Developing Effective Military Leaders:
Facilitating the Acquisition of Experience-Based, Tacit Knowledge

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Overview

The objective of this project is to explore methods for facilitating the acquisition of tacit (i.e., experience-based) knowledge by military leaders. We are investigating the cognitive information processes through which individuals who gain relatively more from their experiences acquire information from stimuli and events in their environment. As tacit knowledge is a critical component of practical intelligence, we expect to show that facilitating the acquisition of tacit knowledge will, in turn, improve practical problem solving. Improved practical problem solving has obvious implications for improved leadership in the complex, rapidly changing environment in which military leaders must work.

During our three-year project we are furthering the development of a theoretical framework through which we describe the cognitive processes underlying tacit-knowledge acquisition and the metacognitive problem solving skills to which tacit knowledge is applied. Sternberg et al. (2000) define tacit knowledge as a complex set of condition-action propositions, the path through which individuals link the appropriate action to a particular condition or set of conditions. By illuminating the role of both the condition and action aspects of tacit knowledge in performance, our theoretical framework serves as the foundation for testing experimental interventions designed to improve the ease with which military leaders will gain from their experiences.

This three-year project therefore involves the development of tacit-knowledge assessments that will not only reflect individuals' choice of action to solve practical problems but will also probe into the cognitive processes and metacognitive problem solving skills individuals use to make their choices. In addition, this project involves the development of reflection methods in which individuals carefully consider the actions they have chosen, the potential impact of those actions, and the implications that impact has regarding the correctness of tacit knowledge. Described in more detail below, participants will receive experimental training interventions in which the degree to which focus on the condition or action aspects of tacit knowledge will be manipulated.

Progress Summary

Over the course of the past year, we have coordinated an extensive literature review with recent findings (Antonakis, Hedlund, Pretz, & Sternberg, 2001) to revise the experimental method presented in the original three-year project proposal, "Developing Effective Military Leaders: Facilitating the Acquisition of Experience-Based, Tacit Knowledge" (DASW01-99-K-0004). The literature review has indicated that two complementary approaches to understanding tacit knowledge have been explored. These approaches will be described and tested in the study

presented below. Further, a comprehensive theoretical model of tacit-knowledge acquisition and practical intelligence, developed in the past year and presented in Antonakis et al. (2001), serves as a springboard for framing the two complementary approaches to understanding tacit knowledge and making predictions regarding experimental training interventions. In addition, the findings from recent results (Antonakis et al., 2001) have implications for the particular training methods to be used in the experimental conditions. More specifically, the finding that brief group discussions of the TKML scenarios did not necessarily aid in performance and, in some cases, hurt performance suggests that more extensive training including individual feedback is necessary for facilitating tacit-knowledge acquisition. Finally, two new instruments for assessing tacit knowledge, PS1 and CS1 (see Antonakis et al., 2001), have been developed in the past year and will be administered as part of the proposed study, described below. For providing feedback in the training interventions, we have recently collected officers' (captains, majors, lieutenant colonels) predictions regarding the outcomes of least frequent (usually less-experienced) responses to the PS1.

Abstract

Below we present a revision of the experimental method presented in the original three-year project proposal, "Developing Effective Military Leaders: Facilitating the Acquisition of Experience-Based, Tacit Knowledge" (DASW01-99-K-0004). Though the stated purpose of the investigation, to "explore ways to promote the acquisition of a flexible base of tacit knowledge and develop the skills needed to acquire tacit knowledge," has not been changed, this revised method presents a study whose design is more in line with current theory and empirical findings regarding tacit knowledge, practical intelligence, and experience-based learning (e.g., Schön, 1983; Sternberg, 1998; Sternberg et al., 2000). Two complementary approaches to understanding tacit knowledge have been explored in the literature and will be tested in this study. The first approach, originating with Polyani (1966) and explored extensively by Sternberg and his colleagues (e.g., Sternberg & Wagner, 1992; Sternberg et al., 2000; Wagner, 1987; Wagner & Sternberg, 1991), is characterized by an information-processing explanation for how knowledge that is not easily articulated enhances performance. Efforts to facilitate the acquisition of tacit knowledge using this approach have targeted individuals' ability to identify the appropriate environmental conditions according to which they must act (e.g., Sternberg, Wagner, & Okagaki, 1993). The second approach, originating with Schön (1983), is characterized by a focus on developing tacit knowledge through personal reflection on the causal loop in which tacit knowledge, actions based on this knowledge, and consequences of the action taken, are situated. According to Schön (1983), action—which links tacit knowledge to action outcomes—and reflection—which links action outcomes to tacit knowledge—serve as the cornerstones of tacit-knowledge development. In the proposed study, three experimental training interventions will be tested in which focus on identifying the environmental conditions for action or reflection on action itself will be manipulated. The relative effectiveness of the experimental training interventions will be assessed at both the platoon and company levels of command[1].

[1] As the availability of active duty military personnel may not correspond to the design of the proposed study, we are considering conducting the study with individuals from the USMA, NTC, or AWC

Proposed Study

Research investigating tacit knowledge and experience-based learning indicates that individuals differ in their ability to learn from experience (McCall, Lombardo, & Morrison, 1988; Sternberg, et al., 2000; Wagner & Sternberg, 1991). In fact, it has long been recognized that knowledge or skill must come from an interaction between the individual and experience. As Argyris (1957) noted: "Experience *per se* teaches nothing. The way in which the individual *uses* experience is the crucial factor" (p. 15). Engaging in experiences leads to the acquisition of knowledge that has been labeled "tacit"—as such knowledge is gained implicitly from experience and is frequently difficult to verbalize (Raelin, 1997; Schön, 1983; Wagner & Sternberg, 1991)— and effective "use" of experience by individuals results in constructive interactions between individuals and their environments and the subsequent development of expertise. However, the processes through which individuals extract tacit knowledge from their experiences and apply that tacit knowledge to developing expertise have not been clearly identified (though see Sternberg, Okagaki, & Jackson, 1990; Sternberg, Wagner, & Okagaki, 1993).

