

In summary, task difficulty has been shown to moderate the task experience - performance relationship. Given the framework of defining task complexity given by Wood (1986), it makes theoretical sense that task difficulty may condition the relationship between task experience and job knowledge. This is because more difficult tasks incorporate more task relevant knowledge, and more experience is needed to master that knowledge. This supposition is yet unexplored, thus the present study contributes to the literature by investigating how task difficulty may moderate the relationship between an amount based, task level measure of experience and job knowledge.

H:3 The relationship between task experience and job knowledge will be moderated by task difficulty. The relationship between task experience and job knowledge will be greater for more difficult tasks.
Cognitive Ability

There is an abundance of research reflecting the strong direct relationship between cognitive ability and performance (Hunter & Hunter, 1984; Olea & Ree, 1994; Ree & Earles, 1991; Ree & Earles, 1992; Ree, Earles & Teachout, 1994). Schmidt, et al. (1986) demonstrated that job knowledge was an important factor in the relationship between cognitive ability and performance. They conducted a path analysis to quantify the relative effects of cognitive ability, work experience, and job knowledge on performance. The strongest predictor of work sample performance was job knowledge \( r = .74 \) versus \( .04 \) for cognitive ability and \( .08 \) for job experience, respectively). However, both job experience and cognitive ability had a strong direct relationship with job knowledge \( (.53 \) versus \( .46 \), respectively). When the effects of experience were controlled, job knowledge was a stronger predictor of work sample performance than was cognitive ability \( (r = .72, r = .04, \) respectively). Therefore, although it was previously concluded that cognitive ability predicts learning on the job and is also used in daily performance as well (Hunter, 1986), the primary mechanism driving performance is job knowledge, and work experience has a stronger direct influence on job knowledge than does cognitive ability (Schmidt, et al., 1986).

The direct effect that cognitive ability has on work experience and job knowledge has been separately investigated. Borman, et al. (1993) report a direct ability - experience relationship and concluded that high ability incumbents must have been given more opportunity to perform tasks. However, other studies found no relationship between cognitive ability and work experience (Schmidt, et al., 1986; Schmidt, et al., 1988; Hunter, 1983; Ford, et al., 1992; Quiñones, et al., 1996; Sego, et al., under
review), and one found only a marginal significant relationship (Lance, et al., 1989). Borman, et al. (1993) suggests that this disparity (with Schmidt, et al., 1986) could be due to the fact that the Borman, et al. (1993) study used incumbents of a supervisory position, while the Schmidt et al. (1986) (and subsequently, Schmidt, et al., 1988; Ford, et al., 1992; Quiñones, et al., 1996; Sego, et al., under review) used non-supervisory positions.

Support for a cognitive ability - job knowledge relationship has also been demonstrated (Hunter, 1983, 1986; Schmidt, et al., 1986). A theoretical basis of this relationship can be taken from Ackerman's (1989) model for predicting skill acquisition. The Ackerman model, which is predicated in part on the Anderson (1982) model of skill acquisition, states that in the early stages of skill acquisition, which involve the development of knowledge, cognitive ability is a strong predictor of performance. In the later stage, where task completion has been automatized, performance is better predicted by psychomotor ability. When subjects are acquiring knowledge about job tasks, cognitive ability seems to have its strongest influence in terms of the amount of task specific knowledge acquired, and the speed at which this acquisition transpires. Hunter (1986) argues that cognitive ability is important because it helps in learning, and learning on the job requires that a worker recognize an event as being significant, and then formulate the lesson inherent in the event. Hunter (1983) suggests that work experience, and not cognitive ability, has the greatest effect on job knowledge, but concludes that ability does play a part in determining the extent to which the knowledge required for efficient performance is mastered.

Ree, et al. (1995) investigated the causal role of cognitive ability and prior job knowledge on subsequent job knowledge and work sample
performance in a training setting. Similar to Schmidt, et al. (1986) they found that the effect of cognitive ability on work sample performance was entirely mediated by job knowledge. For subjects with similar levels of experience, cognitive ability strongly predicted levels of job knowledge, but only job knowledge predicted performance. In contrast, Olea and Ree (1994) found that cognitive ability accounts for most of the performance variance, while job knowledge adds no significant explanation. However, Olea and Ree (1994) defined job knowledge using specific ability measures. They performed a principal component analysis of an aptitude test battery and the first unrotated factor represented cognitive ability while the remaining components represented specific abilities. This is in contrast to measuring job knowledge through a task analysis derived test.

The previous discussion regarded the direct effect that cognitive ability has on job knowledge. However, it may make more conceptual sense to look at the relationship in terms of an aptitude × treatment interaction. Individual differences in the cognitive aptitude for learning is one of the "most well established fact in educational psychology" (Snow & Lohman, 1984, p. 347). It may be that work experience and cognitive ability may interact when it comes to the acquisition of job knowledge. For instance, for low ability incumbents, a high degree of experience may be necessary before high levels of job knowledge are obtained. High ability incumbents may not need as much experience.

Schmidt, et al. (1988) investigated the possible moderation of cognitive ability on the work experience - performance relationship. No support for an interaction was found. The relationship between cognitive ability and performance seemed to be constant, at least up to 5 years. However, Schmidt, et al. (1988) used job tenure as the measure of
experience. As would be expected, a different pattern of results were found when a more appropriate measure of experience was used (Lance, et al., 1989).

Lance, et al. (1989) also investigated the role of cognitive ability in the experience - performance relationship. Using their military subjects' Armed Services Vocational Aptitude Battery (ASVAB) mechanical aptitude index scores, they report that cognitive ability moderates the task experience - performance relationship. There was a stronger relationship between task experience and supervisor performance ratings when cognitive ability was low than when it was high. When task experience was low, those subjects with higher cognitive ability tended to have higher performance ratings. However, as experience increased, the difference in performance between high and low cognitive ability subjects subsided. Thus it appears that more task experience compensated for lower cognitive ability in the distribution of performance ratings.

