

The Influence of Cognitive
Style on Insight Problem Solving

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The Influence of Cognitive
Style on Insight Problem Solving

by

Diane Marie Steele

An Abstract of a Thesis
in
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ABSTRACT OF THESIS

The Influence of Cognitive Style on Insight Problem Solving

This thesis explored the effects of cognitive style, as measured by Kirton Adaption-Innovation Inventory (KAI) and the FourSight inventory, relates to insight problem-solving behavior. One-hundred and forty-seven participants were involved in this study. All participants completed FourSight, the KAI, a biographical data questionnaire, and eight insight problems. Analysis of the cognitive style variables revealed that style had little or no impact on insight problem-solving ability. There was a positive linear relationship between experience and the ability to solve insight problems. Implications of this study support existing theoretical perspectives that the KAI and FourSight measure style and not level of cognitive ability. Experience appeared to be the stronger indicator for success in solving insight type problems. Recommendations for future research were discussed.

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Dedication

This work is dedicated with love to my dearest husband, Patrick, who continues to illuminate my life, mind and spirit, in so very many countless and thoughtful ways. I thank you for providing unconditionally and abundantly the love, faith, encouragement, support, and patience that has enriched my life beyond words. Adventures, challenges, dreams and visions, grand or small, are so much brighter when shared with you. I thank God for you.

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Chapter One: Statement of the Problem

Introduction

The purpose of this research was to explore the influence of individual differences in cognitive styles and experience with activities considered relevant for solving insight problems on insight problem solving ability. The construct of cognitive style refers to how, or in what ways people process information, and relates to individual preferences for certain types of problems, strategies for solving problems, and making decisions.

This chapter begins with a review of insight as related to problem solving, a brief review of various perspectives on the effects of experience on problem solving, and with the introduction of Ovyind Martinsen's research on A-E cognitive style. This chapter continues with a definition of cognitive style and the introduction of two specific cognitive style measures, Kirton's (1976) Adaption-Innovation Inventory and Puccio's (1999) FourSight, previously known as Buffalo Creative Process Inventory (BCPI). It concludes with an introduction to the *Creative Problem Solving Process* (CPS) and the statement of significance including the specific questions that guided this research.

Insight and Insightful Problem Solving

The term *insight* has been used to describe an experience related to a state of understanding which, appears to emerge into one's conscious awareness with sudden abruptness. It has been described as an instant moment of realization when one "sees" in

a new way, a potential solution to a problem or perhaps gains a deeper understanding of a situation that previously eluded contemplation. The unexpected epiphany is usually accompanied with a sense of surprise and correctness referred to as the affective "Aha!" experience. A sense of satisfaction is also experienced, as the missing pieces of a puzzle or the puzzle itself are perceived in a manner in which all of its parts are suddenly snapped perfectly into place, yielding a comprehensive wholeness.

Interest in the topic of insight and insightful problem solving characterized as "a sudden shift in the problem's *gestalt*, or spontaneous restructuring of the problem's mental representation" (Smith, 1999, p. 230) can be traced back to early works of Gestalt psychologists, Wolfgang Kohler, Max Wertheimer and Kurt Koffka. Together they founded the school of Gestalt psychology in the early 1900's which, developed several theories of insight, as well as initiated research to explore characteristics of insight (Pierce, 1999; Smith, 1995). Although interest in insight has waned since the early days of the Gestalt psychologists, there has been a renewed interest in this topic in recent years as modern cognitive researchers continue to grapple with the great unanswered questions previously proposed by the Gestalt psychologists: "What is insight? Where does it come from? How can we foster it?" (Mayer, 1995, p. 27).

Some contentions remain regarding proposed theories of insight, and its role in problem solving and creativity. "At one end of the spectrum is the suggestion that insight processes are outside the purview of cognitive science (e.g., Wertheimer, 1985). At the other end is the suggestion that insight is indistinguishable from other types of problem solving (e.g., Weisberg, 1986)" (Schooler et. al, 1995, p. 580). Regardless of these extreme views, many modern cognitive psychologists are in agreement that even if

insight represents only a small component of creativity, it nonetheless is "one of the major sources of ineffability with which discussions of creativity have grappled. Thus, if we want to explore the unreportable aspects of creativity, it makes sense to begin with insight" (Schooler & Melcher, 1995, p. 98).

"As a way of testing and expanding our understanding of the world" (Gruber, 1995, p. 399) we actively seek out a variety problems in various domains. As such, "insightful problem solving can occur in any domain and can sometimes lead to tremendous advances in knowledge" (Dominowski & Dallob, 1995, p. 56). As noted by Davidson (1995) "many of the world's greatest contributions have derived from insightful problem solving" (p. 125). Furthermore, it is important to understand under what conditions these realizations occur, and in what ways might insightful behavior be cultivated. In fact, "seeing through a problem and arriving at a well-structured solution to a novel situation are behaviors worth promoting" (Dominowski & Dallob, 1995, p. 56).

The nature of insight and its' role in problem solving were of immense interest to Gestalt psychologists. Their "interest in insight stemmed from their interest in intelligent behavior, which they considered to be effective goal-oriented behavior in relatively novel situations" (Mayer, 1995, p. 40). They were concerned with how people solved problem in a new way and also what prevented them from doing so.

Early Gestaltists were the first to give serious consideration to insight processes. And although current debate continues among modern cognitive researcher regarding various theories of insight, their conceptions of insight continue to exert significant foundational influence by providing the basis for ongoing theoretical debate. As such the following section includes a brief review of classic Gestaltists' views of insight and

problem solving.

Gestaltists' Views of Insight and Problem Solving

Gestalt psychologists introduced the concept of "insight" into the study of problem solving at the start of the twentieth century, in part, as a response to the theory of *associationism*, the dominant cognitive theory of the day. Associationism viewed insight as nothing more than an exercise in following a sequence of pre-established associations or more simply stated, stimulus-response associations (Mayer, 1995). The Gestalt psychologists argued for an alternative view, that "insight is a process that differs in kind from ordinary kinds of information processes" (Sternberg & Davidson, 1999, p. 63). They also proposed that, "under certain circumstances, organisms could achieve insight into a problem - this is, through analysis of the problem, the thinker could achieve a solution, even though there had not been extensive experience in the problem situation" (Weisberg, 1995, p. 159).

Gestaltists associated the concept of insight with understanding the underlying structure of a problem and the new relations among the problem components. The goal of their research was to study "how people understand how to solve problems that require a creative solution" (Mayer, 1995, p. 5) as well as, what prevented people from doing so, when it appeared they possessed appropriate knowledge. They considered insight to be the result of *restructuring*, a shift in cognitive perspective, which enabled the problem solver to see the problem in a new and appropriate light. There are many theories regarding the processes that hinder or enhance the problem solvers' behavior to make this transition or shift from a non-solution state to a solution state, (which are furthered

discussed in Chapter Two). Largely obstacles that cause a problem solver to become *fixated* through misinterpretations also hinder the problem solver from discovering any new or more appropriate interpretations. If the obstacles are not overcome perceived progress is absent and the problem solver is said to have reached an *impasse*. An impasse is the point or condition in which the problem solver does not know what to do next. The problem solver would then be required to do something new and different in order to overcome this constraint.

According to Gestalt psychologists, the problem solver would have needed to implement *productive thinking* defined as the "ability to go beyond past experience and produce something new in response to the demand of the problem" (Weisberg, 1995, p. 161). As such, Gestaltists theorized that productive thinking applied to only certain types of problems, problems that were considered *nonroutine*. Nonroutine problems required the problem solver to go beyond past experience and come up with something novel and creative. Whereas, *routine* problem solving utilized *reproductive thinking* which implied a solution may be found through the direct application of previously gained knowledge.

Because the thrust of Gestaltist research focused on productive thinking, they often utilized insight problems as problem solving tasks. They considered insight problems to be different from other more routine problems, and proposed that solving insight problems involved the process of restructuring. They also used "fixation deliberately because they believed that an inappropriate representation was a force directing problem-solving efforts and providing resistance to a new interpretation" (Dominowski & Dallob, 1995, p.45).

Some modern cognitive psychologists have accused the Gestaltists of being soft

scientists, with vague answers to vague questions, as measurement seldom appears in the Gestalt approach (Gruber & Wallace, 1999). Others have proposed "that Gestalt psychologists work on *hard* questions, whereas modern cognitive psychologist sometimes prefer to work on *easy* ones" (Mayer, 1995, p. 26). Even so, Gestalt theories have "played an important yet controversial role in psychological theorizing" (Weisberg, 1995, p. 158) and still many of the old controversies continue to be debated, as new discoveries are confronted.

One particular source of contention was noted by Martinsen (1995) as "the relation between experience and task performance in productive thinking has been a source of disagreement throughout decades of research" (p. 291). In this next section, three differing theoretical perspectives regarding this relation are briefly reviewed.

Experience and Problem Solving

Gestaltists did not consider past experience to be irrelevant to problem solving, as sometimes implied in research literature. "They did claim that past experience was *insufficient* to explain instances of productive problem solving or failures to think productively" (Dominowski & Dallob, 1995, p. 40). They also "argued that insight need not rely on past experience, and in some circumstances such experience may actually impede creative production" (Baker-Sennett & Ceci, 1996, p. 168). In effect, habitual directions may act as a mental block, (e.g., *functional fixedness*, when a problem solver cannot think of a novel use for an object because they are fixated on its original use only). Kaplan and Simon (1990), noted that:

For most problems, knowledge allows one to hack away irrelevant details and

focus on the problem elements that are likely to be critical for a solution. But in insight problems, where the answer often lies in a very obscure place, inappropriate or irrelevant knowledge may guide search to an unproductive region of the problem space. (p. 399)

"Others have claimed that (insight) problems cannot be solved without relevant experience or the availability of functions (Perkins, 1981; Saugstad, 1955; Saugstad & Raheim, 1957; Weisberg & Alba, 1981a, 1981b)" (Martinsen, 1993, p. 443). While others claimed that solving insight problems, just as any other type problem solving activity is based on one's experience (Gick & Lockhart, 1995). The idea is that "the insightful person must first build up a huge reservoir of discipline-relevant information" (Simonton, 1995, p. 17). A notion that permits the contention "that insight is a form of expertise and that the hallmarks of the insight process are those that have come to be associated with expert problem solving" (Ippolito & Tweney, 1995, p. 433). Stated simply as "one person's insightful problem solving may be another's routine problem solving, owing to difference in knowledge representations" (Gick & Lockhart, 1995, p. 201).

In some situations, "people who are experts at dealing with a particular domain may benefit from their prior knowledge in solving problems there" (Seifert et al., 1995, p.80), they can often size up a situation quickly and accurately, making decisions that appear to the novice as intuitive. Yet, Ippolito and Tweeney (1995) warned that the "theory of expertise based largely on accumulated knowledge, dooms the expert to becoming the inhabitant of a golden cage..." (p. 448), they may become too committed to their knowledge base, and may experience conceptual fixedness that diminishes insight. Martinsen (1995) echoed this notion, in that "experience is conducive up to a point. Too

much experience may make people become blind to what's new" (p. 443) and is therefore considered detrimental to performance. At times having more knowledge may actually interfere with the retrieval of information about the topic (Sternberg, 1995).

There also exists a third group of theorists, which proposed the existence of an inverted U relationship between experience and creativity (Martinsen, 1993). In other words, an optimal level of experience is needed for creativity. Sternberg and Lubart (1995) noted:

For creative insight, an intermediate level of knowledge may be optimal. With too little knowledge, major insights will not occur because there are not enough raw materials. Conversely, with too much knowledge, major insights will not occur because they would devalue one's current knowledge base. (p. 548)

Martinsen's (1993, 1995) research explored the concept of a curvilinear relation between experience and creativity, with an underlying intent "to offer a new perspective on the role of experience in problem solving" (Martinsen, 1993, p. 438). In his two studies, he specifically focused on the influence of individual differences in cognitive styles and experience on creative problem solving, as he "argued that the relation between experience and performance cannot be fully understood without recognizing individual differences" (Martinsen, 1995, p. 291). His findings offered some support to the notion that the two seemingly contradictory perspectives regarding relation of experience to insightful problem solving may be integrated. "The possibility suggested by Martinsen's (1995) empirical demonstration is that there is an optimal level of experience for creative work" (Runco & Sakamoto, 1999, p. 66) that varies with an individual's cognitive style.

The next section begins with a brief definition of cognitive style, which is followed by a description of Martinsen's (1993, 1995) studies that focused on the influence of individual differences in cognitive style and experience on creative problem. This section also introduces the two cognitive style measures utilized in this current research, Kirton's KAI and Puccio's FourSight.

Cognitive Style

"Cognitive style has been defined in general terms as consistent individual differences in the ways people experience, organize, and process information" (Martinsen & Kaufmann, 1999, p. 273). Generally cognitive style refers to a person's preferred patterns of mental thinking as demonstrated over time. These patterns relate to the individual's preferences for certain types of problems, strategies for solving problems, and making decisions. "While cognitive styles are defined as describing how or in what way we process information cognitive abilities are defined as how well we process information" (Martinsen & Kaufmann, 1999, p. 274).

Assimilator-Explorer (A-E) Cognitive Style Theory

According to Martinsen (1995) "the theory of assimilative and explorative (A-E) cognitive styles (Kaufmann, 1979, 1983) has a particular potential to explain the relation among experience, problem solving and creativity" (p. 292). Kaufmann's A-E theory is "based on cognitive schema theory with special reference to Piaget's core concepts of assimilation and accommodation" (Martinsen & Kaufmann, 1999, p. 277). The postulate of the A-E cognitive-style theory is that differences exist between individuals and their

tendency to rely on past experience when required to think in a new and different way. (Martinsen, 1995). Also "these individual differences are linked to dispositions towards using general, heuristic strategies, which are posited to have implications for performance on different types of tasks" (Martinsen, 1994, p. 83). The two distinct A-E cognitive styles that lead to different approaches to problem are described as follows:

Assimilators are seen as more rule-bound in problem solving behavior, and as having a disposition toward interpreting new events in terms of existing knowledge.... Explorers are seen as having the strongest disposition toward novelty seeking, which manifests itself in a search for new types of solutions and new ways of solving problems without external pressure to do so. (Martinsen & Kaufmann, 1999, p. 277)

Martinsen asserted that cognitive style is an "important variable in determining how people deal with novelty as it describes preferences for strategies or preferred ways of using one's abilities'... and that 'people differ in *how* they use their abilities in a given situation'" (Martinsen, 1993, pp. 436-437). As criterion for problem solving performance, insight problems were used in his research because they are generally considered ill-defined and high in novelty. Martinsen (1994) further noted that "solving such tasks depends on basic, cognitive process such as search and restructuring. Performance on these tasks has also been linked to processes of creativity" (Martinsen, p. 86).

In his (1993) research Martinsen looked at the joint influence of cognitive style and experience on insight problem solving, and "found that Assimilators profited from a high level of relevant experience in problem solving, while Explorers performed better under conditions of low relevant experience" (Martinsen, 1994, p. 83). Results from

Martinsen's (1995) research, which sought to replicate and extend previous (1993) findings, indicated that "experience may have a facilitating or inhibiting effect on problem solving depending on the cognitive style orientation" (p. 291). These results would tend to support the existence of an inverted U relationship between experience and creativity. Additional research using other measures of cognitive style should be carried out as a way of testing the generalizability of these findings.

Within the domain of problem solving, several theories of cognitive style have proposed a bipolar distinction "between rule bound strategies and exploratory search strategies as main characteristics (Kolb, 1976; Kaufmann, 1979, 1983; Kirton, 1989)" (Martinsen, 1994, p. 83). Kaufmann's (A-E) Assimilator-Explorer is one such theory, another is Kirton's (1976) *Adaption-Innovation Inventory (KAI)* theory which is also noted for distinctive and contrasting a bipolar preference styles termed as adaptor and innovator.

Adaption-Innovation Inventory (KAI)

The KAI inventory developed by Michael J. Kirton, measures thinking style differences on a normally distributed continuum. The range is from high *Adaptor* who tend to stay with the current paradigm and "do things better", to high *Innovator* who tend to abandon the current paradigm and "do things differently" when solving problems (Kirton, 1999). Adaptors tend to accept problems as defined and generate solution that are conventional or less disruptive, relevant and easier to implement. "Adaptors are described as resourceful, efficient, organized, and dependable, but also closed-minded and dogmatic" (Davis, 1999, p. 211). At the other end of the continuum Innovators tend

to redefine the problem with a new approach, they seem less concerned with immediate efficiency, and produce numerous ideas that are not readily accepted or seen as relevant to others. "Innovators are described as original, energetic, individualistic, spontaneous, and insightful, but sometimes impractical, abrasive, and creators of confusion" (Davis, 1999, p. 212).

The KAI was one of two measured that were utilized in this current study. The other measured used was FourSight. It was developed to measure "preferences for the essential components of the innovation process" (Puccio, 2002, p. 3), based on a creative process model called *Creative Problem Solving (CPS)*.

FourSight

FourSight developed by Gerard Puccio, was designed to measure individuals' cognitive style preferences "for different areas of operation within the Creative Problem Solving model" (Puccio, 1999, p. 172). It was observed that individuals demonstrated varying strengths, biases, and preferences for different aspects of the CPS process. "Essentially FourSight is based on the belief that CPS is a reasonable reflection of the creative process and that people, through their cognitive styles, will express preferences for the various mental activities involved in the creative process" (Puccio, 2002, pp. 5-6). The CPS model was used as a framework to identify four distinctly different cognitive preferences that guide specific problem solving behaviors which include, clarifying the situation, generating ideas, developing solutions, and implementing plans.