The proposed study will investigate the process of tacit-knowledge acquisition and its facilitation in a military setting, as tacit knowledge appears to be a critical component of success not only in private sector management (McCall, et al., 1988; Myers & Davids, 1993; Wagner & Sternberg, 1991) but also in military leadership (Horvath et al., 1999; Sternberg et al., 2000). Tacit knowledge, through playing a key role in the application of practical intelligence, assists the individual in adapting to, selecting, and shaping the environment for the purposes of practical problem solving (Sternberg et al., 2000). This ability to modify the environment through which problems are defined and solved is of primary importance when practical problems are complex or difficult to characterize. Leadership training in the military emphasizes the necessity of developing leadership expertise in the field (Horvath, et al., 1999), reflecting awareness that the demands made on military leaders by a rapidly changing and uncertain environment require a flexible knowledge base that can be used for adaptation to, selection of, and shaping of the environment (Schön, 1983; Smith, Ford, & Kozlowski, 1997). More specifically, such a knowledge base allows individuals effectively to isolate the variables in the environment that are relevant to a particular action or set of actions and to determine relative relationships among the relevant variables, actions, and action outcomes (Schön, 1983; Tolman & Brunswik, 1935). Gaining a better understanding of the processes of tacit-knowledge acquisition and how to facilitate the use of these processes is clearly important to developing military leaders who will have a better conception of how to define practical problems and how to acquire the knowledge necessary for solving these problems.

Broadly speaking, the understanding of tacit knowledge and its role in performance has been approached through two complementary perspectives. The first perspective stems from Polyani's (1966) recognition of individuals' ability to implicitly acquire an understanding of the connection between a pattern of stimuli or events and an experience. Polyani (1966) used the example of a blind man identifying objects with a cane to illustrate tacit knowledge by noting how patterns of stimulation to the hand that occur when the cane touches an object become tacitly understood as the presence of the object itself. He noted that the man using the cane would likely be unable to articulate how he "knows" there is an object at the end of the cane,

having focused his attention on the experience of the object, rather than on the sensations on his hand.

Furthering Polyani's (1966) discussion of tacit knowing, Sternberg and his colleagues (e.g., Sternberg & Wagner, 1992; Wagner, 1987; Wagner & Sternberg, 1991) have developed and tested a theory of tacit knowledge and practical intelligence, a component of Sternberg's broader theory of successful intelligence (Sternberg, 1988, 1996). The theory of successful intelligence recognizes the importance of analytical, creative, and practical abilities in the successful accomplishment of personally-valued goals within a particular socio-cultural context. Investigations of tacit knowledge and practical intelligence based on this theory explore the cognitive information processing that occurs when an individual acts on his or her tacit knowledge in a particular situation. As discussed in more detail in the next section, Sternberg and his colleagues have described tacit knowledge as a complex set of condition-action mappings through which individuals select and execute the appropriate action (e.g., turning to avoid a wall) given specific environmental conditions (e.g., stimulation to the hand holding the cane). Extensive research has been devoted to outlining the nature and content of tacit knowledge, specifically, the identification of the particular conditions to which action must be mapped in order to achieve desired action outcomes, as it is the condition calling for action that is the most difficult to articulate (see Sternberg et al., 2000, for a comprehensive review). Sternberg's theory regarding tacit knowledge and practical intelligence has led to the development of occupation-specific (e.g., management, military leadership) tacit-knowledge measures, in which individuals must select actions to solve practical problems based on their sensitivity to the environmental conditions in which the problems are situated.

The second perspective through which tacit knowledge is understood springs from Schön's (1983) work, in which Schön recognized the importance of taking action in shaping the contents of an individual's tacit-knowledge base. According to Schön (1983), tacit knowledge contains hypotheses for relational constraints in the environment and taking action is the necessary step for testing these hypotheses. Rather than specifying the precise conditions that give rise to particular actions, Schön's work and that of several other investigators interested in experience-based learning (e.g., Argyris, 1988; Epstein, 1999; Mezirow, 1991; Raelin, 1997) focuses on the hypothesis-testing process through which individuals come to understand the relational constraints in their environment.

Schön (1983) highlighted the importance of unexpected action outcomes in leading an individual to reflect on the tacit knowledge, or hypotheses, that led to taking the action. Reflection, if used effectively, leads to the updating of tacit knowledge and the increased occurrence of desired action outcomes. While time-consuming, reflection methods characteristic of this approach have been successfully used to enhance the performance of private sector managers (Argyris, 1994, 1999) and medical personnel (Epstein, 1999).

These two approaches to understanding tacit knowledge differ in that the first approach, taken by Sternberg and his colleagues, focuses primarily on the content of tacit knowledge—the conditions giving rise to action—while the second approach, characterized by Schön's work, focuses on the process of tacit knowledge—the actions that are linked to particular conditions and how action outcomes inform the development of tacit knowledge. Using Polyani's example of the blind man, Sternberg's approach focuses on identifying the pattern of stimulation to the hand that gives rise to the experience of an object. In contrast, Schön's approach focuses on how action derived from the expectation of experiencing a particular object, based on a specific pattern of stimulation to the hand, tests the expectation by presenting a situation in which the

action must lead to either a desired or undesired action outcome. If an undesired action outcome results, reflection on the expectations that led to the action may serve to enhance the tacit knowledge that gave rise to the expectation. The two approaches are complementary in that both appear to describe parts of the same whole. That is, although it is critical that an individual recognize the environmental conditions indicating particular actions to take in a given situation, the individual must also recognize how that information relates to particular action outcomes and how reflecting on this relationship leads to enhanced tacit knowledge.

The purpose of the proposed study is to test the relative contribution of these two approaches in facilitating the tacit-knowledge acquisition and practical intelligence of military leaders. Such knowledge and ability would equip individuals to better adapt to, select, and shape the demanding and rapidly changing environments in which they must work. The primary goal of this study is not to teach specific tacit knowledge itself but to develop a better understanding of how to increase individuals' ability to learn from experience (see Horvath et al., 1999). Through targeting ability to acquire tacit knowledge, we expect an increase in tacit knowledge and an increased ability to recognize the practical situations to which acquired knowledge could effectively transfer. The expected outcomes associated with reaching this goal are the development of cognitive strategies for learning from experience and the demonstration of practical intelligence, that is, the application of tacit knowledge to solving practical problems.

