THE MULTIDIMENSIONAL NATURE OF LEARNING STYLES AND CREATIVITY

by

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(Under the Direction of Bonnie Cramond)

ABSTRACT

This collection of three studies presents an attempt to develop a solid framework that better explains and predicts individual differences in learning and creativity. The first study reviews critical problems with learning styles and presents an alternative approach addressing individual differences in learning. Discussed are four constructs: sensory-based skills, knowledge development, order of coding, and fluency. In the second study, two models of creativity (divergent thinking and expertise performance) were tested on a sample of 143 college students. Structural equation modeling was used to test the models including general intelligence, domain knowledge, creative behavior, motivation and creative personality as predictors of creativity. General intelligence and creative personality had a significant influence in the divergent thinking model. In the expertise performance model, general intelligence, domain knowledge, and motivation had a significant influence. Finally, the third study tested four models of creativity (creative behaviors) on a sample of 147 college students. Multiple regressions were used to test the models that included domain knowledge, motivation, and creative personality as predictors of creativity. Motivation influenced domain-general ideation, and domain-specific ideation and activity. Personality influenced domain-general ideation and activity.

INDEX WORDS: learning styles, creativity, divergent thinking, expertise, creative behavior

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Learning styles and creativity research both focus on individual psychological differences. Specifically, learning styles research addresses individual differences in the ways students approach learning; creativity research examines individual differences in production of a novel and effective idea or product (Mumford, 2003; Plucker & Renzulli, 1999). Despite the many ways to measure learning styles and creativity, the two fields have in common a critical problem: the lack of a clear, explanatory framework. The goal of the current studies was to develop an explanatory framework for learning styles and creativity. In the studies, I propose a new approach to addressing individual differences in learning and creativity. This approach will explain individual differences in cognition, motivation, and personality and describe how these differences predict better achievement in learning and creativity.

Lack of an Explanatory Framework for Leaning Styles

Learning styles theories categorize behaviors, yet fail to explain the common processes that underlie these behaviors. For example, Gregorc (1982, 1985) proposed the two dimensions (concrete/abstract and sequential/random). Concrete learners like handling the physical manifestation, and abstract learners enjoy processing a more figurative form. Random learners prefer a disorganized representation, whereas sequential learners desire a well-organized description. Riding and Cheema (1991) suggested two dimensions (verbal/imagery and wholist/analytic). Verbal learners enjoy processing verbal representations, and imagery learners prefer dealing with mental images. Wholists like an overall perspective on a situation, while analytics enjoy seeing a context in parts. However, both theories simply describe a list of behaviors. No explanation is given as to the cognitive and developmental processes that underlie these behaviors.

Learning styles theories often propose constructs that are better described in other theories. For example, Kagan (1966) suggested impulsivity. Dunn, Dunn, and Price (1989) proposed persistence as one of the learning style constructs. Impulsivity and persistence are better explained in temperament theories (e.g., Martine & Holbrook, 1985; Martin, Wisenbaker, & Huttenen, 1994). Riding and Cheema (1991) and Richardson (1977) suggested verbal and visual constructs. These constructs are better explained through cognition theories (e.g., Baddeley & Hitch, 1974; Barsalou, 2008) as sensory-based processing of information.

The lack of an explanatory framework has led to an invalid assumption that dichotomous style learners (e.g., concrete/abstract, impulsive/reflective, random/sequential) are equally likely to achieve. But that is not in line with a wealth of studies showing poor results for students who are concrete learners (e.g., Taasoobshirazi & Carr, 2009). Similarly, students who have an impulsive learning style are unlikely to achieve academic success unless efforts are made to improve their self-control (e.g., Fischer, Barkely, Edelbrock, & Smallish, 1990). And, students who have a random style are more likely to exhibit poorer academic performances than sequential learners (e.g., Davidson & Savenye, 1992; Ross, Drysdale, & Schulz, 2001). Thus, it is necessary to reconceptualize dichotomous styles within an explanatory framework.

Lack of an Explanatory Framework for Creativity

Creativity is multidimensional. Therefore, there are many ways to measure creativity, including divergent thinking tests (e.g., Guildford, 1967; Torrance, 1974; Wallach & Kogan, 1965), expert ratings of performance (e.g., Baer, 1991, 1993), creative behavior checklists (e.g., Hocevar, 1980; Runco, 1987), and personality inventories (e.g., Domino, 1970; Gough, 1979). Although research has been conducted from each perspective, no research has tested how creativity can be predicted within a larger framework that includes common multiple constructs. As an example, divergent thinking and creative expertise performance have different multiple constructs. General cognitive ability is an important cognitive predictor of divergent thinking (e.g., Nusbaum & Silvia, 2011; Rindermann & Neusbauer, 2004). Divergent thinking is linked to creativity motivation as measured by creative behavior checklists (e.g., Hocevar, 1980; Runco, 1987). In regard to personality, openness to experience and extraversion are important predictors of divergent thinking (e.g., King, Walker, & Broyles, 1996). In contrast, domain-specific knowledge is an important cognitive predictor of creative expertise performances within fields (e.g., Weisberg, 1999, 2006). Creative expertise performance is associated with motivation in the form of intrinsic motivation, self-determination, and self-efficacy (e.g., Amabile, Hill, Hennessey, & Tighe, 1994). The effect of personality on creative expertise performance differs across domains (e.g., Feist, 1998; 1999). No study, to date, has tested the effect of cognition, motivation, and personality on two measures of creativity within a common framework.

The lack of an explanatory framework makes it difficult to determine which variables are most critical for each measure of creativity. For example, general cognitive ability is an important predictor of divergent thinking, but it is difficult to determine how important it is when other multiple variables (e.g., domain knowledge, creative behavior, and personality) are considered simultaneously. Similarly, although domain knowledge is a critical predictor of creative expertise performance, it is difficult to determine how much expert knowledge is important as compared to some other variables.

The lack of an explanatory framework has led to a debate on whether creativity is domain-general or domain-specific. A critical problem in the debate is that each side provides a different measure of creativity as evidence. A general position shows the significant correlations in creative behaviors across domains (e.g., Hocevar, 1976; Runco, 1987); a specific position shows the little correlations among different domain-derived artifacts created by the same person (e.g., Baer, 1991, 1993). However, creative behavior and domain-specific artifacts are very different measures of creativity. Creative behavior as measured by self-reported checklists assesses the quantity of creative activities; domain-specific artifacts as measured by expert ratings assess the quality of expert performance within fields. Creative behavior appears more likely to assess a motivational aspect focusing on extracurricular voluntarily activities; domain-specific artifacts appears more likely to assess cognitive ability focusing on expert judgments. I assume that the two sides show contrasting evidence because of their different underlying processes. One step toward verifying the assumption is to build a common framework for creativity.

Objectives of the Current Studies

The objective of the current studies was to develop an explanatory framework for learning styles and creativity. Both lack a solid framework explaining individual differences in cognition, motivation, and personality and describing how these differences predict better achievement. In the first study, I will review problems with learning styles including the lack of a clear, explanatory framework, poor reliability and validity of constructs, and a failure to link to achievement. Then, I will propose an alternative approach for explaining individual differences in learning. This approach is based on coherent theory and empirical research in cognition and personality. The objective of the second study was to develop and test an explanatory framework for two measures of creativity (divergent thinking and creative expertise performance). The model includes measures of general intelligence and domain knowledge, measures of motivation including creative behavior and motivation in the forms of intrinsic motivation, extrinsic motivation, self-efficacy, self-determination, and a measure of creative personality as predictors of creativity. This study contrasts the effects of cognition, motivation, and personality on two measures of creativity. Finally, the objective of the third study was to develop and test an explanatory framework for four forms of creativity (domain-general creative ideation, domain-general creative activity, domain-specific creative ideation, and domain-specific creative activity). The models include the measures of domain knowledge, motivation, and creative personality as predictors of creativity. This study addresses how and whether the same or different variables predict the four forms of creativity.

References

Amabile, T. M., Hill, K. G., Hennessey, B. A., & Tighe, E. M. (1994). The Work Preference Inventory: Assessing intrinsic and extrinsic motivational orientations. *Journal of Personality and Social Psychology, 66*, 950−967.

Baddeley, A. D., & Hitch, G. J. (1974). Working memory. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory*, Vol. 8 (pp. 47–90). New York: Academic Press.

Baer, J. (1991). Generality of creativity across performance domains. *Creativity Research Journal, 4*, 23−39.

Baer, J. (1993). *Divergent thinking and creativity: A task-specific approach*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology, 59*, 617-645.

Davidson, G. V., & Savenye, W. C. (1992). How do learning styles relate to performance in a computer applications course? *Journal of Research on Computing in Education, 24*, 348-358.

Domino, G. (1970). Identification of potentially creative persons from the Adjective Check List. *Journal of Consulting and Clinical Psychology, 35*, 48−51.

Dunn, R., Dunn, K., & Price, G. E. (1989). *Learning style inventory*. Lawrence, KS: Price Systems.

Feist, G. J. (1998). A meta-analysis of personality in scientific and artistic creativity. *Personality and Social Psychology Review, 2*, 290−309.

Feist, G. J. (1999). The influence of personality on artistic and scientific creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 273−296). New York: Cambridge University Press.

Fischer, M., Barkley, R. A., Edelbrock, C. S., & Smallish, L. (1990). The adolescent outcome of hyperactive children diagnosed by research criteria: II. Academic, attentional, and neuropsychological status. *Journal of Consulting and Clinical Psychology, 58*, 580−588.

Gough, H. G. (1979). A creative personality scale for the Adjective Check List. *Journal of Personality and Social Psychology, 37*, 1398−1405.

Gregorc, A. F. (1982). *Gregorc Style Delineator*. Maynard, MA: Gabriel Systems.

Gregorc, A. F. (1985). *Inside styles: Beyond the basics*. Maynard, MA: Gabriel Systems.

Guilford, J. P. (1967). *The nature of human intelligence*. New York: McGraw-Hill.

Hocevar, D. (1976). Dimensionality of creativity. *Psychological Reports, 39*, 869−870.

Hocevar, D. (1980). Intelligence, divergent thinking, and creativity. *Intelligence, 4*, 25−40.

Kagan, J. (1966). Reflection-impulsivity: The generality and dynamics of conceptual tempo. *Journal of Abnormal Psychology, 71*, 17−24.

King, L., Walker, L., & Broyles, S. (1996). Creativity and the five factor model. *Journal of Research in Personality, 30*, 189−203.

Martin, R. P., & Holbrook, J. (1985). Relationship of temperament characteristics to the academic achievement of first-grade children. *Journal of Psychoeducational Assessment, 3*, 131−140.

Martin, R. P., Wisenbaker, J., & Huttunen, M. (1994). Review of factor analytic studies of temperament measures based on the Thomas-Chess structural model: Implications for the Big Five. In C. F. Halverson Jr., G. A., Kohnstamm, & R. P., Martin (Eds.), *The* *developing structure of temperament and personality from infancy to adulthood* (pp. 157−172). Hillsdale, NJ: Erlbaum.

Mumford, M. D. (2003). Taking stock in taking stock. *Creativity Research Journal, 15*, 147−151.

Nusbaum, E. C., & Silvia, P. (2011). Are intelligence and creativity really so different?: Fluid intelligence, executive processes, and strategy use in divergent thinking. *Intelligence, 39*, 36−45.

Plucker, J. A., & Renzulli, J. S. (1999). Psychometric approaches to the study of human creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 35−61). New York: Cambridge University Press.

Richardson, A. (1977). Verbalizer-visualizer: A cognitive style dimension. *Journal of Mental Imagery, 1*, 109−125.

Riding, R. J., & Cheema, I. (1991). Cognitive styles—An overview and integration. *Educational Psychology, 11*, 193−215.

Rindermann, H., & Neubauer, A. C. (2004). Processing speed, intelligence, creativity, and school performance: Testing of causal hypotheses using structural equation models. *Intelligence, 32*, 573−589.

Ross, J. L., Drysdale, M. T. B., & Schultz, R. A. (2001). Cognitive learning styles and academic performance in two postsecondary computer application courses. *Journal of Research on Computing in Education, 33*, 400−412.

Runco, M. A. (1987). The generality of creative performance in gifted and nongifted children. *Gifted Child Quarterly, 31*, 121−125.

Taasoobshirazi, G., & Carr, M. (2009). A structural equation model of expertise in college physics. *Journal of Educational Psychology*, *101*, 630−643.

Torrance, E. P. (1974). *The Torrance Tests of Creative Thinking—norms-technical manual research edition—verbal tests, forms A and B—figural tests, forms A and B*. Princeton, NJ: Personnel Press.

Wallach, M. A., & Kogan, N. (1965). *Modes of thinking in young children: A study of the creativity-intelligence distinction*. New York: Holt, Rhinehart & Winston.

Weisberg, R. W. (1999). Creativity and knowledge: A challenge to theories. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 226−250). Cambridge, England: Cambridge University Press.

Weisberg, R. W. (2006). Modes of expertise in creative thinking: Evidence from case studies. In K. A. Ericsson, N. Charness , P. J. Feltovich, & R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 761−787). New York: Cambridge University Press.

CHAPTER 2

THE MULTIDIMENSIONAL NATURE OF LEARNING STYLES[1]

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Abstract

The purpose of this article is to propose a new approach to explaining and predicting individual differences in learning. First, this article briefly reviews critical problems with learning styles. Three major constructs are discussed: lack of a clear, explanatory framework, poor reliability and validity of constructs, and a failure to link to achievement. Next, this article presents an alternative approach to explaining individual differences in learning. Discussed are four major constructs that are better explained in cognition and personality theories: sensory-based skills, knowledge development, order of coding, and fluency. For fluency, four specific constructs are discussed: attention, persistence, and effortful-control; perfectionism; working memory; and expertise and domain knowledge. Finally, emphasis was placed on describing how individual differences in cognition and personality predict better achievement in learning.

INDEX WORDS: learning styles, individual differences, cognition, personality, achievement

The term, learning styles, has been used in education to examine individual differences in the ways students approach learning. It is assumed that instruction based on learning styles produces better achievement. Despite massive interest in learning styles, there are a number of critical problems with the literature and the activities based on that literature (e.g., Henson & Hwang, 2002; Joniak & Isaksen, 1988; Massa & Mayer, 2006; Price, 2004). Problems include the lack of solid explanatory theory or research supporting the theory, poor reliability and validity of constructs, and a failure to link learning styles-based instruction to achievement. The goal of this paper is to present a better way of understanding and dealing with the individual differences teachers see in their students. In this article, I will briefly review the problems with learning styles, then present a new alternative approach to explaining individual differences in learning. This approach will be based in research in educational psychology and cognition and will both explain individual differences in cognition, development and personality and how these differences predict better achievement.

A Brief Critique of Learning Styles

Learning styles theory has a number of significant problems. The theories describe and categorize behaviors, but fail to explain the developmental processes that underlie these behaviors. Another problem is that the work on learning styles assumes that gearing instruction to learning styles produces better achievement, but the research either does not exist or does not support that assumption (e.g., Massa & Mayer, 2006; McKay, 1999; Price, 2004). Many of the measures of learning styles lack reliability and validity. Measures often use rank ordering, which forces individuals to be good in one style and poor in another.

Lack of Clear, Explanatory Framework

A good learning styles theory should explain the common processes that underlie the learning styles described in the theory. Instead, the bulk of learning styles theories are comprised of lists of preferences with no explanation as to why these preferences would be included in a theory. For example, Gregorc (1982, 1985) has created two learning style dimensions (concrete/abstract and sequential/random), each with its own attributes. Concrete processors enjoy processing the physical expression, and abstract people desire a more figurative expression. Random learners are disorganized in their learning while sequential learners are systematic. No explanation is given as to the cognitive processes that underlie these characteristics or how they developed. What are the cognitive processes and knowledge states that underlie a concrete processor as opposed to an abstract processor? What processes and states cause a student to be more of a random learner as opposed to a sequential learner? As another example, Riding and Cheema (1991) described students as being either wholist or analytic. No explanation is given as to the cognitive processing that would result in a student being one or the other. Instead, these categories are justified through differences in behavior with wholists being students who like seeing context from an overall perspective, whereas analytics refer to people who enjoy seeing a situation as a group of parts. Theory and research needs to explain why analytics enjoy seeing situations as a group of parts or why wholists like an overall perspective on context. Simply describing a behavior is not enough.

Often learning styles theories borrow constructs from other, better-defined theories. Several researchers include styles that reflect differences in personality or self-regulatory skills. For example, Kagan (1966) included a construct of impulsivity. Dunn, Dunn, and Price (1989) included persistence as one of many unrelated learning styles. Persistence and impulsivity are better described and explained in the temperament literature as one of a number of temperament traits (e.g., Martin & Holbrook, 1985; Martin, Wisenbaker & Huttenen, 1994). A number of learning styles describe students as being visual or verbal learners (e.g., Richardson, 1977; Riding & Cheema, 1991), but that work ignores a considerable body of theory and research on verbal and visuo-spatial processing in working and short-term memory.

Most important, learning styles theorists have ignored the research that directly contradicts learning styles theories. There is substantial research showing that students are often skilled at both verbal and visual processing (as opposed to needing to be one or the other), that both types of processing are important for learning (as opposed to gearing instruction to only one learning style), and that both can be improved through instruction (as opposed to instruction designed to work within a given learning style). Other researchers (e.g., Gregorc, 1982, 1985; Honey & Mumford, 1989; Kolb 1976, 1985) described students as being either concrete or abstract, but ignore the considerable body of research showing that students who are concrete are either immature or delayed in their learning (e.g., Chi, Feltovich, & Glaser, 1981; Slotta, Chi, & Joram, 1995; Taasoobshirazi & Carr, 2009). In the case of the concrete/abstract dichotomy, the dichotomy is not a set of attributes but reflects the level of development of the knowledge base and an individual's educational experiences.

Even learning styles researchers have acknowledged the limitations of their studies. Sternberg (2001) described that it is difficult for learning styles researchers to interact with each other as well as with other researchers in psychology because each learning styles theory has its own different conceptual framework. Sternberg also pointed out that learning styles researchers do not consider cognition or personality theories or research even though learning styles are based in these theories.

Poor Evidence Due to Problems of Measurement

Many measures of learning styles use rank ordering (e.g., Gregorc Style Delineator, Gregorc, 1982; Learning Style Inventory, Kolb, 1976, 1985) thus forcing individuals to be high in one learning style and low in the other. This false dichotomy is not supported by measures that independently assess each construct. Rank ordering produces negative correlations between the constructs that are being measured so that the construct validity is inflated (Cornwell & Dunlap, 1994; Henson & Hwang, 2002).

A self-report instrument (e.g., Gregorc Style Delineator and Learning Style Inventory) may be affected by the respondents' honesty, memory (Runco & Okuda, 1988), and concern for social desirability. Specifically, social desirability may push examinees to check what they believe to be true or prefer to be true rather than what is actually true. If reported interests are not matched with actual behaviors (e.g., Price, 2004), the measure has problems in predicting how preference affects achievement.

The measures of learning styles do not have good reliability. The reliability of the Gregorc Style Delineator (Gregorc, 1982) has been reported as poor (Joniak & Isaksen, 1988; O'Brien, 1990; Reio & Wiswell, 2006). Neither the original Learning Style Inventory (Kolb, 1976) nor revised Learning Style Inventory (Kolb, 1985) has good test-retest reliability (Atkinson, 1989, 1991; Freedman & Stumpf, 1980; Henson & Hwang, 2002). The Cognitive Style Analysis (Riding, 1998) showed a poor test-retest reliability (Rezaei & Katz, 2004). The reliability of the Verbalizer-Visualizer Questionnaire (Richardson, 1977) has been reported as poor (Sullivan & Macklin, 1986).

The measures of learning styles have poor validity. The Gregorc Style Delineator (Gregorc, 1982) has been shown to have poor construct validity (Joniak & Isaksen, 1988;

O'Brien, 1990). Many studies showed poor construct validity of Learning Style Inventory (Kolb, 1976, 1985) (e.g., Cornwell, Manfredo, & Dunlap, 1991; Freedman & Stumpf, 1980; Platsidou & Metallidou, 2009). The Verbalizer-Visualizer Questionnaire (Richardson, 1977) has poor construct validity (Boswell & Pickett, 1991) and external validity (Edwards & Wilkins, 1981). The Cognitive Style Analysis (Riding, 1991) has poor external validity with measures that would assess verbal and visual abilities (Mayer & Massa, 2003).

Failure to Link to Achievement

Despite the claim that teaching to a learning style results in better achievement, there is little research showing that this is the case. Learning styles researchers assume that their measures would predict learners' preferences of instructional materials and result in better academic achievement. But a number of studies showed that learning styles measures do not predict the preferences of instructional materials or cognitive ability, and learning styles-based instruction does not produce better academic achievement (e.g., Mayer & Massa, 2003; Massa & Mayer, 2006; McKay, 1999; Price, 2004). Research by Price (2004) found that learning styles as measured by the Learning Style Questionnaire (Honey & Mumford, 1992) and the Group Embedded Figures Test (Witkin, Oltman, Raskin & Karp, 1971) did not predict the preference for learning materials and academic performance in computer science. Research by Massa and Mayer (2006) found no significant interaction effects between learning styles attributes (verbal and visual) as measured by the Verbalizer-Visualizer Questionnaire (Richardson, 1977), the Santa Barbara Learning Style Questionnaire (Mayer & Massa, 2003), the Verbal-Visual Learning Style Rating (Mayer & Massa, 2003), the Learning Scenario Questionnaire (Mayer & Massa, 2003), and Cognitive Styles Analysis (Riding, 1991) and instruction methods (verbal and visual) on learning tests in science. Learning styles dimensions do not predict achievement of standardized cognitive and academic criteria (Riding & Agrell, 1997; Riding & Pearson, 1994; Kolb, Boyatzis, & Mainemelis, 2001).