The four preferences as measured by FourSight are Clarifier, Ideator, Developer and Implementer. Clarifiers like to spend time searching for data and information, to

better understand the details of the problem, and to clarify the "right" problem properly. Ideators enjoy generating imaginative ideas, and tend to think in abstract global concepts, seeing many possible solutions. Developers prefer analyzing, examining, and evaluating, rough ideas that can be transformed and developed into "finely crafted solutions" (Puccio, 2002, p. 4). Implementers like to take action, to bring ideas to fruition into tangible outcomes. They are often concerned with getting things done.

"The four preferences that FourSight measures have no hierarchy" (Puccio, 2002, p.5), which means the preferences are value neutral. In other words, there is no "right" or "wrong" style. Although, the four preferences are calculated with numerical values, these values are used to visually represent levels of individuals' natural inclinations and affinity for each of the four preferences. Through the graphing of these numeric values, a singular peak preference for any one of the four style preferences, as well as two, three, and four-way combinations can be illustrated. The varying combinations yield potentially 15 different FourSight profiles; each with it's own characteristics.

In this next section, the process on which FourSight was developed, the Creative Problem Solving Process (CPS) is introduced.

Creative Problem Solving Process (CPS)

Creative Problem Solving (CPS) model was developed to enhance creative thinking through the utilization of specific procedures and tools. The CPS model originally developed by Alex Osborn in the early 1950's currently remains as one of the most widely used problem-solving processes today. It has been described as "a systematic process that helps individuals and teams analyze problems, generate and refine ideas and

implement action plans more effectively" (Puccio, 2002, p. 2). CPS guides the creative process through six stages: (1) Identify Goal, Wish or Challenge, (2) Gather Data, (3) Clarify the Problem, (4) Generate Ideas, (5) Select & Strengthen Solutions, and (6) Plan for Action. Within each step the two principles of *divergence* and *convergence* thinking are purposely applied.

The principle of *divergence* is to stretch one's thinking, "to exhaust the obvious, known answers and...to push to the point of not knowing." (Vehar, Miller, & Firestien, 1999, p. 23). The principle of *convergence* is to use one's critical judgment, by being selective in one's thinking. To assist in the application of these two thinking skills within the six steps are many "process tools" that specifically guide and enhance each activity. CPS training promotes one's ability to consider alternative ways to fundamentally redefine the problem, "to take on new challenges and come up with effective, even breakthrough solutions" (Vehar, Miller, & Firestien, 1999, p. 4).

The CPS process has been described as a descriptive process as opposed to a prescriptive process (Fox & Fox, 2000). The later process refers to a step-by-step method that does not deviate in the order of events. CPS on the other hand is extremely flexible. It has multiple starting and ending points, which accommodate the exploration of options to generate many solutions to open-ended, ambiguous situations for which a new solution is needed. "It is not a puzzle waiting to be solved by one, right, clever but hidden solution we must find by following clues" (Fox & Fox, 2000, p. 140). In other words, this process may be considered applicable to non-routine problem solving which requires the problem solver to use the cognitive process Gestaltists referred to as productive thinking. Isakesen, Dorval, and Treffinger (1993) stated that CPS is necessary whenever you face a challenge

or concern for which you want new ideas, do not have learned respond, and for which you have some meaningful personal investment" (p. 33).

Rationale for the Present Study and Core Research Questions

Oyvind Martinsen's research on the Kaufmann's A-E style cognitive theory, which focused on the exploration the joint influence of cognitive style and experience on insight problem solving, has provided some rather provocative findings. This study incorporated, in part, some methods and concepts explored in his (1993) research. Martinsen (1993) noted that the A-E style theory "may be seen as describing aspects of metacognition that direct individuals to use their abilities either to seek out novelty or to stay within established frames of experience" (p. 437).

Constructs utilized in his research, consisted of two insight problems, a biographical questionnaire (that assessed previous experience with activities as noted by Martinsen to be of relevance to insight problem solving ability), a vocabulary test, and the A-E measurement questionnaire. In lieu of the A-E questionnaire, the current study administered two cognitive style measures, FourSight and the Kirton Adaption-Innovation Inventory (KAI), a biographical questionnaire that incorporated the same assessment of experiences used in Martinsen's research, and 8 insight problems (4 visual and 4 verbal).

Although the A-E styles theory (e.i., assimilators prefer to use established, well known principles to solve problems, while explorers seek out novel solutions), appear to share similarities with Kirton's A-I styles theory, (e.i., adaptors prefer conventional or customary approaches to problem solving, while innovators prefer to reconstruct the

problem and do things differently), these two cognitive style theories were developed independently.

The A-E style theory was based on Piaget's core concepts of assimilation and accommodation, and was developed within the context of problem solving in general. The A-I style theory was developed through observational studies of change processes in organizations, and has been related to problem solving in the domain of creativity. The purpose of this study was to explore A-I theory in a similar manner to Martinsen's exploration of A-E theory, to discover if any relationships between A-I cognitive styles related to insight problem solving behavior.

The exploration of FourSight in the same manner was relevant for several reasons. Primarily the purpose of the study was to examine the relationship between style preferences and insight problem solving behavior and to further note any relationships between style preference and type of insight problems solved. Additionally and specific to research on the FourSight measure this study explored the potential for broader applications of its use. The focus of much previous research on FourSight has been towards establishing the measure in terms of reliability and validity; it has been used only minimally in task oriented research (e.g., McClean, 2003).

Problem solving training specifically designed to enhance insight problem-solving ability has shown promise (e.g., Dominowski & Dallob, 2000; Sternberg, 1995). Participants in experimental training programs have shown increased success in solving insight problems. The training included practice on similar types of insight problems coupled with strategy based instructions, which assisted in the application of various megacognitive processes. These processes included planning, monitoring, and evaluating

solutions with increased emphasis on finding, understanding, and restructuring of problem representation proved to improve performance. If training which emphasizes increased awareness of metacognitive processes has shown to aid problem solving effects, the question that then arises can a problem solving processes with parallel concepts have an impact on ability to solve insight problems?

The Creative Problem Solving (CPS) model was designed to enhance individuals' ability to generate creative solutions to open-ended problems, not to solve specific types of problems (i.e. insight problems). Yet, because domain-general and domain-specific skills both operate interactively and are complementary (Ippolito & Tweeney, 1995), this study also examined the possibility that problem solving skills as taught in CPS courses might be transferable to insight problem solving tasks.

Research Questions

Specific questions that guided this study were:

- Does adaptive and innovative cognitive styles as measured by the KAI relate to insight problem solving behavior? Are there interactive relationships between style and types of insight problems solved?
- What is the relationship between FourSight style preferences and insight problem solving behavior? Are there interactive relationships between various style preferences and types of insight problems solved?
- Does problem-solving experience facilitate or inhibit the solving of insight problems?
- Do educational courses in Creative Problem Solving (CPS) enhance students' ability to successfully solve insight problems?

Statement of Significance

The focus of this study was to explore the influence of individual differences in cognitive style preferences, experience with creativity relevant activities, and training in CPS on insight problem solving behavior. In research literature it has noted that an individual differences approach has seldom been used in the exploration of insight problem solving behavior. Less often has cognitive style measures been implemented in these studies. Martinsen and Kaufmann (1999) noted that "the research designs that are most frequently applied in stylistic research on creativity seem to be nonexperimental or correlational" (p. 281). The purpose of this research was to extend stylistic research by exploring stylistic influence on one potential sub-component of creativity, that of insight problem solving behavior, using insight problems as experimental manipulation tasks. This research also revisited issues related to experience and its' impact on creative problems solving activities. And finally, this research attempted to shed light on insight problem solving behavior in identifiable and measurable terms.

Summary

This chapter briefly introduced varying perspectives on insight and experience on insight problem solving. The concept of individual differences in cognitive style was explored as having the potential to integrate the relation among experience, insight problem solving, and creativity. Measures and methods incorporated within this current research were introduced and finally, the rationale for this study was discussed.

Chapter Two will further define the nature of insight, insight problems, and insightful discoveries. It will review in detail Gestalt theories related to processes that

hinder or enhance insight and insight problem solving. The chapter then focuses on modern theories and research related to insight and problem solving. It concludes with proposed future directions for additional research to further the development and understanding of insight in alternative ways.

Chapter Two: Literature Review

Introduction

Chapter One briefly introduced Gestalt theories on insight and experience as related to the process of problem solving. Additionally the concept of individual differences in cognitive styles was discussed, through the introduction of three cognitive style measures. This chapter will review the literature associated with key concepts of insight and problem solving from Gestalt and other perspectives. Insight is further defined through aspects of affect, insightful discoveries, and individual differences. Various past, present, and proposed future insight research are presented. The chapter concludes with a chapter summary and a preview of Chapter Three.

Routine versus Nonroutine Problems Solving

Insight is what distinguishes the enlightened from the benighted, the inspiring from the denigrating, the magical from the mediocre. It is the essential process by which we come to make surprising discoveries and realizations, both about real-world issues and problems and about ourselves (Finke, 1995, p. 255).

We encounter challenges and problems daily. At times we purposely seek out difficult or perplexing situations as a way of testing and expanding our understanding of ourselves, and our environment. At other times it would seem we are confronted by

problems we did not or could not anticipate. Fortunately many *routine* problems can be solved through analytical processes and through the application of previously acquired knowledge or experience; this is sometimes referred to as *reproductive thinking*. Solving a nonroutine problem often requires the problem solver to search beyond obvious means, to discover a novel way to attain an insightful and creative solution to the problem (Mayer, 1995; Sternberg & Lubart, 1995). *Productive thinking* emphasizes this generative process, and it occurs "when the problem solver invents a solution procedure that is novel for that problem solver" (Mayer, 1999, p. 439).

Creativity theorists and researchers have often focused on generative processes because it is these processes that produce novel solutions, and are relative to creativity "commonly defined as the creation of an original and useful product" (Mayer, 1999, p. 439). Sternberg and Davidson (1999) asserted that "no understanding of creative thinking - thinking that produces novel task-appropriate ideas that are high in quality - would be complete without an understanding of the insights that seem to underlie such creative thinking" (p. 59). They further proposed that "an understanding of insight is a prerequisite for understanding other interesting psychological functions" (p. 59).

Gestalt Psychology

Early theories and research regarding the nature of insight and its psychological characteristics trace back to the work of the German psychologists Wolfgang Kohler. Kohler, along with Max Wertheimer and Kurt Koffka, established the Gestalt school of psychology, which emphasized particular areas of thinking and learning (Pierce, 1999). Gestalt psychologists proposed that insight could be achieved by restructuring "the

process of arriving at a new understanding of a problem situation" (Dominowski & Dallbo, 1995, p. 50). "*Restructuring* is 'structuring again,' an alteration of a cognitive representation" (Smith, 1995, p. 233). The Gestalt psychologists proposed that changing from one representation of a problem to a very different representation could be done through various ways; reorganizing visual information, reformulating a problem, overcoming a mental block, and finding a problem analog (Mayer, 1995, 1999).

This section briefly outlines six interrelated views of insight. The first view completing a schema is considered pre-Gestalt, the next four views previously noted above were developed in the tradition of Gestalt psychology, and the last view looks at two modern three-process views.

Insight as Completing a Schema

In the 1910s and 1920s Otto Selz "produced psychology's first nonassociation theory of problem solving that viewed insight-as-completing-a-schema" (Mayer, 1995, p. 8). According to this view "insight occurs when a problem solver fills a gap in a structure - that is, when a problem solver sees how the givens and goals fit together within a larger system or complex" (Mayer, 1999, p. 442). The problem solver actively seeks meaning, by figuring out how a gap in information might be filled in a way that the problem becomes a coherent and complete structure. This process was referred to by Otto Selz as *schematic anticipation*, in which the problem solver "mentally built a structure, such as '_____ is a super-ordinate of *newspaper*' and tried to fill it in a way that maintained its structural integrity" (Mayer, 1999, p. 442).

Unfortunately much of Otto Selz's research and writings are considered vague and

imprecise by modern psychologists, as such, his work has not been widely acknowledged. Yet, his ideas did foreshadow the "Gestalt revolution that was to follow and the schema-completion view with which Selz struggled continues to develop within current cognitive theory, including accounts of machine cognition" (Mayer, 1995, p. 10).

Insight as Reorganizing Visual Information

"A second early view of insight corresponds with the Gestalt theory of perception (Kohler, 1929)" (Mayer, 1995, p. 5). This view relates to the visual nature of insight. It associates the occurrence of insight with a sudden mental-restructuring of visual information. "This sudden restructuring was supposedly similar to the perceptual restructuring that can occur, for example, when shifting back and forth between alternate interpretations of certain optical illusions" (Smith, 1995, p. 230) similar to the optical illusion of the necker cube (i.e., the phenomena created by the 3 dimensional wire drawing of a cube which appears to shimmer away or towards the viewer depending on one's perspective). Mayer (1995) explained "just as perception involves building an organized structure from visual input, creative thinking often involves the reorganizing or restructuring of visual information" (p. 5).

Wolfgang Kohler's research on chimpanzees and problem solving were some of the first widely noted experiments on insight. Through his research Kohler concluded that the chimps, when successful in their problem solving efforts, exhibited insightful behavior through the sudden reorganization of the visual field. Kohler had observed for example the presumed insightful behavior of Sultan, a chimpanzee, who had suddenly

realized he could put two sticks together making one long pole, which enabled him to reach outside of his cage to roll a banana previously out of his range towards him (Sternberg, 1999). In Kohler's view, the chimps were able to see how the different parts of the problem situation fit together and connected to the whole of the situation.

Although his research has been faulted for lack of methodological rigor and lacked the correspondence of theory to data; current interest in visual information, thinking, and representation in mental models of cognition still remain the focus for scientific and mathematical problem solving research (Mayer, 1995, 1999).

"The ability to see things in different visual perspectives and to look at things from different points of views has long been regarded as an important characteristic of creative persons" (Torrance & Safter, 1999, p. 196). Torrance and Safter (1999) noted from their longitudinal studies of creative achievement "the ability to present objects on the circle test in unusual visual perspective was one of the most effective single predictors of adult creative achievement" (p. 197). Often creative breakthroughs are born of those persons who are able to see something new in their physical surroundings, things that others might consider as common place, in a new and exciting way.

Insight as Reformulating a Problem

Duncker's (1945) publication, *On Problem Solving* expanded on the concept that "insight results when one redefines or clarifies the problem, such as reformulating the given parts of the problem goals" (Pierce, 1999, p. 109). Duncker referred to two such methods for reformulating a problem as *suggestions from above* and *suggestions from below* (Pierce, 1999; Mayer 1995). Problems that are reformulated via *suggestions from*

above referred to the redefinition or clarification of the goal, from a general to specific purpose. Whereas *suggestions from below*, referred to problems that are reformulated through the functions of the given parts or elements of the problem. In other words, the problem solver seeks ideas about how to reformulate the given information in a new way.

According to these concepts "successful problem solving begins at the general and functional level before it progresses to more specific and concrete solutions" (Mayer, 1995, p. 16). This theoretical concept is consistent with creative problem solving efforts to progress from general qualitative representations of the problem to specific representations, when the goal is to "pinpoint the right problem to be solved" (Vehar, Miller, Firestien, 1999, p. 53). Successful problem solving begins when problem givens are properly clarified and the goal is appropriately understood in a productive way.

The first component in the CPS model addresses the appropriate understanding of a problem through three steps, Mess-Finding, Data-Finding, and Problem-Finding. In Mess-Finding the purpose is to identify and select a broad goal, then through Data-Finding, information most important to understanding the problem is determined, and finally in Problem-Finding a specific problem is brought into focus, well defined and clarified (Isaksen, Dorval, & Treffinger, 1993).

Insight as Overcoming a Mental Block

"Duncker also proposed that the reformulation of a problem situation is often prevented when one's previous experience serves as a mental block" (Pierce, 1999, p. 108). According to this view, a mental block is most likely to be the result of the problem solver's reliance on inappropriate past experience. Specifically, "Duncker used the term

functional fixedness to refer to a situation in which a problem solver tends to think of using a given object only in its most common way rather than in a more novel way" (Mayer, 1999, p. 443). It is not so much the idea that prior use of an object "affects any subsequent use; rather, prior standard or ordinary use inhibits subsequent novel uses" (Dominowski & Dallob, 1995, p. 48).

To investigate this theory Duncker used a problem that consisted of matchboxes, candles, and tacks. The goal of the exercise was to mount three candles side by side at eye-level on a wall. "The solution is to melt wax onto the top of a box, stick the candle onto the wax, and tack the box to the wall" (Davidson, 1995, p. 134). "Most of the subjects were unable to solve the candle problem when the boxes contained candles, tacks, and matches; however, all subjects eventually solved the problem if they were given empty boxes next to piles of candles, tacks, and matches" (Mayer, 1995, p. 17). Essentially, problem solvers needed to use the boxes as platforms tacked to the wall, which then could support the candles. Duncker noted that when the boxes were used as containers for the items, the problem solvers had difficulty devising a new use for the boxes, that of a platform. He proposed the pre-utilization of the boxes as containers had lead to functional fixedness (Mayer, 1995, 1999).