In summary, both work experience and cognitive ability have been shown to have a direct relationship with job knowledge. Ackerman (1989) demonstrated that the relationship between cognitive ability and performance is high in the early stages of skill acquisition, when subjects are acquiring knowledge, but then attenuates at the later stages of skill acquisition, when performance is more strongly predicted by other more task-specific abilities. Lance, et al. (1989) found a stronger relationship between task experience and performance for subjects with lower cognitive ability. One possible explanation for this is that subjects with higher cognitive ability reach asymptotic performance quicker because they were quicker at acquiring the relevant job knowledge. Subjects with lower levels of cognitive ability were still in the learning stages of skill acquisition, and
within group variance in experience still predicted performance. However, there has been no systematic research which has specifically investigated how cognitive ability may condition when and how work experience leads to the acquisition of job knowledge.

The present study specifically examines the moderating effects of cognitive ability on the relationship between an task experience and job knowledge. It has been concluded that certain abilities can moderate the relationship between training environments and various outcomes (Snow & Lowman, 1984), and that those with higher levels cognitive ability benefit more from training during the early stages of training, but that this difference attenuates as the levels of knowledge obtained for high and low ability subjects reach separate asymptotes (Ackerman, 1989, 1992, Fleishman & Murnford, 1989). Theoretically, this moderation should be manifested in subjects’ learning curves, so that these learning curves indicate that subjects with higher cognitive ability reach higher levels of job knowledge than subjects with lower cognitive ability, and that they reach those levels more quickly.

H:4 Cognitive ability will moderate the relationship between task experience and job knowledge. Those subjects with higher levels of cognitive ability will demonstrate quicker asymptote to, and higher levels of, job knowledge than subjects with lower cognitive ability.

*Joint Effects of Task Difficulty and Cognitive Ability*

More difficult tasks incorporate a greater amount of knowledge. A more sophisticated schema of the knowledge necessary to accomplish the task is therefore needed to obtain high performance (Rumelhart & Norman,
1981, in Eysenck & Keane, 1992; Snow & Lohman, 1984; Ackerman, 1992). Snow and Lohman (1984) argue that more difficult tasks require knowing when and how to attend to salient features of a task, encoding these features in potentially useful ways, and monitoring and testing performance strategies. In other words, more difficult tasks have more variables that independently or interactively influence the outcome of task performance. Adequate knowledge of these variables, and their interrelationships, is therefore needed to accomplish the task properly. This would account for the higher correlation between cognitive ability and performance for complex versus simple tasks (Snow & Lohman, 1984).

Through experience with the task, one can gain more task relevant knowledge (Hunter, 1983, 1986). As experience with a task accumulates, individuals have the opportunity to develop particular strategies associated with task performance (Snow & Lohman, 1984; Rumelhart & Norman, 1981, in Eysenck & Keane, 1992). For simple tasks, less experience would be needed to obtain sufficient knowledge to accomplish the task. For more difficult tasks, more experience may be necessary. However, not every one may benefit equally from this experience. One could therefore expect a different pattern of relationships between task difficulty, experience, and performance for individuals varying in cognitive ability.

Ackerman (1992) demonstrated the moderation of cognitive ability between task experience and performance varied between tasks with consistently versus inconsistently mapped stimulus - response relationships. For tasks that had consistent mappings (less difficult), correlations between cognitive ability and performance start high, but then attenuate after repeated trials. The reasoning behind this is that during the early stages of skill acquisition, an individual is obtaining declarative and procedural
knowledge necessary to accomplish the task. Cognitive ability predicts performance at this stage well. With more experience with the task, the individual relies less on the knowledge and behavior, or task performance, is automatized. When this happens, performance levels are better predicted by psychomotor skills (given the nature of Ackerman’s task). For the inconsistently mapped (more difficult) tasks, the correlations between cognitive ability and performance remained high throughout practice trials. For the inconsistently mapped tasks, an individual may not be able to reach the stage in which task performance is automatized; therefore, according to Ackerman’s model, differences in performance correspond to differences in the acquisition and use of knowledge, and the best predictor at this stage of skill acquisition, holding experience constant, is cognitive ability.

In summary, a positive relationship between experience and performance has been consistently demonstrated (Quiñones, et al., 1995). In addition this relationship is mediated by the acquisition of job knowledge (Hunter, 1983, 1986; Schmidt, et al., 1986). The present paper hypothesizes that the relationship between task experience and job knowledge is moderated by both task difficulty and cognitive ability. One could subsequently predict that cognitive ability and task difficulty would jointly interact with the task experience - job knowledge relationship. In other words, those incumbents with lower cognitive ability may need more experience in order to obtain the same level of job knowledge than incumbents with higher cognitive ability; however, when a task is of low difficulty, high experience may compensate for low ability, while no such compensation may be expected for high difficulty tasks.
H.5 The effect that cognitive ability has on the task experience-job knowledge relationship will vary as a function of task difficulty. When task difficulty is low, there will be a stronger relationship between task experience and job knowledge for lower ability subjects. When task difficulty is high, there will be a stronger relationship between task experience and job knowledge for higher ability subjects.

Method

Data Overview

The data used in this study were collected as part of a U.S. Air Force (USAF) project to develop a Job Performance Measurement System (JPMS) (Hedge & Teachout, 1986). The JPMS project’s main goals were to develop performance measurement methodologies and to assess the predictive validity of cognitive ability, as measured by the Armed Forces Vocational Aptitude Battery (ASVAB) (Lance, et al., 1989). Previous research has been published using the JPMS data (Vance, et al., 1988; Vance, et al., 1989; Lance, et al., 1989). The JPMS data were collected from participants in various “career fields” (e.g., jet engine mechanic, aerospace ground equipment specialists, radio operator, and personnel specialist). The Vance, et al. (1988), Vance, et al. (1989), Lance, et al. (1989) studies used participants from the jet engine mechanic career field. The data used in the present study were collected occurred in late 1987.

Subjects

Two hundred and seventy-two United States Air Force personnel in the aerospace ground equipment specialists (AGE) career field were used in this study. These are personnel who work on vehicle and equipment
maintenance and repair. All AGE incumbents undergo an 18 week training course before entry into a work environment. Subsequent promotions are based upon proficiency examinations.

**Tasks**

Twenty-four tasks were selected from a job analysis of the AGE career field. The job analysis was conducted by senior job incumbents as well as subject matter experts. These specific tasks provide a representative sample of the types of tasks performed on the job and were selected to provide adequate variance across studied variables so that statistical analyses could be conducted. See Table 1.