An Alternative to Learning Styles

Focus on Sensory-Based Skills

We have known for a long time that we have sensory-based processing of information. People encode and represent information using five sensory-based codes including visual, auditory, tactile, smell, and taste (e.g., Barsalou, 2008; Goldman-Rakic, 1995; Lyman & McDaniel, 1990; Richardson, Spivey, Barsalou, & McRae, 2003). For example, Baddeley and Hitch's (1974) working memory model consists of three systems: the phonological loop, a temporary holding site of verbally, phonetically coded information, the visuo-spatial sketchpad, a temporary store of visual or spatial information, and the executive workplace that carries out activities related to comprehension and problem-solving. According to Barsalou (2008), it is assumed that when a concept is activated, people re-activate their previous sensory inputs in order to simulate the original experience. In this simulation process, any relevant perceptual modalities (touch, taste, smell, audition, and vision) are activated. For example, when a student learns about sunflowers, he or she would activate the past sensory inputs, such as an image of a sunflower or the spelling of the word sunflower, the sound of the word sunflower or possibly the smell or feel of a sunflower. These multiple perceptual memories are integrated into a single memory that we label as sunflower. As such, concrete concepts such as sunflower, table or chair will have at least a verbal and visual representation in long term memory. Given the research of Barsalou and others, the assumption that words have either a verbal or visual representation makes no sense. Learning styles that divide students into verbal or spatial learners is a false dichotomy that is not supported by research on learning and memory.

What we do know from research is that people are able to encode and represent information in multiple ways, and the activation of the multiple representations increases memory, learning and achievement. For instance, the memory of a smell improved when other sensory processing, such as verbal (naming the smell) or visual (mental picturing of the smell) was activated (Lyman & McDaniel, 1990). The activation of multiple representations, including visual and verbal, promotes learning in mathematics and reading (DeStefano & LeFevre, 2004; Mastropieri & Scruggs, 1997). It is not matching instruction to a learning style that produces good learning, but it is when a teacher activates all of a student' senses.

When students have difficulties learning, it is often because they have difficulty representing information using one or more modalities. In the case of reading disabled students, deficits occur in the phonological loop, which is used to represent and process verbal material. The reading disabled also have deficits in the visual processing (Siegel & Ryan, 1989). Similarly, mathematics disabled students show deficiencies not only in the visuo-spatial sketchpad (number counting) (Siegel & Ryan, 1989), but also in retrieval of basic math facts (Geary & Brown, 1991) and in strategy use (Geary, Brown, & Samaranayaka, 1991).

Some learning style theories (e.g., Richardson, 1977; Riding, 1991, 1998) have verbal and visual processing as mutually exclusive dichotomous categories. Other theories measure spatial ability (visual processing) under a different name. For example, Riding's (1991, 1998) measure of the wholist/analytic dimension is actually a measure of spatial ability measuring students' ability to manipulate visual imagery. Likewise, the field dependent/field independent dimension seen in Witkin's (1971) measure is actually a measure of spatial ability. The items used in the Riding and Witkin measures have been used by cognition researchers to assess spatial ability, including spatial perception, mental rotation, or spatial visualization (Hyde, 1990).

Specifically, spatial visualization which measures one's capacity to find a simple figure hidden within a more complex figure is almost the same as the Cognitive Style Analysis's (Riding, 1991, 1998) second subtest on the wholist/analytic dimension, and Witkin's (1971) embedded figure test for the field dependent/field independent dimension. From an information processing perspective, it makes more sense to assess verbal and spatial/visual skills separately.

In terms of academic skills, mathematics involves visuo-spatial processing to hold and process numbers (Casey, 1996; Casey, Nuttall, & Pezaris, 2001; Geary & Burlingham-Dubree, 1989). Verbal processing is also important for mathematics achievement (Campbell, 1994; DeStefano & LeFevre. 2004; Floyd, Evans, & McGrew, 2003; Lee & Kang, 2002). Likewise, reading achievement is dependent on not only verbal skills (Edwards, Walley, & Ball, 2003; Eldredge, 2005; Stanovich & Siegel, 1994) but also visual/spatial skills (Denis, 1996; Mastropieri & Scruggs, 1997; Pressley, Cariglia-Bull, Deane, & Schneider, 1987). Neuro-psychological research suggests that people utilize visuo-spatial processing as well as verbal processing for the representation and communication of language (Cree & McRae, 2003; Chatterjee, 2001).

Why should we reconceptualize the verbal/visual, wholist/analytic, and field dependent/field independent learning styles as sensory-based coding? Verbal and visual processing is not mutually exclusive but by an integrated common source that children need to develop simultaneously. It is difficult for students to progress in any domain by developing only one form of sensory code. In addition, the learning styles do not include semantically-based processing which is very important, even in simple problem solving such as single-digit addition (DeStefano & LeFevre. 2004). Although young learners or novices have little conceptual knowledge, conceptual knowledge is more important for high performance as students become older and more expert (Vanderwood, McGrew, Flanagan, & Keith, 2001). With only the sensory-based dimensions, achievement in any domain cannot be explained and predicted. Expert knowledge is more than sensory-based memories and includes rich conceptual knowledge.

Expert Characteristic: Knowledge Development

The concrete versus abstract dichotomy commonly found in learning styles theory (e.g., Gregorc, 1982, 1985; Honey & Mumford, 1989; Kolb, 1976, 1985) is better understood as differences in the way novices (concrete learners) and experts (abstract learners) represent knowledge. Novices tend to have little experience in a field and their knowledge of a field is more concrete in that it is linked to memories of specific activities. Novices' understanding is more directly tied to experience. Experts, in contrast, have had considerably more experience and have constructed general abstract memories. Their understanding and problem solving is not tied to experience, but emerges out of a rich, abstract understanding of a topic.

Although children are not typically thought of as experts, one child may be more expert than another child. For example, one second grader will need to count on fingers to add two numbers because he or she has not constructed the abstract representation of numbers, whereas another second grader can add the same numbers through mental calculation because he or she has had considerable experience counting and now no longer needs to count actual objects. One student is more "expert" than another in counting due to experience.

Evidence of the more abstract nature of expert knowledge is evident in novices' tendency to focus on concrete features, and experts' tendency to focus on abstract patterns of the features while perceiving or interpreting what they view. For example, expert and novice teachers differed in their understanding of the events in a videotape of a science class (Sabers, Cushing, & Berliner, 1991). Expert teachers deducted meaningful interpretations from the classroom events based on abstract principles, whereas novices just announced the concrete, physical classroom situations or simple actions of people in sequence.

The more abstract nature of expert knowledge is shown in problem-categorization. For instance, in physics, novice students tended to categorize the mechanic problems according to the concrete objects or superficial similarities, while expert students tended to categorize the problems based on abstract principles or laws (Chi & Slotta, 1993; William & Noyes, 2007). Likewise, novice counselors were more likely to classify the counseling descriptions based on the concrete, shallow features (e.g., time order of descriptions), while expert counselors were more likely to classify them according to abstract, psychological principles (Mayfield, Kardash, & Kivlighan, 1999). As such, there is considerable evidence that people should not be categorized as having concrete or abstract learning styles. Instead, concreteness should be viewed as evidence of a less developed understanding of a topic. The ability to abstractly represent information suggests that the student is more advanced.

It is important to reconceptualize the concrete versus abstract dichotomy as a novice-expert difference in knowledge representation. It is impossible for students to progress in any domain unless their knowledge and problem solving becomes abstract. The goal of education is to help students transition from needing concrete representations to constructing abstract representations. The extent to which a child thinks abstractly in a domain is the extent to which he or she can flexibly problem solve in that domain.

Expert Characteristic: Order of Coding

The random versus sequential dichotomy seen in Gregorc (1982, 1985) has problems in clarifying what this dimension refers to from information processing theory. Gregorc simply described the characteristic of each behavior as random learners enjoy dealing with information in a disorganized manner while sequential learners prefer processing in a systematic way, with no explanation of the underlying cognitive or developmental processes that would cause each characteristic.

The random versus sequential dichotomy (Gregorc, 1982, 1985) is better explained as the novice-expert characteristic of order of coding. Experts have a hierarchically structured knowledge base, and it allows for sequential order of coding which links new information to higher goals. On the other hand, given that novices would not have intermediate levels of the structure that connect new knowledge to a final goal (Chi, 2006), novices are not likely to be sequential. Research by Chiesi, Spilich, and Voss (1979) indicated that baseball experts outperformed novices in recalling sequences of baseball actions because experts have the ability to link each procedure to higher goals, such as earning a score.

Experts have a sequential order of coding in that they use forward inference strategy and complete scripts or frames in solving problems. Experts' well-developed conceptual knowledge structure is linked to the use of working forward strategy (e.g., Schneider 1993; Taasoobshirazi & Carr, 2009). As goal-directed, purposeful problem solving, the working forward strategy allows experts to conclude a solution sequence based on underlying principles (Larkin, 1985), which appear to be a more efficient sequential process. Experts' complete scripts, stereotyped event sequences (Abelson, 1981), enable them to focus on key factors to select proper steps with no need to explore a broad range of feasible options. For example, finance experts who utilize a script can be more goal-directed and suggest financial investments using more sequential steps (Hershey, Walsh, Read, & Chulef, 1990). Experts have a more complete frame (Chi, 2006), in other words, a more complex systematic network (Barsalou, 1992), and it allows them to orderly conclude a solution sequence for a broad range of problems. For example, a tree expert might have a complete tree frame being filled with more features about sensitivity to diverse diseases (Chi, 2006), so the expert would be able to suggest sequential treatment steps to each symptom of different diseases. In addition, given that experts' complete frame is filled with highly weighted features, experts are better at fitting a frame to very new situations and upgrading a frame to fit new situations, thus being able to sequentially suggest multiple alternative solutions, even in unexpected situations. Experts' forward strategy and complete scripts or frames reflect an ability to make the sequential path to take for a successful outcome.

The more sequential nature of experts' order of coding is shown in academic achievement. The ability to sequentially process information in an academic subject indicates that the student is more expert, whereas random processing is evidence of a novice's performance. Research by Davidson and Savenye (1992) and Ross, Drysdale, and Schultz (2001) found that for college students, sequential characteristics were linked to higher academic performance in computer applications, while random characteristics were related to poor academic achievement in that subject area.

Why is it vital to reexplain the random and sequential dimension as a novice-expert difference in order of coding? It is impossible for students to advance in a field unless their problem solving becomes sequential. The goal of education is to allow students to suggest sequential solution procedures using well-organized, hierarchical cognitive structures.

Focus on Fluency

Kolb (1976, 1985) and Honey and Mumford (1989) measured the active experimentation versus reflective observation dichotomy using a self-reporting instrument. The indicators of the active experimentation include the characteristics of practical, doing, active, pragmatic, and responsible; and the indicators of the reflective observation include tentative, watching, observing, reflecting, reserved. But in learning, these characteristics are ambiguous about what they are actually describing because they are just lists of behavior descriptors or patterns. The indicators are not translated into any array of underlying cognitive and personality processes, so they cannot be connected or predict students' achievements in learning.

Kagan (1965, 1966) proposed the impulsive/reflective dimension. The Matching Familiar Figures task was used to measure the dimension and it was assumed that impulsivity results in more errors and reflection results in fewer errors in the task. However, this assumption is invalid because others (e.g., Eska & Black, 1971) have shown that some impulsive individuals have fewer errors and some reflective individuals have more errors. This problem occurs because no explanation is given the common processes that underlie reflective and impulsive characteristics.

The impulsive versus reflective dichotomy seen in learning styles theories (e.g., Honey & Mumford, 1989; Kagan, 1965; Kolb 1976, 1985) might be better explained by several factors including attention, temperament (persistence and effortful control), personality (perfectionism), working memory, and expertise. In the case of attention and temperament, reflective behavior is linked to higher performance. Specifically, the research on sustained attention and inhibition shows that there are individual differences in students' ability to attend, with more attentive students being more reflective and less attentive students being more impulsive. These differences in attention are linked to temperament differences, which show that more persistent temperaments or students with better "effortful control" are more reflective. In the case of perfectionism, reflective behavior is not always linked to higher performance. Specifically, a positive facet of perfectionism (called perfectionist strivings) allows students to put in the extra time and effort, thus making them "reflective". This reflective behavior is linked to higher performance. A negative facet of perfectionism (called perfectionist concerns) also makes students spend a long time so they appear to be reflective. But this facet of perfectionism makes students anxious and stressed, so their results are not necessarily good. Students with a larger working memory can process faster (impulsively) and gain more accurate results because they have the cognitive capacity to fluently solve problems. Being more knowledgeable or expert in a domain will also result in faster, more fluent, responses (impulsive) that are more accurate. Therefore, students, who appear to be more impulsive, but are accurate, likely have a larger working memory or are more expert within that domain than their peers. Each of the potential variables underlying reflective and impulsive characteristics is discussed below.

Attention, persistence, and effortful control. As a multidimensional construct, attention has many forms (e.g., selective attention, sustained attention, divided attention, and alternating attention). In general, all these forms of attention provide mental resources and power for working memory. Thus, more attentive students reflect on more information, and this reflective behavior is linked to better achievement. In order to regulate and control these forms of attention, inhibition is crucial. Inhibition is an ability to suppress responses and to reflect on a situation before really reacting (Barkley, 1996). The characteristic of being intelligent and gifted is associated with inhibiting (ignoring) irrelevant thoughts or information that interferes with learning. Specifically, adults with low intelligence are more likely to have poor inhibition (Ellis & Dulaney, 1991), but young children with good inhibition tend to have a high intelligence in childhood (McCall & Carriger, 1993).

There is an abundance of evidence to show that the lack of attention and inhibition are linked to impulsive behavior and poor performance. Specifically, students with attention deficit disorder with hyperactivity (ADHD), or attention deficit disorder without hyperactivity (ADD/WO), are considered to be less able to self-regulate and inhibit distractions (Barkley, 1994). For example, ADHD boys are less able to regulate or inhibit (ignore) distracters such as toys while watching television for a long time (Lorch, Milich, Sanchez, van den Broek, Baer, Hooks, Hartung, & Welsh, 2000). In Barkely, Grodzinsky, and DuPaul's (1992) study, children with ADHD were less able to inhibit (ignore) the ink colors that were printed in color words when they had to read the color words. Due to the lack of inhibition, students with attention deficit disorders are more impulsive than their same-aged normal peers (Schweitzer & Sulzer-Azaroff, 1995; Voeller & Heilman, 1988). For example, students with ADHD showed poor impulse control on a vigilance test (Fischer, Barkley, Edelbrock, & Smallish, 1990) and chose impulsive-smaller rewards rather than deferred-bigger rewards (Schweitzer & Sulzer-Azaroff, 1995). As a result, attention deficit disorders are linked to poor performance in memory tasks and academic learning (e.g., Felton, Wood, Brown, Campbell, & Harter, 1987; Fischer et al., 1990; Rasile, Burg, Burright, & Donovick, 1995).

Individual differences in the ability to regulate attention are linked to temperament differences including persistence and effortful control. More persistent students can be more reflective because they are able to regulate attention behaviors (Martin et al., 1994). Students with better "effortful control" are also more reflective because the control system allows them to voluntarily coordinate their attention (Ahadi & Rothbart, 1994) and to willfully suppress a prohibited impulse (Kochanska, 1991).

These temperament constructs predict cognitive and academic achievement. Less persistent infants tend to have lower intellectual ability later (Messer, McCarthy, McQuiston, MacTurk, Yarrow, & Vietze, 1986). Children who are less persistent showed poor achievement in reading and mathematics (Martin & Holbrook, 1985) and in physical education (Liew, Xiang, Johnson, & Kwok, 2011). Similarly, college students who are less persistent showed poor academic achievement (Blinne & Johnston, 1998; Dubey, 1982). Effortful control also was linked to children's cognitive and academic achievement including verbal intelligence, reading, and mathematics (Liew, Mctigue, Barrois, & Hughes, 2008; Valiente, Lemery-Chalfant, & Swanson, 2010). Even in preschoolers, an effortful control system (better or worse at delayed gratification) predicted future cognitive and academic performance in adolescence (Shoda, Mischel, & Peake, 1990).

If a student is impulsive due to the lack of self-regulation, he or she would produce poor outcomes. This type of impulsive behavior should be viewed not as a learning style but as a symptom of an attention or temperament problem.

Focus on personality: perfectionism. Perfectionism typically is associated with reflection and better outcomes because perfectionists put in the extra time and effort to make sure everything is done correctly. This is what Stoeber and Otto (2006) called perfectionist strivings, which is a positive facet of perfectionism. However, there is another negative facet called perfectionist concerns (Stoeber & Otto, 2006). People with high perfectionist concerns worry about failure and other people's evaluations (Stoeber & Otto, 2006). These people also take a long time, but their results are not necessarily better than someone who did not take as much time.

Students who are reflective and have good outcomes might be explained by perfectionist strivings. People with high perfectionist strivings have better performance through reflection, by spending more time on a task. Research by Stoeber and Eismann (2007) found that musicians with high perfectionist strivings spent more time on tasks and gained better grades in class than musicians with less perfectionist strivings. Research by Stoeber, Chesterman, and Tarn (2010) found that for college students, perfectionist strivings influenced performance on a simple selfpaced task (letter-detecting) as mediated by reflection (spending more time on the task). In the same study, Stoeber et al. (2010) indicated that students with high perfectionist strivings focus more on doing correctly than on doing rapidly. There is evidence to show that perfectionist strivings are positively correlated with better academic achievement across domains, including music (Stoeber & Eismann, 2007), sports (Stoll, Lau, & Stoeber, 2008), language and mathematics (Stoeber & Rambow, 2007).

In contrast, students who are reflective and have poor outcomes might be explained by perfectionist concerns. Perfectionist concerns are linked to negative characteristics including performance anxiety, stress, and depression (Stoeber & Otto, 2006). For example, research by Stoeber and Rambow (2007) showed that for ninth-graders, perfectionist concerns were related to motivation to avoid failure and low well-being including somatic complaints and depressive symptoms. These negative characteristics might influence academic learning in negative ways. As an example, there is an abundance of evidence to show that anxiety results in poor academic achievement (e.g., Ader & Erktin, 2010; Ashcraft & Kirk, 2001; Peleg, 2009).

If a student is reflective because of perfectionist concerns, he or she may produce poor results. This reflective behavior should be considered not as a learning style construct but rather as a symptom of a personality problem.

Focus on working memory. Students who appear to be impulsive and have good results might be explained by a large working memory capacity. Since working memory functioning is related to processing speed (Salthouse, 1991), a larger working memory capacity can result in faster processing, which on the surface would appear to be impulsive. Research by Salthouse, Mitchell, Skovronek, and Babcock (1989) found that better working memory capacity, as measured by a computational span task predicted faster and more accurate performance on verbal and spatial tasks. Other research also showed that a larger working memory allows for faster and more accurate cognitive processing (e.g., Salthouse, 1991; Salthouse & Pink, 2008). In addition, the role of working memory has been shown in the studies examining age differences in cognitive functioning. An age-related increase in working memory capacity explains the development of cognitive processing during childhood (Case, 1992), and an age-related reduction in working memory capacity is linked to a decrease in fluid intelligence or verbal/spatial reasoning (Salthouse, 1991; Salthouse et al., 1989).

Since the working memory functioning is a basic ability to solve more complex problems in learning, a larger working memory allows for having better academic achievement. In McCutchen, Covill, Hoyne and Mildes's (1994) study, students who received high scores on a writing task had more fluent lexical retrieval and sentence generation. Similarly, students who have fluent retrieval of basic mathematic facts (e.g., addition and multiplication) scored higher on standardized achievement tests, such as SAT math and ITBS (Royer, Tronsky, Chan, Jackson, & Marchant, 1999).

A student with limited working memory may appear to be reflective (slow) and have poor achievement. This reflective behavior should not be viewed as a type of learning style. It should be considered as a manifestation of the lack of cognitive ability.

Expertise and domain knowledge. More expert students appear to be impulsive and have good results because experts' better organized and more scripted structure of knowledge allow for faster, more fluent, responses that are more accurate.

There is a bulk of evidence to show that being more knowledgeable or expert in a domain results in faster retrievals that are more accurate. For example, expert chess players showed faster and more accurate reconstruction of a mid-play chess board than novice players (Chase &

Simon, 1973), and expert pilots read back and remembered pilot communication messages faster and more accurately than did novices (Morrow, Mernard, Stine-Morrow, Teller, & Bryant, 2001). Even children who are expert in a certain area showed similar performances. Research by Chi (1978) found that child experts were able to recall the chess positions faster and more accurately than adult novices (as opposed to recall in digit span tasks). Other research found that children who have more domain knowledge about baseball or soccer had faster and more accurate recall or comprehension of domain specific stories or text (e.g., Gaultney, Bjorklund, & Schneider, 1992; Recht & Leslie, 1988; Schneider, Körkel, & Weinert, 1989).