Literature Review

Tacit Knowledge and Practical Intelligence – An Information-Processing Approach

Polyani (1966) noted that a critical factor contributing to the implicit, rather than explicit, acquisition of knowledge is the direction of attention away from the particular stimuli or events that give rise to an experience and toward the experience itself. To take a practical situation, when determining the receptivity of a potential romantic partner, individuals often report experiencing the reaction of the potential partner to their romantic approach, for example, having "butterflies in the stomach." Attention here is focused away from cues such as body language and toward the experience of the potential partner's interest level. Further, when determinations of interest level are correct and action is taken, desired outcomes are commonly attributed to a capacity possessed by the successful individual to attract romantic partners rather than to the individual's correct identification of the environmental conditions on which his or her action was based. This attribution is supported by the fact that successful individuals frequently cannot articulate their adaptive strategies. "How did you know she/he was interested?" "I don't know. I just got the right vibe."

In order to improve such determinations and resulting actions, however, attention must be directed back to the particular body language that individuals used as cues for action. Working primarily in the domain of complex problem solving, Sternberg and his colleagues (Horvath et al., 1999; Sternberg et al., 2000; Sternberg & Wagner, 1992) have taken an information-processing approach to describe the relationship between the particular stimuli or events that give rise to action and the selection of action itself. They describe tacit knowledge as a complex set of condition-action mappings through which individuals select and execute the appropriate action given specific environmental conditions.

Sternberg and his colleagues characterize tacit knowledge as having three critical features. First, tacit knowledge is acquired through a process that is individual and personal. That

is, tacit knowledge is acquired with little explicit support from sources external to the learner, such as conventional classroom curricula. Second, tacit knowledge contains information regarding the appropriate responses to particular situations. This feature illuminates the action or procedural orientation of tacit knowledge as opposed to simply a fact or declarative orientation. Third, tacit knowledge is applicable to the accomplishment of personally-valued goals. Goals that are unrelated to an individual's success typically do not lead to the acquisition of an extensive body tacit knowledge, as the attention required for learning is devoted elsewhere.

Though tacit knowledge is often difficult to articulate verbally, the possession of tacit knowledge is demonstrated in the individual's general capacity to solve problems of a practical nature (Sternberg et al., 2000). That is, tacit knowledge plays a key role in practical intelligence--the ability to adapt to, select, and shape environments in order to solve everyday problems. The cognitive information processes required for problem solving include the following six metacognitive skills: problem identification, resource allocation, the representation and organization of information, strategy formulation, monitoring of problem-solving strategies, and evaluation of problem solutions (Sternberg, 1988). Based on the recognition that tacit knowledge cannot be directly measured, assessments of tacit knowledge involve the application of tacit knowledge to the solution of practical problems. Described in detail in Sternberg et al. (2000), the process of generating and selecting problems to be used in the assessments is geared toward developing problems that tap knowledge having the characteristics described above. Studies conducted by Sternberg and his colleagues (see Sternberg et al., 2000 for a summary) indicate that assessments of tacit knowledge are related to the performance of military leaders and that such assessments explain leadership effectiveness above and beyond frequently used measures of general cognitive ability. Thus by facilitating the acquisition of tacit knowledge, the metacognitive skills for practical problem solving may be more effectively used and performance—the demonstration of practical intelligence—consequently enhanced.

Sternberg and his colleagues (Sternberg et al., 2000; Sternberg & Wagner, 1992; Wagner & Sternberg, 1991) further describe three cognitive processes that underlie the acquisition of tacit knowledge: selective encoding, selective combination, and selective comparison of information. Selective encoding is defined as the extraction of information from the environment that is relevant to personally-valued goals. Selective combination is defined as the perception and imposition of synthesized patterns on the information extracted from the environment. Finally, selective comparison is defined as the integration of newly acquired knowledge with existing knowledge. These processes work interactively to reduce and organize the vast amount of information that the individual faces in any given situation, which is critical to effective decision making and performance (Schön, 1983; Weinstein & Mayer, 1986). Tacit knowledge, acquired through effective cognitive processes, combined with the ability to appropriately integrate information, should enhance the metacognitive skills used in practical problem solving. Thus, by increasing the effectiveness of selective encoding, combination, and comparison of information, the acquisition of tacit knowledge may be facilitated and practical problem solving improved. Described in more detail later, Sternberg, Okagaki, and Jackson (1990) and Sternberg, Wagner, and Okagaki (1993) have investigated with some success the effectiveness of training interventions targeting these cognitive processes.

As described in Sternberg et al. (2000), the body of tacit knowledge pertaining to military leadership can be divided into three broad categories: intrapersonal tacit knowledge (managing the self), interpersonal tacit knowledge (managing others), and organizational tacit knowledge (solving organizational problems). Interestingly, within these three categories, the relevance of

particular items of tacit knowledge to the jobs of leaders appears related to the rank of the leader (Horvath, et al., 1996). For example, tacit knowledge about managing the self (e.g., temper control, time management) has been reported by military personnel as particularly relevant to the job demands of military leadership for lieutenants, captains, or lieutenant colonels. In contrast, interpersonal tacit knowledge regarding the development of subordinates was shown to be primarily relevant to the jobs of captains in their verbal reports. The patterns of the relevance of tacit knowledge across ranks reflect the shift in job demands—from motivating subordinates using immediate, face-to-face leadership to fostering the future of the army through personnel development and vision—which occurs as military leaders are promoted (Donnithorne, 1993).

In summary, it appears that one path to facilitating the acquisition of tacit knowledge in military leaders may be through the development of more effective cognitive processes that selectively encode, combine, and compare information present in the occupational environment (for an exploration of this see Sternberg et al., 1990, 1993). Through the reduction and organization of information, the acquisition of tacit knowledge would influence the effectiveness and flexibility of the metacognitive skills used to solve practical problems in occupational environments, thus enhancing practical intelligence and development of expertise.