Gestalt psychologist, Abraham Luchins, proposed another theory related to mental blocks caused by prior experience. He referred to the mental block as the *einstellung* effect or (problem-solving set). *Einstellung* problems are a group of problems given in sequence, which can be solved through the implementation of a specific algorithm. In his water-jar problems, subjects were given a series of five *einstellung* problems, "all of which could be solved by one procedure - fill up the second jar and

from it fill up the first jar and the third jar twice" (Mayer, 1995, p. 18). The goal of the problems was to obtain specific volumes of water using empty jars of varying sizes as measures. "After receiving five problems that could be solved using this procedure, subjects received a series of similar-looking problems (called *critical problems*) that could be solved by simpler procedures" (Mayer, 1995, p. 20). Of the subjects who had received the *einstellung* problems prior to the critical problems, very few saw the simpler solution relying instead on the previously encountered problem-solving set. In contrast, subjects who were able to solve the critical problems using a simpler procedure had not received the *einstellung* problems prior to receiving the critical problems. Luchins thus proposed that the preceding experience of the *einstellung* problems had caused a mental set fixation. He concluded the mental set blocked problem-solving success and further demonstrated the "blinding effect" of prior experience.

Insight as Finding a Problem Analog

Wertheimer proposed in contrast to experience as mental block, that certain kinds of experiences facilitate insight through analogy. His theory suggested "that insight sometimes involves grasping the structural organization of one situation and applying that organization to a new problem" (Mayer, 1995, p. 21). As an illustration of this theory he taught two groups of students to find the area of a parallelogram using two different methods, then observed students' ability to transfer learning to new problems (Sternberg & Davidson, 1999; Mayer, 1995).

Some students learned to solve for the area of the parallelogram in the standard method of measuring the height and the base, then multiplying the two measurements

together. Others were taught to understand the relationship of a parallelogram to a rectangle. Students who had learned to solve for the area by understanding the underlying analogous relationship were better able to solve transfer problems. "In other words, they were able to have the insight that allowed them to see the analogy only if they were taught in a way that let them adequately organize and understand the original material" (Sternberg & Davidson, 1999, p. 64). The ability to grasp the structural relations of one problem and apply the understanding to a new problem consequently does rely on past experience to the extent to which the nature and inner relatedness of the experience is understood and connected in accordance with requirements of the new situation (Mayer, 1995).

Wertheimer further focused on the "inner relatedness among the parts of the problems and how they fit together" (Pierce, 1999, p. 109). He proposed a method for understanding a problem that included grouping, reorganization and structurization, whereby the problem is divided into subwholes to see how the subwholes might relate or fit together (Pierce, 1999).

As Sternberg and Davidson (1999) summarized the "views most often associated with the Gestalt psychologists and their successors who believed that one can not study psychological phenomena by decomposing them into their elements, because the whole often differs from the sum of its parts" (p. 63), also believed that "insight is a process that differs in kind from ordinary kinds of information processing" (p. 63). Sternberg and Davidson (1995) have noted that although there are obvious weaknesses with Gestaltists' "special-process view" and that their empirical studies that lacked rigor, they also noted some strengths of their work. The Gestalt psychologists were the first to take insight

seriously, they made several attempts to study insight process empirically, and theorizing provided a basis for later theorizing.

Three-Process Views

Ohlsson (1984, 1992) has since assembled a more "comprehensive modern theory of insight and the process of restructuring" (Ansburg & Dominowski, 2000, p. 31). Ohlsson proposed three possible mechanisms that may contribute to the activation of restructuring: *elaboration*, *re-encoding*, and *constraint relaxation*. The elaboration mechanism involves adding information, which changes the problem representation. Re-encoding involves changing the initial interpretation of problem elements, and "constraint relaxation involves rejecting features of the solution that were previously thought necessary" (Schooler, Ohlsson, & Brooks, 1993, p. 168).

Another, three-process theory was proposed by Sternberg and Davidson based on a theory of selection. "According to the three-process theory (Davidson, 1986; Davidson & Sternberg, 1986), insight comprises selective encoding, selective combination, and selective comparison" (Davidson, 1995, p. 127).

Selective encoding insights involve sifting relevant information from irrelevant information.... *Selective combination* insights involve combining what originally might seem to be isolated pieces of information into a unified whole that may or may not resemble its parts.... *Selective comparison* insights involve relating newly acquired information to information acquired in the past. (Sternberg & Davidson, 1999, p. 65)

Three Perspectives of Insight

Differences in opinion have "focused on whether insight is a special process and on the phenomenon of suddenness" or whether "insight is neither fast nor sudden, neither exotic nor mysterious, but instead is based on past experience" (Gick & Lockhart 1995, p. 215). At one end of the spectrum is the suggestion that insight is a special psychological process referred by Seifert et al. (1995) as the *Wizard Merlin Perspective*. This perspective "claims that true insight stems from seemingly super-natural mental powers, which are possessed by only a few most gifted individuals, whose minds are neither capable of being mimicked nor open to scientific explanation" (Seifert et al., 1995, p. 74). At the other end of the spectrum is the *nothing-special view*, also referred to by Seifert et al. (1995) as the *business-as-usual perspective* which attributes insight "to normal mental processes such as memory search, hypothesis testing, and trial-and error solution attempts based on past experience" (p. 68). As an illustration of the nothing-special view Sternberg and Davidson (1999) noted the work of Patrick Langley, Herbert Simon and their colleagues with computational problem solving. This group devised a series of computer programs that "could generate the same discoveries, and possibly the same insights that the great minds had, using the same kinds of problem-solving processes that could be used to solve any other problem" (p. 62). In other words, because their programs had reproduced several major discoveries similar to those produced previously by great minds, it can be assumed the insight process is not special.

In response to the nothing-special view Davidson (1995) shared the following observation "arguments for the nothing-special view are essentially arguments by default.... After repeated failures to identify a construct empirically, one can easily be

tempted to ascribe the failure to the nonexistence of the construct" (p. 127). Metcalfe (1995) asserted that admitting insight is yet not understood is quite different from denying that it exists at all. She proposed instead the idea that very similar to other natural phenomena, that were initially attributed to divine intervention until their natural causes were discovered, so might the mechanisms underlying insight eventually be understood. Even in its classic version the nothing-special view was challenged by researchers of the day and continues to be challenged by modern research (Mayer, 1999).

Pierce (1999) proposed a balance through the incorporation of both perspectives by stating "we must realize that most problems involve extensive logical reasoning punctuated occasionally by need for insight - when one needs an alternative approach" (p. 118). He further explained that optimum problem solving supports the need for both insight and noninsight processes "when each process is utilized at the appropriate time" a condition is created in which the two processes are complementary (p. 118). Pierce (1999) also suggested that "insight may have evolved as an inseparable part of the process of creative thought... that insight and insightful learning allows an organism to short-circuit the inefficient process of purely random or blind trial-error learning" (p. 119).

There are several others who share this perspective of balance and have forged ahead with attempts to explore insight by balancing the two extreme perspectives. As such, a third point of view has emerged referred to by Seifert et al. (1995) as, "the *prepared-mind perspective* (Posner, 1973)" (p. 74). They suggested within this perspective that both extreme conditions are an acceptable condition for insight. However, it "does not necessarily attribute cases of insight to enigmatic superhuman

mental powers" (p. 75), rather this perspective focuses on concepts expressed by Louis Pasteur that "chance favors the prepared mind" and that people whose minds are prepared "can and do take advantage of fortuitous encounters with relevant external objects and events" (p. 85). The prepared-mind-perspective "strives toward determining how insight may emerge from a combination of information-processing phases whose joint interactions enable subconscious quantum leaps during the generation of new mental products" (Seifert et al., 1995, p. 75). This perspective functions on the premise that insight is a researchable cognitive process.

Definitions of Insight

The distinction between the terms *insight*, *insight experience* and *insight problem* has been made by some cognitive researchers (Smith, 1995). According to *Webster's Encyclopedia Unabridged Dictionary* (1989) insight has been defined as "1. Is an instance of apprehending the true nature of a thing, esp. through intuitive understanding ...2. Penetrating mental vision or discernment; faculty of seeing into inner character or underlying truth.... Syn. 3. Perception, apprehension, intuition, understanding, grasp" (p. 735). This definition has been used differently by two different intellectual communities. One prevalent meaning used "among psychoanalysts and other students of personality, insight refers to the condition of having knowledge rather than to the moment of attaining it.... emphasis is on self-knowledge as the aim; intuition is taken for granted as the way" (Gruber, 1995, p. 398). The other prevalent meaning is used "among students of creativity and cognitive psychologists, *insight* refers to that glorious moment when one suddenly "sees" the solution to a problem. The emphasis is on suddenness and surprise,

solution and correctness" (Gruber, 1995, p. 397). It is this meaning of insight that has often been associated with creativity and is typically illustrated by illumination of the proverbial light going on over one's head. Insight is also a form of discovery and is closely related to concepts of understanding and comprehension. "To gain insight is to understand (something) more fully, to move from a state of relative confusion of one of comprehension" (Dominowski & Dallob, 1995, p. 37). Smith (1995) further clarified insight as "an understanding...for example to understand a mechanism, an analogy, an inductive principle, or a re-conceptualization" (p. 232).

Smith (1995) defined the *insight experience* as the "sudden emergence of an idea into conscious awareness, the "Aha!" experience" (p. 232). Additionally the term insight has been applied to "perceptual and other cognitive processes including moods and motives experienced as making sense" (Gruber, p. 398). "Metcalf and Wiebe (1987) defined insight in terms of the metacognitions immediately preceding the moment when a solution is reached" (Smith, 1995, p. 232). Generally, regarding problem solving research "the term insight has been used to name the process by which a problem solver suddenly moves from a state of not knowing how to solve a problem to a state of knowing how to solve it (Mayer 1992)" (Mayer, 1995, p. 3).

One means by which to elicit this "state of not knowing how to solve a problem" experimentally is through the use of *insight problems*. Similar to puzzles, insight problems seldom have little, if any, connections with other aspects of our knowledge (Dominowski & Dallob, 1995). They are a class of problems considered nonroutine which, also involve novelty through their interpretation, and unusual use of less dominant words, phrases, and objects for their solutions. Dominowski (1995) noted that "finding a

new and productive interpretation of a situation is just one component in creativity, but serves to link solving insight problems with creative thinking" as such, insight problems have often been utilized in the research of insight.

Insight Problems

"The usefulness of insight problems, for example, is that they can be used in the laboratory to induce and study insight experiences" (Smith, 1995, p. 245). The differentiation between insight and non-insight has been noted in several ways. In solving insight problems "subjects initially use operators that fail to move them toward the goal" (Issak & Just, 1995, p. 283). Insight problems may "elicit an initial impasse in which the subjects are unaware of making any progress as they struggle simply to determine the right approach to tackle the problem" (Schooler & Melcher, 1995, p.108). Misleading information in the problem often keeps the subject from selecting the relevant information required to solve the problem. Schooler, Ohlsson, and Brook (1993) further noted differences in that "insight problems are characterized precisely by the necessity to reject the initial, obvious approach in order to find the solution, whereas noninsight problems can be solved by pursuing the obvious approach" (p. 175). Solutions for insight problems in contrast to a noninsight problems are more likely to result from an insight experience, although, "not every solution to a insight problem need be generated by an insight experience" (Smith, 1995, p. 233). Conversely, noninsight problems may be solved via an insight.

"We would expect tasks that might involve insight to have certain features - to require something new or nonobvious to be done and to be difficult enough so the initial

solution attempt is seldom successful" (Dominowski & Dallob, 1995, p. 41). Tasks labeled as insight problems usually contain these characteristics and are defined as problems that are:

- (a) well within the competence of the average subject; (b) have a high probability of leading to an impasse that is a state in which the a subject does not know what to do next; and (c) has a high probability of rewarding sustained effort with an "Aha" experience in which the impasse is suddenly broken and insight into the solution is rapidly attained. (Schooler, Ohlsson, & Brook, 1993, p. 168)

There are several types of insight problems, *object-use*, *spatial*, and *verbal* to list a few. Object- use problems "typically involve multiple objects and require that an object be used in a relatively novel manner to achieve the goal.... object-use problems have been presented with actual objects in real environment or in paper-and-pencil (or computer-screen) versions" (Dominowski & Dallob, 1995, p. 42). A classic example of this type of problem is the two string problem, "the problem solver is asked to tie together two cords that are hanging from overhead but are too far apart to be grasped at once" (Mayer, 1995, p. 15). Several objects are provided in this same space. The problem solver needs to reformulate the approach to the problem by viewing the hanging strings as pendulums. Thereby using an object (e.g., screwdriver) as a weight tied to the end of one of the strings, for the purpose of setting it into motion. The problem solver can then grab the other string as he/she walks toward the second string being used as a pendulum in motion, catching it on the up-swing, then tie the two strings together, solving the problem.

In a spatial insight problem "there are no objects involved, although there is

required activity (drawing lines), and spatial relations among problem elements are relevant" (Dominowski & Dallob, 1995, p. 43). A classic example of this type of problem is the nine-dot problem, which consists of three dots in three rows equally spaced, very similar to the grid layout of the pigs insight problem illustrated in Appendix G. The goal of the nine-dot problem is "to connect all the dots using four straight lines without lifting the pencil from the page or retracing any lines" (Dominowski & Dallob, 1995, p. 43).

Verbal insight problems are loosely defined; these tasks are usually presented in verbal or written form and "their content might refer to spatial or numerical concepts as well as verbal meanings" (Dominowski & Dallob, 1995, p. 43). Dominowski and Dallob (1995) suggested these types of problems "could make data interpretation less clear" (p. 44) because these types of problems, in their opinion, may be further classified into two subtypes *wrong-answer* and *no-answer*. Wrong answers are usually arrived at very quickly; no answers simple represent failure to solve a problem. Their concern is that typically these subtypes of problems are not ordinarily "distinguished but rather are thrown together and discussed collectively, implying that common processes apply to them all" (p. 44). Stating further "it would seem plausible that the dynamics of problem solving may not be the same in all instances" (p. 44) and that "it is reasonable to suspect that as the content changes, different sorts of abilities might affect performance" (p. 43).

The differing characteristics noted between insight and noninsight problem solving suggests the possibility of different types of problem-solving skills being utilized by each. Schooler et al. (1995) had suggested two such skills termed *approach-recognition* and *approach-execution*. They further provided empirical support for these proposed differences in skills.

Empirical Differences Between Insight and Noninsight Problems

Schooler et al. (1995) suggested that "insight problems may tend particularly to tap approach-recognition skills and noninsight problems approach-execution skills" (p. 581). Approach-recognition skills "which entails identifying the possible operators that are available" (p. 580), for example pattern-recognition processes. Whereas approach-execution skills "involves successfully deciding among and executing the identified operators" (p. 581) and "should rely more on reasoning skills and the ability to maintain a representation of where one is and where one is going" (p. 581). As evidenced through their various studies they also noted several differences between the solving of insight and noninsight problems. The recognition of out-of-focus pictures correlated highly with solving insight problems, but did not significantly correlate with noninsight problems. Logical arguments were highly predictive of noninsight problem solving but not of insight problem solving and the frequent "rereading of the problem was negatively correlated with noninsight problems but not insight problems" (Schooler et al., 1995, p. 581).

Additionally Schooler et al. (1995) referred to research findings on *verbal overshadowing* and *feelings of warmth* as evidence of different non-reportable processes involved in solving the two types of problems. Schooler, Ohlsson, and Brooks (1993) explored the hypothesis that verbalization (thinking aloud) might effect, or overshadow non-reportable processes involved in insight problem solving. Their findings noted that, when "compared to the silent control subjects, subjects who verbalized were substantially less likely to solve insight problems but exhibited no decrement on the noninsight problems" (Schooler et al., 1995, p. 583). Schooler and Melcher (1995) asserted these

findings provided "direct evidence for the logical processes used by analytic problem solvers and the lack of such processes in insight problem solving" (p. 118) and further suggested that insight might involve processes that are distinct from language.

In Metcalfe's research on feelings of warmth subjects were required to respond at 10 second intervals with subjective ratings of "warmth" or "cold", in relation to how near to a solution they felt they were when solving both insight and noninsight problems. "Metcalfe's studies show that when people solve noninsight problems, their feelings of warmth increase incrementally until the solution is reached, but when they solve insight problems their sense of finding an impending solutions is very sudden, coming on with little warning" (Ward, Smith, & Finke, 1999, p. 195). In other words, while solving insight problems, subjects felt no closer to the solution until they actually reach it, in fact "it was found that gradually increasing patterns of warmth ratings were more likely to herald an impending failure rather than an impending solution" (Smith, 1995, p. 231). The theoretical implications suggested by the findings of these two studies, according to Schooler, Ohlsson, and Brooks (1993) provided "thus, a strong argument for the existence of distinct insight processes is that they readily account for qualitative differences between insight and noninsight problems observed in two different paradigms" (p. 179).

The Positive Affects of Insight

The affects of restructuring have been compared to that unique moment when we "get" the punch line of a joke (Dominowski & Dallob, 1995; Gick & Lockhart, 1995; Fiore & Schooler, 1998). A well told story-based joke, allows us to search for meaning;

building and fitting elements together in numerous ways, yet, the clues are not given away until the punch line is delivered. At that moment, we often see the story-so-far in a new light. One in which the expected resolution (which, most likely was based on the dominant meaning of a given word or concept) is restructured to an unexpected resolution (one based on a novel or non-dominant meaning). When we "get" the joke there is an instant understanding or an "Aha!" moment. This sense of elation has also been associated with the insight experience, and it has been hypothesized to serve a specific purpose.