**Measures**

Although there have been multiple ways in which task frequency data has been collected, little is known about the conditions under which different questioning formats are more valid and more effective in criterion prediction (Richman & Quiñones, 1996; Longoria, 1994). In the Lance, et al. (1989) study, task experience was quantified using a composite of two amount-based measures: a relative frequency rating, in Likert format, and an actual numerical value of the number of times a task was performed (NTP). Subject responses on these measures were standardized and summed. However, by combining these two metrics, one is not able to investigate the unique contributions that each measurement technique may have in predicting experience outcomes. The present study implemented three different measures of work experience to tests these differences. They were job tenure, task experience ratings, and the number of times a task was performed.
Job Tenure. Subjects were asked to provide a date of entry into the AGE career field. The total time (in years) between this date and the data collection date provides each subject's job tenure. This represents a time-based, job level measure of experience.

Task Experience Ratings. For each task, subjects rated their task experience using a 5-point Likert scale. Higher scores represent more experience. These experience ratings are task specific, and are not relative to other tasks done on the job (e.g., 1 = no experience on this task, 5 = a great amount of experience on this task). This represents an amount-based, task level measure of experience.

Number of Times Performed. The third measure of experience was derived from subjects' reported estimate of the actual number of times they had performed (NTP) each task (e.g., "number of times performed = _ _ _ times"). The response form allowed for a range of 0 to 999. This also represents an amount-based, task level measure of experience.

Cognitive Ability. Each subject had on file a pre-enlistment score on the ASVAB. Again, the ASVAB is a test of cognitive ability used throughout the Department of Defense. It consists of 10 subtests which can be used independently as predictors or combined into composite scores. The Armed Forces Qualification Test (AFQT) is a composite of the arithmetic reasoning, word knowledge, paragraph comprehension, and numerical reasoning subtests. Scores on the AFQT were used as a measure of cognitive abilities. The AFQT reliability, as well as its validity for
predicting performance and training success, have been well documented (DOD, 1984).

**Task Difficulty.** Task learning difficulty data were collected on the sample of 24 tasks. The learning difficulty index (LDI) is a common metric used across USAF career fields to index average rater judgments of the time required for a typical job incumbent to learn to perform tasks satisfactorily (Mumford, et al., 1987; Lance, et al., 1989). The LDI scores for the tasks were previously developed from a job analysis using subject matter experts (SMEs) and senior job incumbents (see Burch, et al., 1982). A benchmark scale was developed within specialties so ratings could be comparable across all career fields. Each task was rated on a 9-point Likert scale, with more difficult tasks getting higher scores. Reported rater reliabilities ranged from .86 to .98 (Burch, et al., 1982). See Table 1 for a list of the tasks used and their corresponding LDI scores.

**Job Knowledge.** Each subject was given a test of job knowledge specific to the AGE career field. The test was administered at the time the job tenure and task experience data were collected. This test consisted of 159 multiple choice items. Items covered both declarative and procedural task specific subject matter (e.g., “Identify the idle adjustment screw.” and “What must be removed prior to unbolting the fuel pump?”). All tasks used in this study were represented in the test. One point was given to each correct answer, thus higher scores represent higher job knowledge.
Table 1.  *Sampled Tasks with Learning Difficulty Score*

<table>
<thead>
<tr>
<th>Description</th>
<th>LDI Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform hydraulic test stand service inspection</td>
<td>5.74</td>
</tr>
<tr>
<td>Perform hydraulic test stand periodic inspection</td>
<td>7.05</td>
</tr>
<tr>
<td>Measure resistance of AGE electrical circuits</td>
<td>5.31</td>
</tr>
<tr>
<td>Change generators and alternators</td>
<td>5.62</td>
</tr>
<tr>
<td>Isolate heater system malfunctions</td>
<td>5.66</td>
</tr>
<tr>
<td>Isolate pneumatic system malfunctions</td>
<td>5.83</td>
</tr>
<tr>
<td>Research TOS charts or diagrams</td>
<td>4.59</td>
</tr>
<tr>
<td>Inspect vehicles for safety of operation</td>
<td>3.71</td>
</tr>
<tr>
<td>Perform gas turbine compressor periodic inspections</td>
<td>6.25</td>
</tr>
<tr>
<td>Perform AGE electrical system operations checks</td>
<td>5.08</td>
</tr>
<tr>
<td>Remove or install carburetors</td>
<td>4.86</td>
</tr>
<tr>
<td>Clean motor or generator armature</td>
<td>4.76</td>
</tr>
<tr>
<td>Remove or install burner control valve</td>
<td>4.88</td>
</tr>
<tr>
<td>Perform load bank service inspections</td>
<td>4.49</td>
</tr>
<tr>
<td>Splice electrical system wiring</td>
<td>4.06</td>
</tr>
<tr>
<td>Remove or install engine fuel pumps</td>
<td>4.09</td>
</tr>
<tr>
<td>Perform generators service inspections</td>
<td>5.13</td>
</tr>
<tr>
<td>Adjust turbine engine fuel system components</td>
<td>6.47</td>
</tr>
<tr>
<td>Isolate engine, motor, or generator mechanical malfunctions</td>
<td>6.03</td>
</tr>
<tr>
<td>Remove or install hydraulic lines or fittings</td>
<td>4.86</td>
</tr>
<tr>
<td>Remove or install AGE tire, tube or wheel assemblies</td>
<td>3.85</td>
</tr>
<tr>
<td>Prepare AGE for mobility or training exercises</td>
<td>4.5</td>
</tr>
<tr>
<td>Pack wheel bearings</td>
<td>3.48</td>
</tr>
</tbody>
</table>
Results

Descriptive Statistics

Prior to analysis, the data were examined for missing or out of range values, outliers, and adherence to the assumptions of regression analysis (Tabachnick & Fidell, 1989). Missing values were found for each of the variables, thus for the following analyses, sample sizes will vary. Table 2 shows the descriptive statistics for each of the individual level variables. Table 3 presents their correlation matrix. Table 4 presents a partial correlation matrix with AFQT scores controlled. Table 5 shows the descriptive statistics for each of the task level variables.