In the professional world, experts' complete scripts allow them to handle a domain-relevant task fluently and efficiently. Research by Hershey et al. (1990) indicated that experts' complete scripts in financial investment enabled them to process fewer steps and spend less time than novices in solving problems. Other research by Mayfield et al. (1999) found that expert counselors analyzed a counseling script faster and better than did novice counselors.

If a student is reflective (slow) because of the lack of expertise in a domain, he or she may have poor achievement. This student should be viewed as a novice in that domain, not as a reflective style learner.

Conclusion

Learning styles theories have a number of problems including the lack of solid explanatory framework, poor reliability and validity of constructs, and a failure to link to achievement. Therefore, an alternative approach to reconceptualizing learning styles dimensions was discussed in this paper. Specifically, measures of the wholist/analytic (Riding, 1991, 1998) and field dependent/field independent (Witkin, 1971) dimensions are better described as measures of spatial ability. The verbal/visual (Richardson, 1977; Riding, 1991, 1998) dimension is better explained as sensory-based coding. Both abilities should be improved simultaneously for better achievement. The concrete/abstract (Gregorc, 1982, 1985; Honey & Mumford, 1989; Kolb, 1976, 1985) and sequential/random (Gregorc, 1982, 1985) dimensions are better understood as the novice-expert characteristics in knowledge development and order of coding. Experts' abstract nature of knowledge and experts' sequential order of coding are linked to higher performance. Finally, the impulsive/reflective dimension (Honey & Mumford, 1989; Kagan, 1965; Kolb 1976, 1985) is better explained by several factors including attention, temperament, perfectionism, working memory, and expertise. In the case of attention, temperament (persistence and effortful control), and perfectionist strivings, reflective behavior is linked to higher performance, but reflective behavior may be linked to poor performance with regard to perfectionist concerns, limited working memory capacity, and lack of expertise. In conclusion, students should not be categorized as having learning styles. Instead of focusing on a learning style, I recommend that teachers focus on alternative explanations for individual differences in learning to guide students to be high achievers.

References

Abelson, R. P. (1981). Psychological status of the script concept. *American psychologist, 36*, 715−729.

Ader, E., & Erktin, E. (2010). Coping as self-regulation of anxiety: A model for math achievement in high-stakes tests. *Cognition, Brain, Behavior: An Interdisciplinary Journal, 14*, 311−332.

Ahadi, S. A., & Rothbart, M. K. (1994). Temperament, development, and the Big Five. In C. F. Halverson, G. A. Kohnstamm, & R. P. Martin (Eds.), *The developing structure of temperament and personality from infancy to adulthood* (pp.189−207). Hillsdale, NJ: Erlbaum.

Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General, 130*, 224−237.

Atkinson, G. (1989). Kolb’s Learning Style Inventory—1985: Test-retest déjà vu. *Psychological Reports, 64*, 991−995.

Atkinson, G. (1991). Kolb's Learning Style Inventory: A practitioner's perspective. *Measurement and Evaluation in Counseling and Development, 23*, 149−161.

Baddeley, A. D., & Hitch, G. J. (1974). Working memory. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory*, Vol. 8 (pp. 47−90). New York: Academic Press.

Barkley, R. A. (1994). Delayed responding and attention deficit hyperactivity disorder: Toward a unified theory. In D. K. Routh (Ed.), *Disruptive behavior disorders in children: Essays in honor of Herbert Quay* (pp. 11−57). New York: Plenum.

Barkley, R. A. (1996). Critical issues in research on attention. In G. Lyon & N. A. Krasnegor (Eds.), *Attention, memory, and executive function* (pp. 45−56). Baltimore: P. H. Brookes.

Barkley, R. A., Grodzinsky, G., & DuPaul, G. J. (1992). Frontal lobe functions in attention deficit disorder with and without hyperactivity: A review and research report. *Journal of Abnormal Child Psychology, 20*, 163−188.

Barsalou, L. W. (1992). Frames, concepts, and conceptual fields. In A. Lehrer & E. F. Kittay (Eds.), *Frames, fields, and contrasts: New essays in semantic and lexical organization* (pp. 21−74). Hillsdale, NJ: Erlbaum.

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology, 59*, 617−645.

Blinne, W. R., & Johnston, J. A. (1998). Assessing the relationships between vocational identity, academic achievement, and persistence in college. *Journal of College Student Development, 39*, 569−576.

Boswell, D. L., & Pickett, J. A. (1991). A study of the internal consistency and factor structure of the Verbalizer-Visualizer Questionnaire. *Journal of Mental Imagery, 15*, 33−36.

Campbell, J. I. D. (1994). Architectures for numerical cognition. *Cognition, 53*, 1−44.

Case, R. (1992). *The mind's staircase: Exploring the conceptual underpinnings of children's thought and knowledge.* Hillsdale, NJ: Erlbaum.

Casey, M. B. (1996). Understanding individual differences in spatial ability within females: A nature/nurture interactionist framework. *Developmental Review, 16*, 241−260.

Casey, M. B., Nuttall, R. L., & Pezaris, E. (2001). Spatial-mechanical reasoning skills versus mathematics self-confidence as mediators of gender differences on mathematics subtests using cross-national gender-based items. *Journal for Research in Mathematics Education, 32*, 28−57.

Chase, W. G., & Simon, H. A. (1973). Perception in chess. *Cognitive Psychology, 4*, 55−81.

Chi, M. T. H. (1978). Knowledge structures and memory development. In R. S. Siegler (Ed.), *Children's thinking: What develops?* (pp. 73−96). Hillsdale, NJ: Erlbaum.

Chi, M. T. H. (2006). Laboratory methods for assessing experts' and novices' knowledge. In K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 167−184). New York: Cambridge University Press.

Chi, M. T. H., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices, *Cognitive Science, 5*, 121−152.

Chi, M. T. H., & Slotta, J. D. (1993). The ontological coherence of intuitive physics. *Cognition and Instruction, 10*, 249−260.

Chiesi, H. L, Spilich, G. J., & Voss, J. F. (1979). Acquisition of domain-related information in relation to high and low domain knowledge. *Journal of Verbal Learning and Verbal Behavior, 18*, 257−273.

Cornwell, J. M., & Dunlap, W. P. (1994). On the questionable soundness of factoring ipsative data: A response to Saville & Willson (1991). *Journal of Occupational and Organizational Psychology, 67*, 89−100.

Cornwell, J. M., Manfredo, P. A., & Dunlap, W. P. (1991). Factor analysis of the 1985 revision of Kolb's Learning Style Inventory. *Educational and Psychological Measurement, 51,* 455−462.

Cree, G. S., & McRae, K. (2003). Analyzing the factors underlying the structure and computation of the meaning of chipmunk, cherry, chisel, cheese, and cello (and many other such concrete nouns). *Journal of Experimental Psychology: General, 132*, 163−201.

Davidson, G. V., & Savenye, W. C. (1992). How do learning styles relate to performance in a computer applications course? *Journal of Research on Computing in Education, 24*, 348−358.

Denis, M. (1996). Imagery and the description of spatial configurations Models of visuospatial cognition. In M. Vega, M. J. Intons-Peterson, P. N. Johnson-Laird, M. Denis, & M. Marschark (Eds.), *Models of visuospatial cognition* (pp. 128−197). New York: Oxford University Press.

DeStefano, D., & LeFevre, J. (2004). The role of working memory in mental arithmetic. *European Journal of Cognitive Psychology, 16*, 353−386.

Dubey, R. S. (1982). Trait persistence, sex differences and educational achievement. *Perspectives in Psychological Researches, 5*, 15−18.

Dunn, R., Dunn, K., & Price, G. E. (1989). *Learning style inventory*. Lawrence, KS: Price Systems.

Edwards, J. D., Walley, A. C., & Ball, K. K. (2003). Phonological, visual and temporal processing in adults with and without reading disability. *Reading and Writing, 16*, 737−758.

Edwards, J. E., & Wilkins, W. (1981). Verbalizer-Visualizer Questionnaire: Relationship with imagery and verbal–visual ability. *Journal of Mental Imagery, 5*, 137−142.

Eldredge, J. L. (2005). Foundations of fluency: An exploration. *Reading Psychology, 26*, 161−181.

Ellis, N. R., & Dulaney, C. L. (1991). Further evidence for cognitive inertia of persons with mental retardation. *American Journal on Mental Retardation*, *95*, 613−621.

Eska, B., & Black, K. N. (1971). Conceptual tempo in young grade-school children. *Child Development, 42*, 505−516.

Felton, R. H, Wood, F. B., Brown, I. S., Campbell, S. K., & Harter, M. R. (1987). Separate verbal memory and naming deficits in attention deficit disorder and reading disability. *Brain and Language, 31*, 171−184.

Fischer, M., Barkley, R. A., Edelbrock, C. S., & Smallish, L. (1990). The adolescent outcome of hyperactive children diagnosed by research criteria: II. Academic, attentional, and neuropsychological status. *Journal of Consulting and Clinical Psychology, 58*, 580−588.

Floyd, R. G., Evans, J. J., & McGrew, K. S. (2003). Relations between measures of Cattell-Horn-Carroll (CHC) cognitive abilities and mathematics achievement across the school-age years. *Psychology in the Schools, 40*, 155−171.

Freedman, R. D., & Stumpf, S. A. (1980). Learning style theory: Less than meets the eye. *Academy of Management Review, 5*, 445−447.

Gaultney, J. F., Bjorklund, D. F., & Schneider, W. (1992). The role of children's expertise in a strategic memory task. *Contemporary Educational Psychology, 17*, 244−257.

Geary, D. C., & Brown, S. C. (1991). Cognitive addition: Strategy choice and speed-of-processing differences in gifted, normal, and mathematically disabled children. *Developmental Psychology, 27*, 398−406.

Geary, D. C., Brown, S. C., & Samaranayake, V. A. (1991). Cognitive addition: A short longitudinal study of strategy choice and speed-of-processing differences in normal and mathematically disabled children. *Developmental Psychology, 27*, 787−797.

Geary, D. C., & Burlingham-Dubree, M. (1989). External validation of the strategy choice model for addition. *Journal of Experimental Child Psychology, 47*, 175−192.

Goldman-Rakic, P. S. (1995). Anatomical and functional circuits in prefrontal cortex of nonhuman primates: Relevance to epilepsy. In H. H. Jasper, S. Riggio, & P. S. Goldman-Rakic (Eds.), *Epilepsy and the functional anatomy of the frontal lobe* (pp. 51−62). New York: Raven Press.

Gregorc, A. F. (1982). *Gregorc Style Delineator*. Maynard, MA: Gabriel Systems.

Gregorc, A. F. (1985). *Inside styles: Beyond the basics*. Maynard, MA: Gabriel Systems.

Henson, R. K., & Hwang, D. Y. (2002). Variability and prediction of measurement error in Kolb's learning style inventory scores a reliability generalization study. *Educational and Psychological Measurement*, *62*, 712−727.

Hershey, D. A., Walsh, D. A., Read, S. J., & Chulef, A. S. (1990). The effects of expertise on financial problem solving: Evidence for goal-directed, problem-solving scripts. *Organizational Behavior and Human Decision Processes*, *46*, 77−101.

Honey, P., & Mumford, A. (1989). *Learning styles questionnaire*. *Maidenhead*: Peter Honey.

Honey, P., & Mumford, A. (1992). *The manual of learning styles: Revised version*. Maidenhead: Peter Honey.

Hyde, J. S. (1990). Meta-analysis and the psychology of gender differences. *Signs: Journal of Women in Culture and Society, 16*, 55–73.

Joniak, A. J., & Isaksen, S. G. (1988). The Gregorc Style Delineator: internal consistency and its relationship to Kirton's adaptive-innovative distinction. *Educational and Psychological Measurement, 48*, 1043−1049.

Kagan, J. (1965). Impulsive and reflective children: Significance of conceptual tempo. In J. D. Krumboltz (Ed.), *Learning and the educational process* (pp.133−161). Chicago: Rand McNally.

Kagan, J. (1966). Reflection-impulsivity: The generality and dynamics of conceptual tempo. *Journal of Abnormal Psychology, 71*, 17−24.

Kochanska, G. (1991). Socialization and temperament in the development of guilt and conscience. *Child Development, 62*, 1379−1392.

Kolb, D. A. (1976). *Learning Style Inventory: Technical manual*. Boston, MA: McBer & Co.

Kolb, D. A. (1985). *Learning Style Inventory*. Boston, MA: McBer & Co.

Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2001). Experiential learning theory: Previous research and new directions. In R. J. Sternberg & L. Zhang (Eds.). *Perspectives on thinking, learning, and cognitive styles* (pp. 227−247). Mahwah, NJ: Erlbaum.

Larkin, J. H. (1985). Understanding problem representations and skill in physics. In S. F. Chipman, J. W. Segal, & R. Glaser (Eds.), *Thinking and learning skills: Vol 2. Research and open questions* (pp. 141–159). Hillsdale, NJ: Erlbaum.

Lee, K. M., & Kang, S. Y. (2002). Arithmetic operation and working memory: Differential suppression in dual tasks. *Cognition, 83*, B63–B68.

Liew, J., McTigue, E. M., Barrois, L., & Hughes, J. N. (2008). Adaptive and effortful control and academic self-efficacy beliefs on achievement: A longitudinal study of 1st through 3rd graders. *Early Childhood Research Quarterly, 23*, 515–526.

Liew, J., Xiang, P., Johnson, A. Y., & Kwok, O. (2011). Effortful persistence and body mass as predictors of running achievement in children and youth: A longitudinal study. *Journal of Physical Activity and Health, 8*, 234–243.

Lorch, E. P., Milich, R., Sanchez, R. P., van den Broek, P., Baer, S., Hooks, K., Hartung, C., & Welsh, R. (2000). Comprehension of televised stories in boys with attention deficit/hyperactivity disorder and nonreferred boys. *Journal of Abnormal Psychology, 109*, 321–330.

Lyman, B. J., & McDaniel, M. A. (1990). Memory for odors and odor names: Modalities of elaboration and imagery. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*, 656–664.

Martin, R. P., & Holbrook, J. (1985). Relationship of temperament characteristics to the academic achievement of first-grade children. *Journal of Psychoeducational Assessment, 3*, 131–140.

Martin, R. P., Wisenbaker, J., & Huttunen, M. (1994). Review of factor analytic studies of temperament measures based on the Thomas-Chess structural model: Implications for the Big Five. In C. F. Halverson Jr., G. A., Kohnstamm, & R. P., Martin (Eds.), *The developing structure of temperament and personality from infancy to adulthood* (pp. 157–172). Hillsdale, NJ: Erlbaum.

Massa, L. J., & Mayer, R. E. (2006). Testing the ATI hypothesis: Should multimedia instruction accommodate verbalizer-visualizer cognitive style. *Learning and Individual Differences, 16*, 321–335.

Mastropieri, M. A., & Scruggs, T. E. (1997). Best practices in promoting reading comprehension in students with learning disabilities: 1976 to 1996. *Remedial and Special Education, 18*, 197–213.

Mayer, R. E., & Massa, L. J. (2003). Three facets of visual and verbal learners: cognitive ability, cognitive style, and learning preference. *Journal of Educational Psychology, 95*, 833–846.

Mayfield, W. A., Kardash, C. M., & Kivlighan, D. M. (1999). Differences in experienced and novice counselors' knowledge structures about clients: Implications for case conceptualization. *Journal of Counseling Psychology, 46*, 504–514.

McCall, R. B., & Carriger, M. S. (1993). A meta-analysis of infant habituation and recognition memory performance as predictors of later IQ. *Child Development, 64*, 57–79.

McCutchen, D., Covill, A., Hoyne, S. H., & Mildes, K. (1994). Individual differences in writing: Implications of translating fluency. *Journal of Educational Psychology, 86*, 256–266.

McKay, E. (1999). An investigation of text-based instructional materials enhanced with graphics. *Educational Psychology, 19*, 323–335

Messer, D. J., McCarthy, M. E., McQuiston, S., MacTurk, R. H., Yarrow, L. J., & Vietze, P. M. (1986). Relation between mastery behavior in infancy and competence in early childhood. *Developmental Psychology, 22*, 366–372.

Morrow, D. G., Menard, W. E., Stine-Morrow, E. A. L., Teller, T., & Bryant, D. (2001). The influence of expertise and task factors on age differences in pilot communication. *Psychology and Aging, 16*, 31–46.

O'Brien, T. P. (1990). Construct validation of the Gregorc Style Delineator: an application of LISREL 7. *Educational and Psychological Measurement, 50*, 631–636.

Peleg, O. (2009). Test anxiety, academic achievement, and self-esteem among Arab adolescents with and without learning disabilities. *Learning Disability Quarterly, 32*, 11–20.

Platsidou, M., & Metallidou, P. (2009). Validity and reliability issues of two learning style inventories in a Greek sample: Kolb's learning style inventory and Felder & Soloman's index of learning styles. *International Journal of Teaching and Learning in Higher Education*, *20*, 324–335.

Pressley, M., Cariglia-Bull, T., Deane, S., & Schneider, W. (1987). Short-term memory, verbal competence, and age as predictors of imagery instructional effectiveness. *Journal of Experimental Child Psychology, 43*, 194–211.

Price, L. (2004). Individual differences in learning: Cognitive control, cognitive style, and learning style. *Educational Psychology, 24*, 681–698.

Rasile, D. A., Burg, J. S., Burright, R. G., & Donovick, P. J. (1995). The relationship between performance on the Gordon Diagnostic System and other measures of attention. *International Journal of Psychology, 30*, 35–45.

Recht, D. R., & Leslie, L. (1988). Effect of prior knowledge on good and poor readers' memory of text. *Journal of Educational Psychology, 80*, 16–20.

Reio, T. G., & Wiswell, A. K. (2006). An examination of the factor structure and construct validity of the Gregorc Style Delineator. *Educational and Psychological Measurement*, 66, 489–501.

Rezaei, A. R., & Katz, L. (2004). Evaluation of the reliability and validity of the cognitive styles analysis. *Personality and Individual Differences, 36*, 1317–1327.

Richardson, A. (1977). Verbalizer-visualizer: A cognitive style dimension. *Journal of Mental Imagery, 1*, 109–125.

Richardson, D. C., Spivey, M. J., Barsalou, L. W., & McRae, K. (2003). Spatial representations activated during real-time comprehension of verbs. *Cognitive science, 27*, 767–780.

Riding, R. J. (1991). *Cognitive styles analysis*. Birmingham, UK: Learning & Training Technology.

Riding, R. J. (1998). *Cognitive styles analysis: research applications*. Birmingham, UK: Learning & Training Technology.

Riding, R. J., & Agrell, T. (1997). The effect of cognitive style and cognitive skills on school subject performance. *Educational Studies, 23*, 311–323.

Riding, R. J., & Cheema, I. (1991). Cognitive styles—An overview and integration. *Educational Psychology, 11*, 193–215.

Riding, R. J., & Pearson, F. (1994). The relationship between cognitive style and intelligence. *Educational Psychology, 14*, 413–425.

Ross, J. L., Drysdale, M. T. B., & Schultz, R. A. (2001). Cognitive learning styles and academic performance in two postsecondary computer application courses. *Journal of Research on Computing in Education, 33*, 400–412.

Royer, J. M., Tronsky, L. N., Chan, Y., Jackson, S. J., & Marchant, H. (1999). Math-fact retrieval as the cognitive mechanism underlying gender differences in math test performance. *Contemporary Educational Psychology, 24*, 181–266.

Runco, M. A., & Okuda, S. M. (1988). Problem discovery, divergent thinking, and the creative process. *Journal of Youth and Adolescence, 17*, 211–220.

Sabers, D. S., Cushing, K. S., & Berliner, D. C. (1991). Differences among teachers in a task characterized by simultaneity, multidimensional, and immediacy. *American Educational Research Journal, 28*, 63–88.

Salthouse, T. A. (1991). Mediation of adult age differences in cognition by reductions in working memory and speed of processing. *Psychological Science, 2*. 179–183.

Salthouse, T. A., Mitchell, D. R., Skovronek, E., & Babcock, R. L. (1989). Effects of adult age and working memory on reasoning and spatial abilities. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*, 507–516.

Salthouse, T. A., & Pink, J. E. (2008). Why is working memory related to fluid intelligence? *Psychonomic Bulletin & Review, 15*, 364–371.

Schneider, W. (1993). Acquiring expertise: Determinants of exceptional performance. In K. A. Heller, F. J. Monks, & A. H. Passow (Eds.), *International handbook of research and development of giftedness and talent* (pp. 311–324). London: Pergamon Press.

Schneider, W., Körkel, J., & Weinert, F. E. (1989). Domain-specific knowledge and memory performance: A comparison of high-and low-aptitude children. *Journal of Educational Psychology, 81*, 306–312.

Schweitzer, J. B., & Sulzer-Azaroff, B. (1995). Self-control in boys with attention deficit hyperactivity disorder: Effects of added stimulation and time. *Journal of Child Psychology and Psychiatry, 36*, 671–686.

