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The Development of an Instrument to Assess Strategical Information Processing Style.

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THE DEVELOPMENT OF AN INSTRUMENT TO ASSESS STRATEGICAL INFORMATION PROCESSING STYLE

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DEDICATION

This dissertation is dedicated to my husband, Thomas, who inspires me everyday. His support and loyalty granted me the freedom to complete this research. When I felt discouraged, he encouraged me to persevere.

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ABSTRACT

Underpinned on the theories of individual differences and the information processing paradigm, the author hypothesized that there were five different strategical information processing styles (SIPS) that individuals prefer to use when processing information. The five constructs are visuo-spatial, analytical, social, categorical, and verbal. Based on this hypothesis, the researcher developed a self-assessment instrument containing specific measurable descriptors for each of the five hypothesized constructs. However, in this study the empirical evidence verified only four strategical information processing styles: visuo-spatial, analytical, social, and categorical. Although the verbal style is theoretically appealing, it did not prove to be a valid construct in this study and was excluded from the final instrument.

The final instrument was evaluated using a sample of 514, which was split into two groups. A confirmatory factor analysis was performed on the first group ($n = 325$) to develop a model. The model was confirmed using the second group ($n = 189$). The confirmatory factor analysis of the final model revealed acceptable convergent and discriminate validity with composite reliabilites ranging from .60 to .81. The absolute fit and the parsimony of the measurement model were acceptable. The incremental fit of the model was marginally acceptable. The chi-square difference test was not significant at $p < .05$. Therefore, the model was confirmed indicating that the theoretical model provided a fit to the data that was the same as the measurement model.

Although limited to the participants in this study, gender differences were the most influential factor with regard to the strength of preference of strategical information processing styles. Females showed a stronger preference for the analytical, social, and categorical styles. Whereas, the male gender was a significant predictor of the visuo-spatial style.

The strategical information processing style assessment should prove to be a useful tool for determining the strategies that individual students prefer to employ when processing information. These strategies should prove to be a useful asset in the dynamic workplace of the twenty-first century.

CHAPTER 1: INTRODUCTION

The traditional learning style instruments measure how students learn by interacting with their environments. Although these instruments are widely accepted, many are based on early theories and have questionable reliability and validity. The goal of this research was to furnish educators with a high quality, easily administered self-assessment tool to determine individual differences in strategical information processing styles, which are a measure of the strategies that individuals use to process information transmitted by the senses.

The study of individual differences was introduced by the psychologist, Carl Jung (1933) in the early nineteen hundreds. In 1933, Jung described different psychological types and introduced his theory on individual differences in personalities. Based on the Jungian personality theory, Myers and Briggs (1990) developed the Myers-Briggs Type Indicators (MBTI), a widely used personality self-assessment (Bouchard & Hur, 1998). In 1971, Kolb, Rubin, and McIntyre introduced theories on learning styles that led to the development of the Learning-Style Inventory (Kolb, 1985). Using the theories of Kolb, Jung, and neuroscientists such as John Bradshaw (1989), McCarthy (1991) developed the 4MAT system. McCarthy (1991) contended that "people have major learning styles and hemispheric processing preferences" (p. 1). According to McCarthy, teaching and learning can be improved by designing and employing instruction that involves the four learning styles described in the 4MAT system (McCarthy, 1991,1996). McCarthy asserted that individuals learn by perceiving and processing and there are individual differences in the ways that individual students perceive and process (McCarthy, 1991). The strategical information processing styles

(SIPS) assessment, developed in this research project, was designed to measure individual differences in processing. The instrument design was based on the information processing system theory.