An investigation of Subjects’ NTP estimations for each of the 24 tasks revealed non-normal distributions. Therefore, logarithmic transformations were used so the data would satisfy the requirements for linear regression. Since the value of 0 was meaningful, 1 was added to each score so that the logarithmic transformation would capture those values. For subsequent analyses, using non-linear regression, the NTP estimations were left in raw form. However, an examination of the raw data revealed the presence of outliers (using a +/- 3 standard deviation criteria). These data were deleted. This left an sample of 127 who had complete data for all variables.
Table 2.  *Descriptive Statistics for Individual Level Variables*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>N†</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFQT</td>
<td>60.22</td>
<td>18.44</td>
<td>25.00</td>
<td>99.00</td>
<td>172</td>
</tr>
<tr>
<td>Job Tenure (in years)</td>
<td>1.65</td>
<td>.69</td>
<td>.45</td>
<td>3.08</td>
<td>220</td>
</tr>
<tr>
<td>Mean NTP Estimate (after log transformation)</td>
<td>1.85</td>
<td>1.20</td>
<td>.22</td>
<td>6.91</td>
<td>272</td>
</tr>
<tr>
<td>Mean Task Experience Ratings</td>
<td>2.96</td>
<td>.71</td>
<td>1.33</td>
<td>4.79</td>
<td>269</td>
</tr>
<tr>
<td>Job Knowledge</td>
<td>95.43</td>
<td>11.97</td>
<td>58.00</td>
<td>125.00</td>
<td>268</td>
</tr>
</tbody>
</table>

† Sample sizes vary due to missing data.

Table 3.  *Correlation Matrix of Individual Level Variables*

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mean Task Experience Ratings</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Mean NTP Estimate</td>
<td>.30**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Job Tenure</td>
<td>.19*</td>
<td>.52**</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. AFQT</td>
<td>.03</td>
<td>.14</td>
<td>.14</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>5. Job Knowledge</td>
<td>.18*</td>
<td>.32**</td>
<td>.09</td>
<td>.36**</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* p < .05  
** p < .01  
n (listwise deletion) = 127
Table 4. **Partial Correlation Matrix of Individual Level Variables with AFQT Controlled**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mean Task Experience Rating</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Mean NTP Estimate</td>
<td>.30**</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Job Tenure</td>
<td>.19*</td>
<td>.51**</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>4. Job Knowledge</td>
<td>.17*</td>
<td>.27**</td>
<td>.04</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* p < .05  
** p < .01  
n (listwise deletion) = 127

Table 5. **Descriptive Statistics for Task Level Variables**

<table>
<thead>
<tr>
<th>Variable†</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Experience Rating</td>
<td>1.02</td>
<td>1.01</td>
<td>-1.09</td>
<td>2.83</td>
</tr>
<tr>
<td>- Job knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- b weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NTP Estimate - Job knowledge</td>
<td>-.29</td>
<td>.81</td>
<td>-2.18</td>
<td>1.01</td>
</tr>
<tr>
<td>- b weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task Experience Rating</td>
<td>-.02</td>
<td>.66</td>
<td>-2.97</td>
<td>1.10</td>
</tr>
<tr>
<td>× Cognitive Ability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- b weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NTP Estimate × Cognitive Ability</td>
<td>-.07</td>
<td>.02</td>
<td>-.13</td>
<td>-.03</td>
</tr>
<tr>
<td>- b weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning Difficulty Index Scores</td>
<td>5.02</td>
<td>.92</td>
<td>3.48</td>
<td>7.05</td>
</tr>
</tbody>
</table>

n = 24 tasks  
† b weights derived from n = 165
Hypothesis 1 predicted a positive relationship between work experience and job knowledge. To test this hypothesis, an average score for both task experience ratings and NTP estimations across the 24 tasks was computed. Simple regression was then used to separately test the significance of the relationships between the three measures of work experience and job knowledge. Subjects' AFQT scores were also entered into the regression equations so that the relationship between work experience and job knowledge could be examining with the effect of cognitive ability controlled. Since the validities across analyses were to be compared, only subjects with complete data on all variables were used. This insured equal sample sizes in the derivation of the regressions' beta weights.

Tables 6, 7 and 8 provide the regressions equations' statistics for job tenure, task experience ratings, and NTP estimates, respectively. Results indicated that after controlling for cognitive ability, there was a non-significant relationship between job tenure and job knowledge (Beta = .04). Subjects’ scores on the job knowledge test did not vary as a function of how long they may have been on the job. However, the relationships between the task experience measures and job knowledge were significant, thus giving support to Hypothesis 1. Results indicate a positive relationship between subjects' task experience ratings and job knowledge scores (Beta = .17, \( p < .05 \)), as well as a positive relationship between subject’s NTP estimations and job knowledge scores (Beta = .27, \( p < .001 \)). Those subjects with higher task experience were more likely to have higher job knowledge scores. Regression tests of the quadratic expressions of the task experience
measures on job knowledge were non-significant. This indicates that at the time the data were collected, job knowledge was still following a linear trend, and had not reached an asymptote.

Table 6.  
Regressions for Job Tenure and Job Knowledge

<table>
<thead>
<tr>
<th>Variable</th>
<th>b</th>
<th>SE b</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFQT</td>
<td>.283</td>
<td>.068</td>
<td>.35</td>
<td>4.18***</td>
</tr>
<tr>
<td>Job Tenure</td>
<td>.002</td>
<td>.004</td>
<td>.04</td>
<td>.46</td>
</tr>
<tr>
<td>(Constant)</td>
<td>77.63</td>
<td>4.44</td>
<td></td>
<td>17.44***</td>
</tr>
</tbody>
</table>

n = 126  
*** = p < .001

Table 7.  
Regressions for Task Experience Ratings and Job Knowledge

<table>
<thead>
<tr>
<th>Variable</th>
<th>b</th>
<th>SE b</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFQT</td>
<td>.28</td>
<td>.07</td>
<td>.35</td>
<td>4.27***</td>
</tr>
<tr>
<td>Task Experience Ratings</td>
<td>2.80</td>
<td>1.40</td>
<td>.17</td>
<td>2.00*</td>
</tr>
<tr>
<td>(Constant)</td>
<td>70.43</td>
<td>5.65</td>
<td></td>
<td>12.46***</td>
</tr>
</tbody>
</table>

n = 126  
* = p < .05  
*** = p < .001
Table 8.  *Regressions for NTP Estimate and Job Knowledge*