Shoda, Y., Mischel, W., & Peake, P. K. (1990). Predicting adolescent cognitive and self-regulatory competencies from preschool delay of gratification: Identifying diagnostic conditions. *Developmental Psychology, 26*, 978–986.

Siegel, L. S., & Ryan, E. B. (1989). The development of working memory in normally achieving and subtypes of learning disabled children. *Child Development, 60*, 973–980.

Slotta, J. D., Chi, M. T. H., & Joram, E. (1995). Assessing students' misclassifications of physics concepts: An ontological basis for conceptual change. *Cognition and Instruction, 13*, 373–400.

Stanovich, K. E., & Siegel, L. S. (1994). Phenotypic performance profile of children with reading disabilities: A regression-based test of the phonological-core variable-difference model. *Journal of Educational Psychology, 86*, 24–53.

Sternberg, R. J. (2001). Epilogue: Another mysterious affair at styles. In R. J. Sternberg & L. Zhang (Eds.). *Perspectives on thinking, learning, and cognitive styles* (pp. 249–252). Mahwah, NJ: Erlbaum.

Stoeber, J., Chesterman, D., & Tarn, T. (2010). Perfectionism and task performance: Time on task mediates the perfectionistic strivings–performance relationship. *Personality and Individual Differences*, *48*, 458–462.

Stoeber, J., & Eismann, U. (2007). Perfectionism in young musicians: Relations with motivation, effort, achievement, and distress. *Personality and Individual Differences, 43*, 2182–2192.

Stoeber, J., & Otto, K. (2006). Positive conceptions of perfectionism: Approaches, evidence, challenges. *Personality and Social Psychology Review, 10*, 295–319.

Stoeber, J., & Rambow, A. (2007). Perfectionism in adolescent school students: Relations with motivation, achievement, and well-being. *Personality and individual differences, 42*, 1379–1389.

Stoll, O., Lau, A., & Stoeber, J. (2008). Perfectionism and performance in a new basketball training task: Does striving for perfection enhance or undermine performance? *Psychology of Sport and Exercise, 9*, 620–629.

Sullivan, G. L., & Macklin, M. C. (1986). Some psychometric properties of two scales for the measurement of verbalizer-visualizer differences in cognitive style. *Journal of Mental Imagery, 10*, 75–85.

Taasoobshirazi, G., & Carr, M. (2009). A structural equation model of expertise in college physics. *Journal of Educational Psychology, 101*, 630–643.

Valiente, C., Lemery-Chalfant, K., & Swanson, J. (2010). Prediction of kindergartners' academic achievement from their effortful control and emotionality: Evidence for direct and moderated relations. *Journal of Educational Psychology, 102*, 550–560.

Vanderwood, M. L., McGrew, K. S., Flanagan, D. P., & Keith, T. Z. (2001). The contribution of general and specific cognitive abilities to reading achievement. *Learning and Individual Differences, 13*, 159–188.

Voeller, K. K. S., & Heilman, K. M. (1988). Motor impersistence in children with attention deficit hyperactivity disorder: Evidence for right-hemisphere dysfunction. *Annals of Neurology, 24*, 323–323.

Williams, D. J., & Noyes, J. M. (2007). Effect of experience and mode of presentation on problem solving. *Computers in Human Behavior, 23*, 258–274.

Witkin, H. A., Oltman, P. K., Raskin, E., & Karp, S. A. (1971). *Manual for embedded figures test, children's embedded figures test, and group embedded figures test*. Palo Alto, CA: Consulting Psychologists Press.

CHAPTER 3

THE MULTIDIMENSIONAL NATURE OF DIVERGENT THINKING AND CREATIVE EXPERTISE PERFORMANCE[2]

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Abstract

The purpose of this study was to examine how and whether the same or different variables predict two measures of creativity: divergent thinking and creative expertise performance. Two models of creativity were tested on a sample of 143 college students. Structural equation modeling was used to test the models including the measures of general intelligence and domain knowledge, measures of motivation including creative behavior and motivation in the form of intrinsic motivation, extrinsic motivation, self-efficacy, and self-determination, and a measure of creative personality as predictors of two measures of creativity (divergent thinking and creative expertise performance). Results were very different for both measures of creativity: General intelligence and creative personality had a significant influence in the divergent thinking model. In the creative expertise performance model, general intelligence and domain knowledge had a significant influence, and motivation had a significant influence as mediated by domain knowledge. In both models, motivation significantly influenced creative behavior.

INDEX WORDS: creativity, general intelligence, expertise, motivation, personality

Introduction

The debate on the nature of creativity, specifically whether creativity is domain-general or domain-specific is on-going (Baer, 1998; Plucker, 1998). For decades, researchers assumed creativity was domain-general and measured it by assessing ideational fluency, flexibility, and originality as measured through divergent thinking tests (e.g., Guilford, 1967; Torrance, 1974; Wallach & Kogan, 1965). However, more recently, researchers have begun to view creativity as domain-specific, and that can be measured by expert ratings of creative performances within fields (e.g., Amabile, 1996; Baer, 1991). While research has been conducted from each perspective independently, no research has compared the two approaches of creativity simultaneously.

Although both approaches assume that cognitive and motivational processes underlie creative production, the two approaches assume different constructs. Many proponents of domain-general creativity assume that domain-general cognitive ability, often in the form of IQ, underlies divergent thinking (e.g., Nusbaum & Silvia, 2011; Rindermann & Neubauer, 2004). In contrast, most proponents of the domain-specific model of creativity assume that expertise, in the form of domain-specific knowledge and strategies, plays the key role in creative performances within fields (e.g., Baer, 1991, 1993; Weisberg, 1999, 2006). For proponents of domain-general creativity, divergent thinking is often viewed as a product of motivation as measured through creative behavior, including creative activity and creative ideation (e.g., Milgram & Milgram, 1976; Plucker, Runco, & Lim, 2006; Runco, 1987). Proponents of domain-specific creativity often assume that motivation in the form of intrinsic motivation, self-determination, and self-efficacy influences creative performances within fields (e.g., Amabile, Hill, Hennessey, & Tighe, 1994; Rostan, 2010).

Furthermore, the two approaches assume different roles of personality in creativity. Many proponents of domain-general creativity assume that divergent thinking is linked to two personality traits, extraversion and openness to experience (e.g., King, Walker, & Broyles, 1996; Wuthrich & Bates, 2001). In contrast, most proponents of domain-specific creativity assume that the contribution of different personality traits to creative outcomes differs as a function of domain (e.g., Feist, 1998, 1999). For example, Feist's (1998) meta-analysis indicated that scientists tend to have more extraversion, openness to experience, and conscientiousness; artists tend to have more openness to experience and less conscientiousness traits. Within the domain of science, creative people are more open to experience and are more extraverted (Feist, 1998), whereas, in the domain of art, creative people are more neurotic and are less extraverted (Gotz & Gotz, 1973).

In addition, the two approaches differ in the definition of creativity and how it is measured. Most domain-general proponents describe creativity as the production of plentiful and unusual ideas. They measure creativity with divergent thinking tests (e.g., Torrance, 1974; Wallach & Kogan, 1965). In divergent thinking tests, test-takers are asked to generate as many of their own solutions as they can (Plucker & Renzulli, 1999), and the responses are assessed through the criteria of fluency, flexibility, and originality (see Charles & Runco, 2000−2001). In contrast, most domain-specific proponents conceptualize creativity as an unusual and effective product on a domain-specific task. They measure creativity via expert judgments of performances within fields (e.g., Amabile, 1996; Baer 1991, 1993). For example, Baer (1991) proposed that expert raters assessed domain-specific products (verbal and mathematical) based on their own sense of what is regarded as being creative.

A critical problem is that the two approaches essentially reflect two distinct theories of creativity with different predictors of creative outcomes and different measures of creativity. One step towards unifying the two perspectives is to determine whether there are common constructs that predict both measures of creative outcomes. No study, to date, has included measures of cognition, motivation, and personality from both perspectives to test whether separate models are needed. Thus, the purpose for this study was to examine from both perspectives the influence of cognition, motivation, and personality on the two creative outcomes (divergent thinking and creative expertise performance). In the following sections, I review the literature related to the cognitive, motivational, and personality constructs hypothesized to underlie divergent thinking and creative expert performance.

Creativity and General Cognitive Ability

Many proponents of domain-general creativity assume that general cognitive abilities, such as IQ and other measures of general knowledge and skill, are critical predictors of divergent thinking but see (Cropley, 1968; Torrance, 1967) for a different perspective. There is evidence to show a significant relationship between measures of general cognitive abilities and measures of divergent thinking for college students. Research by Batey, Chamorro-Premuzic, and Furnham (2009) found that college students with superior general knowledge as measured by the General Knowledge Test (Irwing, Cammock, & Lynn, 2001) had higher scores on these three divergent thinking tasks: Guilford's (1967) Uses Test, Guilford's Consequences Test (1967), and Thurstone's Word Fluency Test (Thurstone, 1938). In the same study, Batey et al. (2009) correlated performance on the Wonderlic Personnel Test of mathematics, vocabulary and reasoning (Wonderlic, 1992) and the Baddeley Reasoning Test (Baddeley, 1968) with the Guilford's (1967) Uses Test and found a significant correlation. Other research by Nusbaum and

Silvia (2011) found that college students' divergent thinking performance (unusual uses task) was related to a latent variable of general knowledge and skill consisting of the measures of reasoning (the Raven's Advanced Progressive Matrices, a paper folding task, and a letter sets task), measures of verbal fluency (name instances of a concept and words beginning with the same letter), and measures of strategy generation (come up with strategies for verbal fluency tasks).

Similar results were found with high school students. Research by Furnham, Batey, Anand, and Manfield (2008) showed that high school students with higher scores on the Baddeley Reasoning Test (Baddeley, 1968) had better divergent thinking performance on Guilford's (1967) Uses Test. Rindermann & Neubauer (2004) found that for high school students, general cognitive abilities as measured by the Raven's Advanced Progressive Matrices (Raven, 1958) and Kognitiver Fähigkeits-Test [Cognitive Abilities Test] (Heller, Gaedike, & Weinläder, 1985) correlated with divergent thinking performance on the Verbaler Kreativitäts-Test [Verbal Creativity Test] (Schoppe, 1975) and the Verwendungs-Test [Unusual Uses Test] (Facaoaru, 1985). Similarly, research by Cho, Te Nijenhuis, Van Vianen, Kim, and Lee (2010) found that for ages 15-27 years, general intelligence as measured by the Raven's Advanced Progressive Matrices (Raven, 1980) and Wechsler Adult Intelligence Scale (Wechsler, 1981) correlated with divergent thinking performance as measured by the Torrance Tests of Creative Thinking Figural and Verbal Forms (Torrance, 1999ab). These studies support the hypothesis that divergent thinking is a product of general cognitive processes in the form of IQ and other measures such as the Raven's Advanced Progressive Matrices and the Baddeley Reasoning Test.

However, the relationship between measures of general intelligence and divergent thinking is not as strong for elementary school age children. Kim's (2005) meta-analysis found that the elementary school group had a weaker relationship between IQ and divergent thinking measures than older groups (middle school, high school, and adults). Research by Wallbrown and Huelsman (1975) found that for third- to fourth-grade children, general intelligence as measured by the Wechsler Intelligence Scale for Children (Wechsler, 1949) did not correlate with divergent thinking performance as measured by the Wallach-Kogan Creativity Test (Wallach & Kogan, 1965).

Many proponents of domain-specific creativity point out a number of studies that find no relationship between measures of general cognitive ability and measures of domain-specific outcomes. For example, research by MacKinnon (1961) found architects' scores on the Terman Concept Mastery Test (Terman, 1973) did not correlate with creative performance within the area of architecture. Gough (1976) administered the same measure of intelligence to professional scientists and found that it did not correlate with their creative achievement as measured by peer and supervisor ratings. These studies used expert adults that are older than the high school and college aged samples used in the studies examining predictors of general creativity. It may be that while students are in school, general intelligence measures predict creativity but once I look at creativity in adulthood within areas of expertise, general cognitive factors play less of a role.

The research to date would suggest that a general measure of intelligence would predict divergent thinking better than creative expertise performance. However, this may be a function of age or expertise. General intelligence seems to become less important when the focus is on older adults with expertise. In this sample, I looked at emerging expertise in college-students. In this case, more general measures of intelligence may play out to be more important for expert performance. One goal of the current study was to contrast the effect of general cognitive ability as a predictor of divergent thinking and creative expertise performance.

Creativity and Expert Knowledge

Experts have greater and better-organized conceptual knowledge, use goal-oriented strategies, and have more effective metacognition in comparison to novices (e.g., Alexander, 2003; Chi, 2006; Zimmerman, 2006). Research indicates that the organization of expert knowledge allows for better problem-solving (e.g., Chi, Glaser, & Rees, 1982; Sabers, Crushing, & Berliner, 1991). For example, the Mayfield, Kardash, and Kivlighan's (1999) study found that expert counselors tend to analyze counseling descriptions based on psychological principles while novice counselors tend to classify the descriptions with concrete features such as the time order of statements. Research by Chi, Feltovich, and Glaser (1981) found that expert students tend to categorize physics problems based on underlying physics principles whereas novice students tend to do according to literal surface features. This indicates that experts have qualitatively better domain knowledge than novices and this knowledge supports problem-solving.

Most proponents of domain-specific creativity argue that domain-specific knowledge is an important predictor of creative achievement. Weisberg' retrospective case studies (1999, 2006) showed that highly distinguished creators across domains had highly developed domain-specific knowledge. With regard to creative problem-solving, research by Vincent, Decker, and Mumford (2002) found that military leaders with more domain-specific knowledge had more creative solutions to military leadership problems. Research by Mumford, Baughman, Supinski, and Maher (1996) indicated that college students' better knowledge about advertising predicted creative solutions to advertising problems. Furthermore, there is little correlation among the ratings of domain-specific artifacts produced by the same person (e.g., Baer, 1991, 1993) so that an individual may be creative in one domain but will not be able to replicate that result in a different domain.

Furthermore, when general intellectual ability has been compared to domain-specific knowledge, domain-specific knowledge is a better predictor of superior performance within a domain. Third, fifth, and seventh graders' ability to remember a text about soccer was more dependent on domain-specific knowledge than on general intellectual ability (Schneider, Körkel, & Weinert, 1989, 1990). Research by Recht and Leslie (1988) found that junior high school students' prior knowledge about baseball, as compared to their general reading ability, was a better predictor of reading performance on a domain-relevant text. Within the domain of chess, Chase and Simon (1973) found that experts' better performance on a mid-play chess board (as opposed to random placement of pieces on the board) was linked to their better-organized domain knowledge about chess. This research, however, did not examine whether expert knowledge produced more creative outcomes than general intellectual ability.

In the current study domain-specific knowledge was contrasted with general intelligence as a predictor of both divergent thinking and creative performance with expertise in educational psychology. The research to date would suggest that domain-specific knowledge would predict creative expertise performance. It is not clear whether it would predict divergent thinking within the same domain of expertise. The current study allowed us to examine the contributions of both domain knowledge and general intelligence to creativity as defined as divergent thinking and expertise performance.

Creativity and Motivation

Many proponents of domain-general creativity have predominantly used a self-report biographical questionnaire to measure creativity motivation. They argue that the motivation to engage in creative behavior, including creative activity and ideation, is associated with divergent thinking. A measure of creative activity assesses how often respondents have engaged in creative activities in various fields (e.g., Hocevar, 1980; Runco, 1987); a measure of creative ideation assesses how often respondents have had creative ideas in everyday life (e.g., Runco, Plucker, & Lim, 2000−2001). Both measures focus on out-of-school (extracurricular) voluntary behaviors.

Evidence shows a relationship between creativity motivation (creative behavior) and divergent thinking. Research by Runco (1987) indicated that the divergent thinking scores of fifth- through eighth-grade children correlated with the number of extracurricular creative activities in various fields (e.g., writing, music, crafts, performing arts, and science). Milgram and Milgram (1976) found that the divergent thinking performance of high school students to be linked to the number of extracurricular creative activities in various domains (e.g., fine arts, social leadership, and writing). Other research by Hocevar (1980) with college students found that divergent thinking performance correlated with the number of extracurricular creative activities in the crafts, performing arts, and math-science domains. With regard to creative ideation, Runco et al. (2000−2001) postulated that the production of creative ideas in daily life is associated with divergent thinking performance. Plucker et al. (2006) showed evidence that college students' scores on divergent thinking tests were linked to creative ideation in everyday life as measured by the Runco Ideational Behavior Scale (Runco et al., 2000−2001). The results of these studies indicate that high creativity motivation to engage in creative behavior (activity and ideation) is related to better divergent thinking performance.

In contrast, proponents of domain-specific creativity have often assumed that motivation to perform a specific task, in the form of intrinsic motivation, extrinsic motivation, self-efficacy, and self-determination, is critical for domain-specific outcomes. Intrinsic motivation refers to an internal desire to engage in a task for its own value; extrinsic motivation refers to a desire stemming from an outside stimulus such as getting a good job (Ryan & Deci, 2000); self-efficacy refers to task performers' confidence in their abilities to succeed in a task (Bong, 2001); and self-determination refers to task performers' beliefs to manage and to opt for the task process (Reeve, Hamm, & Nix, 2003).

Evidence shows that these components of motivation are linked to domain-specific creative performance. Research by Amabile et al. (1994) indicated that college students' intrinsic motivation, self-determination, and competence motivation (self-efficacy) correlated with creative artistic performance. Moneta and Siu (2002) also found that college students' intrinsic motivation, self-determination, and competence motivation (self-efficacy) were related to their creative writing performance. Other research by Rostan (2010) indicated that the competent motivation (self-efficacy) of art students (9-16 years old) was linked to artistic performance. Similar results were found in the work environment as well as the academic field. Eisenberger and Rhoades (2001) found that for employees, intrinsic motivation and self-determination were linked to creative performances in their jobs.

The role of extrinsic motivation in achievement and creative performance is not clear-cut. Extrinsic motivation is thought to hurt achievement and creativity by reducing task interest. Amabile (1985) found that young adults with high extrinsic motivation performed poorly on creative writing. In Kruglanski, Friedman and Zeevi's (1971) study, high school age students who were promised an extrinsic reward showed poorer recall of newspaper stories and nonsense syllables and less creative writing than those who were not promised one. Other research by Amabile (1982) found this negative effect of an extrinsic reward on creative collage-making for elementary school age children. However, extrinsic motivation may also improve achievement and creative performances within fields when extrinsic rewards are linked to the quality of outcomes (Eisenberger & Aselage, 2009; Eisenberger, Pierce, & Cameron, 1999). Research by Eisenberger and Rhoades (2001) found that college students who were promised a performance-contingent reward showed better creative performance (producing creative titles that fit a story) than those who were not promised one. In the same study by Eisenberger and Rhoades (2001), employees' expectancy of a performance-contingent reward enhanced their creative task performance in the workplace as mediated by self-determination or intrinsic motivation. Other research by Eisenberger and Aselage (2009) found that a performance-contingent reward improved college students' creative verbal performance as mediated by self-determination and intrinsic motivation.

The two approaches to assessing motivation are not incompatible with each other. Whether creativity is assessed via divergent thinking or expertise performance, it would be expected that people who are more intrinsically and extrinsically motivated, and who have higher self-efficacy and self-determination would be more likely to be involved in more creative behavior (activity and ideation) and would be more creative. The research to date would suggest that creative behavior would better predict divergent thinking while the four forms of motivation (above) would better predict creative expertise performance. However, given that no research has compared the two forms of motivation, it was also possible that the two types of motivations would predict the two measures of creativity equally well.

Creativity and Personality

Many proponents of domain-general creativity assume that a creative personality is an important predictor of divergent thinking. Researchers generally use the Creative Personality Scale (Gough, 1979) to measure the creative personality, which is a self-report scale assessing either positive for creativity (e.g., inventive and original) or negative for creativity (e.g., commonplace and conservative) personality traits across domains. Research shows a significant relationship between measures of divergent thinking and creative personality as measured by the Creative Personality Scale. Research by McCrae (1987) found that the Creative Personality Scale correlated with five measures of divergent thinking (i.e., associational fluency, expressional fluency, ideational fluency, word fluency, and remote consequences) in a sample of adult males. Research by Sánchez-Ruiz, Hernández-Torrano, Pérez-González, Batey and Petrides (2011) found that for college students and recent graduates, the Creative Personality Scale was linked to their divergent thinking as measured by the Torrance Tests of Creative Thinking Figural Form (Torrance, 1974). Other research by Carson, Peterson, and Higgins (2005) found a significant relationship between the Creative Personality Scale and college and graduate students' divergent thinking as measured by the Torrance Tests of Creative Thinking Verbal Form (Torrance, 1968). However, among the sub-constructs of divergent thinking, creative personality is more likely to account for originality and flexibility than fluency. In the same study, Carson et al. (2005), total divergent thinking scores, originality, and flexibility showed significant correlations with the Creative Personality Scale, but fluency did not. Research by Plucker, Qian, and Wang (2011) correlated the Creative Personality Scale with Wallach and Kogan's (1965) divergent thinking tests and found a significant relationship with originality, but not with fluency. These studies support the hypothesis that general creative personality is related to divergent thinking in general, but it appears to be more related to originality and flexibility rather than fluency.