The ultimate "Aha!" experience might be accompanied by a sense of joy and correctness. Ippolito and Tweney (1995) offered an explanation of this emotional experience, as nature's way of patting us on the back, which may in fact bolster self-esteem through feelings of self-validation. The accompanying emotional component is compelling, because "the increased arousal could amplify the positive reinforcing affect that the problem solver experiences, making it more likely that he or she will seek additional future insights" (Seifert et al., 1995, p. 118). When viewed in the light of *emotion-focused* and *problem-focused* coping behavior related to *problem orientation*, the concept of insight experiences as motivational stimulus is extremely interesting.

D'Zurilla and Sheedy (1991) referred to problem orientation as "the motivational components of the problem solving process, consisting of generalized cognitive, emotional, and behavioral response.... arising primarily from past problem solving experiences" (p. 841). Depending on the nature of these orienting response sets, their influence can either facilitate or inhibit problem-solving performance. "Individuals characterized by problem-focused coping develop strategies that consist of behaviors

designed to reduce or eliminate the problem in question. ... In, contrast, individuals characterized by emotion-focused coping are influenced strongly by the affect state itself" (Blankstein, Flett, & Watson, 1992, p. 37).

D'Zurilla and Sheedy (1991) suggested a positive orientation that facilitates problem-solving performance might include tendencies to "(a) perceive a problem as a challenge or opportunity for benefit, (b) respond to a problem with positive emotions (e.g., hope, eagerness), and (c) actively approach a problem and handle it with dispatch" (p. 841). In contrast, a negative orientation that inhibits problem-solving performance might include tendencies to "(a) view the problem as significant threat to well-being, (b) respond to a problem with strong negative emotions (e.g., anxiety and depression), and (c) avoid or cut off dealing with a problem" (p. 841). It would appear, the "positive reinforcing affect" of an insight experience would be beneficial to both types of problem solvers, yet perhaps more so, for those problem solvers who are emotion-focused and are "influenced strongly by the affect state itself". Also as noted by Blankstein, Flett, and Watson (1992) "self-efficacy feelings that involve the ability to solve problems also may lead to increased levels of performance" (p. 37).

Intrinsic motivation and perseverance play very important rolls in problem solving and creativity. Often creative people are highly motivated (intrinsically) and are "driven by opportunities to solve challenging, boundary-pushing problems" (Collins & Amabile, 1999, p. 300). In Csikszentmihalyi's (1990) book, *Flow: The Psychological Optimal Experience* he describes one highly intrinsically motivated state referred to the *flow* experience. The flow experience has been described as a psychological "high". It refers to a condition in which a person is so deeply involved and so fully focused in an

activity to "such an extent that nothing else matters" (Davis, 1999, p. 4). It has been hypothesized that this "flow" condition increases creative productivity, as such it has been suggested that creative persons might actively seek this condition (Collins & Amabile, 1999).

There appears to be a conceptual similarity between flow and insight experiences as both are proposed to have positive reinforcing affects, which motivate the creative person to pursue additional similar experiences. The results of insightful problem solving are more often born to those individuals who are motivated to push beyond all current expectations (Csikszentmihalyi & Sawyer, 1995). "Many of the world's greatest contributions have derived from insightful problem solving, as opposed to more routine and less subjectively sudden forms of problem solving (Gruber, 1979; Nickles, 1978)" (Davidson, 1995, p. 125).

Insightful Discoveries

"There appears to be a general tendency, in all cultures and historical periods to differentiate between mental processes that are routine, shallow, trivial on one hand and those that are unusual, profound and important on the other" (Csikszentmihalyi & Sawyer, 1995, p. 329). Moments of creative insight in the lives of creative individuals have fascinated researchers and biographers alike. "Under various names - hunches, illuminations, inspirations, quantum leaps, and acts of intuition, and the like - flashes of insight have received credit for some the greatest contributions of human culture, whether in the sciences or arts" (Simonton, 1995, p. 466). Some well-known examples of such epiphanies include: Alexander Flemings's discovery of penicillin, Roentgen's discovery

of x-rays, Gutenberg's invention of the printing press, Newton's apple and discovery of gravity, Kekule's discovery of the molecular structure of the organic compound benzene, and Poincare's celebrated flash of insight into the nature of Fuchsian functions.

Archimedes' apocryphal "eureka!" experience is probably the most recognized among students of creativity.

Archimedes had been given the problem of determining whether king Hiero's crown was pure gold or mixed with silver. He knew the density of gold and the weight of the crown, but needed to measure its volume (an irregular shape) without melting it down. He had worked for quite awhile without finding a solution, when one day as he lowered himself into a bathtub, he noticed as he submerged his body into the tub the water rose simultaneously. Archimedes had discovered a means for measuring irregular volumes; objects when submerged in liquid displace their own volume! "It is said that Archimedes' joy at this insight was so great that he leaped from his bath and ran naked through the streets of Syracuse, exclaiming 'Eureka' (I have found it!)" (Langley & Jones, 1988, p. 200).

Although many recounts of insight appear to be sudden experiences, insightful problem solving can occur in both short and long time frames. More often a person must commit great attention to a problematic area in a domain prior to and after an insight experience, giving credence to the adage that creativity is 99 percent perspiration and 1 percent inspiration. Davidson (1995) also noted that "insightful problem solving is not always faster problem solving....Often a great deal of time must occur before one can experience insight" (p. 151). A creative problem solution may result from months, even "years, of systematic planning, hard work, and trial-and-error experimentation" or "may

be born instantly in an 'Aha!' (insight) experience, inspired by the chance encounter of a needed idea or solution" (Davis, 1999, p. 116).

It is important to note that "insight experiences need not result in profound earth-shattering ideas, such as theory of evolution, or ideas of special relativity in physics" (Smith, 1995, p. 232). Insights may simply serve as an important step in the resolution of a meaningful dissonance, conscious or unconscious incongruity. Also whether an insight is gained through the "incremental acquisition of knowledge or via a sudden realization of an idea" (Smith, 1995, p. 232) it is only one part of a larger problem-solving process. Perkins cautioned (1995) "that the brief moments in which an insight builds and emerges should be considered only the tip of the iceberg of the phenomenon of insight" (p. 495).

Insight - Part of a Larger Problem Solving Process

Graham Wallas in 1926 proposed in his book *The Art of Thought* a four-stage problem solving theory in which insight or "illumination" was noted as the third stage. He described the four stages or phases in creative thinking as: (1) preparation, (2) incubation, (3) illumination, and (4) verification. Generally insight is associated with the third stage or the illumination phase; during which the penetrating "flash of insight" abruptly surfaces into consciousness as the resultant culmination of applied effort in the previous two stages. Details of the insight are then resolved in the last stage. Seifert et al. (1995) suggested that there may be at "least two obvious places where we might find some wellspring of insight. One of these is the initial preparation phase, and the other is the intermediate incubation phase" (p. 76).

Phase One - Preparation

The first phase of Wallas' problem solving model the preparation phase, includes time-consuming research, data analyzing, generating and combining ideas. As noted by Davidson (1995) "problem definition is a problem-solving process (Sternberg, 1985) that must occur before a correct solution can be reached" (p. 148). Consequently the preparation phase involves hard work and intense effort in attempting to clarify and solve the problem. Sometimes this effort leads directly to a solution. Defining the nature of the problem, as well as understanding what exactly is being asked to be solved, is not only important to problem solving in general, but is especially important to solving insight problems, as they are often purposely misleading. Mayer (1995) asserted that in the search for insight one must begin with a focus on *problem representation*, defined as the building of "an internal representation of a problem that suggests a plan or solution", rather than problem *solution*, which "is the carrying out of a solution plan" (p. 4). This appears to echoes Albert Einstein's observation that "the identification of the problem is more important than the solution, which may merely be a matter of mathematical or experimental skills" (Davis, 1999, p. 11).

In the case of a very difficult or complex problem, resolution might not be reached in the first phase. The problem solver may reach an impasse and eventually "give up" or decide to set the problem aside for a while. At any rate, the information processing of the first phase provides "the raw material on which the subconscious can begin working. The second stage, which can last a very short time or go on for years, is the stage of *incubation*" (Csiksentmihalyi & Sawyer, 1995, p. 333).

Phase Two - Incubation

Once the problem has been set aside and the problem solver devotes his/her attention to other issues or gets involved in unrelated activities, phase two of the problem solving process referred to as incubation has begun. The term incubation suggests "a biological metaphor, implying that the cognitive pattern resembles a process similar to biological maturation. When an egg is laid, the opaque shell prevents us from seeing the development within" (Smith, 1995, p. 242). This metaphor suggests that invisible unconscious processes are valuable for the insightful development of ideas, yet these processes may not be available to introspection. As such, many hypotheses and theories have been developed in an attempt to explain the proposed unconscious activities involved in the incubation phase. Only one theory is reviewed herein, for a more comprehensive review various theories see (i.e., Smith & Blankenship, 1991; Schooler & Melcher, 1995; Knoblich, Ohlsson, Rhenius & Haider, 1999).

Seifert et al. (1995) proposed that the incubation phase contains three-substages and all three substages must be completed as a precursor to a future insightful outcome. The three stages are intermediate incubation, exposure to new information, and retrieval of failure indices. Their theory is based on the *opportunistic-assimilation* hypothesis, an extension of the prepared mind perspective. According to their hypothesis, "initial information-processing encounters with problematic situations that end in an impasse...leave failure indices in long-term memory...as sign posts that guide subsequent retrieval processes back to stored aspects of the problem situation (Schank, 1982)" (Seifert et al., 1995, pp. 86-87). They also assert that their theory discounts several other proposed theories of subconscious processes, "growth of subliminal

memory-trace activation (Bowers et al., 1990), selective forgetting of inappropriate memory traces (Silveira, 1971), and covert random reorganization of knowledge structures" (Seifert et al., 1995, p. 114). Rather incubation allows for "incidental exposure to various external stimuli, some of which may be relevant for solving prior problematic impasses" (p. 114). Numerous encounters with various environmental stimuli provide needed opportunity for exposure to relevant new information, which might then trigger the access of failure indices previously associated with the problematic impasse. Once relevant information has been encountered and failure indices accessed the subconscious processes interprets and assimilates this information "into the original mental representation of the problem" (Seifert et al., 1995, p. 118). Similar to fitting puzzle pieces together the problem may need restructuring to accommodate the new information. The moment when the appropriate piece is fitted into place, an automatic realization of the problem's resolution enters full consciousness. The incubation phase culminates when the solution to the problem is comprehended through the flash of insight.

Phase Three - Illumination

"The delightful "Aha!" experience colored by an increased physiological arousal level with positive affective overtones, which further facilitates opportunistic assimilation and long-term memory consolidation" (Seifert et al., 1995, p. 118) enhances the illumination experience as "the emphasis is on suddenness and surprise, solution and correctness" (Gruber, 1995, p. 397). The proposed positive reinforcing affects of insight, as motivation to seek future insights and as "nature's way of patting us on the back" (Ippolito & Tweeney, 1995) for extended problem solving effort has been previously

discussed.

The notion or issue of a "true or correct" insight verses a false insight is an important concept to consider (Gruber, 1995). Establishing the correctness of an insightful solution or idea is important when solving problems. Therefore the next and final stage of the problem solving process includes the *verification*, the further check or test out of the newly received revelation.

Phase Four- Verification

An insight experience "is generally accompanied by a feeling of certainty that one's new idea is true or correct" (Smith & Ward, 1999, p. 100). Gruber (1995) noted that "ordinarily, we would not speak of a false insight, although we might speak of a misleading feeling of insight" (p. 398). Pierce (1999) also noted that "an insight experience does not guarantee a correct solution or real insight. One may restructure or recombine elements into a unique configuration that provides the experience of suddenness and surprise but is nevertheless an incorrect solution to the problem" (p. 110). False or incorrect insights "tend to be overlooked in the discovery literature because usually they are rejected soon after generation. But most scientists will admit that some of the their most promising insights have failed to stand up under scrutiny" (Langley & Jones, 1988, p. 198). Creative and novel ideas often "require a period of development during which they are 'fleshed out', explored, and improved in incremental ways that expand the originally generated ideas" (Smith & Ward, 1999, p. 104).

Expertise and hard work may increase the proportion of true insights as noted by Langley and Jones (1988). "The ratio of false insights to useful ones will depend on the

indexing scheme and the particular connections formed, and this will depend on the problem solver's level of expertise and the effort spent during preparation" (Langely & Jones, 1988, p. 199).

Csikszentmihalyi and Sawyer (1995) asserted that a fuller and more accurate theory of creative insight could be developed through the exploration of "individual differences in the experience of the creative process - such as the dialectic process between hard work and insight, or continuous periods that combine work, insight, and elaboration" (p. 359).

Individual Differences

At the broadest level Dominowski and Dallob (1995) suggested that "all instances of insightful behavior are procedurally identical - that is, restructuring or reorganization of the problem situation leads to solution" (p. 57). Yet, as Policastro (1995) noted "there are individual differences, and various individuals might not follow the same kind of creative process (Gardner, 1993a; Weber & Perkins, 1992)" (p. 101). "Some individuals process information in a manner that allows them to generate gaps, assumptions, and creative opportunities" (Runco, 1993, p. 348). Sensing gaps, problems, and missing elements, can be the catalyst that leads one to an insight experience. Unfortunately not all have journeyed this path, according to Simonton (1995) "not everyone has insights; some unfortunates are lucky if they have one solid revelation in their entire lifetime. Others overflow with so many novel ideas that only death turns off the spigot" (p. 479).

Regarding the latter, Sternberg and Lubart (1995) offered this explanation, "the insightful person is perhaps better at reorganizing or reformulating problems, at finding

shortcuts to problem solving, or at breaking through mental blocks" (p. 535). Sternberg and Lubart (1995) also acknowledged that "more insightful people are better endowed with certain abilities" (p. 535) additionally creative insight "requires a specific attitude in addition to cognitive abilities.... one of searching for the unexpected, the novel, and for what others might label as bizarre" (p. 536). Straying from convention, taking risks, and confronting dissonance can be complicated and challenging, as it "often means the articulation of the unknown that the dissonance prompted us to resolve.... emotions, experiences, attitudes, and beliefs all play a part in confrontation" (Murray, 1995, p. 23).

Barron (1988) "listed just six 'ingredients' of creativity that intermix affective and cognitive traits: 1. Recognizing patterns, 2. Making connections, 3. Taking risks, 4. Challenging assumptions, 5. Taking advantage of chance, and 6. Seeing in new ways" (Davis, 1999, p. 95). There are many more influences that cause individuals to differ enormously from one to another in terms of their discussion making and creative cognitive processes (e.g., personality traits, biographical traits, experience, cognitive abilities, and cognitive style).

Martinsen and Kaufman (1999) noted that in classical experimental research on human cognition such "individual differences generally have been perceived as irrelevant, or as a 'nuisance' in terms of error variance" (p. 275). They proposed that to investigate whether people solve problems creatively in predictively different ways, the use of an individual differences approach may help to disentangle the cognitive processes that underlie the relations between cognitive style, creative problem solving and the production of insight. They further noted that the inclusion of such data "adds to our knowledge about human cognition beyond classical experimental research and beyond

variables associated with academic intelligence" (p. 275).

An individual differences approach has been used more frequently in identifying the processes associated with intelligence, Schooler and Melcher (1995) have noted that "relatively little research has used this approach to identify the processes associated with insight problem solving" (p. 119). Yet, the recent research of Ansburg's (2000), appeared to follow suggestions noted by Schooler and Melcher (1995), who proposed the use of an individual-differences approach as a first step in identifying the component processes and associated skills involved in solving insight problems. Her research focused on determining which general thinking skills might underlie the insightful problem solving process. Findings from her study "were consistent with the notion that the abilities to apprehend relations and fluency of thought are involved in insightful problems solving" (Ansburg, 2000, p. 143).

Policastro (1999) noted potential individual differences related to cognitive style in her exploration of highly creative individuals. She emphasized that even when two experts in the same domain "are endowed with a rich, well-organized, and automatically accessible knowledge base, which allows them to perform intuitively and effectively" (p. 91) they do not perform the same in terms of generating creative intuition. She suggested that each might "be responding to a different set of subjectively constructed parameters" (p. 91) and proposed these parameters were specifically related to individual differences in cognitive style, which influences the way in which information is encoded, organized, and retrieved.

Martinsen and Kaufmann (1999) proposed "the hypothesis that cognitive styles do indeed have a function in creativity seems to draw considerable support" (p. 281).

Additionally theories of style that suggest propensities for reflective thought processes such as; problem recognition, enumeration of possibilities, reasoning, revision, and evaluation warrant examination with respect to their relevance to creativity (Martinsen & Kaufmann, 1999). Martinsen and Kaufmann (1999) further suggested that "in order to yield more precise information on the relation between style and creativity.... stylistic influences on various subcomponents of creativity (like insight, analogical reasoning, remote associations, ideational productivity, convergent thinking, and so on)" (p. 281) offer potential areas in which to integrate creativity and cognitive style research.

Metacognition and Training for Insight Problem Solving

Dominowski and Dallob (1995) encouraged the investigation of more complex and extensive training using *metacognition* as "a possible bases for broadly applicable skill " (p. 58) to promote insightful problem solving. Metacognition "refers to a person's awareness of his or her own cognitive processes... the planning, monitoring, and evaluation of solution processes" (Dominowski & Dallob, 1995, p. 58). Essentially the problem solver thinks about how they think. Emphasis on metacognition has been found to facilitate problem solving as the problem solver learns to focus their attention on becoming more aware of the processes and techniques they use to solve problems. Ansburg and Dominowski "found that requiring solvers to monitor their work improves insightful problem solving (Dallob & Dominowski, 1992)" (Ansburg & Dominowski, 2000, p. 42).