<table>
<thead>
<tr>
<th>Variable</th>
<th>b</th>
<th>SE b</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFQT</td>
<td>.26</td>
<td>.07</td>
<td>.32</td>
<td>3.97***</td>
</tr>
<tr>
<td>NTP Estimate</td>
<td>5.54</td>
<td>1.65</td>
<td>.27</td>
<td>3.35***</td>
</tr>
</tbody>
</table>

(Constant) 71.25 4.41 16.41***

n = 126  
*** = p < .001

Hypothesis 2 predicted a stronger validity for task experience than for job tenure in predicting job knowledge. As shown, the correlations for both the task experience ratings and NTP estimates in predicting job knowledge were higher than job tenure's (see Table 4). Regression analyses were then used to test the independent effects of task experience in the prediction of job knowledge. Subjects' AFQT scores and job tenure were entered into the equations so that the unique contribution of task experience in predicting job knowledge could be examined. Results indicated that after controlling for AFQT and job tenure, task experience predicted job knowledge for both the task experience ratings (Beta = .16, p < .05) and the NTP estimates (Beta = .34, p < .001). Thus, support for Hypothesis 2 was demonstrated. See Tables 9 and 10.
Table 9. Unique Prediction of NTP Estimates on Job Knowledge

Dependent Variable = Job Knowledge

<table>
<thead>
<tr>
<th>Variable</th>
<th>b</th>
<th>SE b</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFQT</td>
<td>.27</td>
<td>.07</td>
<td>.33</td>
<td>4.08***</td>
</tr>
<tr>
<td>Job Tenure</td>
<td>-.01</td>
<td>.004</td>
<td>-.13</td>
<td>-.142</td>
</tr>
<tr>
<td>NTP Estimate</td>
<td>6.91</td>
<td>1.91</td>
<td>.34</td>
<td>3.62***</td>
</tr>
<tr>
<td>(Constant)</td>
<td>72.47</td>
<td>4.47</td>
<td></td>
<td>16.18***</td>
</tr>
</tbody>
</table>

n = 126
*** = p < .001

Table 10. Unique Prediction of Task Experience Ratings on Job Knowledge

<table>
<thead>
<tr>
<th>Variable</th>
<th>b</th>
<th>SE b</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFQT</td>
<td>.28</td>
<td>.07</td>
<td>.35</td>
<td>4.21***</td>
</tr>
<tr>
<td>Job Tenure</td>
<td>.0003</td>
<td>.004</td>
<td>.007</td>
<td>.09</td>
</tr>
<tr>
<td>Task Experience Ratings</td>
<td>2.78</td>
<td>1.43</td>
<td>.16</td>
<td>1.95*</td>
</tr>
<tr>
<td>(Constant)</td>
<td>70.33</td>
<td>5.79</td>
<td></td>
<td>12.15***</td>
</tr>
</tbody>
</table>

n = 126
* = p < .05
*** = p < .001

Task Difficulty x Task Experience Interaction

Hypothesis 3 predicted that task difficulty would moderate the relationship between task experience and job knowledge. Task difficulty was measured as a task-level variable (variance occurs between each task),
and task experience and job knowledge were individual-level variables (variance occurs between each individual). To integrate these variables into a single equation for significance testing, the task experience - job knowledge relationship needed to be transformed into a task-level variable. To do this, a simple regression with task experience predicting job knowledge was conducted for each task so that:

$$ JK_j = b_{gj} + b_{TEj} + e $$

where $JK$ is the job knowledge score for subject $j$, $g_j$ is the AFQT score for subject $j$, $TE$ is the task experience score for subject $j$, $b$ represents the unstandardized regression weight for the respective variables ($b$ weight), and $e$ is error. Unstandardized regression weights, as opposed to standardized regression weights (Beta weights), were chosen because the original units of measurement are meaningful. Unstandardized regression weights remain in raw units while Beta weights are derived from the standardized variables. Therefore $b$ weights are more stable than Beta weights as "one goes from study to study" (Cohen & Cohen, 1983, p. 366). Each task then had two new variables: the resulting $b$ weights (across all subjects) representing the relationships (slopes) between task experience ratings and job knowledge and between NTP estimates and job knowledge. These two new $b$ weights (one for each measure of task experience) were then regressed upon the tasks' LDI scores. Subjects' AFQT scores were also entered into the regression equations so that the relationship between task experience and job knowledge could be examined with the effects of cognitive ability controlled. To insure equal sample sizes for all regression analyses, only subjects with data on all tasks were used ($n = 165$).
significant correlation (across tasks) would indicate that the relationship between task experience and job knowledge varies as a function of task difficulty, thus an interaction.

Results were mixed. The b weights from the NTP estimation - job knowledge regressions were not predicted by the tasks' difficulty ($r = .14$, n.s.). However, the relationships between task experience ratings and job knowledge did vary as a function of task difficulty ($r = .67$, $p < .001$). See Table 11. As the difficulty of the tasks increased linearly, there was a stronger, positive relationship between task experience and job knowledge. Figure 1 shows the nature of this interaction. For graphing purposes, task difficulty and task experience were dichotomized into high (+1 sd) and low (-1 sd) groups to form an artificial $2 \times 2$ matrix. The figure shows that the relationship between task experience and job knowledge is stronger positive for higher difficult tasks than it is for lower difficult tasks, thus support for Hypothesis 3 was provided.