Many proponents of domain-general creativity often assume that personality as measured by two of the big five (extraversion and openness to experience) are also critical predictors of divergent thinking. Extraversion is thought to improve divergent thinking by increasing stimulation-seeking and risk-taking (Batey & Furnham, 2006; Eysenck & Eysenck, 1985). Research by Sen and Hagtvet (1993) indicated that for 15-to-16 year old students, higher extraversion was linked to better divergent thinking performance. Similar results were found with adult samples. Aguilar-Alonso's (1996) study showed that a group of more extroverted adults comprised of college students and professionals tend to have better divergent thinking performance. Other research by King et al. (1996) and Wuthrich and Bates (2001) also found a relationship between college students' divergent thinking scores and extraversion. Another personality characteristic, openness to experience, is thought to increase divergent thinking by improving imagination and openness to novel ideas (Batey et al., 2009; Costa & McCrae, 1992). Research by Wuthrich and Bates (2001) and King et al. (1996) indicated that college students who are more open to experience had better divergent thinking scores. In McCrae's (1987) study, a positive relationship was found between a measure of openness to experience and five measures of divergent thinking (i.e., associational fluency, expressional fluency, ideational fluency, word fluency, and remote consequences) in a sample of adult males. Research shows that the two personality traits correlated with the Creative Personality Scale (e.g., McCrae, 1987; Wolfradt & Pretz, 2001), which indicates that the two traits are linked to a creative personality as well as divergent thinking.

In regard to domain-specific creativity, the assumption is that the role of creative personality (the same as a predictor of divergent thinking) in creative performance differs across domains. Research by Meneely and Portillo (2005) shows that general creative personality as measured by the Gough Adjective Check List, scored for Domino's Creativity Scale (ACL-Cr; Domino, 1970), significantly predicted college students' creative performance (design a three-dimensional form) within the field of design. Creative personality as measure by the Creative

Personality Scale (Gough, 1979) correlated with college students' creative performance (write a story about a picture) within the domain of writing (Wolfradt & Pretz, 2001). However, research by Dollinger, Urban, and James (2004) found no correlation between the Creative Personality Scale and college students' photo essays (describe who they are with photos). Within the field of music, Charyton and Snelbecker's study (2007) found that for college students, the Creative Personality Scale was not correlated with the measure of music improvisation creativity. These studies indicate that the influence of creative personality may have more or less impact as a function of domain, but as of yet we know little about how and why it varies.

Most domain-specific proponents assume that the role of standard personality traits (big five model) differs as a function of domain. Creativity is accompanied by different personality traits in different domains (Feist, 1998, 1999). For example, Feist's (1998) meta-analysis found that scientists tend to be more extroverted, open to experience, and conscientious; artists tend to be more open to experience and less conscientious. Within the domain of science, creative scientists tend to be more extroverted and open to experience than less creative scientists (Feist, 1998); within the domain of art, creative artists tend to be more neurotic and less extroverted than less creative artists (Gotz & Gotz, 1973). These differences may be a function of what is needed to be successful within a given field. The field of science seeks to find solutions to problems and requires more logical and organized forms of expression (Ludwig, 1998), so scientists may be more conscientious than artists. However, the field of art seeks to exploit aesthetics and requires more subjective and emotive forms of expression (Ludwig, 1998), so creative artists may be more neurotic and less extroverted than less creative artists.

One goal of the current study was to contrast the effect of creative personality on the two measures of creativity. Given that creative personality has been found to predict both divergent thinking and creative expertise performance, I focused on its effects on the two different measures of creativity. Given the research to date, it would be expected that creative personality would predict both divergent thinking and creative expertise performance in educational psychology. The question for this study is whether creative personality predicts each measure of creativity equally well when other factors, such as general intelligence, domain knowledge and motivation are considered.

Present Study

The current study addresses the question of how and whether the same or different cognitive, motivational, and personality variables predict two models of creativity. I compared a model of divergent thinking with a model of creative expertise performance. The models differ only in that one model includes divergent thinking as the outcome and the second model includes creative performance with expertise as the outcome measure. I looked at both outcomes within a specific domain to contrast the two measures of creativity within the same field. In terms of divergent thinking, measuring general divergent thinking appears to be common, but other researchers (e.g., Diakidoy & Constantinou, 2000−2001; Hu & Adey, 2002; Hu, Shi, Wang, & Adey, 2010) have measured it within a particular domain. A general creativity theory would suggest that general intelligence, creative behavior, and creative personality would predict divergent thinking better than they would predict creative expertise performance. In contrast, a domain-specific creativity theory would suggest that motivation and domain knowledge would predict creative expertise performance better than they would predict divergent thinking. Based on this assumption I developed the path diagram shown in Figures 3.1 and 3.2.

Method

Participants

Participants include a total of 143 undergraduates (58 men and 85 women) enrolled in six introductory educational psychology courses taught by three different instructors at four different universities in South Korea. This educational psychology course is one of the classes required to complete the teacher training course of study, which covers the fundamental theories of educational psychology and is standardized across universities. Of the total of 143 students, 128 (89.5 %) registered for the course as a teaching profession subject, four (2.8 %) as an elective subject, four (2.8%) as a subject for general education, and seven (4.9%) as a prerequisite subject for the Graduate School of Education.

Procedures and Materials

Students were administered a set of instruments and activities comprised of an intelligence test, a motivation questionnaire, two creative behavior questionnaires (activity and ideation), a creative personality questionnaire, and two creativity tasks including the divergent thinking and creative expertise performance questions. All instruments written in English were translated into Korean by three Korean-English bilinguals, two Korean experts in educational psychology, and a Korean-American specialist in education. This set of instruments was administered in the classroom at the end of the semester after the course had covered the most basic educational psychology theories. Participants could not refer to any documents, books, or notes as they worked. Two experts in educational psychology scored the set of documents. Students completed the entire set in 45-60 minutes.

General intelligence. I measured students' intelligence scores using a general verbal intelligence scale, the Comprehension section from the Multidimensional Aptitude Battery-II

(MAB-II; Jackson, 1998), a group intelligence test. The intelligence test had a time limit of seven minutes. Comprehension from the MAB-II is a 28-item verbal scale. Each item yields one point, so the range of scores is 0 to 28. This scale has shown good reliability and validity. Prior findings (Jackson, 1998) showed that internal consistency reliability ranged from .82 to .90 across age, and the test-retest reliability was .95. Correlation with the WAIS-R (Wechsler, 1981) was .73. Internal consistency for this study was found to be α = .62.

Domain knowledge. Students' course grades in the educational psychology foundation course were collected to obtain a measure of domain knowledge. I obtained individual final raw scores (of 100 total) from instructors, and these scores were converted to standard t-scores because each class had a different mean and standard deviation.

Creative behavior. The motivation to engage in creative behavior in educational psychology was assessed by two measures of creative activity and ideation. Creative activity was assessed using the Creative Activities Check List (Okuda, Runco, & Berger, 1991). The original version used in Okuda et al. (1991) was a 50-item scale with five domains (i.e., writing, music, crafts, science, and public performance). This scale is reliable and valid. Okuda et al. (1991) showed that the reliability was .91. Runco, Noble, and Luptak (1990) showed a good validity. For this study, 10 of the original 50 items were selected and modified to assess students' creative activities related to educational psychology (e.g., "How many times have you participated in an Educational Psychology club or organization?"). The items were scored on a 4-point Likert scale with these options: never (1), once or twice (2), three to five times (3), and six or more times (4). Internal consistency in this study found to be α = .70.

Creative ideation was assessed using the Runco Ideational Behavior Scale (RIBS; Runco et al., 2000−2001). The RIBS is reliable and valid. The reliability ranged from .84 to .93 (Runco et al., 2000-2001; Runco, Walczyk, Acar, Cowger, Simundson, & Tripp, 2013). The RIBS showed a good construct validity (Runco et al., 2000-2001), discriminate validity (Runco et al., 2000-2001), and concurrent validity (Runco et al., 2013). For creative ideation in educational psychology, 10 of the original 23 items were selected and modified (e.g., "How often have you had ideas about how to apply principles of educational psychology in new ways to solve everyday problems?"). The items were scored on a 5-point Likert scale with these options: never (1), once a year (2), once a month (3), several times a week (4), and daily (5). For this study, internal consistency was reported as $\alpha = .88$. The total scores of each measure were converted to standard z-scores and the two sets of z-scores were added together.

Motivation. Motivation in educational psychology was measured using the Educational Psychology Motivation Questionnaire (EPMQ) modified from the Science Motivation Questionnaire II (SMQ II; Glynn, Brickman, Armstrong & Taasoobshirazi, 2011). The SMQ II is a 25-item questionnaire, which assesses five motivation constructs when learning science (i.e., intrinsic motivation, self-determination, self-efficacy, career motivation, and grade motivation). Glynn et al. (2011) indicates that the SMQ II has good reliability and validity. The reliability (internal consistency) of all 25 items was .92. The multiple fit indices showed good construct validity, and the significant relationship with students' college science GPAs demonstrated a good criterion-related validity. The EPMQ includes the same 25 items measuring these five constructs when learning educational psychology: intrinsic motivation (e.g., "Learning educational psychology is interesting"), self-determination (e.g., "I put enough effort into learning educational psychology"), self-efficacy (e.g., "I am confident I will do well on educational psychology tests"), career motivation (e.g., "Learning educational psychology will help me get a good job"), and grade motivation (e.g., "It is important that I get an "A" in educational psychology"). The items were scored on a 5-point Likert scale ranging from 1 (never) to 5 (always). Internal consistency was reported as α = .92 in this sample.

Creative personality. The Creative Personality Scale (CPS; Gough, 1979) was administered to assess students' creative personality. The CPS is a self-report scale on creative personality. Participants score on a yes-no scale whether they consider themselves from a more positive perspective checking positive creative traits such as insightful, inventive, and humorous, and less negative in that they do not check attributes such as commonplace, conservative, and conventional. Scores were created by summing the checked positive traits and subtracting the checked negative traits. Prior findings (Gough, 1979) reported good reliability and validity of the CPS. The reliability (internal consistency coefficients) ranged from .73 to .81. The positive correlations with other general creativity measures (e.g., Domino's scale for creativity, Schaefer's scale for creativity, and Welsh's four creativity scales) showed good validities. Total scores ranged between -12 and 18. Internal consistency was reported as α = .60 in this sample.

Divergent thinking task. Students were administered a divergent thinking task (see Table 3.1). They were asked to produce as many of their own creative hypotheses as possible to account for a real-world problem relevant to educational psychology. This task was designed based on the divergent thinking task of real-world problem-finding (Okuda et al., 1991). Two experts in educational psychology scored the divergent thinking task using three criteria: fluency, flexibility, and originality, thereby following the general divergent thinking-rating guidelines (see Charles & Runco, 2000−2001). Fluency was identified as the total number of appropriate ideas in a given context produced by a participant. Two judges scored fluency by counting the number of adequate hypotheses ranging from 0 to 3: zero number of ideas (0), one to three numbers of ideas (1), four to six numbers of ideas (2), and seven or more numbers of ideas (3).

Inter-rater correlation coefficient was .97. Flexibility was measured as the number of categories in which ideas produced by a participant were included. First, two judges classified all hypotheses produced by the students into three separate categories (i.e. cognitive, social, and motivational). Students received one point for each category in which their ideas were placed, and the score ranged from 0 to 3: zero number of categories (0), one number of category (1), two numbers of categories (2), and three numbers of categories (3). Inter-rater correlation coefficient was .96. Two judges assessed originality, which was conceptualized as novel and unusual ideas rarely produced by the majority of people. Prior to scoring, two experts classified all hypotheses produced by students as either original or non-original, and counted the number of original ideas per participant. Students received one point for each original idea ranging from 0 to 3: no original ideas (0), one original idea (1), two original ideas (2), and three or more original ideas (3). Inter-rater correlation coefficient was .95. Points were summed across the three criteria (i.e. fluency, flexibility, and originality), and the total scores ranged between 0 and 9.

Creative expertise performance task. Students were given a creative expertise performance task in educational psychology (see Table 3.2). This task asked students to select one specific problem from many hypotheses they had previously produced for the divergent thinking task, and discuss the solution of the problem by specifically adapting educational psychology theories. Two experts in educational psychology scored the task using three criteria of appropriateness, originality, and quality. Appropriateness was measured by two experts based on how aptly students selected and explained the theories. Ratings of their discussions ranged from 0 to 2: when there was no response or inappropriate or incorrect theories were selected and explained (0); when responses included appropriate explanations of theory content yet specific theories were not clearly mentioned (1), and when appropriate theories were clearly mentioned and appropriately explained (2). Inter-rater correlation coefficient was .98. Two judges scored originality based on how students innovatively selected theories and how well they described the solutions from an original view point. Responses were rated from 0 to 2: when there was no response or overly conventional theories were selected and explained from a broad perspective (0), when somewhat conventional but specific theories were selected and explained from a more defined viewpoint (1), and when novel theories were selected and explained from an original view (2). Inter-rater correlation was .98. In terms of quality, two judges scored responses based on how profoundly and logically students synthesized theories and solutions, with ratings ranging from 0 to 5. Inter-rater correlation coefficient was .92. Points were summed across three criteria (i.e. appropriateness, originality, and quality), and the total scores ranged from 0 to 9.

Results

Descriptive statistics and correlations among the measures are presented first. Described next are model testing and decomposition of effects. Finally the results obtained from alternative models are presented. The two creativity models differed in the influence of the constructs of cognition, motivation, and personality. The measures of general intelligence and creative personality had the strongest influence on divergent thinking; however, the measures of general intelligence, domain knowledge and motivation influenced creative expertise performance.

Descriptive Statistics and Correlations

The descriptive statistics and correlations among the variables across models are described in Table 3.3. Divergent thinking correlated positively with the two independent variables of general intelligence and creative personality. Creative expertise performance correlated with the three independent variables of general intelligence, domain knowledge, and motivation. The correlation between the two dependent variables of divergent thinking and creative expertise performance was significant. With the exception of motivation, neither general intelligence nor domain knowledge seemed to correlate with the other independent variables. Motivation seemed to correlate with all the independent variables, with the exception of creative personality. Creative behavior correlated only with motivation and creative personality. Finally, creative personality did not correlate with the other independent variables, with the exception of creative behavior.

Model Testing and Decomposition of Effects

Structural equation modeling was used to test the models. There was no missing data. As shown in Table 3.3, the skewness and kurtosis are close to zero. This indicates the data were normally distributed. M-plus version 6.11 (Muthén, L. K., & Muthén, 1998−2011) was used to test the models with the maximum likelihood estimation.

Divergent thinking model. The overall fit of the divergent thinking model was very good. The χ^2 (5) = 5.90, p = .32, χ^2 /*df* ratio = 1.18, SRMR = .04, RMSEA = .04, CFI = .98, and TLI = .95. Figure 3.3 shows the model with standardized path coefficients. Table 3.4 includes the standardized path coefficients and corresponding *t*-values. The cutoff value determining whether the paths are significant was t = 1.96. The significant size of path values was determined by the criteria proposed by Keith (1993): small but meaning influences (.05 to .10); moderate influences (.11 to .25); and large influences (above .25).

The decomposition of effects is shown in Table 3.4. Among the seven direct paths, four significant paths were found. Although general intelligence did not have a significant influence (.03) on domain knowledge, the path from general intelligence to divergent thinking was moderately significant (.25). Motivation had a significant and large influence (.27) on domain knowledge; it also had a significant and large influence (.39) on creative behavior. However, creative behavior did not have a significant influence (−.09) on divergent thinking. The path from domain knowledge to divergent thinking was not significant (.10). Finally, creative personality had a significant and moderate influence (.19) on divergent thinking. As can be seen in Table 3.4, there was no significant path among the two indirect paths. The findings are somewhat consistent with the research and theory on divergent thinking with more general measures of intelligence and personality influencing divergent thinking. Surprisingly, creative behavior did not have an effect on divergent thinking.

Creative expertise performance model. The overall fit of the creative expertise performance model was very good. The χ^2 (5) = 7.29, p = .20, χ^2 /df ratio = 1.46, SRMR = .04, RMSEA = .06, CFI = .96, and TLI = .91. The model with standardized path coefficients can be seen in Figure 3.4. Table 3.5 includes the standardized path coefficients and corresponding *t*-values. The cutoff value determining whether the paths are significant was t = 1.96. Based on Keith’s (1993) criteria, the size of path values was determined as previously described.

Table 3.5 shows the decomposition of effects. Among the seven direct paths, four significant coefficients were found. General intelligence did not have a significant influence on domain knowledge (.03); however, the path from general intelligence to creative expertise performance was moderately significant (.17). Motivation had a significant and large influence (.27) on domain knowledge; it also had a significant and large influence (.39) on creative behavior. However, creative behavior did not have a significant influence (−.02) on creative expertise performance. The path from domain knowledge to creative expertise performance was largely significant (.38). Finally, creative personality did not have a significant influence on creative expertise performance (−.01). As shown in Table 3.5, one significant path was found among the two indirect paths. Motivation had a significant indirect influence (.10) on creative expertise performance via domain knowledge. These findings are in line with the research and theory on creative expertise performance with measures of motivation and domain knowledge influencing creative expertise performance. Surprisingly, general intelligence, but not creative personality, had an effect on creative expertise performance.

Alternative Models

The bulk of the research examining the impact of motivation on creative expertise performance focuses on its direct effect. Therefore, I tested an alternative model in which motivation predicts creative expertise performance directly. For this, I changed the path of Motivation → Domain Knowledge to the path of Motivation → Creative Expertise Performance and retested the model. Results indicate a worse model fit. The χ^2 (5) = 16.00, p = .01, χ^2/df ratio = 3.20, SRMR = .07, RMSEA = .12, CFI = .81, and TLI = .55. The direct path from Motivation → Creative Expertise Performance was not significant (.10). The conclusion was that changing the path resulted in a worse model fit because the initial path value was large and the changed path value was not significant.

The same alternative model was tested for divergent thinking. The path of Motivation → Domain Knowledge was changed to the path of Motivation → Divergent Thinking, and the model was retested. Results indicate a worse model fit. The χ^2 (5) = 16.00, p = .01, χ^2/df ratio = 3.20, SRMR = .07, RMSEA = .12, CFI = .76, and TLI = .43. The direct path from Motivation → Divergent Thinking was not significant (.00). The conclusion was that changing the path resulted in a worse model fit because the initial path value was large and the changed path value was not significant.

Discussion

This is the first study to simultaneously assess and compare the impact of the common measures of cognition, motivation, and personality on the two measures of creativity. Results indicate that very different constructs underlie the two measures of creativity. In the divergent thinking model, general intelligence and creative personality had a significant influence. However, in the creative expertise performance model, general intelligence and domain knowledge had a significant influence, and motivation had a significant influence as mediated by domain knowledge. Interestingly, creative behavior did not have a significant influence on divergent thinking, and general intelligence, but not creative personality, had a significant influence on creative expertise performance.

In regard to cognitive measures, general intelligence predicted divergent thinking. This finding replicates previous research (e.g., Nusbaum & Silvia, 2011; Rindermann & Neubauer, 2004), but added to the literature by showing the relationship exists when other factors including domain knowledge are considered at the same time. In contrast, both domain knowledge and general intelligence predicted creative expertise performance. The significant impact of domain knowledge is in line with the previous research (e.g., Weisberg, 1999, 2006), but extends it by showing the relationship exists when other factors including general intelligence are included in the model. However, the significant effect of general intelligence is not consistent with the previous research (e.g., Gough, 1976; MacKinnon, 1961) with a sample of expert adults. This may be because I used college-age samples. This finding supports the hypothesis that general intelligence appears to become less important as a function of age or expertise. Another reason may be because general intelligence is important when other factors are included in the model. Within the model, the impact of domain knowledge was larger than that of general intelligence.

This finding is in line with the previous research examining expert performance within a field (e.g., Schneider et al., 1989, 1990; Recht & Leslie, 1988), but extends it by examining creative performance within a domain.

Creative behavior did not predict divergent thinking. This finding is not consistent with previous research (e.g., Milgram & Milgram, 1976; Runco, 1987). This may be because the current study measured creative behavior in combination with intelligence and personality. It indicated that these variables, and not creative behavior, are important for divergent thinking. In contrast, motivation predicted creative expertise performance as mediated by domain knowledge. This finding is in line with the previous research (e.g., Amabile et al., 1994; Moneta & Siu, 2002), but it added to the literature by showing the relationship exists when other factors including creative behavior are considered at the same time. The current finding also extends it by showing the indirect effect via domain knowledge.

Finally, creative personality predicted divergent thinking. This finding replicates the previous research (e.g., McCrae, 1987), but extends it by simultaneously considering other factors. In contrast, creative personality did not predict creative expertise performance. Although some research showed the importance of personality for creative performance with expertise (e.g., Meneely & Portillo, 2005; Wolfradt & Pretz, 2001), the current finding indicates that it is not important when motivation and domain knowledge are considered at the same time.

Taken together, my findings indicate that the two measures of creativity have very different constructs. Although both measures have a common construct, general intelligence, my data suggest that divergent thinking is more influenced by personality whereas creative expertise performance is more influenced by motivation as it affects the development of domain knowledge. Therefore, two separate models are needed to explain creativity when defined as divergent thinking and creative expertise performance.