Theory-based Principles for Facilitating Tacit Knowledge Acquisition I: Targeting the Conditions for Action

By outlining the cognitive information processes underlying tacit knowledge and practical intelligence, the theory described above suggests the characteristics that efforts to improve tacit knowledge acquisition should share. That is, such efforts should involve the environmental context in which tacit knowledge is situated and yet should provide the individual with a somewhat more general facility to acquire tacit knowledge from experience. In the interests of developing a teaching strategy for improving the ability with which students adapt to, select, and shape their environments, Sternberg (1998) presented twelve principles for translating his theory of successful intelligence into specific instructional methods for schoolteachers. These principles provide an example of an instructional method geared toward facilitating tacit-knowledge acquisition in a particular environment while simultaneously suggesting general methods for learning from experience. Although practical intelligence represents but a component of the theory of successful intelligence, which also describes the critical contribution of analytical and creative intelligence to the adaptation to, selection of, and shaping of environments, we focus here on practical intelligence as it appears to be especially relevant to military leadership. A subset of the twelve principles—as it relates to practical intelligence in particular—is presented in this proposal, and serves as the basis for the design for some of the proposed experimental conditions.

Principle 1. The goal of instruction is the creation of expertise through a well and flexibly organized, easily retrievable knowledge base. This principle emphasizes the critical role that instruction plays in providing for the creation of expertise through an environment in which strategies for acquiring knowledge and skills are developed. In relation to the facilitation of tacit knowledge in military leaders, this principle reflects the importance of providing an instructional method in which military leaders can acquire a set of learning strategies to use adaptively in the field. As the unaided acquisition of tacit knowledge occurs through experience in actual occupational environments, the facilitation of tacit-knowledge acquisition in an experimental setting should provide insight regarding how such acquisition is done in the field, in order to

maximize its effectiveness and relevance (Horvath et al., 1999). Therefore, some of the experimental conditions will explore a method for helping officers take techniques for enhancing tacit knowledge and practical intelligence to the field both in peacetime and in combat.

Principle 2. Instruction and assessment should involve utilization, at various times, of all six metacomponents of the problem-solving cycle. As stated previously, tacit knowledge is required in order to apply practical intelligence toward successfully solving practical problems that occur on the job. However, because tacit knowledge cannot be directly measured, tacit-knowledge assessments require well-developed problem-solving skill. Facilitation of tacit-knowledge acquisition may not occur simply through the recognition of relevant information and associated actions, but also through the successful use of this recognition. Therefore, some of the proposed experimental conditions will explore the role of the six metacognitive skills of problem solving in order to better understand the interplay between tacit knowledge and performance on tacit-knowledge assessments.

3. Instruction should involve utilization, at various times, of at least three knowledge-acquisition components, including (a) selective encoding, (b) selective comparison, and (c) selective combination. Findings described in Sternberg et al. (1993) suggest that targeting the cognitive processes underlying tacit-knowledge acquisition (i.e., selective encoding, combination, and comparison) is critical for enhancing performance. Sternberg et al. (1993) tested a tacit-knowledge training intervention in which they attempted to enhance the effectiveness of trainees' cognitive processes in private-sector management situations. In the experiment, three groups of fifteen college students each received training in a particular process, either selective encoding, selective combination, or selective comparison. Two additional groups were used as controls, and did not receive an intervention. Sternberg et al. (1993) found that the training strategies were effective. That is, trainees who received cues for selective encoding or selective comparison targeted more relevant information than did the control groups, missed fewer relevant pieces of information, and had fewer false alarms—labeled fewer pieces of information as relevant when they were, in fact, irrelevant—than did the control groups. In order to test these findings in an actual occupational setting, some proposed experimental conditions will target the cognitive processes of the individual—particularly, selective encoding and selective combination of information—as well as the metacognitive skills for problem solving. Findings from a study in which the training of cognitive processes and metacognitive skills enhanced the practical thinking of high school students (Sternberg et al., 1990) indicate that such a test will yield positive results.

4. Instruction should help students (a) adapt to, (b) shape, and (c) select environments. As described previously, the primary function of tacit knowledge and practical intelligence is to aid the individual in adapting to, shaping, and selecting environments that are practical in nature (e.g., finding a mate, performing well on the job, etc.). The broad focus of the experimental conditions designed to develop a better understanding of the acquisition of tacit knowledge and the development of practical intelligence should be relevant to the external, long-term outcomes of developed expertise—an adaptive and flexible overall relationship with the practical world (e.g., see Smith, Ford, & Kozlowski, 1997). Such a relationship would allow military leaders to better adapt to environments to which they are initially ill-suited, to select environments that allow them to capitalize on their strengths and compensate for their weaknesses, and to shape environments that would maximize both their learning and performance outcomes.

Learning from Experience – A Hypothesis-Testing Approach

Past work shows the often remarkable ability that individuals have to demonstrate effective knowledge without awareness (Schön, 1983). However, it also shows that tacitly held beliefs are frequently maladaptive (e.g., Argyris, 1988). Instead of attempting to characterize the nature and content of effective tacit knowledge, several investigators (Argyris, 1988; Epstein, 1999; McCall et al., 1988) have sought to investigate the effects of incorrect tacit knowledge and the processes through which this knowledge is updated or changed. Agreeing that being able to learn from experience is critical to job success, investigators taking this approach have devoted a great deal of research to developing models of on-the-job learning and to facilitating the acquisition of tacit knowledge in occupational environments (e.g., McCall et al., 1988; Myers & Davids, 1993; Nonaka, 1994; Raelin, 1997; Schön, 1983; Smith et al., 1997). Like the work of Sternberg and his colleagues, the work of these researchers emphasizes the importance of developing a flexible, adaptive body of knowledge that can be applied to problem solving in occupational environments in which the problems are complex and ill-defined. The findings from research and practice using this approach suggest that personal reflection guided by expert knowledge is critical for improving what is learned from experience—a practice used for instructing cadets in military leadership at West Point (McNally, Gerras, & Bullis, 1996).

Broadly defined, reflective practice is the use of introspection, typically initiated by unexpected action outcomes, to determine the relationship between tacitly held theories regarding actions and their related outcomes, the actions themselves, and the actual outcomes of those actions (Aryris, 1999; Epstein, 1999; Mezirow, 1991; Raelin, 1997). Ideally, reflection is integrated with action so that reflection and action work seamlessly together to update knowledge and enhance performance (Schön, 1983). However, Schön (1983) noted that the timeline defining action may range in length from just a few seconds (e.g., kicking a field goal) to several months (e.g., preparing a legal case) to even an entire career. He also observed that the shorter action timelines are less likely to benefit from reflection than the longer ones, as there is more opportunity for reflection to interrupt the action process. Reflection, however, may also occur *after* an action has been taken. Indeed, several reflective-practice methods described in the literature involve introspection on actions already taken rather than introspection during the course of action (Epstein, 1999; Raelin, 1997). Still, the goal of such methods is to facilitate learners' ability to reflect in real time.