Table 11. **Regressing Task Experience Ratings - Job Knowledge b Weights on LDI Scores**

<table>
<thead>
<tr>
<th>Variable</th>
<th>b</th>
<th>SE b</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Experience Ratings - Job Knowledge b weights</td>
<td>.61</td>
<td>.14</td>
<td>.67</td>
<td>4.27***</td>
</tr>
<tr>
<td>(Constant)</td>
<td>4.39</td>
<td>.20</td>
<td></td>
<td>21.00***</td>
</tr>
</tbody>
</table>

n = 24
*** = $p < .001$
Figure 1.  *Task Difficulty × Task Experience Interaction*
Hypothesis 4 predicted that the job knowledge learning curve would vary as a function of subjects' cognitive ability. To test this, the average score for each subject's task experience ratings and NTP estimations across the 24 tasks were used. Moderated regression was conducted for both measures of task experience. A test of the quadratic task experience × AFQT interaction was non-significant for both measures of task experience. However, results did indicate a significant linear interaction between task experience and AFQT scores in the prediction of job knowledge. See Tables 12 and 13. Findings indicate that the relationship between task experience ratings and job knowledge was stronger when cognitive ability was high (see Figure 2). Similarly, the relationship between NTP estimations and job knowledge was stronger when cognitive ability was high (see Figure 3). This indicates that, in terms of their job knowledge, those subjects with higher cognitive ability demonstrated greater benefit from increased task experience.

Table 12.  *Cognitive Ability  × NTP Estimate Interaction*

<table>
<thead>
<tr>
<th>Variable</th>
<th>b</th>
<th>SE b</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTP Estimate</td>
<td>13.22</td>
<td>3.23</td>
<td>1.31</td>
<td>4.09***</td>
</tr>
<tr>
<td>AFQT</td>
<td>.53</td>
<td>.09</td>
<td>.75</td>
<td>5.87***</td>
</tr>
<tr>
<td>NTP × AFQT</td>
<td>-.16</td>
<td>.04</td>
<td>-1.63</td>
<td>-4.37***</td>
</tr>
<tr>
<td>(Constant)</td>
<td>58.33</td>
<td>6.50</td>
<td></td>
<td>8.98***</td>
</tr>
</tbody>
</table>

n = 166
*** = p < .001
Table 13.  *Cognitive Ability × Task Experience Ratings Interaction*

**Dependent Variable = Job Knowledge**

<table>
<thead>
<tr>
<th>Variable</th>
<th>b</th>
<th>SE b</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Experience Ratings</td>
<td>-4.66</td>
<td>3.92</td>
<td>-.28</td>
<td>-1.19</td>
</tr>
<tr>
<td>AFQT</td>
<td>-.15</td>
<td>.19</td>
<td>-.21</td>
<td>-.78</td>
</tr>
<tr>
<td>TER × AFQT</td>
<td>.13</td>
<td>.06</td>
<td>.68</td>
<td>2.04*</td>
</tr>
<tr>
<td>(Constant)</td>
<td>94.88</td>
<td>11.68</td>
<td></td>
<td>8.12***</td>
</tr>
</tbody>
</table>

n = 166  
* = p < .05  
*** = p < .001

Figure 2.  *Task Experience Ratings × Cognitive Ability Interaction*
Cognitive Ability $\times$ Task Difficulty $\times$ Task Experience Interaction

Hypothesis 5 predicted a three-way interaction between task experience, cognitive ability, and task difficulty, on job knowledge. To test this hypothesis, b weights were derived from a regression model so that:

$$ JK_j = b \ TE_j + b \ gj + b \ TE_j \times gj + e, $$

where JK is the job knowledge score for subject $j$, TE is the task experience score for subject $j$, g is the ASVAB score for subject $j$, TE $\times$ g is the interaction term, b represents the unstandardized regression weight for the respective variables (b weight), and e is error. The b weight for the
interaction term has partialed out the main effects of task experience and cognitive ability. To insure equal sample sizes for all regression analyses, only subjects with data on all tasks were used. Each task then had two new variables: the resulting b weights (across all subjects) representing the task experience ratings × cognitive ability interaction term on job knowledge and the NTP estimate × cognitive ability interaction term on job knowledge. These two new b weights (one for each measure of task experience) were then regressed upon scores of the task learning difficulty index (LDI). Significant correlations (across tasks) indicate that the task experience × cognitive ability interaction on job knowledge varies as a function of task difficulty, thus a three-way interaction.

Results were mixed. The relationship between the b weight of the task experience ratings × cognitive ability interaction term and the LDI scores was non-significant ($r = .29$, n.s.). However, the relationship between the b weight of the NTP estimation × cognitive ability interaction term and the LDI scores was significant ($r = -.57$, $p < .01$). See Table 14. As the difficulty of the tasks increased, the b weight of the NTP × cognitive ability interaction term decreased.

Table 14. *Regressing NTP × AFQT Interaction Terms’ b Weights on LDI Scores*

<table>
<thead>
<tr>
<th>Variable</th>
<th>b</th>
<th>SE b</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTP × AFQT b Weights</td>
<td>-.02</td>
<td>.005</td>
<td>-.57</td>
<td>-3.28**</td>
</tr>
<tr>
<td>(Constant)</td>
<td>.008</td>
<td>.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*n = 24

** = $p < .01$
Figures 4 shows the nature of this interaction. For graphing purposes, task difficulty, cognitive ability, and task experience were each dichotomized into high (+1 sd) and low (-1 sd) groups to form an artificial $2 \times 2 \times 2$ matrix. The graphs indicate the nature of the ability $\times$ experience interaction changes as a function of task difficulty. For high difficult tasks, the relationship between task experience and job knowledge was stable across levels of cognitive ability. However, when task difficulty was low, there was a positive relationship between task experience and job knowledge for high ability subjects and a negative relationship between task experience and job knowledge for low ability subjects.
Figure 4. *Task Difficulty × Cognitive Ability × Task Experience Interaction*

**Low Difficult Tasks**

![Graph showing the relationship between NTP Estimates and Job Knowledge for High and Low Ability in low difficulty tasks.]

**High Difficult Tasks**

![Graph showing the relationship between NTP Estimates and Job Knowledge for High and Low Ability in high difficulty tasks.]

Discussion

Summary of Results

The purpose of the present study was to provide insight on theoretical and methodological factors that influence the relationship between work experience and job knowledge. From a review of cognitive, human factors, and traditional industrial/organizational psychology literature, five hypotheses were developed. First it was hypothesized that a positive relationship would exist between work experience and job knowledge, and second, that this relationship would be stronger when work experience was measured at the task level as opposed to the job level. These hypotheses were supported. While job tenure did not predict job knowledge, the amount of subjects’ task experience did. This is consistent with Quiñones, et al. (1995) which found that task level measures of experience demonstrated higher validity in predicting performance. Previous research has reported a significant relationship between job tenure and job knowledge (Schmidt, et al., 1986). One possible reason that job tenure was not predictive of job knowledge in the present study was the relatively smaller range of incumbents’ job tenure. In the Schmidt et al. study, job tenure means varied from 2.56 years to 3.75 years. In this study, the range was .45 to 3.08 years with a mean of 1.65. Despite this, the pattern of results are consistent with the a priori hypotheses.