Another implication of the study is to suggest an expert cognitive characteristic to measure the domain-specific form of creativity. I asked participants to adapt (abstract) expert theories to solve a problem. The more abstract nature of domain knowledge is a major cognitive characteristic that distinguishes experts from novices within a domain. Experts focus on abstract patterns of features and underlying principles while novices focus on concrete features and surface similarities (e.g., Chi et al., 1981). Expertise researchers have studied the expert cognitive processes within a domain, but they do not focus on creative production. In contrast, (domain-specific) creativity researchers have studied creative production within a domain (e.g., artifact creation), but they do not focus on expert cognitive characteristics such as the abstract knowledge base. This current study assessed creative production reflecting an expert cognitive characteristic.

Limitations and Future Research

Both measures of cognition (general and specific) have limitations. I used only the Comprehension section from the Multidimensional Aptitude Battery-II (Jackson, 1998) to assess general cognitive ability. The section is a part of an intelligence test predominately focusing on general knowledge and reasoning. Future researchers need to use a complete package of an intelligence test. Also, I used students' course grades to assess domain-specific knowledge. Further research should include a better measure of expert knowledge beyond academic achievement.

My study considered either domain-general or domain-specific measures regarding the motivation and personality measures. I looked only at domain-specific motivations (motivation and creative behavior) because researchers know little about the link of domain motivations with creative outcomes. Future research is needed to examine domain-general motivations together, and contrast their effect with that of domain-specific motivations. Also, I measured only general creative personality because no concept and measure of domain-specific personality exists in the field of educational psychology. Although research has examined domain-specific personality in some areas including science and art (e.g., Feist, 1998, 1999), many other fields (such as educational psychology) still remain to be studied. Future research is needed to explore domain-specific personality according to areas, including educational psychology, and contrast its effect with that of general personality on creativity.

Results of this study cannot be generalized to all domains. These outcomes should be interpreted only within the field of educational psychology. This is because the impact of cognition and motivation can differ among domains as the effect of personality does (e.g., Feist, 1998, 1999). I suggest that future researchers use the models designed in this study to explain creativity in other fields. I also propose reflecting expert cognitive processes (e.g., conceptual knowledge, strategy use, and meta-cognition) to assess domain-specific creative production in other areas.

Table 3.1

The Divergent Thinking Problem Solved by the Students

Q1. Hyunmin, a first-year middle school student, had studied hard and enjoyed school life until just a month ago. Recently he does not study hard and does not want to go to school. Why would he act like this? Please guess and generate as many of your own ideas of the possible reasons.

Table 3.2

The Creative Expertise Performance Problem Solved by the Students

Q2. Choose one reason among your responses in Q1 above and discuss how to solve the problem by applying Educational Psychology theories (e.g., development, learning, motivation, individual differences, etc.) specifically. Please specify the theories you used. You can use as many theories as you want.

Table 3.3

Correlation Matrix, Means, Standard Deviations, Skewness, and Kurtosis.

Variable	1	2	3	4	5	6	7
1. DT	__						
2. CEP	.23**	__					
3. Intelligence	.27**	.19*	__				
4. Knowledge	.10	.39**	.07	__			
5. Motivation	.05	.20*	.18*	.27**	__		
6. Behavior	−.05	.02	−.02	.12	.39**	__	
7. Personality	.17*	−.03	.02	−.04	.08	.18*	__
M	4.47	3.12	18.65	50.00	92.74	0.00	.58
SD	1.69	2.31	3.32	9.93	12.13	1.81	3.83
Skewness	.52	.41	−.67	−.74	−.13	.36	.09
Kurtosis	1.32	−.62	.51	.23	−.35	−.61	.01

Note. DT = divergent thinking; CEP = creative expertise performance; Intelligence = general intelligence; Knowledge = domain knowledge; Behavior = creative behavior; Personality = creative personality.
* $p < .05$. ** $p < .01$.

Table 3.4

Decomposition of Effects in the Divergent Thinking Model.

		Direct effect		Indirect effect	
Predictor	Criterion	PC	*t*	PC	*t*
Intelligence	DT	.25	3.30	.00	0.33
	Knowledge	.03	0.34		
Knowledge	DT	.10	1.28		
Motivation	Knowledge	.27	3.35		
	Behavior	.39	5.52		
	DT			−.01	−0.25
Behavior	DT	−.09	−1.15		
Personality	DT	.19	2.39		

Note. DT = divergent thinking; Intelligence = general intelligence; Knowledge = domain knowledge; Behavior = creative behavior; Personality = creative personality; PC = standardized path coefficient.

Table 3.5

Decomposition of Effects in the Creative Expertise Performance Model.

		Direct effect		Indirect effect	
Predictor	Criterion	PC	*t*	PC	*t*
Intelligence	CEP	.17	2.19	.01	0.34
	Knowledge	.03	0.34		
Knowledge	CEP	.38	5.40		
Motivation	Knowledge	.27	3.35		
	Behavior	.39	5.52		
	CEP			.10	2.07
Behavior	CEP	−.02	−0.23		
Personality	CEP	−.01	−0.18		

Note. CEP = creative expertise performance; Intelligence = general intelligence; Knowledge = domain knowledge; Behavior = creative behavior; Personality = creative personality; PC = standardized path coefficient.

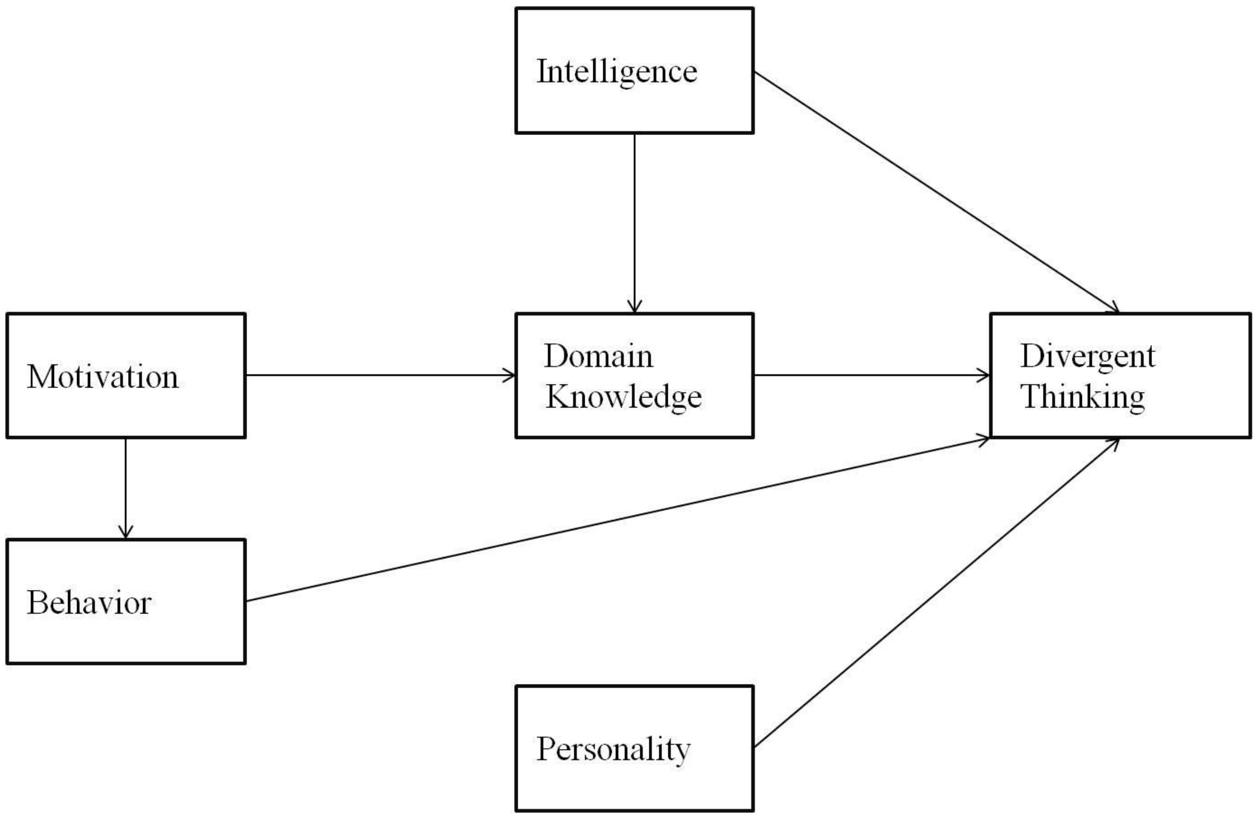

Figure 3.1: Theoretical model of divergent thinking. Note that Intelligence = general intelligence; Behavior = creative behavior; Personality = creative personality.

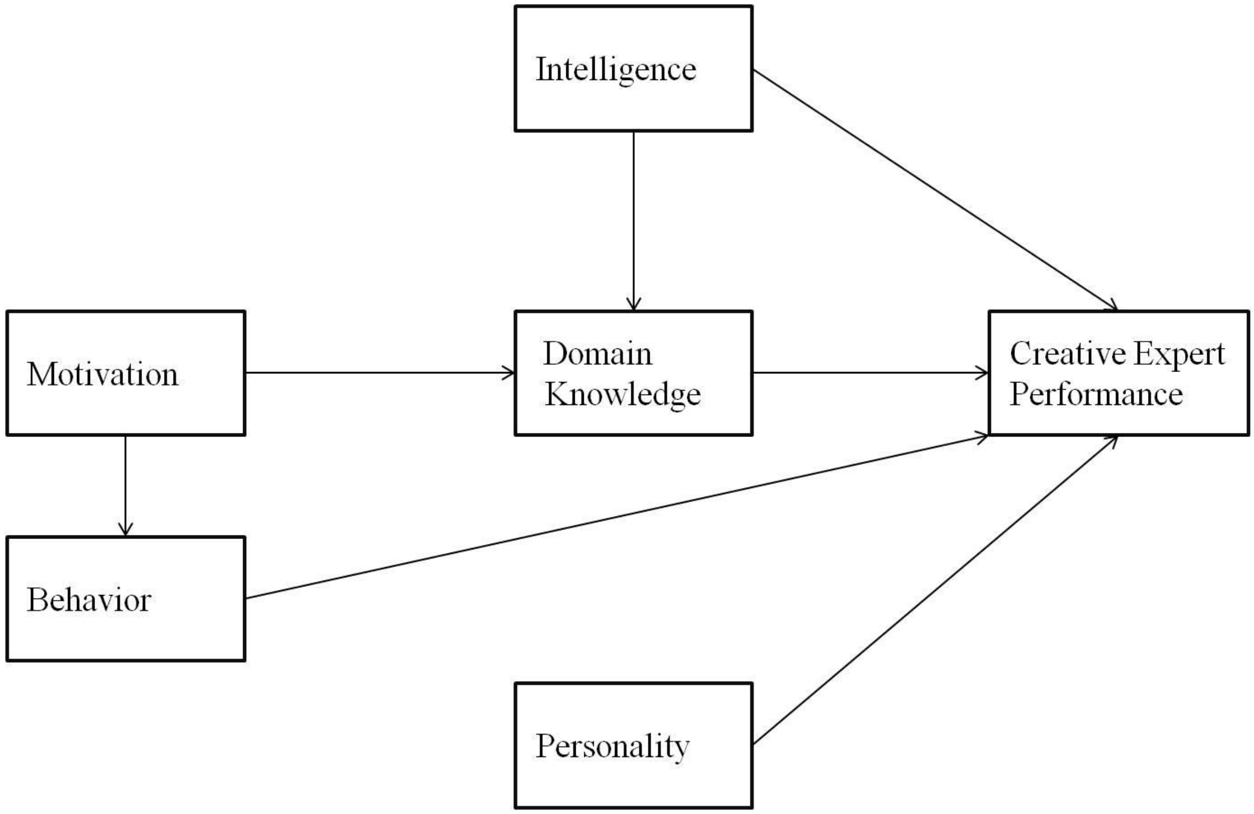

Figure 3.2: Theoretical model of creative expertise performance. Note that Intelligence = general intelligence; Behavior = creative behavior; Personality = creative personality.

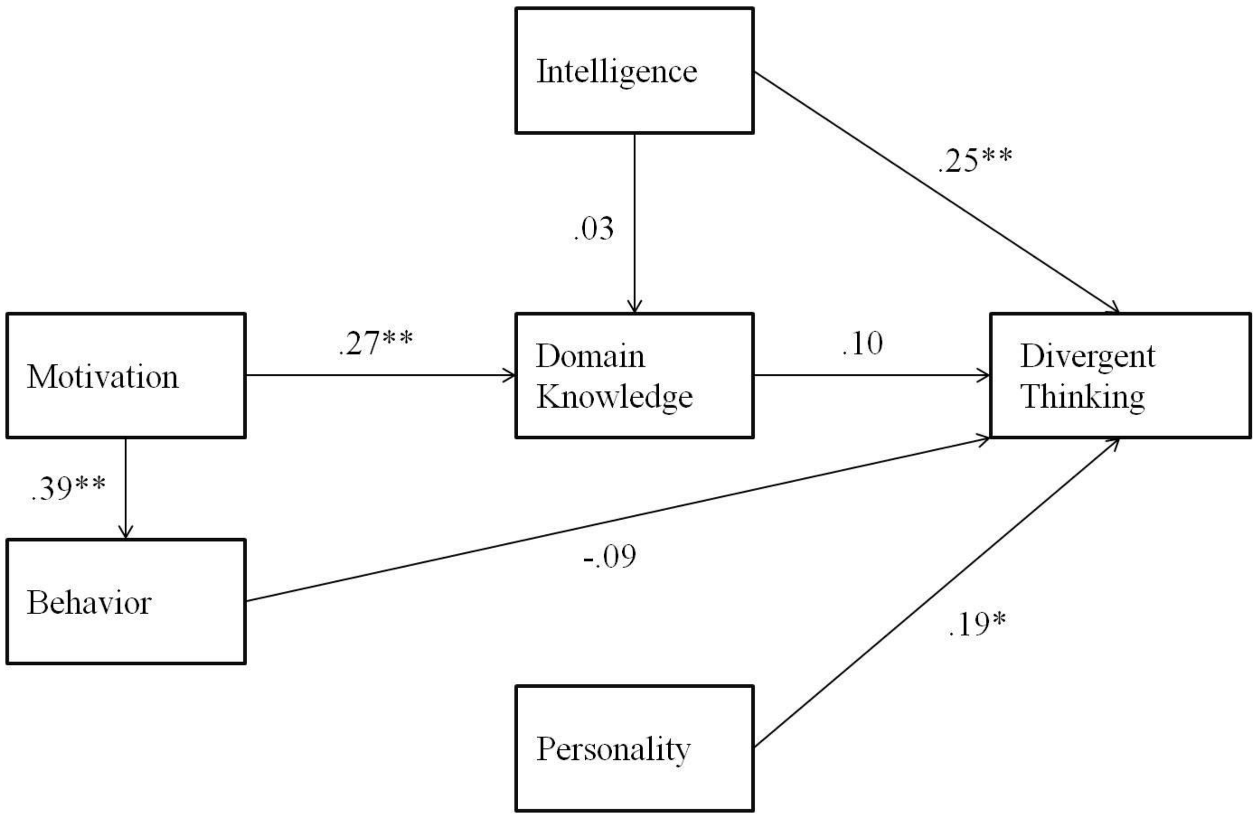

Figure 3.3: Model for divergent thinking, with standardized path values. Note that Intelligence = general intelligence; Behavior = creative behavior; Personality = creative personality.
* $p < .05$. ** $p < .01$.

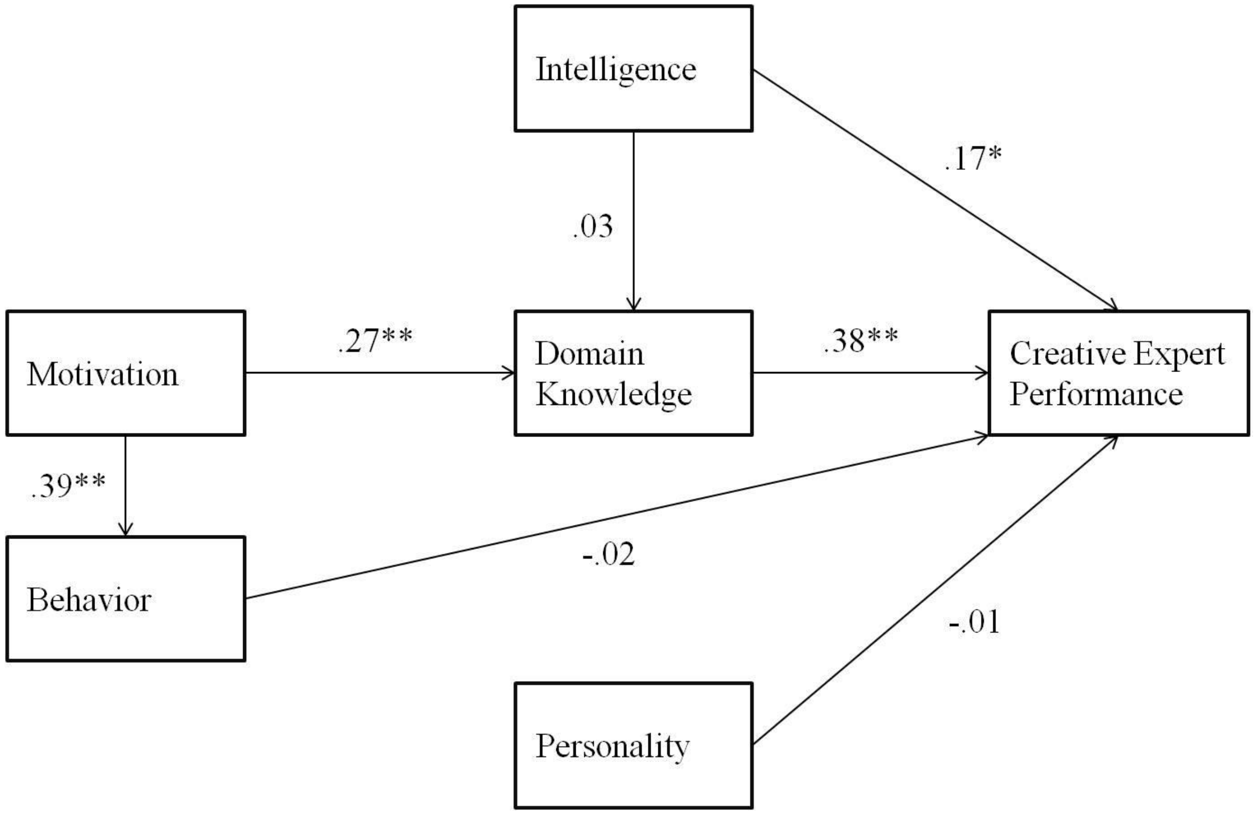

Figure 3.4: Model for creative expertise performance, with standardized path values. Note that Intelligence = general intelligence; Behavior = creative behavior; Personality = creative personality.
* *p* < .05. ** *p* < .01.

References

Aguilar-Alonso, A. (1996). Personality and creativity. *Personality and Individual Differences, 21*, 959−969.

Alexander, P. A. (2003). Can we get there from here? *Educational Researcher, 32*, 3−4.

Amabile, T. M. (1982). Children's artistic creativity: Detrimental effects of competition in a field setting. *Personality and Social Psychology Bulletin, 8*, 573−578.

Amabile, T. M. (1985). Motivation and creativity: Effects of motivational orientation on creative writers. *Journal of Personality and Social Psychology, 48*, 393−399.

Amabile, T. M. (1996). *Creativity in context: Update to the social psychology of creativity*. Boulder, CO: Westview.

Amabile, T. M., Hill, K. G., Hennessey, B. A., & Tighe, E. M. (1994). The Work Preference Inventory: Assessing intrinsic and extrinsic motivational orientations. *Journal of Personality and Social Psychology, 66*, 950−967.

Baddeley, A. D. (1968). A 3 min reasoning test based on grammatical transformation. *Psychonomic Science, 10,* 341−342.

Baer, J. (1991). Generality of creativity across performance domains. *Creativity Research Journal, 4*, 23−39.

Baer, J. (1993). *Divergent thinking and creativity: A task-specific approach*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Baer, J. (1998). The case for domain specificity of creativity. *Creativity Research Journal, 11,* 173−177.

Batey, M., Chamorro-Premuzic, T., & Furnham, A. (2009). Intelligence and personality as predictors of divergent thinking: The role of general, fluid and crystallised intelligence. *Thinking Skills and Creativity, 4*, 60−69.

Batey, M., & Furnham, A. (2006). Creativity, intelligence, and personality: A critical review of the scattered literature. *Genetic, Social, and General Psychology Monographs, 132*, 355−429.

Bong, M. (2001). Between and within-domain relations of academic motivation among middle and high school students: Self-efficacy, task value, and achievement goals. *Journal of Educational Psychology, 93*, 23−34.

Carson, S. H., Peterson, J. B., & Higgins, D. M. (2005). Reliability, validity, and factor structure of the creative achievement questionnaire. *Creativity Research Journal, 17*, 37−50.