The utility of reflective practice methods for organizations is apparent when one notes that articles or book chapters describing such methods are typically found in publications geared toward practitioners (e.g., Epstein, 1999; Raelin, 1997) or at least that discuss the use of work on reflection in the field (e.g., Argyris, 1999; McCall et al., 1988; McNally et al., 1996). However, the effects that reflection has on occupational effectiveness are still not fully known and there are diverse points of view regarding the usefulness of introspection with regards to identifying and changing behavior (e.g., Mezirow, 1991; Nisbett & Wilson, 1977; Nonaka, 1994; Schön, 1983). Further, theory regarding the processes through which reflective practice has its influence is diverse. Nevertheless, there do appear to be some common threads that tie this body of work together. Mezirow (1991) revealed one thread quite clearly in his book, in which he claimed that hypothesis testing is the fundamental basis of effective reflection. Indeed, other investigators share the conviction that developing ideas about the reasons for proceeding with a particular course of action, following up on those ideas by actually taking action, and then reflecting on the results, are steps that are critical to updating knowledge and improving performance (Argyris, 1999; Epstein, 1999; Schön, 1983).

Theory-based Principles for Facilitating Tacit Knowledge Acquisition II: Reflection and Action

While various reflection methods have been proposed (e.g., Argyris, 1999; Epstein, 1999; McNally et al., 1996; Raelin, 1997), as indicated above, there is general agreement on how these methods facilitate learning from experience and how use of these methods will be reflected in performance outcomes. These points of agreement serve as a useful springboard for developing principles on which an experimental reflection method may be based. Described below are three principles derived from the theory presented above, upon which the reflective-practice conditions in the proposed study will be based.

Principle 1. Reflection methods must direct attention to the precise action taken and the outcome of that action relative to some known standard. As noted previously, hypothesis testing—or testing of the tacitly held condition-action propositions—is critical to effective reflective practice and facilitating knowledge acquisition (Mezirow, 1991). Action plays a key role in this testing process (Schön, 1983). Reflection on the coupling of action taken and its consequences facilitates learning by requiring the learner to monitor the role of his or her actions in determining environmental outcomes that have been evaluated relative to some known standard. The known standard may reflect either personally- or culturally-valued behavioral goals. This alerts the learner to the possibility that there are tacit influences, possibly negative, on his or her decision-making (e.g., Argyris, 1988, 1999; Schön, 1983) and that he or she tacitly holds ideas regarding the condition-action relationships in the environment that constrain action outcomes (Schön, 1983; Tolman & Brunswik, 1935).

Principle 2. Reflection methods must direct attention to the tacit condition-action propositions that gave rise to the action taken. Awareness of the fundamental link between tacitly held condition-action relationships, action, and action outcomes is a critical step in improving decision making and is the primary goal of reflective practice (Argyris, 1988; Schön, 1983). Reflection increases learner awareness of this fundamental link through a process in which the learner must revisit a situation in which a desirable outcome did not follow action. After analyzing tacitly held beliefs regarding condition-action constraints in the environment, the individual engaged in reflective practice then selects the perceived best course of action to solve the problem, based on a newly developed understanding of condition-action relationships (e.g., see Epstein, 1999). Actions based on the new knowledge developed through reflection are then committed to test the validity of the knowledge (Epstein, 1999; Schön, 1983).

Principle 3. Initially, reflective practice should be guided by feedback, preferably that of an interested expert, so that newly developed condition-action propositions are less likely to be maladaptive. After actions are committed, feedback—ideally, performance outcomes accompanied by the guidance of experts—guides the development of further knowledge that can be applied to novel situations (McNally et al., 1996). Generally, the use of reflection methods is apparent in performance that is characterized by flexibility and adaptability in complex, rapidly changing, and ambiguous situations. However, this may not always be the case. Nisbett and Wilson (1977) described a series of experiments in which it was repeatedly demonstrated that individuals were unable to correctly identify the particular stimuli that influenced their judgment and decision making. The implication of this and related work (Nisbett & Bellows, 1977; Wilson & Nisbett, 1978) suggests that individuals may benefit differentially from reflective practice, depending on how adept they are at identifying the actual influences on their behavior. A further implication is that feedback may reduce individual differences. A final implication is that

without a specific target of reflection—cognitive knowledge- acquisition processes and metacognitive problem-solving skills—reflective practice has the potential to do more harm than good.

There are several specific methods through which reflective practice can be accomplished, including journal keeping/note taking, working with mentors, and group exercises (Raelin, 1997). Notably, each of these methods appears to follow the principles outlined above, and each has been demonstrated to be effective in the field. Argyris (1999) described a case-construction method in which trainees must evaluate the symmetry between their actions—in this case, their contribution to interpersonal interactions—and the intention behind their actions—in this case, tacit thoughts and feelings regarding the other person in the interaction. Argyris (1999) found that although this method is a time-consuming process, it is effective for helping leaders discover maladaptive assumptions regarding the people with which they interact and how they negatively influence interaction outcomes. Taking a different approach, McNally et al. (1996) described a reflection method at West Point in which small classroom groups participated in open-ended discussions that target the improvement of high-level analytical problem-solving skills.

Putting it all Together – A Conceptual Framework

As stated previously, the two approaches to understanding tacit knowledge presented above are complementary. Further, their corresponding implications for facilitating tacit-knowledge acquisition, the principles derived from the theory, can be integrated into a comprehensive framework for understanding the role that both the condition and action aspects of tacit knowledge play in practically intelligent performance. Reproduced and slightly modified below in Figure 1, is a theoretical framework presented in Antonakis, Hedlund, Pretz, and Sternberg (2001) that illuminates how these approaches fit together. Elements in the shaded portion of the figure represent the tenets of Sternberg's theory regarding practical intelligence and the role that tacit knowledge plays in the demonstration of practical thinking. Non-shaded elements represent the tenets of Schön's theory regarding the role of action and reflection in updating tacit knowledge. The condition and action aspects of tacit knowledge and practical problem solving are clearly represented in the top and bottom halves of the figure.