The test for a quadratic trend for work experience by linear job knowledge was not significant, implying that job knowledge had not reached asymptote. This suggests that learning was still occurring as a function of work experience.
It was further hypothesized that task difficulty would moderate the relationship between work experience and job knowledge. Mixed results were found for this hypothesis. No task experience $\times$ task difficulty interaction was found using NTP estimates. However, when subjects' task experience ratings were used, it was demonstrated that the relationship between task experience and job knowledge was strongest when tasks were difficult, thus supporting Hypothesis 3. This is consistent with Lance, et al. (1989) who reported a stronger relationship between task experience and performance for the more difficult tasks.

The results for hypothesis 3 could have possibly been explained if (1) the more difficult tasks were either more heavily represented in the job knowledge test and thus correlated more strongly with the total test score, or (2) there was more variance across subjects in the experience ratings for the more difficult tasks. Both of these alternative explanations were tested.

First, for each task, a score was assigned that represented the number of questions in the job knowledge test that regarded that particular task. This new variable was then separately regressed upon (1) the tasks' LDI scores and (2) the tasks' experience-job knowledge b weights. There was no relationship between the number of task-specific questions and the experience-job knowledge b weights ($R^2 = .14$, n.s.) nor between the number of questions and the LDI scores ($R^2 = .01$, n.s.). Thus, this alternative explanation was discounted.

Another explanation which was explored was that there could have been more variance across subjects in the task experience ratings for the more difficult tasks. This higher variance may have accounted for a difference in the correlations. To test this, each task was assigned a new score corresponding to the standard deviation of that particular task's
experience rating across subjects. This new variable was then separately regressed upon (1) the tasks LDI scores and (2) the tasks' experience-job knowledge b weights. Results were non-significant. There was no relationship between the standard deviation of the tasks' experience ratings and the experience-job knowledge b weights ($R^2 = .03$, n.s.) nor with the LDI scores ($R^2 = .01$, n.s.). Thus, this alternative explanation was also discounted.

The fourth hypothesis predicted that cognitive ability would moderate the task experience $\times$ job knowledge relationship. A significant task experience $\times$ cognitive ability linear interaction was found. The pattern of this interaction indicated a stronger relationship for the higher cognitive ability subjects than for the lower cognitive ability subjects. Given that the job knowledge scores for both high and low ability subjects had not yet reached asymptote (as tested in hypothesis 1), it appears that subjects were still in the early stages of skill acquisition. According to Ackerman (1989, 1992), during this stage, individuals are acquiring knowledge. This would explain why the levels of job knowledge for subjects in this study continued to increase with additional task experience. This study demonstrated that the relationship between task experience and job knowledge became stronger as cognitive ability increased. It can be concluded that the higher ability subjects were able to obtain higher levels of job knowledge more quickly.

The final hypothesis predicted a cognitive ability $\times$ task difficulty $\times$ task experience interaction on job knowledge. Mixed results were demonstrated. No interaction was found using subjects' task experience ratings. However, a significant interaction was demonstrated with subject's NTP estimates. The relationship between task experience and job
knowledge did not vary as a function cognitive ability when task difficulty was high. However, when task difficulty was low, the relationship between task experience and job knowledge was positive for high ability subjects and negative for low ability subjects. Although the interaction was significant, the findings were not congruent with the prediction of the original hypothesis.

The question remains as to why experience with low difficult tasks is negatively related to job knowledge for subjects with lower cognitive ability. One possibililty could be that the subjects were not given equal opportunity to perform the various tasks. In other words, perhaps those subjects with low levels of job knowledge either selected or were allocated a disproportionately low amount of high difficult tasks.

To test this explanation, subjects' data were divided into high or low cognitive ability (+/- one standard deviation). This left 52 subjects. Also, tasks were divided into high and low difficulty (+/- one standard deviation). This left 4 high difficult tasks, and 4 low difficult tasks. Each of the included subjects then had a mean NTP estimate for both high and low difficult tasks. This produced a 2 × 2 mixed design that was then subjected to a multivariate analysis of variance (MANOVA). Table 15 displays the means and standard deviations for the analysis.

Table 15. Descriptive Statistics for Cognitive Ability × Task Difficulty MANOVA

<table>
<thead>
<tr>
<th></th>
<th>Low Ability</th>
<th>High Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Difficulty</td>
<td>2.60 (.98)</td>
<td>4.39 (2.16)</td>
</tr>
<tr>
<td>High Difficulty</td>
<td>.69 (.49)</td>
<td>3.01 (2.9)</td>
</tr>
</tbody>
</table>

Subject n=52
Results of the MANOVA indicate a significant AFQT by task difficulty interaction, $F (1,50) = 8.79, p<.01$. See Table 16. Figure 5 demonstrates the nature of this interaction. The within subject difference between NTP estimates for low and high task difficulty tasks varied as a function of cognitive ability, with a greater difference being demonstrated by low cognitive ability subjects. Thus, according to subjects' NTP estimates, it appears that (1) high difficult tasks were performed less often than low difficult tasks, (2) low cognitive ability subjects reported less experience on the tasks used in this analysis, and (3) there was a greater difference between NTP estimates for low and high difficult tasks for the low cognitive ability subjects. This indicates that although all subjects performed the more difficult tasks less frequently, the low cognitive ability subjects received a disproportionately lower opportunity to perform the more difficult tasks.