The recent works of Ansburg and Dominowski (2000) provided some promising evidence which supports the "notion that insightful problem solving can indeed be

conceptualized as a trainable, general thinking skill" (p. 48). They further suggested that the training techniques examined in their research "could be applied to situations in which the encouragement of critical and creative thinking are the goals" (p. 50). The three-component method for training domain-general skills proposed as useful to insight problem solving, was devised through the review of skill acquisition literature and analysis of previous research attempts to facilitate insightful problem solving. Ansburg and Dominowski (2002) noted the following considerations:

First, solvers should be provided with advance strategic instructions that (a) are procedurally relevant, (b) point to the procedural similarities among problems, and (c) emphasize the usefulness of the procedures across the problems. Second, practice on procedurally identical problems whose surface structures differ would serve to teach relevant procedural knowledge, as well as to help to decontextualize the general principles....Third, the training should make explicit the underlying similarity between practice problems; this goal can be met by employing problem comparison. (p. 34)

They argued perhaps the most important result of the research findings was that "training procedures taught subjects how to process problems for underlying structure" (Ansburg & Dominowski, 2000, p. 50). "First, the strategic instructions showed an immediate positive impact on solution rates. Second, the elevated performance level that resulted from exposure to training remained relatively stable across practice trials and transfer tasks" (pp. 48-49).

The training engaged metacognitive processes of planning, monitoring and evaluating. The strategic instructions served as an advanced organizer, trained subjects

monitored for improper problem representation, and were cognizant of an impasse when it had been reached. They could then search for different representations. "Because the training techniques examined in this study are not tied to a particular domain, it is expected that they would be useful tools in promoting the development and transfer of other general thinking skills" (Ansburg & Dominowski, 2000, p. 50). They further suggest future research regarding the implication of this type of training on classroom instruction.

Metastrategies or higher-order strategies that are executed in planning, monitoring, and selection of task-specific strategies are considered by a number of researchers to be more strongly associated with cognitive style, as opposed to task-specific strategies (Martinsen & Kaufmann, 1999). "A task-specific strategy can be seen as, for example, a relatively specific procedure that can be used to solve a particular class of problem solving tasks" (Martinsen & Kaufmann, 1999, p. 274). An implication of this distinction "is that styles should be more consistent across tasks and over time than task-specific cognitive strategies. This issue has, however, received relatively little attention in practical research (Martinsen & Kaufmann, 1999, p. 274). They also noted "that style should be seen as a disposition more than as situational preference" (p. 274). So in terms of experience this would seem to imply task-specific strategies might be applied with some flexibility relative to a style disposition rather than to the situational preference.

The Future and Insight

Since the early days of Gestalt psychology there has been significant increases in basic knowledge and research tools. Additional "paths have opened onto some of the

most exciting avenues of contemporary research in cognition, including the study of schemas, mental models, expertise, teaching of problem solving, and analogical thinking" (Mayer, 1995, p. 27). There are many ways to explore insight in the future both empirically and non-empirically.

Rodriguez-Fernandez (1996) explored the question "Is 'sudden illumination' the result of the activation of a creative center at the human brain" (p. 287). He noted "It has been hypothesized that language and even consciousness may have a center at the human brain" (p. 300) as such, he suggested there is circumstantial evidence that a creative thinking center may also exist. Once this center is localized, "anatomical studies can be carried out in specially creative subjects" (p. 300), through the use of MRI and/or X-ray computer tomography. To date the neuroimaging techniques "lack the necessary temporal resolution to distinguish the sequential activation of areas in the moment close to sudden illumination" (p. 300).

However, neuroimaging advances in the future, and information obtained from different levels of analysis...may contribute to the verification of the existence of this center. The identification of the center and, further in future, the identification of the molecular changes that take place in the human brain during a creative process, is an effort that will open new avenues to human creativity. (Rodriguez-Fernandez, 1996, p. 300)

Regarding human evolution and creativity, from a philosophical perspective Smith and Ward (1999) reflected on the future of insightful minds and shared the following hope filled sentiments:

As our civilization matures, a period of stability throughout the world could

provide the safety and protection essential to curiosity, creative exploration, and discovery. Another advance could be a more deliberate and systematic use of the intrinsic rewards of insight. That is, the joy and inspiration that arise from discovery and creation are personally rewarding experiences, a source of self-actualization. If children learn to seek these intrinsic rewards, the result will be adults whose creative contributions to society will come as a by-product of personally fulfilling activities. (p. 104)

Summary

This chapter began with a review of concepts related to routine and nonroutine problem solving, Gestalt Psychology, and differing perspectives on insight. The chapter continued with definitions of insights, the proposed positive affects of the insight experience, and a brief review of historical insightful discoveries, including a discussion of insight as a part of a larger problem solving process. The chapter further discussed individual differences, metacognition and cognitive style, and concluded with a glimpse of proposed future considerations for insight.

The next chapter outlines methods, procedures and materials used in this research to explore individual differences in cognitive style preferences and experience, on insight problem solving ability.

Chapter Three: Method and Procedures for Conducting the Study

Introduction

The purpose of this chapter is to outline methods and procedures used to conduct this study. First a description of participants will be reviewed. Second, materials used for data collection are discussed, which includes two measures, FourSight (v 6.1) and the Kirton Adaption-Innovation Inventory (KAI), a biographical experience questionnaire and 8 insight problems. Third, procedures for data collection and analysis is recounted. Finally, the chapter concludes with a summary and a preview of Chapter Four.

Participants

One hundred and forty-seven participants (65 male and 82 female) aged 18-57 volunteered to take part in this study. This sample included 58 graduate and 89 undergraduate students enrolled in the fall 2002 semester at the Buffalo State, State University of New York. Participants consisted of students enrolled six different courses, five offered through the Department of Creative Studies and one through the Business Department.

Materials

FourSight

The first of the two measures utilized in this study was FourSight, a paper and

pencil self-assessment inventory, "designed to identify preferences in terms of the major operations with Creative Problem Solving" (Puccio, 1999, p. 171). Participants responded to 36 items (nine statements for each of the four scales) by indicating how descriptive that statement is of the subject. (See Appendix C: FourSight Inventory for sample questions). Each statement is descriptive of "activities associated with each stage of the Creative Problem Solving Model" (Puccio, 1999, p. 173). The 5-point response scale range is from "Not like me at all" to "Very much like me." (Puccio, 2001, p. 2). Results of the measure identified participants' cognitive style preference in terms of each of the following four style preferences, Clarifier, Ideator, Developer, and Implementer.

A Clarifier likes to spend time clarifying a problem, enjoys the process of gathering information, data and details, to ensure the right problem is targeted. An Ideator likes to generate broad concepts and ideas, tends to think in abstract and global ways, enjoys stretching the imagination and is a flexible, visionary type of thinker. A Developer likes to spend time analyzing and evaluating potential solutions by examining strengths and weakness of a solution prior to implementation to ensure success. An Implementer likes to bring ideas to fruition by transforming rough ideas into tangible outcomes (Puccio, 2002). Two-way, three-way and four-way combinations of the four preferences yield an additional 11 profile style preferences for the creative problem solving process.

The internal consistency of FourSight as assessed through using Cronbach Alpha Coefficients for this study ranged from .73 to .82 (n=147), see Table 3.1.

Table 3.1
Cronbach Alpha, Measure of Internal Consistency
for FourSight Inventory Reliability Analysis

Style Preferences	Mean	SD	Items	N	Alpha
Clarifier	31.7823	5.9513	9	147	0.7955
Ideator	32.0404	6.8795	9	147	0.8190
Developer	29.7211	6.6506	9	147	0.8192
Implementer	32.1837	5.7968	9	147	0.7303

The Kirton Adaption-Innovation Inventory (KAI)

The second measure utilized in this study was the Kirton Adaption-Innovation Inventory (KAI) designed to measure preferred thinking style differences, on a normally distributed continuum. The range is from high Adaptor to high Innovator, which defines cognitive styles relative to behavior change strategies as expressed in problem solving, decision making and creativity. The "more adaptive prefer their problems to be associated with more structure. ...The more innovative prefer solving problems with less structure" (Kirton, 1999a, p. 2).

The KAI, also a paper and pencil self-assessment inventory, contained 33 items descriptive of a particular image. Participants responded by indicating on a 5 point scale range, how difficult or easy it would be for the subject to maintain the image presented in each statement, consistently over a long period of time. (See Appendix D: Kirton Adaption-Innovation Inventory for sample questions). Results of the measure identified participants' cognitive style preference by numerically locating the total score on the Adaption-Innovation continuum, further the total score breaks down into three inter-

related sub scores, Sufficiency of Originality (SO), Efficiency (E), and Rule/Group Conformity (RGC).

Sufficiency of Originality relates to one's method of idea generation. Efficiency relates to one's method of problem solving and Rule/Group Conformity relates to one's style of relating to structure, both impersonal and personal (Kirton, 1999a, p. 6).

Eight studies across varied populations (8 countries; two languages) involving over 3000 participants, yielded internal reliabilities for the factor traits, SO, E, and R, with coefficients derived between .73 and .87 (Kirton, 1999b, p. 88).

Biographical Experience Questionnaire

The biographical experience questionnaire was designed to gather basic descriptive data, including number of creative problem solving courses taken and an assessment of experience on six problem-solving related activities. The assessment of experience required participants to rate their level of experience on 0-3 scale; 0 represented lack of experience, 3 represents frequent in-depth experience on the six activities. The following six activities, considered particularly relevant for insight problem solving were adapted from Martinsen's (1993) research: "(a) wood-working and carpentry, (b) 'mind stretchers,' (c) drawing and painting, (d) jig-saw puzzles, (e) technical drawing, (f) mathematical and scientific problem solving" (p. 439). (See Appendix E: Biographical Data Questionnaire for additional information). The sum was used in subsequent correlational and regression analysis.

Insight Problems

A booklet containing 4 verbal and 4 visual type insight problems was developed for use in this study. (See Appendices G through N for illustration of problems utilized in current study). A rating scale of 0-1 was applied to evaluate solutions. Incorrect or no answer was given 0 points and a correct answer received 1 point. An exception to this rating scale was implemented when rating the Farm problem due a discrepancy in the interpretation of the problem. The Farm problem refers to an inverted L-shaped form (a visual type insight problem) and asked, "How can you divide this piece of land into four equally shaped pieces" (Weisberg, R. W., 1995, p. 186). The discrepancy in interpretation is that it can be argued that four equally shaped pieces does not have the same meaning as four pieces equal in shape and size. One point was applied to the answer matching the original expected solution and 0.5 point was applied to several other plausible solutions, see Appendix I for additional information.

Written instructions included in the booklet were adapted from previous research as utilized by Ansburg and Dominowski (2000, p. 60). The strategic instructions were developed "to directly communicate the underlying principles required for successful completion of the task" (Ansburg & Dominowski, 2000, p. 40). It was thought that the instructions would serve as guide by providing a "framework against which the solver can plan and monitor their problem solving activities (English, 1992). For example the strategic instructions may have prompted suspicion about the first response that led to evaluations of the responses" (Ansburg & Dominowski, 2000, p. 42). (See Appendix F: Strategic Instructions for additional information).

Procedure

The procedure for gathering data was implemented within the 75-minute class session for each of the six classes tested. A general format for data collection was followed for each group, although the sequence of collection varied with four different combinations (i.e., rotating the order of verbal and visual problems, with the rotation of measures administered).

Prior to data collection a brief review of the activities for data collection was given, all students were then informed that participation in the study was voluntary. Volunteers received an envelope containing all testing material, a pencil, and a pen.

Participants were asked to read and sign the consent form, then to fill in the data required by biographical experience questionnaire. The use of the 0-3 rating scale specific to the assessment of experience was explained out loud and any questions were answered.

The format for completing the insight booklet included the researcher reading to the participants generally accepted characteristics, as noted by Schooler, Ohlsson, and Brook (1993), associated with solving insight problem as follows:

(a) is well within the competence of the average subject; (b) has a high probability of leading to an impasse, that is a state in which the subject does not know what to do next; and (c) has a high probability of rewarding sustained effort with an "Aha" experience in which the impasse is suddenly broken and insight into the solution is rapidly attained. (p. 168)

Participants then individually read instructions given within the booklet (see Appendix F). The researcher further illustrated the concept of an insight problem visually by using

an overhead projector to share two sample insight problems similar to those included within the booklet. Subjects were informed of the timing of the problems, 3 minutes each for verbal insight problems and 5 minutes each for visual insight problem. Additional verbal instruction given by the researcher were as follows: (a) should you finish before the time is up, look your answers over again; (b) be sure to answer the yes/no question at the bottom of the page; (c) you can go back to correct an answer, but, do not look ahead to the next problem, please be patient and wait until we move as a group on to the next problem; and (d) please note this is not an intelligence test, so relax, have fun, just do the best you can. Item (d) was added with "the intent to reduce extrinsic motivational influences of expectancy, which can be found to be detrimental to creativity" (Martinsen, 1993, p. 440).

Participants were instructed to remove the tab from the edge of the booklet and to begin work on the first problem. When the allotted time was up, participants were asked to stop working on that problem, be sure to answer the yes/no question at the bottom of the page, then to turn the page and begin work on the next insight problem. This pattern was repeated for all eight insight problems, upon completion of the last problem, booklets were returned to the envelope.

The two measures were administered in rotating order among groups, (i.e., some groups completed FourSight first, other groups completed insight problems first), a brief description of the measure was given and instructions were read out loud, as well as illustrated again through the use of an overhead projector, again any questions were answered. The participants were given as much time as needed to complete each inventory. Completed inventories were also returned to the envelope, materials were

collected and scored.

All students were invited to debriefing sessions on the KAI and FourSight instruments. Three dates were offered for their convenience. The debriefing sessions contained information on the history, theory and description of cognitive style preferences as measured by the two instruments. Students received written feedback for both measures and student questions were answered.

Qualitative data collected were then analyzed to assess relationship of cognitive style, cognitive preferences, and experience to insight problem solving ability. Mean and standard deviation of main variables were calculated. Degree of relationship between the main variables was also analyzed using Pearson product-moment coefficient. Several multiple regression procedures using four models were used to analyze the four FourSight style preferences, the three sub-scores of the KAI, experience, and their joint effect on problem solving scores, using total insight scores, verbal scores, and visual scores as the dependent variable.

Summary

This chapter reviewed the methods and procedures used to conduct this study. Participants, materials, and procedures for data collection and analysis were recounted herein. The next chapter will present the results of statistical analysis of data gathered by this study.

Chapter Four: Presentation and Analysis of Data

Introduction

The purpose of this chapter is to present the results of the statistical analysis of quantitative data gathered for this study. Data were analyzed for the degree of relationship between the main variables using Pearson product-moment coefficient. Scores for the main variables included, FourSight four style preferences, KAI total score and the three sub-scores, total score for all 8 insight problems with sub-scores for verbal and visual insight problems, total score for assessment of experience and total number of creative problem solving courses. Additionally Pearson product-moment coefficient analysis was used to measure relationships of gender and major to insight problem scores. Multiple regression procedures were used to analyze the four FourSight style preferences, experience, and their joint effect on problem solving scores, using total insight scores, verbal scores, and visual scores as the dependent variable. Multiple regression procedures were also applied to analyze the three sub-scores of the KAI, experience, and their joint effect on problem solving scores, using the same dependent variables.

Results

A summary of the mean and standard deviation calculations, for the main variables are shown in Table 4.1. A total of 147 subjects (65 male and 82 female) participated in this study, 58 graduate students and 89 undergraduate; average age of

students was 27 years. Within this sample 86% of the participants ($n = 127$) had either taken, or were currently enrolled in creative problem solving courses and/or creativity related courses. The average number of creativity courses taken by these participants (i.e., previously or currently) was 1.86 with a standard deviation of 1.11 ($n = 127$). Data collected on participants' major course of study were coded 1 for Creative Studies majors or 2 respectively for all other majors and expressed in terms of percentages are as follows: Creative Studies majors 14.96% ($n = 22$) and other majors 83.67% ($n = 123$), 1.37% ($n = 2$) did not specify a major course of study.

The mean and standard deviation for total score for the experience assessment questionnaire was 8.88 and 2.8 ($n = 146$), and was slightly higher to that noted in Martinsen's (1993) research, which was 6.18 and 3.40 ($n = 87$), respectively.

A total of 147 participants completed FourSight, of the four style preferences the Developer had the lowest mean of 29.72 ($n = 147$), and the Implementer had the highest mean of 32.78 ($n = 147$). Mean scores for SO, EFF, RGC, and KAI total as outlined in the KAI Manual 3rd Edition 1999 Table 15 Factor Trait Norms, ($N = 562$) are as follows; SO 40.78 ($SD = 8.89$), EFF 18.82 ($SD = 5.59$), RGC 35.39 ($SD = 8.56$), and KAI total 94.99 ($SD = 17.90$). The mean and standard deviation for the KAI total for this study as noted in Table 4.1 were 103.08 and 16.14 respectively, placing the total mean score 8.09 points to the right on the theoretical continuum in the direction of innovator preference. The largest contribution towards the increased KAI total was attributable to the higher SO subscale, a preference for increased proliferation of original ideas.