Charles, R. E., & Runco, M. A. (2000−2001). Developmental trends in the evaluation and divergent thinking of children. *Creativity Research Journal, 13*, 417−437.

Charyton, C., & Snelbecker, G. E. (2007). General, artistic and scientific creativity attributes of engineering and music students. *Creativity Research Journal, 19*, 213−225.

Chase, W. G., & Simon, H. A. (1973). Perception in chess. *Cognitive Psychology, 4*, 55−81.

Chi, M. T. H. (2006). Two approaches to the study of experts' characteristics. In K. A. Ericsson, N. Charness , P. J. Feltovich, & R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 21−30). New York: Cambridge University Press.

Chi, M. T. H., Feltovich, P. J., Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science, 5*, 121−152.

Chi, M. T. H., Glaser, R., & Rees, E. (1982). Expertise in problem solving. In R. J. Sternberg (Ed.), *Advances in the psychology of human intelligence, Vol. 1* (pp. 7−75). Hillsdale, NJ: Erlbaum.

Cho, S. H., Te Nijenhuis, J., Van Vianen, A. E. M., Kim, H. B., & Lee, K. H. (2010). The relationship between diverse components of intelligence and creativity. *The Journal of Creative Behavior, 44*, 125−137.

Costa, P. T., & McCrae, R. R. (1992). *Revised NEO personality inventory and NEO five-factor inventory professional manual*. Odessa, FL: Psychological Assessment Resources.

Cropley, A. J. (1968). A note on the Wallach-Kogan test of creativity. *British Journal of Educational Psychology, 38*, 197−201.

Diakidoy, I. N., & Constantinou, C. P. (2000−2001). Creativity in physics: Response fluency and task specificity. *Creativity Research Journal, 13*, 401−410.

Dollinger, S. J., Urban, K. K., & James, T. A. (2004). Creativity and openness: Further validation of two creative product measures. *Creativity Research Journal, 16*, 35−47.

Domino, G. (1970). Identification of potentially creative persons from the Adjective Check List. *Journal of Consulting and Clinical Psychology, 35*, 48−51.

Eisenberger, R., & Aselage, J. (2009). Incremental effects of reward on experienced performance pressure: Positive outcomes for intrinsic interest and creativity. *Journal of Organizational Behavior, 30*, 95−117.

Eisenberger, R., Pierce, W. D., & Cameron, J. (1999). Effects of reward on intrinsic motivation—negative, neutral, and positive: Comment on Deci, Koestner, and Ryan (1999). *Psychological Bulletin, 125*, 677−691.

Eisenberger, R., & Rhoades, L. (2001). Incremental effects of reward on creativity. *Journal of Personality and Social Psychology, 81*, 728−741.

Eysenck, H. J., & Eysenck, M. W. (1985). *Personality and individual differences: A natural science approach*. New York: Plenum Press.

Facaoaru, C. (1985). *Kreativität in Wissenschaft und Technik: Operationalisierung von Problemlösefähigkeiten und kognitiven Stilen*. Bern, Switzerland: Huber.

Feist, G. J. (1998). A meta-analysis of personality in scientific and artistic creativity. *Personality and Social Psychology Review, 2*, 290−309.

Feist, G. J. (1999). The influence of personality on artistic and scientific creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 273−296). New York: Cambridge University Press.

Furnham, A., Batey, M., Anand, K., & Manfield, J. (2008). Personality, hypomania, intelligence and creativity. *Personality and Individual Differences, 44*, 1060−1069.

Glynn, S. M., Brickman, P., Armstrong, N., & Taasoobshirazi, G. (2011). Science Motivation Questionnaire II: Validation with science majors and nonscience majors. *Journal of Research in Science Teaching, 48*, 1159−1176.

Gotz, K. O., & Gotz, K. (1973). Introversion-extraversion and neuroticism in gifted and ungifted art students. *Perceptual and Motor Skills, 36*, 675−678.

Gough, H. G. (1976). Studying creativity by means of word association tests. *Journal of Applied Psychology, 61*, 348−353.

Gough, H. G. (1979). A creative personality scale for the Adjective Check List. *Journal of Personality and Social Psychology, 37*, 1398−1405.

Guilford, J. P. (1967). *The nature of human intelligence*. New York: McGraw-Hill.

Heller, K. A., Gaedike, A.-K., & Weinläder, H. (1985). *Kognitiver Fähigkeits-Test (KFT).* Weinheim, Germany: Beltz.

Hocevar, D. (1980). Intelligence, divergent thinking, and creativity. *Intelligence, 4*, 25−40.

Hu, W., & Adey, P. (2002). A scientific creativity test for secondary school students. *International Journal of Science Education, 24*, 389−403.

Hu, W., Shi, Q. Z., Han, Q., Wang, X., & Adey, P. (2010). Creative scientific problem finding and its developmental trend. *Creativity Research Journal, 22*, 46−52.

Irwing, P., Cammock, T., & Lynn, R. (2001). Some evidence for the existence of a general factor of semantic memory and its components. *Personality and Individual Differences, 30*, 857−871.

Jackson, D. N. (1998). *Multidimensional Aptitude Battery-II: Technical Manual.* Port Huron, MI: Sigma Assessment Systems.

Keith, T. Z. (1993). Causal influences on school learning. In H. J. Walberg (Ed.), *Analytic methods for educational productivity* (pp. 21−47). Greenwich, CT: JAI Press.

Kim, K. H. (2005). Can only intelligent people be creative? A meta-analysis. *Journal of Secondary Gifted Education, 16*, 57-66.

King, L., Walker, L., & Broyles, S. (1996). Creativity and the five factor model. *Journal of Research in Personality*, *30*, 189−203.

Kruglanski, A. W., Friedman, I., & Zeevi, G. (1971). The effects of extrinsic incentive on some qualitative aspects of task performance. *Journal of Personality*, *39*, 606−617.

Ludwig, A. M. (1998). Method and madness in the arts and sciences. *Creativity Research Journal, 11*, 93−101.

MacKinnon, D. W. (1961). Fostering creativity in students of engineering. *Journal of Engineering Education, 52*, 129−142.

Mayfield, W. A., Kardash, C. M., & Kivlighan, D. M. (1999). Differences in experienced and novice counselors' knowledge structures about clients: Implications for case conceptualization. *Journal of Counseling Psychology, 46*, 504−514.

McCrae, R. R. (1987). Creativity, divergent thinking, and openness to experience. *Journal of Personality and Social Psychology, 52*, 1258−1265.

Meneely, J., & Portillo, M. (2005). The adaptable mind in design: Relating personality, cognitive style, and creative performance. *Creativity Research Journal, 17*, 155−166.

Milgram, R. M., & Milgram, N. A. (1976). Creative thinking and creative performance in Israeli students. *Journal of Educational Psychology, 68*, 255−259.

Moneta, G. B., & Siu, C. M. Y. (2002). Trait intrinsic and extrinsic motivations, academic performance, and creativity in Hong Kong college students. *Journal of College Student Development, 43*, 664−683.

Mumford, M. D., Baughman, W. A., Supinski, E. P., & Maher, M. A. (1996). Process-based measures of creative problem-solving skills: II. Information encoding. *Creativity Research Journal, 9*, 77−88.

Muthén, L. K., & Muthén, B. O. (1998−2011). *Mplus User's Guide* (6th ed.). Los Angeles, CA: Muthén & Muthén.

Nusbaum, E. C., & Silvia, P. (2011). Are intelligence and creativity really so different?: Fluid intelligence, executive processes, and strategy use in divergent thinking. *Intelligence, 39*, 36−45.

Okuda, S. M., Runco, M. A., & Berger, D. E. (1991). Creativity and the finding and solving of real-world problems. *Journal of Psychoeducational Assessment, 9*, 45−53.

Plucker, J. A. (1998). Beware of simple conclusions: The case for content generality of creativity. *Creativity Research Journal, 11*, 179−182.

Plucker, J. A., Qian, M., & Wang, S. (2011). Is originality in the eye of the beholder? Comparison of scoring techniques in the assessment of divergent thinking. *The Journal of Creative Behavior, 45*, 1−22.

Plucker, J. A., & Renzulli, J. S. (1999). Psychometric approaches to the study of human creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 35−61). New York: Cambridge University Press.

Plucker, J. A., Runco, M. A., & Lim, W. (2006). Predicting ideational behavior from divergent thinking and discretionary time on task. *Creativity Research Journal, 18*, 55−63.

Recht, D. R., & Leslie, L. (1988). Effect of prior knowledge on good and poor readers' memory of text. *Journal of Educational Psychology, 80*, 16−20.

Reeve, J., Hamm, D., & Nix, G. (2003). Testing models of the experience of self-determination in intrinsic motivation and the conundrum of choice. *Journal of Educational Psychology, 95*, 375−392.

Rindermann, H., & Neubauer, A. C. (2004). Processing speed, intelligence, creativity, and school performance: Testing of causal hypotheses using structural equation models. *Intelligence, 32*, 573−589.

Raven, J. C. (1958). *Advanced progressive matrices*. London: Lewis.

Raven, J. C. (1980). *Advanced progressive matrices set a!*. J. C. Raven Ltd.

Rostan, S. M. (2010). Studio learning: Motivation, competence, and the development of young art students' talent and creativity. *Creativity Research Journal*, *22*, 261−271.

Runco, M. A. (1987). The generality of creative performance in gifted and nongifted children. *Gifted Child Quarterly, 31*, 121−125.

Runco, M. A., Noble, E. P., & Luptak, Y. (1990). Agreement between mothers and sons on ratings of creative activity. *Educational and Psychological Measurement*, *50*, 673−680.

Runco, M. A., Plucker, J. A., & Lim, W. (2000−2001). Development and psychometric integrity of a measure of ideational behavior. *Creativity Research Journal*, *13*, 393−400.

Runco, M. A., Walczyk, J. J., Acar, S., Cowger, E. L., Simundson, M., & Tripp, S. (2013). The Incremental validity of a short form of the Ideational Behavior Scale and usefulness of distractor, contraindicative, and lie scales. *The Journal of Creative Behavior*, *48*, 185-197.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, *25*, 54−67.

Sabers, D. S., Cushing, K. S., & Berliner, D. C. (1991). Differences among teachers in a task characterized by simultaneity, multidimensional, and immediacy. *American Educational Research Journal*, *28*, 63−88.

Sánchez-Ruiz, M. J., Hernández-Torrano, D., Pérez-González, J. C., Batey, M., & Petrides, K. V. (2011). The relationship between trait emotional intelligence and creativity across subject domains. *Motivation and Emotion*, *35*, 461−473.

Schneider, W., Körkel, J., & Weinert, F. E. (1989). Domain-specific knowledge and memory performance: A comparison of high- and low-aptitude children. *Journal of Educational Psychology*, *81*, 306−312.

Schneider, W., Körkel, J., & Weinert, F. E. (1990). Expert knowledge, general abilities and text processing. In W. Schneider & F. E. Weinert (Eds.), *Interactions among aptitudes, strategies and knowledge in cognitive performance* (pp. 235−251). New York: Springer.

Schoppe, K. (1975). *Verbaler Kreativitäts-Test (VKT)*. Göttingen, Germany: Hogrefe.

Sen, A. K., & Hagtvet, K. A. (1993). Correlations among creativity, intelligence, personality, and academic achievement. *Perceptual and Motor Skills, 77*, 497−498.

Terman, L. M. (1973). *Concept Mastery Test manual*. New York: Psychological Corporation.

Thurstone, L. L. (1938). *Primary mental abilities*. Chicago, USA: Chicago University Press.

Torrance, E. P. (1967). The Minnesota studies of creative behavior: National and international extensions. *The Journal of Creative Behavior, 1*, 137−154.

Torrance, E. P. (1968). Examples and rationales of test tasks for assessing creative abilities. *The Journal of Creative Behavior, 2*, 165−178.

Torrance, E. P. (1974). *The Torrance Tests of Creative Thinking—norms-technical manual research edition—verbal tests, forms A and B—figural tests, forms A and B*. Princeton, NJ: Personnel Press.

Torrance, E. P. (1999a). *Torrance Tests of Creative Thinking: Thinking creatively with pictures, form A*. Bensenville, IL: Scholastic Testing Service.

Torrance, E. P. (1999b). *Torrance Tests of Creative Thinking: Thinking creatively with words, form A*. Bensenville, IL: Scholastic Testing Service.

Vincent, A. S., Decker, B. P., & Mumford, M. D. (2002). Divergent thinking, intelligence, and expertise: A test of alternative models. *Creativity Research Journal, 14*, 163−178.

Wallach, M. A., & Kogan, N. (1965). *Modes of thinking in young children: A study of the creativity-intelligence distinction*. New York: Holt, Rhinehart & Winston.

Wallbrown, F. H., & Huelsman (1975). The validity of the Wallach-Kogan creativity operations for inner-city children in two areas of visual art. *Journal of Personality, 43*, 109-126.

Wechsler, D. (1949). *The Wechsler Intelligence Scale for Children*. New York: Psychological Corporation.

Wechsler, D. (1981). *WAIS manual: Wechsler Adult Intelligence Scale-Revised*. New York: The Psychological Corporation.

Weisberg, R. W. (1999). Creativity and knowledge: A challenge to theories. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 226−250). Cambridge, England: Cambridge University Press.

Weisberg, R. W. (2006). Modes of expertise in creative thinking: Evidence from case studies. In K. A. Ericsson, N. Charness , P. J. Feltovich, & R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 761−787). New York: Cambridge University Press.

Wolfradt, U., & Pretz, J. E. (2001). Individual differences in creativity: Personality, story writing, and hobbies. *European Journal of Personality, 15*, 297−301.

Wonderlic, E. F. (1992). *Wonderlic personnel test user's manual*. Libertyville, IL: E.F. Wonderlic.

Wuthrich, V., & Bates, T. C. (2001). Schizotypy and latent inhibition: Non-linear linkage between psychometric and cognitive markers. *Personality and Individual Differences, 30*, 783−798.

Zimmerman, B. J. (2006). Development and adaptation of expertise: The role of self-regulatory processes and beliefs. In K. A. Ericsson, N. Charness , P. J. Feltovich, & R. R. Hoffman

(Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 705−722). New York: Cambridge University Press.

CHAPTER 4

THE MULTIDIMENSIONAL NATURE OF CREATIVE BEHAVIOR[3]

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Abstract

The objective of this study was to test whether creativity is domain-general or domain-specific. This was done not only by looking at correlations among measures of domain-general and domain-specific creativity, but also by examining how each is related to indices of cognition, motivation, and personality. Participants were 147 college students enrolled in a foreign language course. The measures included domain knowledge, motivation, and creative personality as predictors of four forms of creative behavior (i.e., domain-general ideation, domain-general activity, domain-specific ideation, and domain-specific activity). Results of the correlations indicated that the four forms of creative behavior were related to one another except for domain-general activity and domain-specific ideation. Results of multiple regressions indicated that motivation and creative personality significantly predicted domain-general creative ideation. Domain knowledge negatively predicted domain-general creative activity; creative personality positively predicted domain-general creative activity. Finally, motivation significantly predicted both domain-specific creative ideation and domain-specific creative activity. Limitations and future directions are discussed.

INDEX WORDS: nature of creativity, creative behavior, cognition, motivation, personality

Introduction

There is a debate whether creativity is domain-general or domain-specific (e.g., Baer, 1998; Plucker 1998). Researchers arguing domain-generality often contend that creativity is a general trait or cognitive process. Plucker (1998) pointed out that creativity, predominantly in the form of divergent thinking, has been studied under an assumption of generality (e.g., Guilford, 1967; Torrance, 1974). Plucker (1999) showed that the general processes of divergent thinking predicted creative achievement within fields. The key evidence for this position is that significant correlations in creative behaviors were obtained among various domains when measured as creative behavior checklists. For example, Runco (1987) assessed both gifted and non-gifted children's creative behaviors and found significant correlations among the indices in seven domains (i.e., writing, music, crafts, art, science, performing arts, and public presentation). Hocevar's (1976) study indicated that for college students, significant correlations were found among creative behaviors in six domains (i.e., fine arts, crafts, performing arts, math-science, literature, and music). These studies support the hypothesis that the nature of creativity is domain-general.

In contrast, researchers arguing domain-specificity assume that creativity is something that emerges within fields. The critical evidence for this position is the low correlation among different domain-derived artifacts created by the same person. For example, Baer's (1991) study indicated that for eighth graders, non-significant correlations were found among diverse domain-specific products (i.e., mathematical, verbal, and combined). Runco (1989) indicated that for fourth, fifth, and sixth graders, there were low correlations (average r = .18) among three different types of artwork. Baer (1993) found non-significant correlations among different domain-oriented products (e.g., poems, math puzzles, and collages) in a sample of diverse age groups (elementary children to adults). Another evidence for the position is low relationships between domain-general creativity and domain-specific creativity. Han (2003) showed that second-graders' general divergent thinking was not correlated with their domain-specific artifacts in language, art, and mathematics. Diakidoy and Spanoudis's (2002) study showed that ninth-graders' performances (fluency and originality) between the domain-general and domain-specific divergent thinking tests were significantly different. These studies support the hypothesis that the nature of creativity is domain-specific.

Although both sides of the debate assume that creativity is viewed as multidimensional (cognition, motivation, and personality), the roles of knowledge and personality vary in different kinds of creativity. Specifically, domain-specific cognition (domain knowledge) is critical for domain-specific creativity (e.g. Vincent, Decker, and Mumford, 2002; Weisberg, 2006), but it may be unrelated to, or negatively associated with, domain-general creativity when cognition is measured as academic grades (e.g., Holland, 1961; Holland & Richards, 1965). General creative personality contributes to domain-general creativity (e.g., Carson, Peterson, & Higgins, 2005; McCrae, 1987); however, the impact of personality on domain-specific creativity differs among domains (e.g., Feist, 1998), so it does not appear that the role of general creative personality in a domain-specific creativity model would be as important as in the general model.

The primary objective of this work was to test the general-specific positions. This can be done not only by looking at correlations among measures of general and specific creativity, but also by examining how each is related to indices of cognition, motivation, and personality known to be associated with domain-general creativity (i.e., general creative personality) or domain-specific creativity (i.e., domain knowledge and motivation). The current study is unique in that it included cognitive, motivational, and personality variables all together as predictors of creativity.

Method

Participants

Participants included a total of 147 undergraduates enrolled in Korean as a foreign language course at a large university in the southeastern United States. The Korean language courses are divided and organized according to language proficiency. Seven classes at three different levels participated in this study. Specifically, the 147 participants consisted of 41 students from two elementary Korean courses, 68 from three intermediate Korean courses, and 38 from two advanced Korean courses. Students completed a set of instruments as an extra credit activity in the classroom. The fact that participants are only Korean language students suggests a limitation but it also provides an opportunity to define domain-specific work very carefully.

Measures

Domain-general creative ideation. Domain-general (everyday) creative ideation was assessed with the Runco Ideational Behavior Scale (RIBS; Runco, Plucker, & Lim, 2000-2001). The RIBS measured how frequently students thought about creative ideas in everyday life. The RIBS has demonstrated good reliability in various previous studies (e.g., Runco et al., 2000-2001; Runco, Walczyk, Acar, Cowger, Simundson, & Tripp, 2013). The RIBS showed good validities in terms of construct validity (Runco et al., 2000-2001), discriminate validity (Runco et al., 2000-2001), and concurrent validity (Runco et al., 2013). For this study, 20 of the original 23 items were adapted (e.g., "How often do you have ideas about a new invention?"). The items were scored on a 5-point Likert scale: never (1), once a year (2), once a month (3), several times a week (4), and daily (5). Internal consistency in this study was $\alpha = .85$.

Domain-general creative activity. Domain-general (everyday) creative activity was assessed with the Everyday Activity Checklist adapted from the Creative Activities Check List

(Okuda, Runco, & Berger, 1991). This checklist measured how many times students did creative activities in their everyday lives. Previous findings (Okuda et al., 1991; Runco, Noble, & Luptak, 1990) indicate that the Creative Activities Check List is reliable (α = 91) and valid. This type of checklist has been used by many others (see Runco, 1987, for review). For this study, 20 of the original 50 items were adapted (e.g., “How many times have you cooked an original dish?). The items were scored on a 4-point Likert scale with these options: never (1), once or twice (2), three to five times (3), and six or more times (4). Internal consistency was found to be α = .85 in this sample.

Domain-specific creative ideation. Creative ideation in the foreign language domain was assessed using the RIBS for Korean Language modified from the RIBS (Runco et al., 2000-2001). For the RIBS for Korean Language, 10 of the original 23 items were selected and modified for the foreign language domain (e.g., “how often have you thought about Korean language or culture that you would like to share with another person?”). The RIBS for Korean Language was on a 5-point Likert scale: never (1), once a year (2), once a month (3), several times a week (4), and daily (5). Internal consistency was found to be α = .87 in this sample.

Domain-specific creative activity. Creative activity in the foreign language domain was assessed using the Creative Activities Check List for Korean Language modified from the Creative Activities Check List (Okuda et al., 1991). For the Creative Activities Check List for Korean Language, 10 of the original 50 items were selected and modified for the foreign language domain (e.g., “how many times have you participated in a club or organization related to Korean language or culture?”). This scale was on a 4-point Likert scale with these options: never (1), once or twice (2), three to five times (3), and six or more times (4). Internal consistency in this study was α = .64.