Table 16. MANOVA Statistics for Cognitive Ability $\times$ Task Difficulty Interaction in Predicting Task Experience

<table>
<thead>
<tr>
<th>Dependent Variables = Mean NTP for Low Difficult Task</th>
<th>Mean NTP for High Difficult Task</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Between Subject Effects</strong></th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFQT</td>
<td>124.37</td>
<td>1</td>
<td>124.37</td>
<td>16.86***</td>
</tr>
<tr>
<td>Within Cells</td>
<td>368.87</td>
<td>50</td>
<td>7.38</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Within-Subject Effects</strong></th>
<th>SS</th>
<th>DF</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Difficulty</td>
<td>57.46</td>
<td>1</td>
<td>116.13***</td>
</tr>
<tr>
<td>AFQT $\times$ Task Difficulty</td>
<td>4.35</td>
<td>1</td>
<td>8.79**</td>
</tr>
<tr>
<td>Within Cells</td>
<td>24.74</td>
<td>50</td>
<td>.49</td>
</tr>
</tbody>
</table>

$n=52$

** = $p < .01$

*** = $p < .001$
Figure 5. Cognitive Ability $\times$ Task Difficulty Interaction in Predicting Task Experience

Conclusions

The results of this study have theoretical, methodological, and practical implications. Previous research has demonstrated that the relationship between work experience and performance is mediated by job knowledge (Hunter, 1983; Schmidt, et al., 1986). Others have demonstrated that task level measures of work experience have the highest validity in predicting performance (Quiñones, et al., 1995). This study adds to the literature by demonstrating that amount based, task level measures of work experience are stronger predictors of job knowledge than time-based, job level measures. In addition it was demonstrated that the work experience-job knowledge relationship is moderated by both cognitive ability and task difficulty.
The construct of work experience has been traditionally used in the work place to predict performance. These findings reinforce the idea that the function that work experience plays on outcome variables is not a matter of how long an individual has held a particular position, but rather is a function of the types of tasks with which a person has had experience, as well as the frequency in which those tasks were performed. One can then use this amalgamation of experience information in the prediction of job specific knowledge.

This study has also demonstrated that cognitive ability moderates the work experience - job knowledge relationship. Future research can examine the extent to which other individual differences serve as moderators. For instance, perhaps incumbents with high motivation show greater benefit from task experience. In addition, there could be factors at the work environment level, such as supervisor or work group support, that may also serve as moderators.

The present study was conducted in a field environment as opposed to a lab. With field studies come both advantages and disadvantages. The major disadvantages manifested in the present study are (1) a lack of control of variables that may have influenced task experience scores, (2) the task experience scores that were reported may not have captured a subject's "true" experience, and (3) the present study is correlational which limits the cause and effect conclusions that can be drawn.

Low ability subjects reported disproportionately low levels of experience with high difficult tasks. However, whether this is a function of task selection or allocation, can not be explored by this study and remains a topic for future research. Regardless, however, this level of experience has practical implications. Past research has found that individuals are not
necessarily equal in the opportunities to perform job tasks (i.e., gain experience) (Ford, et al., 1992; Quiñones, Ford, Sego, & Smith, 1995). For instance, incumbents within a job may have various levels of knowledge, skills, and abilities, and those judged to be less effective may be assigned different duties or assigned the job in name only (Vineberg & Joyner, 1983). How variations in opportunities to gain on the job experience influence various outcomes is a continuing topic of research. This study has demonstrated construct validity for the task experience, as well as cognitive ability, task difficulty and job knowledge measures. In addition, it was shown that the work environment can be considered a learning environment. Overall, with the effects of cognitive ability controlled, as incumbents reported more task experience, their job knowledge increased. Therefore, any prohibition of task experience, either self imposed or imposed by a supervisor, deprives an individual of a primary mechanism through which job knowledge is acquired.

The method through which task experience was measured is another limitation of the study. Consistent with others, this study emphasizes the need to measure experience in a method that has theoretical relevance to the criterion of interest. However, this study measured, what was in essence, individuals’ perceptions of their experience. It has been argued that while relative frequency scales provide within-job task data, more absolute frequency scales may provide the means for across job comparisons (Harvey, 1991; Richman & Quiñones, 1996). Although subjects in this study were asked to rate their task experience in an apparently objective manner (i.e., “I have no experience/great deal of experience on the task”, as opposed to “I conduct this task more often than other tasks in my job”), it could be that subjects instinctively used other job tasks as a frame of
reference and thus made relative task experience comparisons. There is no reason to believe that such comparisons were made when subjects provided estimates of the number of times each task was performed. However, neither measure may not have adequately captured subjects' "true" task experience. Research has shown that both relative and absolute task experience ratings have modest correlations with actual task frequency (i.e., the same accuracy), however, the correlations between the two measures are relatively low (Richman & Quiñones, 1996). The mixed results demonstrated between the task experience measures within this study may be a function of this lack of correspondence.

Despite these limitations, the major advantages of conducting this study in a field setting were that (1) the tasks examined were real and meaningful, and (2) that the range of task experience exceeded that which could have been achieved in a laboratory setting. The twenty-four tasks that were studied came from a job analysis of the AGE career field, and thus represented actual incumbent job duties. In laboratory experiments, although presented in a controlled environment, subjects are often presented with new or novel tasks and their experience with these tasks is often limited to the relatively small range associated with psychological experimentation. The present study examined task experience that accumulated over a range from about half a year to a little over 3 years.

In conclusion, the work environment can be considered an avenue for continual on-the-job-training, or more accurately, on-the-job-learning. Goldstein (1993) argues that effective training systems should take into consideration trainees' attributes as well as task characteristics. This study has demonstrated that cognitive ability and task difficulty should be considered when modeling an effective on-the-job-learning environment.
Such information can be used to select individuals for training or assign them to particular training designs (Fleishman & Mumford, 1989). Consistent with this notion, models can be developed so that incumbents with various attributes would receive enough work experience to obtain the levels of job knowledge necessary to achieve appropriate levels of performance. This would be of particular importance to the military, where there are necessary levels of “military readiness” that must be maintained. This may also be of particular importance when certain variables are held relatively constant. For example, if by the nature of the work flow, or training time-line, it is not possible to give all incumbents great amounts of hands-on task experience, then a training design, or selection cutoff, using cognitive ability should be developed that considers the difficulty of the tasks. This follows a Fleishman & Mumford (1989) conclusion which recognized that high ability individuals may be able to develop skills more rapidly and also generate accurate job related mental models, while lower ability individuals may require trainers to build up these outcomes over an extended period of time.
References