A mean score of 1.48 for verbal insight problems was slightly higher than the mean score for visual insight problems 1.24. The verbal insight problems to visual

insight correlation yielded a positive relationship ($r = .264$, $p = \leq .01$).

Table 4.1

Mean and Standard Deviation for Main Variables

Variable	N	Mean	SD	Min.	Max.
Descriptive					
Age	144	27.17	9.40	18.00	57.00
CRS Courses	127	1.86	1.11	1.00	5.00
Experience	146	8.66	2.80	1.00	15.00
FourSight					
Clarifier	147	31.78	5.95	19.00	45.00
Ideator	147	32.04	6.88	13.00	44.00
Developer	147	29.72	6.67	13.00	44.00
Implementer	147	32.18	5.80	19.00	44.00
Kirton Adaption-Innovation Inventory					
SO	147	46.05	7.24	28.00	61.00
EFF	147	19.20	5.09	7.00	33.00
RGC	147	37.83	8.67	16.00	60.00
KAI Total	147	103.08	16.14	60.00	150.00
Insight Problems					
Verbal Total	147	1.48	1.09	0.00	4.00
Visual Total	147	1.24	0.89	0.00	4.00
Insight Total	147	2.72	1.58	0.00	7.00

Table 4.2 summarizes Pearson-product moment coefficients for the three main variables, gender, CRS courses, experience and the four FourSight style preferences. In Table 4.2, 11 significant relationships were produced. The first two significant relationships noted were negative relationships between Gender and the Clarifier preference ($r = -.164$, $p = \leq .05$) and Gender to Experience ($r = -.180$, $p = \leq .05$). The negative relationship indicates that males tended to have higher scores on the Clarifier style preference and Experience. Next, when you look at Courses taken, or currently enrolled in, there were no significant relationships between the four preferences and this variable. Experience yielded three significant relationships to four of the FourSight style

preferences, yet was not related to the number of Courses taken. All three of the relationships between Experience and the FourSight preferences were positive with a moderately strong relationship found for Ideator to Experience ($r = .309, p \leq .01$). Within the FourSight scales all relationships were positive. The strongest of these relationships was found with Clarifier to Developer ($r = .717, p \leq .01$). Three strong to moderate correlations were found with Ideator to Clarifier ($r = .461, p \leq .01$), Developer to Ideator ($r = .577, p \leq .01$), and Developer to Implementer ($r = .473, p \leq .01$). Two moderate to weak correlations were noted with Implementer to Clarifier ($r = .303, p \leq .01$) and Ideator to Implementer ($r = .305, p \leq .01$). The indication of these positive relationships implies that as a particular style preference score increased, there is a tendency for the remaining three preference scores to increase in a corresponding manner.

Table 4.2**FourSight Correlations to Main Variables**

		Courses	Experience	Clarifier	Ideator	Developer	Implementer
Gender	<i>r</i>	-.019	-.180 *	-.164 *	-.055	-.089	.066
	<i>n</i>	147	146	147	147	147	147
CRS Courses	<i>r</i>		-.040	-.123	.096	-.090	-.138
	<i>n</i>		127	127	127	127	127
Experience	<i>r</i>			.118	.309 **	.245 **	.181 *
	<i>n</i>			146	146	146	146
Clarifier	<i>r</i>				.461 **	.717 **	.303 **
	<i>n</i>				147	147	147
Ideator	<i>r</i>					.577 **	.305 **
	<i>n</i>					147	147
Developer	<i>r</i>						.473 **
	<i>n</i>						147

* $p \leq .05$, ** $p \leq .01$

Tables 4.3 summarized Pearson-product moment coefficients for the three main variables, gender, CRS courses, and experience to KAI subscales and to KAI total. There

were no significant relationships found for the first two variables, gender and courses

Table 4.3

KAI Correlations to Main Variables

		SO	EFF	RGC	KAI Total
Gender	<i>r</i> □	-.062	-.092	-.046	-.081
	<i>n</i> □	147	147	147	147
CRS Courses	<i>r</i> □	.010	.086	.073	.070
	<i>n</i> □	127	127	127	127
Experience	<i>r</i> □	.213 **	-.069	.114	.135
	<i>n</i> □	146	146	146	146
SO	<i>r</i> □		.113	.474 **	.739 **
	<i>n</i> □		147	147	147
EFF	<i>r</i> □			.442 **	.604 **
	<i>n</i> □			147	147
RGC	<i>r</i> □				.890 **
	<i>n</i> □				147

* $p \leq .05$, ** $p \leq .01$

taken to the KAI subscales or to total KAI. One positive relationship was found between Experience and the KAI subscales, and that was found to be significant with Sufficiency for Originality (SO), ($r = .213$, $p \leq .01$). This positive relationship indicates that there was a corresponding increase in Experience when the SO score became more innovative. In other words, people who have a higher score on Sufficiency of Originality report having greater experience with activities relevant to insight problems. Of the three coefficients that looked at relationships among the KAI subscales two out of the three were found to be significant, both relationships are positive and are moderately strong, RGC to SO ($r = .474$, $p \leq .01$) and RGC to EFF ($r = .442$, $p \leq .01$). This would indicate that as RGC scores increased towards the innovative preference for less structure there is a corresponding increase in SO preference towards proliferation of ideas (being less confined by structure). Also as RGC scores increased there is a corresponding increase in EFF scores towards more innovative preference, shedding detail and "working in less

consensually agreed structure" (Kirton, 1999, p. 44). The lack of relationship of SO to EFF indicates one's style preference to "produce spontaneously sufficiency of ideas" (Kirton, 1999, p. 44) does not correlate with one's preference for thoroughness or attention to detail.

The next Table 4.4 summarizes coefficient correlations for the two style measures, FourSight and the KAI. Among the 16 correlations, 10 relationships were found to be significant. The total KAI score was significantly related to the Ideator preference ($r = .587, p \leq .01$); which is a strong relationship, indicating as scores become more innovative on the KAI the scores on Ideator tend to go up, this is consistent with past findings (Puccio, 1999). "This is theoretically consistent since the innovator likes to toy with ideas" (Puccio, 1999, p. 176). Ideator also showed strong relationships with SO ($r = .620, p \leq .01$) and RGC ($r = .465, p \leq .01$) subscales. These two relationships were positive. Again this indicates that as the preference for ideation increases; the SO score or preference towards proliferation of ideas, as well as, the RGC score or preference for less structure increase as well. The weakest significant relationship was found with Ideator and EFF ($r = .188, p \leq .05$). This positive relationship indicated that as the preference for ideation increased, the EFF score also increased toward the innovative preference, "paying less attention to meticulous detail and thoroughness" (Kirton, 1999, p. 45).

Correlations of Sufficiency of Originality (SO) to the remaining three FourSight style preferences, yielded three significant relationships, Clarifier to SO ($r = .253, p \leq .01$), Developer to SO ($r = .361, p \leq .01$), and Implementer to SO ($r = .336, p \leq .01$). This would indicate that as any one of the FourSight style preference scores increased there was a tendency for SO scores to also increase in the direction of a more innovative

preference.

Table 4.4

KAI and FourSight Coorelation of Measures

		SO	EFF	RGC	KAI Total
Clarifier	<i>r</i>	.253 **	-.201 *	.017	.059
	<i>n</i>	147	147	147	147
Ideator	<i>r</i>	.620 **	.188 *	.465 **	.587 **
	<i>n</i>	147	147	147	147
Developer	<i>r</i>	.361 **	-.259 **	.064	.115
	<i>n</i>	147	147	147	147
Implementer	<i>r</i>	.336 **	-.249 **	.053	.100
	<i>n</i>	147	147	147	147

* $p < .05$, ** = $p < .01$

In contrast to these positive relationships, three negative relationships were found, which were moderate to weak with the Efficiency (EFF) subscale. The strongest of these relationships was found with Developer to EFF ($r = -.259$, $p \leq .01$), which indicates that as the EFF score decreased, moving in the direction of adaptive preference, the Developer score increased. In other words, a decreased EFF score means an increased preference for thoroughness, attention to detail with precision, reliability and efficiency. An increase in the Developer score is indicative of having increased preference for using methodical and analytical thinking processes. Similar relationships were found for Clarifier to EFF ($r = -.201$, $p \leq .05$) and Implementer to EFF ($r = -.249$, $p \leq .01$), which makes sense in that Clarifiers like to examine details, "researching, investigating and digging for information that will help them better understand the crux of an issue" (Puccio, 2002, p. 6). Implementers like to "focus on 'workable' ideas... enjoy giving structure to ideas so they become a reality" (Puccio, 2002, p. 7), to this end Implementers also utilize analytical thinking processes to determine how to take action on ideas.

The next analysis focused on the relationship between the Insight Problems and the Main Variables, FourSight, and the KAI; this information was summarized into tables 4.5, 4.6, and 4.7.

Table 4.5
Insight Problems Correlations to Main Variables

		Verbal Total	Visual Total	Insight Total
Major	<i>r</i>	-.037	.024	-.012
	<i>n</i>	145	145	145
Gender	<i>r</i>	-.171 *	-.199 *	-.230 **
	<i>n</i>	147	147	147
CRS Courses	<i>r</i>	.081	-.090	.003
	<i>n</i>	127	127	127
Experience	<i>r</i>	.212 *	.241 **	.283 **
	<i>n</i>	146	146	146

* = $p \leq .05$, ** = $p \leq .01$

In Table 4.5 Insight Problem Correlations to Main Variables shows that of the twelve possible relationships six were significant. What is notable is that the number of Creativity Courses or Major taken did not relate at all. The correlation of Gender to Verbal ($r = -.171$, $p \leq .05$) and Visual Insight Problems ($r = -.199$, $p \leq .05$), as well as, Insight Total yielded significant relationships. These relationships were negative and somewhat weak. As males were coded 1 and females coded 2, the results indicated that males tended to do better than females when solving insight problems, which is also similar to results noted in Martinsen research. The correlation of Experience to Verbal ($r = .212$, $p \leq .05$) and Visual Insight Problems ($r = .241$, $p \leq .01$), as well as Insight Total, also yielded significant relationships. These relationships were positive, and are weak to moderate, which indicated that the higher the participants rated their experience in terms of the items included in the questionnaire, the more successful they were in solving

insight problems. (See Appendix E for specific items included in biographical questionnaire).

Table 4.6 shows the relationships between the creativity style preferences, as measured by FourSight, and the Insight Problems. Two of the four FourSight style preferences showed weak yet significant relationships to Insight Total score. Both relationships were positive, that of Ideator to Total Score ($r = .225$, $p \leq .01$) and Developer to Total Insight score ($r = .193$, $p \leq .05$). These positive relationships indicated the higher the score for the Ideator and/or Developer style preference the more likely participants were able to successfully solve insight problems. This relationship was also found to be applicable across both Ideator to Verbal ($r = .168$, $p \leq .05$) and Ideator to Visual ($r = .194$, $p \leq .05$) Insight problems. There were no correlations noted between Implementer to insight problems or, Clarifier to insight problems.

Table 4.6

Insight Problems Correlations to FourSight Measure

		Verbal Total	Visual Total	Insight Total
Clarifier	<i>r</i>	.125	.053	.116
	<i>n</i>	147	147	147
Ideator	<i>r</i>	.168 *	.194 *	.225 **
	<i>n</i>	147	147	147
Developer	<i>r</i>	.150	.158	.193 *
	<i>n</i>	147	147	147
Implementer	<i>r</i>	.120	-.019	.072
	<i>n</i>	147	147	147

* = $p \leq .05$, ** = $p \leq .01$

Table 4.7 summarizes the correlation coefficient between preferred creativity style, as measured by the KAI, and Insight Problems. In this table 12 potential relationships were noted, none were found to be significant. This would indicate no

significant relationships were generated between thinking style preferences and the ability to solve insight problems. It is interesting to note that the relationship of Sufficiency of Originality (SO) to Insight Total approached significance ($p = .065$), similar to Ideator, in that as the preference for ideation and the proliferation of ideas increased, scores for insight problem solving tended to increase. The relationship between verbal and visual insight problems was also examined, a moderate relationship of ($r = .264$, $p \leq .01$) was noted, similar findings were reported by Martinsen.

Table 4.7
Insight Problems Correlations to KAI Measure

		Verbal Total	Visual Total	Insight Total
SO	<i>r</i>	.133	.108	.153
	<i>n</i>	147	147	147
EFF	<i>r</i>	.044	.042	.054
	<i>n</i>	147	147	147
RGC	<i>r</i>	.033	.123	.091
	<i>n</i>	147	147	147
KAI Total	<i>r</i>	.091	.128	.135
	<i>n</i>	147	147	147

* = $p \leq .05$, ** = $p \leq .01$

The next two tables 4.8 and 4.9 summarized the results of multiple regression analyses that were conducted to further examine the extent to which cognitive style predicted success in solving insight problems. Since past research (Martinsen, 1993, 1995) showed that experience was related to success in solving insight problems and our correlations showed a high degree of relationship, experience was included in this analysis. Specifically multiple regression procedures were used to analyze the four FourSight style preferences with experience, and their joint effect on problem solving scores, having used the total insight scores, verbal scores, and visual scores as the

dependent variable. These same procedures were then applied to analyze the three subscales of the KAI with experience and their joint effect on the very same dependent variables. As with Martensin's data, all data were mean-centered to reduce problems of multicollinearity.

Four models were created for the regression analysis. The first model was based on experience alone. The second model included the FourSight scales in addition to experience. In the third model experience was squared to see if there was a curvilinear relationship, similar to that found in Martinsen's research. The final model included experience, the four FourSight preferences, experience squared, and the joint effect of the experience with each of the four FourSight preferences.

When one examines the results shown in Table 4.8, the only beta that is significant is that of experience. No matter what model is put into the regression analysis, experience is the variable that predicts success in solving the insight problems. The Ideator beta was not significant, so where we had previously found a significant relation between Ideator and Insight Total score ($r = .225, p \leq .01$) this effect disappeared when the analysis controlled for experience, as well as the other FourSight preferences. When considering the Ideator to Experience relationship ($r = .309, p \leq .01$), the correlation was noted as moderately strong, which may imply that perhaps Ideators tend to have more experience with activities related to enhancing insight problem solving abilities. It may in fact be the impact of this experience, which enhanced the Ideator's ability to solve insight problems, rather than style preference itself.

Table 4.8
The Regression Analysis of Coefficients
of Total Insight Problem Scores to FourSight

		Standard Coefficient		
Model		Beta	t	Sig.
1	Experience	0.283	3.544	0.001
2	Experience	0.230	2.708	0.008
	Clarifier	-0.053	-0.458	0.648
	Ideator	0.136	1.352	0.179
	Developer	0.116	0.869	0.386
	Implementer	-0.059	-0.654	0.514
3	Experience	0.224	2.642	0.009
	Clarifier	-0.070	-0.604	0.547
	Ideator	0.152	1.494	0.138
	Developer	0.123	0.923	0.358
	Implementer	-0.068	-0.742	0.459
	Experience x Experience	-0.095	-1.167	0.245
4	Experience	0.216	2.464	0.015
	Clarifier	-0.061	-0.511	0.610
	Ideator	0.161	1.526	0.129
	Developer	0.114	0.833	0.406
	Implementer	-0.050	-0.522	0.602
	Experience x Experience	-0.114	-1.293	0.198
	Experience x Clarifier	0.001	0.007	0.994
	Experience x Ideator	0.062	0.552	0.582
	Experience x Developer	-0.019	-0.127	0.899
	Experience x Implementer	0.048	0.498	0.619

The results found in Table 4.9, which summarizes the exact same analysis having used the KAI subscores and KAI Total in lieu of the FourSight style preferences, show the same pattern of the results. Again, the only beta that was significant or approaching significance was that of experience. Identical analyses were further completed on Verbal and Visual Insight scores independently and a similar pattern was apparent in those analyses, with experience again being the only variable that predicted success when solving insight problems.

Table 4.9**The Regression Analysis of Coefficients of Total Insight Problem Scores to KAI**

Model		Standand Coefficient	t	Sig.
		Beta		
1	Experience	0.283	3.544	0.001
2	Experience	0.271	3.275	0.001
	Sufficiency of Originality	0.090	0.966	0.336
	Efficiency	0.076	0.838	0.403
	Rule Group Conformity	-0.011	-0.106	0.916
3	Experience	0.265	3.215	0.002
	Sufficiency of Originality	0.107	1.139	0.257
	Efficiency	0.092	1.009	0.315
	Rule Group Conformity	-0.011	-0.113	0.910
	Experience x Experience	-0.105	-1.282	0.202
4	Experience	0.259	2.986	0.003
	Sufficiency of Originality	0.118	1.215	0.227
	Efficiency	0.098	1.055	0.293
	Rule Group Conformity	-0.021	-0.205	0.838
	Experience x Experience	-0.101	-1.147	0.253
	Experience x SO	0.039	0.397	0.692
	Experience x EFF	0.037	0.368	0.714
	Experience x RGC	-0.069	-0.632	0.529

See Tables 4.10 through 4.13 following chapter summary for additional information.

Summary

This chapter presented the analysis of qualitative data collected to assess the relationships of cognitive style as measured by FourSight, cognitive preferences as measured by the KAI, and experience to insight problem solving ability. Conclusions and recommendations of findings are discussed in the following chapter, as well as implications for future research presented.