Cognition. Students' course grades in their Korean classes were collected to measure domain-specific knowledge in foreign language. The individual final raw scores (of 100 total) were obtained from instructors, and the scores were converted to standard t-scores.

Motivation. Motivation in foreign language was measured using the Korean Motivation Questionnaire (KMQ) modified from the Science Motivation Questionnaire II (SMQ; Glynn, Brickman, Armstrong & Taasoobshirazi, 2011). The SMQ II includes 25 items and five motivational constructs to learn a science (i.e., intrinsic motivation, self-determination, self-efficacy, career motivation, and grade motivation). The SMQ II is reliable and valid (Glyn et al., 2011). The KMQ has the same 25 items and the five constructs as the SMQ II: intrinsic motivation (e.g., I enjoy learning Korean), self-determination (e.g., I use strategies to learn Korean well), self-efficacy (e.g., I am confident I will do well on Korean projects), career motivation (e.g., Understanding Korean will benefit me in my career), and grade motivation (e.g., Getting a good Korean grade is important to me). This assessment was on a 5-point Likert scale with these options: never (1), rarely (2), sometimes (3), usually (4), and always (5). Internal consistency was found to be $\alpha = .88$ in this sample.

Personality. Creative personality was measured using the Creative Personality Scale (CPS: Gough, 1979). The CPS is reliable and valid (Gough, 1979). The reliability ranged from .73 to .81. The significant correlations were shown between the CPS and other creativity measures (e.g., Domino's scale for creativity, Schaefer's scale for creativity, and Welsh's four creativity scales). The CPS is a 30-item self-report scale on creative personality traits. It includes 18 positive (e.g., insightful, inventive, and humorous) and 12 negative (e.g., commonplace, conservative, and submissive) creativity personality traits. Participants were asked to check all traits that described themselves. They received 1 point for each positive trait and -1 point for each negative trait. Total scores ranged from -12 to 18. Internal consistency was found to be α = .76 in this sample.

Results

Descriptive Statistics and Correlations

As can be seen in Table 4.1, Korean course grades significantly negatively correlated with domain-general activity (r = −.27, $p < .01$). Korean motivation significantly correlated with domain-general ideation (r = .35, $p < .01$), domain-specific ideation (r = .37, $p < .01$) and domain-specific activity (r = .22, $p < .05$). Korean motivation also significantly correlated with creative personality (r = .20, $p < .05$). Finally, creative personality significantly correlated with domain-general ideation (r = .25, $p < .01$) and domain-general activity (r = .24, $p < .05$).

Four forms of creative behavior correlated with one another except for domain-general activity and domain-specific ideation. The correlation between domain-general ideation and domain-general activity was significant (r = .51, $p < .01$). Domain-general ideation also significantly correlated with domain-specific ideation (r = .32, $p < .01$) and domain-specific activity (r = .32, $p < .01$). Domain-general activity significantly correlated with domain-specific activity (r = .34, $p < .01$). However, the relationship between domain-general activity and domain-specific ideation was not significant (r = .12, $p > .05$). Finally, domain-specific ideation correlated with domain-specific activity (r = .19, $p < .05$).

Multiple Regressions

The data were analyzed using multiple regressions, with the four forms of creative behavior as the criterion variables. The four models include the same cognition (Korean course grade), motivation (Korean motivation), and personality (creative personality) measures as predictors of creative behavior. Results for the multiple regressions are included in Table 4.2.

Results from the analysis indicated that Korean motivation ($\beta = .26$, $p < .01$) and creative personality ($\beta = .26$, $p < .01$) significantly predicted domain-general ideation. For domain-general activity, the prediction of creative personality was significant ($\beta = .30$, $p < .01$); however, Korean course grades negatively predicted domain-general activity ($\beta = -.24$, $p < .05$). For domain-specific ideation, the prediction of Korean motivation was significant ($\beta = .36$, $p < .01$). Finally, Korean motivation significantly predicted domain-specific activity ($\beta = .29$, $p < .01$).

Canonical Correlation

The canonical correlation was significant ($Rc = .49$, $p < .01$). Thus, and quite importantly, 24.3% of variance in creativity criteria can be explained if cognition, motivation and personality are all used as predictors.

Discussion

The result of this study showed that correlations among the four measures of creative behavior were significant except for domain-general activity and domain-specific ideation. Although the four measures of creative behavior were correlated, the coefficients do not imply that they are redundant with one another. When creative behavior is considered as ideation and activity separately, domain-general ideation was significantly correlated with domain-specific ideation; domain-general activity was significantly correlated with domain-specific activity. This finding indicates that creative ideation and activity in the foreign language are associated with general (everyday) creative ideation and activity, respectively.

Although there were significant correlations among the measures of creativity, the contribution of predictors differed between domain-general and domain-specific creative behaviors. For general creative behavior, creative personality contributed to both ideation and activity. This outcome replicates previous research (e.g., McCrae, 1987) showing the relationship between general creative personality and general creativity but extends it by considering other dimensional indices (cognition and motivation) all together. Within the same general behavior, a difference was found between ideation and activity. Interestingly, domain motivation predicted general ideation. This may be because of a unique characteristic that the domain of foreign language involves: language cannot be separated from thinking (ideation) and reflects life and culture from a broad perspective, so foreign language motivation may be linked to everyday (general) ideation. For general activity, domain-specific cognition (course grades) negatively predicted. This finding is in line with the previous research (e.g., Holland, 1961; Holland & Richards, 1965) showing a negative or non-significant relationship between academic achievement and general creativity, but extends it by considering other dimensional predictors (motivation and personality) all together.

In contrast, domain motivation predicted both ideation and activity for domain-specific creative behavior. This outcome replicates previous research (e.g., Rostan, 2010) indicating the association of domain motivation with domain-specific creativity but extends it by simultaneously considering other dimensional (cognition, personality) indices. However, domain-specific cognition did not predict domain-specific creative behavior (both ideation and activity) although previous research (e.g., Vincent et al., 2002; Weisberg, 2006) indicated the importance of domain knowledge for domain-specific creativity. It may be because this study measured the quantity of creative behaviors that students voluntarily engaged in, not the quality of creative products that requires domain-specific cognitive abilities such as domain knowledge and strategies. In terms of personality, the general measure of creative personality did not contribute to domain-specific creative behavior (both ideation and activity). This result supports the hypothesis that the effect of personality on creativity differs among domains (Feist, 1998), so it appears that the role of general creative personality in the domain-specific creativity model would not be as critical as in the general creativity model.

Previous researchers have tested the general-specific positions of creativity by examining the correlations among the measures of creativity. The general position has provided significant correlations among creativity measures in diverse domains (e.g., Hocevar, 1976), or a significant relationship between general (divergent thinking test) and specific creativity measures (e.g., Plucker, 1999); the specific position has provided non-significant correlations among creativity measures in diverse domains (e.g., Baer 1991, 1993) or a non-significant relationship between general (divergent thinking test) and specific creativity measures (e.g., Diakidoy & Spanoudis, 2002). If the result of the current study is interpreted with this approach, the conclusion will be that the nature of creativity is domain-general. This is because significant correlations were found between domain-general and domain-specific behaviors (ideation and activity). However, regarding the indices of cognition, motivation, and personality that underlie creative behaviors, their prediction was very different between the two models of creativity. Therefore, the current study concludes that the nature of creativity is domain-specific when it comes to the domain of foreign language. An important implication of this study is a need to consider the underlying indices of creativity as well as the correlations among creativity measures to test the general-specific positions.

This study examined only domain-specific cognition and motivation and domain-general personality as predictors of creativity. Future research is needed to examine both general and specific indices to better understand the multidimensional nature of creativity. Another limitation is that the result of the study can be interpreted only within the field of foreign language under the assumption that the nature of creativity (whether domain-general or domain-specific) would be differ across domains. This study suggests that future research tests the general-specific position in other domains considering the common multidimensional processes that underlie both domain-general and domain-specific creativity.

Table 4.1

Correlation Matrix, Means, Standard Deviations, Skewness, and Kurtosis

Variable	1	2	3	4	5	6	7
1. Cognition	__						
2. Motivation	.14	__					
3. Personality	.06	.20*	__				
4. Ideation G	−.09	.35**	.25**	__			
5. Activity G	−.27**	.02	.24*	.51**	__		
6. Ideation K	.12	.37**	.03	.32**	.12	__	
7. Activity K	−.10	.22*	−.04	.32**	.34**	.19*	__
M	50.00	71.40	3.09	62.16	45.71	32.09	14.95
SD	9.78	11.24	3.62	10.60	10.52	7.27	3.54
Skewness	−1.13	−.38	.20	−.31	.04	−.14	.72
Kurtosis	1.39	.43	−.51	−.25	−.31	−.18	.08

Note. Ideation G = domain-general ideation; Activity G = domain-general activity; Ideation K = domain-specific (Korean language) ideation; Activity K = domain-specific (Korean language) activity.
* *P* < .05. ** *p* < .01.

Table 4.2

Multiple Regressions of Predictors and Four Forms of Creative Behavior

DV	Predictor	B	SE	β	*t*
Ideation G[a]	Cognition	−.12	.10	−.11	−1.25
	Motivation	.25	.09	.26	2.76**
	Personality	.77	.27	.26	2.86**
Activity G[b]	Cognition	−.26	.11	−.24	−2.45*
	Motivation	−.09	.10	−.09	−0.94
	Personality	.87	.29	.30	2.97**
Ideation K[c]	Cognition	.06	.06	.09	1.01
	Motivation	.24	.06	.36	4.04**
	Personality	−.06	.18	−.03	−0.35
Activity K[d]	Cognition	−.05	.03	−.13	−1.34
	Motivation	.09	.03	.29	3.09**
	Personality	−.05	.09	−.05	−0.56

Note. DV = dependent variable; Ideation G = domain-general ideation; Activity G = domain-general activity; Ideation K = domain-specific (Korean language) ideation; Activity K = domain-specific (Korean language) activity.
[a]R^2 = .16, adjusted R^2 = .14, R = .40**, [b]R^2 = .15, adjusted R^2 = .12, R = .39**, [c]R^2 = .15, adjusted R^2 = .12, R = .38**, [d]R^2 = .09, adjusted R^2 = .06, R = .30*
* *P* < .05. ** *p* < .01.

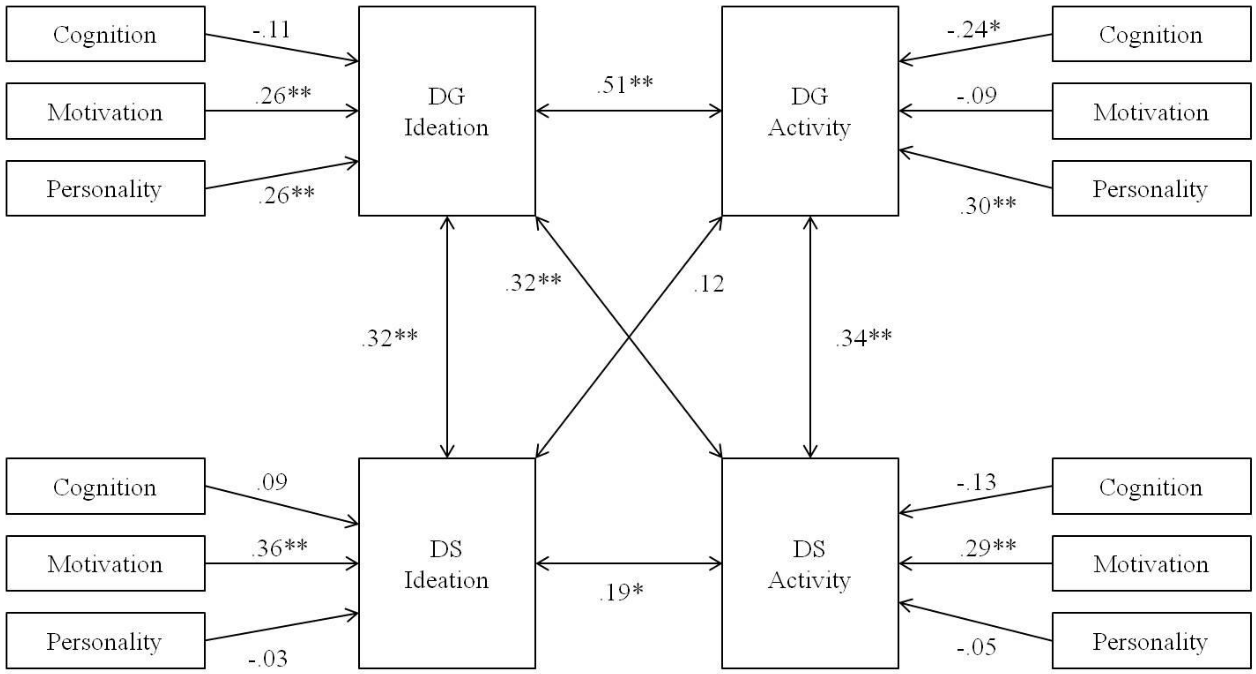

Figure 4.1: Model for creative behavior, with standardized path values. Note that DG Ideation = domain-general ideation; DG Activity = domain-general activity; DS Ideation = domain-specific ideation; DS activity = domain-specific activity.

References

Baer, J. (1991). Generality of creativity across performance domains. *Creativity Research Journal, 4*, 23-39.

Baer, J. (1993). *Divergent thinking and creativity: A task-specific approach*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Baer, J. (1998). The case for domain specificity of creativity. *Creativity Research Journal, 11*, 173-177.

Carson, S. H., Peterson, J. B., & Higgins, D. M. (2005). Reliability, validity, and factor structure of the creative achievement questionnaire. *Creativity Research Journal*, *17*, 37-50.

Diakidoy, I. N., & Spanoudis, G. (2002). Domain specificity in creativity testing: A comparison of performance on a general divergent-thinking test and a parallel, content-specific test. *The Journal of Creative Behavior, 36*, 41-61.

Feist, G. J. (1998). A meta-analysis of personality in scientific and artistic creativity. *Personality and Social Psychology Review, 2,* 290-309.

Glynn, S. M., Brickman, P., Armstrong, N., & Taasoobshirazi, G. (2011). Science Motivation Questionnaire II: Validation with science majors and nonscience majors. *Journal of Research in Science Teaching, 48*, 1159-1176.

Gough, H. G. (1979). A creative personality scale for the Adjective Check List. *Journal of Personality and Social Psychology, 37*, 1398-1405.

Guilford, J. P. (1967). *The nature of human intelligence*. New York: McGraw-Hill.

Han, K. (2003). Domain-specificity of creativity in young children: How quantitative and qualitative data support it. *The Journal of Creative Behavior, 37*, 117-142.

Hocevar, D. (1976). Dimensionality of creativity. *Psychological Reports, 39*, 869-870.

Holland, J. L. (1961). Creative and academic performance among talented adolescents. *Journal of Educational Psychology, 52*, 136-147.

Holland, J. L., & Richards, J. M. (1965). Academic and nonacademic accomplishment: Correlated or uncorrelated? *Journal of Educational Psychology, 56*, 165-174.

McCrae, R. R. (1987). Creativity, divergent thinking, and openness to experience. *Journal of Personality and Social Psychology, 52*, 1258-1265.

Okuda, S. M., Runco, M. A., & Berger, D. E. (1991). Creativity and the finding and solving of real-world problems. *Journal of Psychoeducational Assessment, 9*, 45-53.

Plucker, J. A. (1998). Beware of simple conclusions: The case for content generality of creativity. *Creativity Research Journal, 11*, 179-182.

Plucker, J. A. (1999). Is the proof in the pudding? Reanalyses of Torrance's (1958 to present) longitudinal data. *Creativity Research Journal, 12*, 103-114.

Rostan, S. M. (2010). Studio learning: Motivation, competence, and the development of young art students' talent and creativity. *Creativity Research Journal, 22*, 261-271.

Runco, M. A. (1987). The generality of creative performance in gifted and nongifted children. *Gifted Child Quarterly, 31*, 121-125.

Runco, M. A. (1989). The creativity of children's art. *Child Study Journal, 19*, 177-190.

Runco, M. A., Noble, E. P., & Luptak, Y. (1990). Agreement between mothers and sons on ratings of creative activity. *Educational and Psychological Measurement, 50*, 673-680.

Runco, M. A., Plucker, J. A., & Lim, W. (2000-2001). Development and psychometric integrity of a measure of ideational behavior. *Creativity Research Journal, 13*, 393-400.

Runco, M. A., Walczyk, J. J., Acar, S., Cowger, E. L., Simundson, M., & Tripp, S. (2013). The Incremental validity of a short form of the Ideational Behavior Scale and usefulness of distractor, contraindicative, and lie scales. *The Journal of Creative Behavior, 48*, 185-197.

Torrance, E. P. (1974). *The Torrance Tests of Creative Thinking—norms-technical manual research edition—verbal tests, forms A and B—figural tests, forms A and B*. Princeton, NJ: Personnel Press.

Vincent, A. S., Decker, B. P., & Mumford, M. D. (2002). Divergent thinking, intelligence, and expertise: A test of alternative models. *Creativity Research Journal*, *14*, 163-178.

Weisberg, R. W. (2006). Modes of expertise in creative thinking: Evidence from case studies. In K. A. Ericsson, N. Charness , P. J. Feltovich, & R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 761-787). New York: Cambridge University Press.

CHAPTER 5

CONCLUSIONS

The current studies developed a new framework explaining individual differences in cognition, motivation, and personality and described how these differences predict better achievement in learning and creativity.

In the first study, I reviewed the problems with learning styles including the lack of a clear framework, poor reliability and validity of constructs, and a failure to link to achievement. Then, I presented an alternative approach to dealing with individual differences in learning. Described were four major constructs that are better explained in cognition and personality theories: sensory-based skills, knowledge development, order of coding, and fluency. For fluency, I discussed four constructs in cognition and personality theories: attention, persistence, and effortful control; perfectionism; working memory; and expertise and domain knowledge. Finally, this study presented a better way of predicting achievement in the classroom by using the new approach.

The second study developed and tested a theoretical model of two measures of creativity: divergent thinking and creative expertise performance. The model includes measures of general intelligence and domain knowledge, measures of motivation including creative behavior and motivation in the form of intrinsic motivation, extrinsic motivation, self-efficacy, and self-determination, and a measure of creative personality as predictors of creativity. Results indicate that the two measures of creativity have very different cognitive, motivational, and personality processes. General intelligence and creative personality predicted divergent thinking. However, general intelligence, domain knowledge, and motivation predicted creative expertise performance within a field. In both models, motivation predicted creative behavior. This study allowed us to determine which variables were most critical for the two measures of creativity so that we can better predict achievement in divergent thinking and creative expertise performance. The current study also allowed us to propose a new approach to testing the hypothesis that creativity is domain-specific.

Finally, the third study developed and tested a theoretical model of four forms of creativity: domain-general ideation, domain-general activity, domain-specific ideation, and domain-specific activity. The model includes a measure of domain knowledge, domain motivation, and creative personality as predictors of creativity. Results indicate that very different constructs underlie the four forms of creative behavior. Domain motivation and creative personality significantly predicted domain-general creative ideation. Domain knowledge negatively predicted domain-general creative activity; creative personality positively predicted domain-general creative activity. Finally, domain motivation significantly predicted domain-specific creative ideation and domain-specific creative activity. Results of the study allowed us to determine which variables were important for the four forms of creative behavior. Another critical implication of this study is a need to examine the common processes that underlie creative outcomes to test the general-specific positions of creativity.

Taken together, this collection of three studies presents an attempt to explain the common processes that underlie individual differences in learning and creativity. Findings of the current studies indicate how individual differences in the cognitive, motivational, and personality processes predict better achievement in learning and creativity. Specifically, the first study suggests how new alternative approaches to learning styles constructs predict better achievement in learning. The second study shows that divergent thinking and creative expertise performance have very different cognitive, motivational, and personality constructs. Therefore, teachers need to train students to improve these two forms of creativity from a different perspective. Finally, the third study shows that domain-general and domain-specific creative behaviors have very different cognitive, motivational, and personality constructs. Interestingly, the third study's findings validate the second study's findings in that motivation is important for the domain-specific form of creativity.

The present studies have limitations. First, the sample sizes of the two empirical studies (Chapters 3 & 4) were not very large. Future research is needed to test the same models with larger samples. Second, the two empirical studies included either domain-general or domain-specific measures regarding some predictors. The second study looked only at domain-specific motivations and domain-general personality (Chapter 3); the third study looked only at domain-specific cognition, domain-specific motivation, and domain-general personality (Chapter 4). Future research is needed to examine both domain-general and domain-specific measures to better understand the nature of creativity. Third, the two empirical studies (Chapters 3 & 4) measured creative personality using Gough's Creative Personality Scale, which is limited to dichotomous responses. Future research is needed to use a Big Five measure or other scales for investigating a creative personality variable. Finally, results of the two empirical studies cannot be generalized to all domains. Two fields of studies, educational psychology (Chapter 3) and foreign language (Chapter 4), were used to assess domain-specific creativity. Each outcome should be interpreted within each domain because the nature of creativity can differ as a function of domain. Future research is needed to test the same domain-specific creativity models in other domains.