Illustrating the work of Sternberg and his colleagues, the framework draws clear links between the cognitive processes underlying knowledge acquisition and indicates the role that knowledge acquisition plays in supporting the cognitive metacomponents engaged in practical problem solving. Performance components then execute the decisions made by the individual. Activation of the performance components is shown to lead to a particular action, which leads to an outcome. Illustrating Schön's work, the action taken provides a test, the outcome of which will either serve to support existing condition-action propositions held by the individual or to challenge them. The connection between reflection on action outcomes and tacit knowledge is shown to occur in two possible ways. The first connection between reflection and action outcomes, shown in the middle of the figure, occurs when action outcomes are expected and the condition-action propositions contained in tacit knowledge are supported. Additionally, if action outcomes do not occur as expected, this connection represents the adjustment of action or application of tacit knowledge. The second connection between reflection and action outcomes, shown on the left side of the figure, indicates the path of re-integration of knowledge and re-

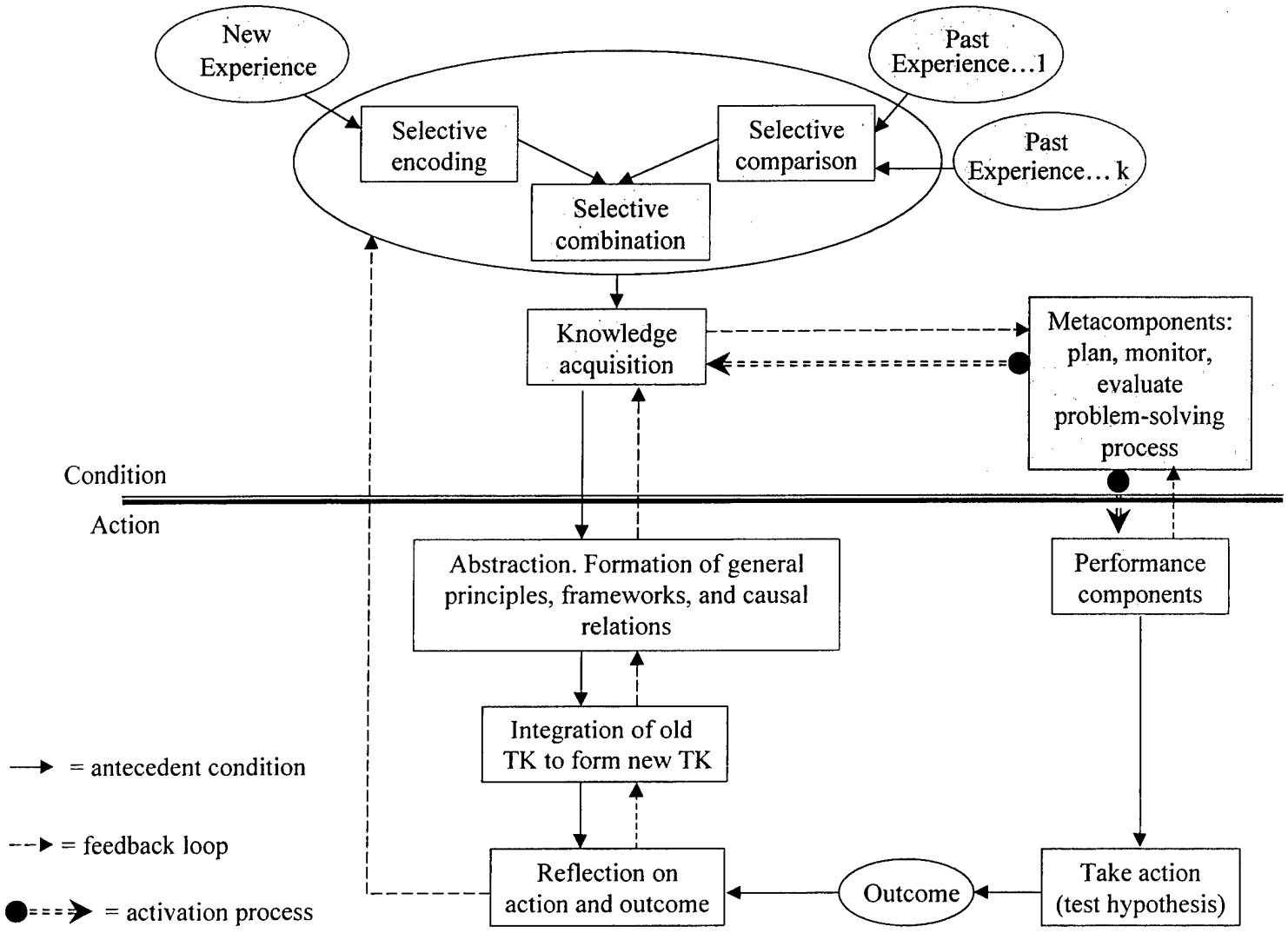

Figure 1 – Model of practical intelligence and tacit-knowledge acquisition (based on Antonakis et al., 2001)

formulation of condition-action propositions that occurs when unexpected outcomes occur as a result of action. This connection occurs when the individual must reframe the problem.

Together, the top and bottom halves of the figure clearly indicate the potential benefit of focusing on either the condition aspects of tacit knowledge, the action aspects of tacit knowledge, or both, when attempting to facilitate tacit-knowledge acquisition. With the proposed study, we will test the relative effectiveness of experimental conditions that reflect focusing on the condition, action, and combined condition-action aspects of tacit knowledge. In this way, we expect to determine the aspects of tacit knowledge on which attempts to facilitate such knowledge should focus in order to maximize both efficiency and effectiveness. In addition, we expect the findings of the proposed study to further inform theory regarding the complex relationship between information processing, action, and knowledge acquisition.