Table 4.10
The Regression Analysis of Coefficients
of Verbal Insight Problem Scores to FourSight

Model		Standard Coefficient Beta	t	Sig.
1	Experience	0.212	2.608	0.010
2	Experience	0.173	1.982	0.049
	Clarifier	0.038	0.319	0.750
	Ideator	0.086	0.827	0.410
	Developer	0.005	0.040	0.968
	Implementer	0.041	0.444	0.658
3	Experience	0.169	1.939	0.055
	Clarifier	0.028	0.233	0.816
	Ideator	0.094	0.901	0.369
	Developer	0.010	0.070	0.945
	Implementer	0.037	0.393	0.695
	Experience x Experience	-0.054	-0.643	0.522
4	Experience	0.161	1.788	0.076
	Clarifier	0.032	0.263	0.793
	Ideator	0.102	0.943	0.348
	Developer	0.009	0.061	0.951
	Implementer	0.056	0.572	0.568
	Experience x Experience	-0.058	-0.638	0.525
	Experience x Clarifier	0.012	0.095	0.924
	Experience x Ideator	0.080	0.688	0.493
	Experience x Developer	-0.111	-0.708	0.480
	Experience x Implementer	0.091	0.925	0.356

Table 4.11**The Regression Analysis of Coefficients of Verbal Insight Problem Scores to KAI**

		Standard Coefficient		
Model		Beta	t	Sig.
1	Experience	0.212	2.608	0.010
2	Experience	0.203	2.408	0.017
	Sufficiency of Originality	0.117	1.234	0.219
	Efficiency	0.087	0.944	0.347
	Rule Group Conformity	-0.081	-0.783	0.435
3	Experience	0.199	2.358	0.020
	Sufficiency of Originality	0.130	1.352	0.179
	Efficiency	0.099	1.063	0.290
	Rule Group Conformity	-0.082	-0.788	0.432
	Experience x Experience	-0.078	-0.932	0.353
4	Experience	0.201	2.268	0.025
	Sufficiency of Originality	0.134	1.342	0.182
	Efficiency	0.104	1.103	0.272
	Rule Group Conformity	-0.085	-0.801	0.425
	Experience x Experience	-0.067	-0.738	0.462
	Experience x SO	0.006	0.064	0.949
	Experience x EFF	0.028	0.268	0.789
	Experience x RGC	-0.061	-0.539	0.591

Table 4.12
The Regression Analysis of Coefficients
of Visual Insight Problem Scores to FourSight

		Standard Coefficient		
Model		Beta	t	Sig.
1	Experience	0.241	2.975	0.003
2	Experience	0.195	2.286	0.024
	Clarifier	-0.140	-1.212	0.227
	Ideator	0.137	1.348	0.180
	Developer	0.199	1.487	0.139
	Implementer	-0.157	-1.717	0.088
3	Experience	0.189	2.218	0.028
	Clarifier	-0.159	-1.365	0.175
	Ideator	0.153	1.501	0.136
	Developer	0.206	1.546	0.124
	Implementer	-0.165	-1.811	0.072
	Experience x Experience	-0.102	-1.251	0.213
4	Experience	0.185	2.102	0.037
	Clarifier	-0.149	-1.239	0.217
	Ideator	0.160	1.511	0.133
	Developer	0.191	1.399	0.164
	Implementer	-0.157	-1.651	0.101
	Experience x Experience	-0.131	-1.485	0.140
	Experience x Clarifier	-0.014	-0.108	0.914
	Experience x Ideator	0.012	0.107	0.915
	Experience x Developer	0.103	0.671	0.503
	Experience x Implementer	-0.028	-0.290	0.773

Table 4.13**The Regression Analysis of Coefficients of Visual Insight Problem Scores to KAI**

		Standard Coefficient		
Model		Beta	t	Sig.
1	Experience	0.241	2.975	0.003
2	Experience	0.230	2.746	0.007
	Sufficiency of Originality	0.015	0.161	0.872
	Efficiency	0.027	0.297	0.767
	Rule Group Conformity	0.081	0.786	0.433
3	Experience	0.225	2.691	0.008
	Sufficiency of Originality	0.030	0.312	0.756
	Efficiency	0.041	0.444	0.658
	Rule Group Conformity	0.081	0.781	0.436
	Experience x Experience	-0.090	-1.083	0.281
4	Experience	0.212	2.401	0.018
	Sufficiency of Originality	0.045	0.456	0.649
	Efficiency	0.045	0.474	0.636
	Rule Group Conformity	0.067	0.636	0.526
	Experience x Experience	-0.098	-1.089	0.278
	Experience x SO	0.061	0.615	0.540
	Experience x EFF	0.032	0.310	0.757
	Experience x RGC	-0.049	-0.435	0.664

Chapter Five: Conclusions, Recommendations, and Implications

Introduction

The purpose of this chapter is to present the findings of this study in light of the questions that guided this thesis. Conclusions drawn from analysis of quantitative data as well as the recommendations are discussed. Further, implications for future research are proposed.

Conclusions

The purpose of this research was to explore the influence of individual differences in cognitive style and experience, on insight problem solving ability. Analysis of variables revealed that style and preference had little or no impact, rather the stronger indicator for success in solving insight type problems appeared to be that of experience. Each of the guiding research questions, as noted in Chapter One, is addressed in the following section.

- *Does adaptive and innovative cognitive styles as measured by the KAI relate to insight problem solving behavior? Are there interactive relationships between style and types of insight problems solved?*

Person product-moment was used to generate 12 quantitative relationships between Insight Variables and KAI style total along with its three subscales SO, EFF and RGC.

None of the 12 correlation coefficients were found to be significant, although one relationship that of SO to Insight Total approached significance ($r = .153$, $p = .065$). In general these findings would seem to indicate that adaptive and innovative styles as measured by the KAI are not related to insight problem solving ability (both verbal and visual). Further analysis using multiple regression revealed no interactive effects on success in solving visual or verbal types of insight problems.

Kirton (1999b) asserted that the "Adaption-Innovation Theory is quite explicit that only style is its domain and that level should theoretically lie orthogonally to it" (p. 142), yet remains as a source of contention among some cognitive researchers. Martinsen and Kaufmann (1999) stated "Kirton's idea of distinction between the style and the level of creativity is interesting, but the support for this idea is so far not sufficient to warrant such a conclusion" (p. 277) and suggested more rigorous tests are necessary to further investigate his style-level hypothesis. According to Martinsen and Kaufmann (1999) to date the bulk of the research on the KAI theory "is correlational or factor analytic. This implies that some of this research may lack the necessary control to make this casual inferences" (p. 277). Additional "efforts should thus be made to demonstrate experimentally that Adaptors and Innovators indeed utilize qualitatively different strategies that are uncontaminated by level of creativity" (p. 277). For example "in such experimental studies the type of task may be an experimental condition, and performance can be studied through style by task, and eventually through style by creative ability by type of task interactions" (p. 277).

This current research to some degree attempted to study performance through style by task. The task of insight problem solving is considered by some as being a task

that contains creative elements. It may be presumptuous to state the interaction of style by creative ability by type of task was fully explored herein. Although this study may have touched on this idea conceptually, that is if one views solving insight problems as creative ability, which may imply a certain level of creativity, then suggested experimental conditions may have been met. As such, these findings would seem to align theoretically with Kirton's assertion that the KAI as a style measure does not measure level.

More importantly the findings of this study would also indicate that the ability to solve insight problems is not exclusive but rather, inclusive of both style preferences. No significant differences in performance were noted among the three groups, Adaptors, Innovators, and Bridgers (those with intermediate scores) when mean scores for insight problems totals were reviewed through one-way ANOVA analysis using a half-standard deviation from the mean style scores of each group. Therefore, performance on solving insight problems across the three groups was comparable. This is encouraging as it would appear as though one style is no more able to solve insight problems, rather as suggested by another theoretical principle of Kirton's A-I theory, the two styles are both creative just in different ways, one is not more creative than the other.

- ***What is the relationship between FourSight style preferences and insight problem solving behavior? Are there interactive relationships between various style preferences and types of insight problems solved?***

Person product-moment was also used to generate 12 quantitative relationships between Insight Variables and the four creativity style preferences Clarifier, Ideator,

Developer, and Implementer as measured by FourSight. In review of the 12 correlation coefficients, four relationships were found to be significant, all positive. Three relationships related to Ideator and Insight Variables and the fourth relationship related to Developer and Insight Total. Through further regression analysis of these coefficients this relationship disappeared when the additional analysis controlled for the impact of experience. It could then be said that these findings would indicate that preferences as measured by FourSight do not relate to insight problem solving ability or types of problems solved. However, these finding might also indicate that additional questions could be raised for consideration.

If initial relationships are discounted through later regression analysis that controlled for experience, we might then want to consider the relationship of experience as measured in this research to the creative style preferences as measured by FourSight. As noted in Table 4.2 FourSight Correlations to Main Variables three out of four style preferences correlated with Experience. This would seem to indicate that Ideator, Developer, and Implementer style preferences tend to have more experience with activities related to enhancing insight problem solving abilities. The questions are then why and in what specific ways do these preferences relate to Experience? Also, why did Clarifier not correlate to Experience?

If initial relationships noted are not discounted, these findings might imply style preferences for ideation and solution evaluation/development could assist in insight problem solving. In terms of types of problems solved ideation related to both verbal and visual insight problems, whereas the Developer preference related to total insight score only. Additional questions might then be as follows: Does this relationship indicate these

preferences might be more related to task-specific strategies rather than metacognitive strategies? And would this imply, in part, that FourSight may be measuring cognitive ability as well as cognitive style?

And finally, although this study did not focus specifically on gender related research, it has been noted in Table 4.2 that Gender correlated negatively to style preference of Clarifier and to Experience. Essentially this indicates that males tend to have higher scores on Clarifier style preferences and Experience, which then again the question is why?

• **□ *Does problem solving experience facilitate or inhibit solving of insight problems?***

As noted previously in Chapter One the concept of experience acting as a two-edged sword was discussed. At times experience inhibits insight problem solving when such experience results in mental sets or fixation. At other times experience acts as resource base from which the problem solver can mine for applicable knowledge. Issak and Just (1995) noted that "in problem solving-literature, the integration of experiences or ideas is again seen to facilitate the generation of novel solutions" (p. 307). More importantly, although knowledge or experience may provide individuals with the means to approach a problem, "only the integration of ideas or experience can lead to inventive solutions" (Issak & Just, 1995, p. 307). Additionally the combination of ideas from more than one domain has often contributed to the occurrence of major insights (Csikszentmihalyi & Sawyer 1995). Perhaps this notion of diverse experiences enhancing problem solving ability influenced Martinsen's (1993) development of the experience assessment questionnaire utilized in his research.

This same experience assessment questionnaire was utilized within this study. Martinsen based the questionnaire on six items he asserted were related to problem solving ability. Each student self-rated their level of experience on each item using a scale of 0-3; 0 represented lack of experience, 3 represented in-depth experience. The sum total was then used in correlation and regression analysis.

As noted in Table 4.5 the results of Experience coefficient correlations to Insight Variables yielded three significant positive relationships; they were experience to verbal type insight problems, to visual type insight problems, and to total insight problem score. These positive relationships would indicate that the higher the participant rated themselves on activities listed in the experience questionnaire the more successful they were on solving insight type problems. Further, as noted previously, through the regression analysis of the variable coefficients, experience was the only variable predictive of success in solving insight problems. Therefore, experience as measured within this study did facilitate the solving of "insight problems".

- ***Do educational courses in Creative Problem Solving (CPS) enhance students' ability to successfully solve insight problems?***

The variable for (CRS) courses taken was analyzed for relationship to success in solving insight problems using Pearson product-moment correlations. No significant relationship was produced between this variable and success in solving insight problems. As such, this would appear to indicate educational courses in Creative Problem Solving (CPS) did not enhance students' ability to successfully solve insight problems. This finding has several potential implications.

First, if this answer is taken at face value it might imply CPS tools and techniques are not applicable to insight problem solving, and that perhaps CPS as a process that encourages creative solutions to open-ended problems cannot be used to solve closed-ended problems with one right answer. Or perhaps it's a matter of transferability in that the connection was not made that processes and tools taught in the CPS can be applied to closed-ended solution type of problems.

Second it may be a matter of inexperience, of the 144 participants that participated in this study, 127 of them noted having taken some CRS courses. The mean score for courses taken was 1.86 this is less than 2 classes on average. This might indicate the participants are still learning to apply recently gained knowledge. They could be considered as novices, and as such they may not as yet "internalized" such processes. Previous studies on expertise and problem solving behavior has shown that many years of practice in a domain is required to develop skills and knowledge before one can apply his or her experience intuitively to problem solving. Of course this is at the extreme level, and may not be the case here. Mayer (1999) noted that problem solving skills need not always be mastered to be useful earlier on in novice learning, "the *constraint-removal* view is based on the ideas that students can engage in higher-level problem solving in situations that do not require complete mastery of lower-level skills" (p. 446).

Third, the ability to solve insight problems might require intrinsic motivation which may be more a matter of personal preference, as Gick and Lockhart (1995) noted that "casual observation suggests that there are individual differences in insight problem solving, both in terms of success at it and of liking it. Some people hate games and puzzles and do terribly on them, whereas other thrive on them and see them as a

challenging form of recreation" (p. 221). In this case CPS training may only be helpful to some, for others who lack intrinsic motivation it may not prove helpful in solving these types of problems.

And lastly, perhaps a better or more appropriate method can be developed to measure impact of CPS training on insight problem solving ability. For example, rather than using only the correlation of frequency of courses taken, perhaps pre-training testing compared with post training testing on insight problems would more accurately assess impact.

Recommendations

There are several limitations to this study. One such limitation is that this study did not incorporate analytical problems concurrently with insight problems in tests of ability. Analytical problems are considered non-insight type of problems, similar to logic or mathematical problems, in which the solution is reached through the application of a step-by-step procedure. Including analytical problems are important for two reasons. First, as Schooler and Melcher (1995) noted:

Past published studies of the correlates of insight problems solving have typically omitted a critical control, the inclusion of analytic problems. In the absence of an analytical problem control, a correlation between insight problem solving and other individual differences measures may suggest a factor that is unique to insight problem solving, or it may simply correspond to a general problem-solving skill. In order to determine the processes that are unique to insight, it is necessary to examine the relationship between individual-differences measures and both insight and analytic problem-solving ability. (p. 119)

And second, as noted by Martinsen in his (1995) research, he chose to include analytic problems as well as insight problems. He noted a difference in the relationship of experience to problem solving stating the reason for these differences as follows:

It can be noted that in the previous study (Martinsen, 1993b), the relation between experience and problem solving was curvilinear, but the same relation was linear in the present study. This could mean that experience may be curvilinear related to creativity related processes, whereas experience and analytic problem may be linearly related. This can be checked in future research. (Martinsen, 1995, p. 297)

Therefore it is recommended that future research of individual differences in insight problem solving behavior include analytical problems as well as insight problems.

Another limitation of this study relates to scoring answers 0 for no or wrong answers and 1 for correct answers. As noted by Sternberg and Davidson (1999) "sometimes the people being tested are more insightful than the people doing the testing. Thus, one must be careful in studying insight not to disallow answers that maybe more insightful than the ones that was intended" (67). This is an interesting concept, as some answers offered to problems by participants in this study might be considered humorous and perhaps even insightful. For example, see Appendix G regarding the Pigs problem in which the problem solver is asked to draw two more square enclosures that would put each pig in a pen by itself, one participant suggested as a solution that it may be better to just sell the pigs. Two other examples related to the Prisoner problem, (see Appendix M) in which a prisoner attempts to escape from a tower by using a rope that is half long enough to permit him to reach the ground safely. Yet he is able to divide the rope in half, tie the two parts together and does escape. The problem solver is asked to answer how

could he have done this. One participant suggested his cell is on the first floor of the tower and he did not need the rope to escape, another suggested he used the rope to hang himself, pronounced dead he was then removed from the tower. There were several other problems in which imaginative answers were offered up as solution, none of which, received credit unless they matched the correct or anticipated right answer. Perhaps in future research on insightful problem solving, a method for measuring alternative answers could be developed for additional analysis. The acknowledgment of alternative answers might then allow for more open-ended solution to problems that are currently considered closed-ended. Also in finding a way to evaluate alternative answers, connections may be made between style preferences and creative cognitive products, which might yield additional insights into creative thinking.

Lastly, the use of the aggregate total generated by the Experience questionnaire may have had added some limitations to this study of individual differences in insight problem solving. Utilization of the aggregate total of Experience although it was successful in illustrating the notion that increased experience on a variety of related problem-solving activities enhanced the problem solver's ability to solve insight problems, it also yielded additional limitations. For instance it does not allow for deeper analysis or reflection in terms of how and why these activities enhanced insight problem solving ability. Specifically related to correlation analysis of style preferences to experience, although positive relationships suggested that some style preferences tend to have more experience with activities related to enhancing insight problem solving abilities, again it does not allow for specific connections to be made regarding what those activities might be. Further it does not allow for additional analysis of how or in what

ways, style preferences and experience relate to solving of specific types of problems. Therefore it is recommended that in future studies on individual differences on insight problem solving behavior when significant correlations are noted through the use of this questionnaire, in lieu of using the experience aggregate total, individually experience items should be further correlated with style preferences and all insight problems. In other words, it might be helpful to analyze specifically which items of experience yielded the strongest correlations to insight problems, as well as to style preferences. This additional analysis might then allow, as suggested by Martinsen and Kaufmann (1999) the study of performance of problem solving behavior through "style by task, and eventually through style by type of task interaction" (p. 277).

With limitations and recommendations so noted, the next section discusses implications of this study.