Research Method

General Overview

As stated above, the proposed study will examine the relative effectiveness of experimental training conditions in which the inclusion of knowledge-acquisition processes and metacognitive problem-solving skills and the inclusion of reflective practice methods are manipulated. More specifically, experimental conditions involving instruction that targets specific tacit-knowledge structures will focus on the cognitive processes underlying tacit-knowledge acquisition (i.e., selective encoding, combination, and comparison of information) and the metacognitive, problem-solving skills through which the possession of tacit knowledge is demonstrated. In keeping with previous investigations (Sternberg et al., 1990, 1993), such information will be in the form of cues regarding the relevant information and patterns of information present in specific tacit-knowledge scenarios and will target the seven metacognitive skills for practical problem solving: problem identification, resource allocation, representation and organization of information, strategy formulation, strategy monitoring, and solution evaluation. In contrast, experimental conditions involving instruction that targets the action aspects of tacit knowledge through testing individual hypotheses that give rise to the responses on the tacit-knowledge measures. Experimental conditions including reflective practice will provide the learner with a method for comparing his or her answers on the tacit-knowledge pre-test with those provided as feedback in the instruction, and a guided method for identifying the hypotheses on which the answers were based.

Based on relevant theory (McCall et al., 1988; Schön, 1983), it can be expected that reflection will facilitate tacit-knowledge acquisition. However, our own data reveal that reflection methods may be useful only when trainees already have an appropriate understanding of the information upon which reflection is being performed (Antonakis et al., 2001). In fact, without such an understanding, the effects of reflection may even be counterproductive. As described previously, Nisbett and his colleagues (Nisbett & Wilson, 1977; Nisbett & Bellows, 1977; Wilson & Nisbett, 1978) have demonstrated repeatedly that individuals are frequently poor at identifying the causes of their behavior through introspection.

The interaction of the experimental conditions with general cognitive ability, experience, and rank will also be tested. By examining these possible covariates, we expect to determine if these individual differences variables play a role in having access to key information required for decision making, taking advantage of access to that same key information, and benefiting from instruction geared towards enhancing both. In addition, we will assess self-report attitudes regarding the utility and relevance of training interventions in order to identify possible motivational influences on the relative or overall effectiveness of the experimental conditions and possible affective outcomes of the intervention. Since the investigation of person-condition interactions *per se* is not a primary focus of this study, individual differences variables not associated with a direct role in knowledge acquisition (e.g., distal traits, such as personality or interests) will not be assessed.

The immediate effects of the experimental conditions will by determined by examining the difference in performance on pre- and post-test assessments of tacit knowledge. In addition, depending on the availability of the experimental participants, we will assess trainees' ability to transfer the tacit knowledge they acquire to scenarios that occur six months after participating in

the experimental conditions. Finally, we will examine the effect of the experimental conditions on assessments of actual leadership performance. While it is recognized that paper-and-pencil tacit-knowledge measures serve only as a proxy for actual leadership situations, such low-fidelity simulations (Motowidlo, Dunnette, & Carter, 1990) have served as a useful method for assessing occupational performance for the purposes of prediction. In addition, Means, Salas, Crandall, and Jacobs (1995) noted that simulation is a particularly useful method for training effective decision making in ill-structured problem situations because it allows exposure to several practice problems with immediate feedback. Therefore, it is expected that skills acquired in the experimental interventions including tacit-knowledge measures will be applicable to actual leadership performance.

Description of the Experimental Conditions

The previously described manipulations of training-intervention content—the condition versus action aspects of tacit knowledge--give rise to the following four experimental conditions:

Experimental Condition 1. *Condition Aspects Only*

a. Provide demographic information and complete individual differences and self-report assessments
b. Take the TK pre-test
c. Receive instruction on cognitive processes and metacognitive skills (discussed below)
d. Take the TK post-test
e. Rate satisfaction with instructional method/content

Experimental Condition 2. *Action Aspects Only*

a. Provide demographic information and complete individual differences and self-report assessments
b. Take the TK pre-tests
c. Participate in reflective practice (discussed below)
d. Take the TK post-tests
e. Rate satisfaction with instructional method/content

Experimental Condition 3. *Condition and Action Aspects*

a. Provide demographic information and complete individual differences and self-report assessments
b. Take the TK pre-test
c. Receive instruction on cognitive processes and metacognitive skills (discussed below)
d. Participate in reflective practice (discussed below)
e. Take the TK post-test
f. Rate satisfaction with instructional method/content

Experimental Condition 4. *Control group: No intervention, pre- and post-test only*

a. Provide demographic information and complete individual differences assessments

b. Take the TK pre-test
c. Take the TK post-test

Materials and Procedure

Tacit Knowledge Scenarios and Training Procedures. Tacit knowledge pre- and post-tests will be used 1) to obtain a baseline level of tacit knowledge, 2) to serve as a reference for instruction and reflection, and 3) to assess any change in tacit knowledge following the intervention. The tacit-knowledge pre-test will be slightly different for the company and platoon levels. First, both lieutenants and captains will be administered a measure of metacognitive ability, PS1, as described in Antonakis et al. (2001). As this measure is open-ended and supports the exploration of metacognitive processes, it is ideal for providing instruction on both knowledge acquisition components and metacognitive problem solving skills. Additionally, this measure was selected because both lieutenants and captains are expected to have tacit knowledge applicable to platoon-level practical problems.

Because training in Conditions 1 and 3 addresses shortcomings in the cognitive processes devoted to knowledge acquisition and the metacognitive skills devoted to problem solving, the following questions will follow the extended scenario presented in PS1 in order to help the learner identify their own shortcomings:

1) What is the main problem that must be solved in this scenario? Why do you consider this to be the main problem? (*problem identification and definition*)

2) What information did you feel was most relevant to determining what the problem is? (*selective encoding*)

3) What course of action would you take to solve this problem? Why do you consider this course of action to be most appropriate? How would you go about seeking additional information, if that was necessary? What additional information would you seek? (*formulation of strategies, selective encoding*)

4) How does this problem relate to experiences you have had previously? What would you do to organize the information you have for solving the problem in order to come up with a solution? (*formation of mental and external representations, selective comparison, selective combination*)

5) How critical is the main problem to the overall performance of your unit (platoon, company)? How much time would you take to solve this problem relative to the other problems in the scenario? (*allocation of resources, selective encoding*)

6) How would you determine whether you had adequate information or resources to solve the main problem? What additional information or resources would you seek? (*monitoring of problem solving, selective encoding*)

7) What outcome do you hope will result from your course of action? What obstacle(s) do you foresee to achieving that outcome? (*evaluation of problem solution*)

8) How would you know if you have achieved the desired outcome? What would you do to learn from working on this problem so that you could deal with others like it? (*evaluation of problem solution, selective comparison*)

After taking the PS1, lieutenants and captains will receive several scenarios of the TKML (described in Sternberg et al., 2000), concordant with their rank. As these scenarios do not require the exploration of metacognitive processes (Antonakis et al., 2001), the answers to these scenarios will not be addressed specifically in the instruction in experimental Conditions 1 and 3, but will serve primarily as a pre-condition assessment of tacit knowledge.