Implications

This study explored the influence of individual differences in cognitive style as measured by the KAI and FourSight inventories and their effects on insight problems solving behavior. Results revealed that these style preferences had no or little impact on insight problem solving behavior. Conclusions drawn have noted of these findings that potentially three theories related to cognitive style have been confirmed. First that "lack of, or low correlations between style and ability is commonly seen as a necessary condition for a style construct to be valid" (Martinsen & Kaufmann, 1999, p. 274). Second, as there is no evidence that one or several styles out performed others styles, this might imply that the ability to solve insight problems is inclusive rather than exclusive to

a particular style preference. And lastly regarding the relationship of style preference to insight problem solving behavior lack of significant correlations might also imply alignment with the theory of cognitive style as being value neutral, in terms of all styles are being considered as capable of exhibiting creativity, they just do so in different ways.

This study also explored effects of individual differences in experience to problem solving behavior through the use of an experience assessment questionnaire and experience through the number of creativity related and/or problem solving courses. Results indicated that experience related to various insight problem solving activities, as defined by the assessment questionnaire, was a stronger indicator of the problem solver's ability to successfully solve insight problems. Experience in terms of number of courses taken relative to creativity and creative problem solving did not enhance students' ability to solve insight type problems. Clearly additional research is required to further clarify implications of these findings.

Two studies in particular have illustrated the positive impact of training on insight problem solving ability. The early works of Sternberg and Davidson and the more recent works of Ansburg and Dominowski suggest a potential direction for which other problem solving models may be applied. For example:

Sternberg and Davidson (1984) devised an elaborate training scheme that included fourteen hours of direct instructions about the nature and application of selective comparison, selective combination, and selective encoding. Participants who underwent this training showed a moderate increase in ability to solve insight". (Ansburg & Dominowski, 2000, p. 36)

Also as previously described in Chapter Two Ansburg and Dominowski (2000) derived a

training scheme based on Ohlsson's theories of elaboration, re-encoding, and constraint relaxation. The results of their training scheme provided positive evidence that the ability to enhance insight problem solving behavior can indeed be "conceptualized as a trainable, general thinking skill" (p. 48). Further they noted the transferability of the training "across problems that vary widely in content and are not analogues, the magnitude of overall transfer effects, ranging from about 15% to 26%, was substantial" (p. 48).

The Creative Problem Solving (CPS) model contains elements or components that I would consider synonymous to theories noted above. Also, CPS is based on two guiding principles that of divergent and convergent thinking. Fink (1995) noted the relationship of these two principles to insight ability as important thinking skills:

Divergent thinking refers to thinking that flows outward from a concept, making contact with other ideas and possibilities that one might not ordinarily consider. It leads to the discovery of remote associations and insights into unusual uses for common things, such as realizing that a pair of scissors can be used as a weapon, a hole punch, or a weight for a pendulum (Maier, 1931). *Convergent thinking*, on the other hand, refers to thinking that focuses on a single idea or possibility, given a collection of facts.... In *convergent insight*, one discovers a creative structure or solution that makes sense out of apparently disconnected facts.... *Divergent insight*, in contrast, occurs when one begins with a structure and seeks to find novel uses for it or novel implications of it. In divergent insight, one tries to find the meaning in the structure rather than to structure that which is meaningful. (pp. 255-256)

Further CPS utilizes the creative tool of brainstorming as developed by Alex Osborn, for

the purpose of stimulating idea generation. Perkins (1995) defined brainstorming in terms of insight as a tool to overcome the condition of an impasse, through this statement "*Brainstorming*: When humans inquires face impasses, they often deliberately widen the scope of search, brainstorming a number of very different approaches" (p. 523).

I propose that even though CPS has traditionally been used to solve open-ended types of problems, there are many aspects to CPS that would seem to suggest there is a natural fit here. One might consider using CPS to also solve closed-ended insight problems. Perhaps a future focus of research might include defining the ways in which CPS training might also be used to enhance insight problem solving ability. Given the success of the two training schemes previously noted, that of Sternberg and Davidson, and that of Ansburg and Dominowski, in which their findings provided plausible opportunities for successful training, it would seem reasonable as well as possible for the CPS model to do the same.

Summary

Chapter Five answered each guiding thesis question via the presentation of conclusions drawn from analysis of quantitative data. Additionally, limitations of this study were identified. Recommendations were discussed to address limitations as identified, including rationale for utilization in future individual differences in insight problem solving research. The chapter concluded with the presentation of implications as noted in this study, also a potential direction for future research on insightful problem solving was proposed.

In closing, from the perspective of creative insight being a worthy individual

investment Sternberg and Lubart (1995) expressed the following philosophical sentiments:

The impetus for creative insight and change must come from within, for that is also where the rewards will be enjoyed most intensely. Each person must find his or her own place in the spectrum of creative expression in order to reap the highest returns on the investment. Hence, the returns will vary with the person, but all will know the pleasure of having changed the world in some definable way. (p. 555)

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The Research Foundation of SUNY
State University College at Buffalo
PROPOSAL ABSTRACT FOR RESEARCH
INVOLVING HUMAN SUBJECTS

Protocol # 158

Certificate of Exemption

Initial Review _____

Request for Continuation _____

Researcher/Project Director Diane M. Steele Ext. 6222 Room # 245 Chase
Faculty Sponsor (for student projects) Dr. Gerard Puccio
Project Title The Effects of Creative Problem Solving Training on
Insight Problem Solving
Project Dates 7/02 to 11/02 Date of Submission 7-2-02
Sponsoring Agency Creative Studies Department

Briefly describe the project: (attach a copy of the abstract and consent form)
Please see attached description. Consent form in test booklet.

Do the potential subjects of this study include any of the following:

Children (under the age of 18)	No <u>X</u> Yes _____
Prisoners	No <u>X</u> Yes _____
Pregnant	No <u>X</u> Yes _____
Cognitively Impaired Persons	No <u>X</u> Yes _____

Number of subjects requested 90

Method (i.e., questionnaire, video/audio, observation, etc.) Paper & pencil questionnaire

Population (i.e., adults, minors, institutionalized, etc.) Adults

Keyword (i.e., Family Health, Marine Biology, Speech Pathology, etc.) Creativity

I certify that the project identified above, in which the only involvement of human subjects will be in one or more of the categories checked below, is exempt from IRB review and approval.

1. Research conducted in established or commonly accepted educational settings, involving non-educational practices, such as
 - ☐ a.) research on regular and special educational instructional strategies, or
 - ☐ b.) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior, UNLESS
 - ☐ a.) information obtained is recorded in such a manner that human subjects cannot be identified, directly or through identifiers linked to the subjects; AND
 - ☐ b.) any disclosure of the human subjects' responses outside the research context would reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, or observation of public behavior that is not exempt under (2)

- ☐ a.) the human subjects are elected or appointed public officials in public office; or
- ☐ b.) federal statute(s) require(s) without exemption that the confidential personally identifiable information will be maintained throughout research and thereafter.

Research involving the collection or recording of data or specimens, including the collection or recording of diagnostic specimens, recorded by the investigator in such a manner that subjects cannot be identified directly or through identifiers linked to the subjects.

5. Research and demonstration projects which are conducted by or subject to the approval of federal department or agency heads, and which are designed to study, evaluate, or otherwise examine
 - ☐ a.) public benefit or service programs;
 - ☐ b.) procedures for obtaining benefits or services or services under those programs;
 - ☐ c.) possible changes in or alternatives to those programs or procedures; or
 - ☐ d.) possible changes in methods or levels of payment for benefits or services under those programs.

Certification of Project Director:

I have reviewed the Federal regulation concerning the use of human subjects in research and training programs, and the guidelines of at the State University College at Buffalo agree to abide by these policies.

Miane M. Steele
Signature of Project Director

7/1/02
Date

Faculty Sponsor Approval:

[Signature]
Signature of Faculty Sponsor

Date

Research Foundation Approval:

[Signature]
Signature of RF Operations Manager or Designee

7/8/02
Date

Subject Consent Form

**** You Must Be 18 Years of Age or Older to Participate in this Study****

1. Purpose:

The purpose of this study is to explore an individual's problem solving style preferences.

2. Procedure:

You will be asked to complete three tasks: the FourSight Inventory, the Kirton's Adaptive-Innovation Inventory (KAI) and 8 insight problems. The results of the FourSight and the KAI will be forwarded to you at the completion of the study.

3. Time Required:

Your participation will involve one 75-minute session. This session will occur within your scheduled class time or as scheduled extra credit session during Bengal Pause.

4. Risks:

It is not anticipated that this study will present any risk to you.

5. Your Rights:

- The information gathered will be recorded in anonymous form. Data or summarized results will not be released in any way that could identify you.
 - If you want to withdraw from this study at any time, you may do so without penalty. The information collected from you up to that point would be destroyed if you so desire.
 - At the end of the project, you have the right to a complete explanation of what this study is all about. If you have any questions afterward, please contact you administrator, Diane Steele at 877-1049 or dianesteele@att.net.
6. If you have any concerns about your treatment as a participant in this study, please call Dr. Gerard Puccio, Department of Creative Studies, Buffalo State College, (716) 878-6223.

I have read the above information and willingly consent to participate in this study.

Signed _____ Date _____

Print Name _____

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Biographical Data**Please fill in all bla

and a

Rating Scale:

0 = Lack of Experience

1 = Little Experience

2 = Some Experience

3 = In-depth Experience

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Theme:
Identifying the Impact of Creative Problem Solving on Individuals and Groups
Initiative:
Using individual differences to explore the impact of CPS

Thesis Title: The Influence of Cognitive Style on Insight Problem Solving

Purpose and Questions: The purpose of this thesis is to explore the influence of individual differences in cognitive style preferences and experience on insight problem solving ability. This study will examine how relationships of cognitive styles, adaptive and innovative, as measured by the *Kirton Adaption-Innovation Inventory* (KAI) and cognitive style preferences (Clarifier, Ideator, Developer, and Implementer) as measured by the *Buffalo Creative Process Inventory* (BCPI), can influence insight problem solving behavior. Further exploration of prior experience with creative problem solving activities considered relevant to insight problem solving ability will be examined for impact on insight problem solving performance.

Specific questions that will guide this study are:

- Does adaptive and innovative cognitive styles as measured by the KAI relate to insight problem solving behavior? Are there interactive relationships between style and types of insight problems solved?
- What is the relationship between BCPI style preferences and insight problem solving behavior? Are there interactive relationships between various style preferences and types of insight problems solved?
- Does problem solving experience facilitate or inhibit solving of "insight problems"?
- Do educational courses in Creative Problem Solving (CPS) enhance student ability to successfully solve "insight problems"?

Rationale & Statement of Significance: "Insightful problem solving can occur in any domain and can sometimes lead to tremendous advances in knowledge. Seeing through a problem and arriving at a well-structured solution to a novel situation are behaviors worth promoting. An important question is whether there are ways to increase the occurrence of insightful behavior" (Dominowski & Dallob, 1995, p. 56).

Many cognitive psychologist agree that insight plays an important roll in the development of creative solutions and assert that restructuring is the cognitive process that underlies the production of insight, in that insightful problem solving includes a sudden change in the solver's internal state (Ansburg & Dominowski, 2000, p. 31). Schooler, Ohlsson, and Brook (1993) differentiate insight problems from other problems in that "insight problems are characterized precisely by the necessity to reject the initial, obvious approach in order to find the solution, whereas noninsight problems can be solved by pursuing the obvious approach" (p. 175). An insight problem may "elicit an initial impasse in which the subjects are unaware of making any progress as they struggle simply to determine the right approach to tackle the problem" (Schooler & Melcher, 1995, p.108). Gestalt psychologists also considered insight problems to be different from other problems that can be solved by reproductive means, in that insight is associated with understanding problem structure, restructuring, and changed representation or interpretation of meaning for their solution (Dominowski, 1995, p. 74). "Overcoming convention and generating new understanding of a situation is considered to be an important component of creativity... finding a new and productive interpretation of a situation is just one component in creativity, but it serves to link solving insight problems with creative thinking" (Dominowski, 1995, pp. 77-78). Insight problem solving can also be

said to involve novelty, in that the unusual use of an object may be required to achieve the goal of solving a problem. Or if a particular meaning of a word or phrase is less familiar, a less dominant meaning is needed (Dominowski, 1995, p. 76). Martinsen (1993) proposed that cognitive style is an "important variable in determining how people deal with novelty as it describes preferences for strategies or preferred ways of using one's abilities"... and that 'people differ in *how* they use their abilities in a given situation'" (pp. 436-437).

The focus of the present study is to explore individual differences in cognitive style preference and experience with creative problem solving activities on insight problem solving behavior. In part this study will incorporate some methods and concepts explored in Oyvind Martinsen's 1993 research on the influence of cognitive styles and experience on insight problem solving. Martinsen's research method included the administration of the Assimilator-Explorer questionnaire, to measure A-E styles which "may be seen as describing aspects of metacognition that direct individuals to use their abilities either to seek out novelty or to stay within established frames of experience" (Martinsen, 1993, p. 437). Additional constructs administered included a biographical questionnaire, a vocabulary test, and 2 insight problems. In lieu of the A-E questionnaire, the current study will administer the *Kirton Adaption-Innovation Inventory* (KAI), developed by Michael J. Kirton, which measures thinking style differences, on a normally distributed continuum. The range is from high Adaptor, who tend to stay with the current paradigm, to high Innovator, who tend to abandon the current paradigm when solving problems (Kirton, 1999, p. 3). Additional constructs will include; a biographical questionnaire that incorporates the same assessment of experience used in Martinsen's research, the *Buffalo Creative Process Inventory* (BCPI), and 8 insight problems.

The *Buffalo Creative Process Inventory* (BCPI), developed by Dr. Gerard Puccio, was designed to measure individual's cognitive style preferences "for different areas of operation within the Creative Problem Solving model" (Puccio, 1991, p. 172). The Creative Problem Solving (CPS) model guides the creative process through six stages and is based on two basic principles, *divergence* and *convergence*. The principle of *divergence* is to stretch one's thinking, "to exhaust the obvious, known answers and...to push to the point of not knowing." (Vehar, Miller, & Firestien, 1999, p. 23). The principle of *convergence* is to use one's critical judgment, by being selective in one's thinking. CPS training may enhance one's ability to consider alternative ways to fundamentally redefine the problem, and to move through the impasse phenomena associated with insight problems.

Schooler and Melcher (1995) proposed a first step to establishing the component processes involved in a skill is to understand individual-differences approach. "The basic logic of this approach is that if process A is involved in a particular skill B, then performance on tasks involving process A should be predictive of tasks requiring skill B" (p. 118). In light of this current study, additional research on the BCPI and KAI relative to exploring individual cognitive style preferences, the ways in which people differ in how they problem solve or think creatively, may help to identify processes associated with solving insight problems.

Description of the Method or Process: To gain quantitative data for this thesis 150 students will complete a consent form, 2 psychometric measurements, the KAI and the BCPI, 1 biographical questionnaire, and 8 paper and pencil insight-problem solving activities. The first psychometric measurement, the KAI containing 33 questions will be administered to measure thinking style bases on the adaptive-innovative continuum. The second psychometric measurement, the BCPI containing 37 questions will be administered to identify cognitive style by preferences (Clarifier, Ideator, Developer, Implementer). The biographical questionnaire is designed to collect experience data

relevant to problem solving activities. It will include the same six items with a 0-3 rating scale as used in Martinsen (1993) research (p. 439).

Testing will be done on several groups containing both undergraduate and graduate students from various disciplines. Each group will receive the written instructions identical to those utilized in previous research by Ansburg and Dominowski (1995) Appendix C Strategic Instructions (p. 60).

Testing activities will consist of a total of 8 insight problems, 4 verbal (3 minutes each) and 4 visual (5 minutes each). Subjects will be informed that this is "not a study of intelligence, with the intent to reduce the extrinsic motivational influence of expectancy, which can be found to be detrimental to creativity" (Martinsen, 1993, p. 440).

Upon completion of testing, a rating scale of 0-1 will be applied to evaluate solutions. Incorrect or no answer will receive 0 points, and a correct answer will receive 1 point. This data will be analyzed for relationships between the main variables, cognitive style preferences, thinking style, CPS training and experience, and its impact on solving insight problems.

Personal Learning Goals:

- Gain knowledge and practice with quantitative research in the field of creativity;
- To prepare a high-level quantitative research project;
- To learn to administer, score, analyze, and compare data from profiling biographical and personal assessments; and
- To obtain knowledge on the impact of cognitive style on problem solving behavior.

Outcomes:

- Quantitative data to investigate the potential of cognitive style preferences in developing insightful problem solving behavior;
- (2) Executive Summaries for Creativity Based Information Research (CBIR) and one annotation of this thesis; and
- Thesis write-up.

Timeline:

- May 2002: Concept Paper approved for thesis work
Meet with advisor for approval of testing booklet and materials
- June 2002: Obtain Human Subjects approval
Continue literature review
- July 2002: Continue literature review
- August 2002: Continue literature review
- September 2002: Prepare materials required for data collection
Complete data collection
- October 2002: Complete literature review
Analyze and finalize data
Prepare draft of thesis
- November 2002: Refine and finalize draft
Submission of final draft of thesis
- December 2002: Master's thesis approved and signed
Graduate

Principal Investigators:

- Dr. Gerard J. Puccio, Faculty Advisor; Diane M. Steele, Master's Candidate

Related Literature:

- Ansburg, P. I., & Dominowski, R. L. (2000). Promoting insightful problem solving. *The Journal of Creative Behavior*, 34(1), 30-60.
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