After examinees take the tacit-knowledge pre-test, the experimental conditions addressing the condition aspects of tacit knowledge will present theory about the importance of effective cognitive processes and metacognitive skills, and will use expert answers to the PS1 questions to illustrate the appropriate cognitive processing and metacognitive skills required to perform well on the tacit knowledge assessments.

The effect of experimental condition on tacit knowledge will be assessed by administering several scenarios from the TKML, according to rank, to the lieutenants and captains. These scenarios will be different from those used in the tacit-knowledge pre-test. In addition, the CS1 metacognitive ability test (Antonakis et al., 2001) will be administered for exploratory purposes.

Reflective Practice Methods and Procedure. Reflective practice will involve a pencil and paper note-taking technique. Two reflective-practice methods will be used, depending on the experimental condition (Condition 2 or 3). Although both methods share the same process, they differ in content. More specifically, trainees will receive one hour of time to use the note-taking personal- reflection method, in which the structure of the reflection either contains specific questions relating to cognitive processing and metacognitive skill or does not, depending on the experimental condition. In the experimental condition combining the condition and action aspects of tacit knowledge, Condition 3, trainees will receive a note-taking sheet on which the following questions—attempting to direct thought to malfunctioning cognitive processes and undeveloped metacognitive skill—will be asked:

1) The type of question (e.g., questions that have to do with selective encoding, problem definition, etc.) that I got wrong the most frequently was:

2) My answers differed from the experts' answers in the following ways:

3) I expect that if the experts had actually had an opportunity to implement their solutions to the problems, the following outcomes would have resulted:

4) I expect that if I had actually had an opportunity to implement my solutions to the problems in the scenarios, the following outcomes would have resulted:

5) How are the outcomes presented in Questions 3 and 4 different? What does this suggest about how I have approached the problem, relative to the experts?

6) Given what I just learned on selective encoding, combination, and comparison, my answer to Question 1 suggests that I had the following gaps in my cognitive processing:

7) Given what I just learned on problem-solving skills, my answer to Question 1 suggests that I had the following gaps in my metacognitive skills:

8) The pattern among my incorrect/non-expert responses suggests that I need to work on:

9) The pattern among my correct/expert responses suggests that I am working well in the area of:

10) I should take the following specific actions to improve my cognitive processes and metacognitive skills with which I am having trouble:

In Condition 2, trainees will receive paper and pencil with which to take notes, with the following questions provided:

1) My answers differed from the experts' answers in the following ways:

2) I expect that if the experts had actually had an opportunity to implement their solutions to the problems, the following outcomes would have resulted:

3) I expect that if I had actually had an opportunity to implement my solutions to the problems in the scenarios, the following outcomes would have resulted:

4) How are the outcomes presented in Questions 3 and 4 different? What does this suggest about how I have approached the problem, relative to the experts?

In essence, trainees will simply be asked to reflect on why differences between their responses and the expert profile occurred on the tacit-knowledge pre-test, and what possible real-world outcomes based on their responses versus the expert responses would have occurred. Feedback regarding the adequacy (i.e., the degree to which reflection addressed tacitly held beliefs) and accuracy of personal reflection will be provided at the end of the hour of reflection time. In addition, in both reflection conditions, when introducing the reflection method, there will be an emphasis on the temporary nature of the specific reflection technique. That is, it will be emphasized that reflective practice need not require pencil and paper in the future but that the same type of questions should be asked during reflection that is either concurrent with or follows action.

Individual Differences Measures.

General cognitive ability. We will use both the archival data on which original personnel selection or educational acceptance decisions were made (e.g., ACT, SAT) and administer a set of widely accepted measures of general ability (e.g., the Mill Hill Vocabulary Scale and the Cattell Culture-Fair Test of g). As stated earlier, assessment of cognitive ability will occur prior to the tacit-knowledge pre-test.

Experience/Rank. We will administer a brief demographic survey in which trainees will report number of years in the service, number of years in the current position, rank, relevant other positions held, amount of academic leadership training received, etc. As stated earlier, demographic data will be collected prior to the tacit-knowledge pre-test.

Self-report attitudes. We will develop a short survey to assess trainees' attitudes regarding perceived effectiveness of training interventions within the context of leadership. Specifically, trainees will be asked to report how "trainable" they feel leadership is, and how effective they feel a training intervention could be for making improvements in leadership ability. They will also be asked to report their attitudes toward the impact of psychological research on their jobs and the perceived effectiveness (pre-training) of the experimenter. Smither and Reilly (2001) note that such attitudes may affect the outcome of attempts to guide others through the learning process. These attitudes will be surveyed prior to the tacit-knowledge pre-test.

Affective Outcomes. We will develop a short survey to assess trainees' affective reactions to the training intervention. Specifically, trainees will be asked to rate how effective they felt the training intervention was in aiding tacit knowledge acquisition. In addition, trainees will be asked to rate the relevance of the training intervention to their performance on the job. This survey will be administered after the rest of the study has been completed.

Meetings and Communications

We have been communicating with Dr. Joseph Psotka at the Army Research Institute in Alexandria, VA, who has made efforts to coordinate the availability of platoon leaders and company commanders for participation in data gathering sessions.

Plans for Next Year

During the next year we expect to execute data collection using the provided umbrella weeks. As preparation for data collection, we will develop and coordinate the individual differences measures, the tacit-knowledge assessment modifications, and the reflection methods described above.

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