The information processing system theory (Craik & Lockhart, 1972), which is the nucleus of cognitive psychology, explains how individuals receive and process information for memory encoding, rehearsal, storage, and retrieval. The theory includes the senses, the sensory registers, short-term (working) memory, and long-term memory. The senses are important as information receptors. They receive stimuli from the environment. Not all stimuli received are processed--some of them are lost or discarded. Information that is not discarded enters the sensory registers. The sensory registers are like collection bins. As the information enters the sensory registers, some of the data moves into short-term memory and some is discarded. From the sensory registers, information travels to working memory (Blanton, 1998; Craik & Lockhart, 1972; Parker, 1993). Working memory has a small capacity and processes a limited amount of information (Baddeley, 1992, 1993, 1996; Broadbent, 1958; Craik & Lockhart, 1972; Kalyuga, Chandler, & Sweller, 1998; Parker, 1993). Working memory is composed of three systems: the executive control, the phonological loop, and the visuo-spatial sketch pad (Baddeley, 1992, 1993, 1996). Once in working memory, the information is processed. It is connected to information stored in long-term memory, rehearsed, or discarded. Information that receives attention and that is meaningful is encoded for storage in long-term memory. Long-term memory has an unlimited capacity. Once information is stored in long-term memory, it is there permanently (Craik & Lockhart, 1972; Parker, 1993; Tulving, 1993). However, it must be retrieved

into working memory for processing (Baddeley, 1992; 1993; Broadbent, 1958; Massaro & Cowan, 1993; Torgesen, 1996). Craik and Lockhart (1972) posited that the format of information in long-term was largely semantic. Parker (1993) contended that items were encoded in memory as words or pictures. The researchers agreed that long-term memory has no known limit or capacity and that information is never lost; however, over time the accessibility to the information is lost (Craik & Lockhart, 1972; Parker, 1993). Teaching strategies can serve as cues that enhance retrieval or accessibility to stored items (Parker, 1993).

The Statement of the Problem

In order to assist students in their educational quest, educators must be attuned to the individual differences in students' strategical information processing styles. The information processing paradigm consists of stages of input and transformation of information such as encoding, rehearsal, storage, and retrieval. Individual differences have been recognized in the processes of pattern recognition, rehearsal, working memory, memory encoding, memory search, declarative and procedural memory stores, self-schemata, and retrieval (Gagné, 1989). Researchers have been unable to establish a correlation between general intelligence or general knowledge and the cognitive abilities such as the speed of information processing and working memory capacity. Regardless of cognitive abilities, general intelligence, or general knowledge, a college student's success seems to be dependent on his strategical information processing style or his preferred method of utilizing his cognitive resources (Sternberg, 1997).

Standardized test scores can sometimes predict academic success but they cannot predict how well an individual will perform in the work environment. Success

in the workplace requires more than high performance on standardized tests. Generally, college graduates are considered successful in the workplace if they possess motivation, self-efficacy, and self-esteem (Shepard, Fasko, & Osborne, 1999). These graduates have the ability to adapt to the real world environment and to accomplish goals. They have a repertoire of cognitive strategies that they skillfully employ in a workplace setting (Sternberg & Kaufman, 1998). A student's cognitive style is influence by his cognitive abilities, his repertoire of cognitive strategies, his learning style, his general intelligence, and his general knowledge. However, the student's success depends on how he chooses to employ these resources. His choice is influenced by motivation, self-efficacy, self-esteem, and emotional intelligence (Averill, 1999). Thus a student's workplace success is influenced by individual differences.

However, instrument development and validation is needed in the arena of the information processing paradigm and the evaluation of individual differences. Gagné (1989) contends "this new field of learning research needs not only an acceptable lexicon of operational definitions but valid and reliable techniques of measuring the variables of the learning process" (p. 4).

A simple pen and pencil self-assessment that can be used to measure students' strategical information processing styles would benefit both students and educators. An evaluation of the student's strategical information processing style would increase his self-awareness, which can enhance learning. A simple, easily administered tool would enable educators to quickly evaluate individual differences in SIPS. Educators could use the data from the assessments to improve instruction and delivery of information.

Purpose and Objectives

The purpose of this study was to develop an instrument with demonstrated reliability and validity that will assess strategical information processing styles. The researcher theorized that there were five different strategical styles that were based on individual differences in the information processing paradigm.

The objectives of the study were to:

1. Develop a self-assessment instrument with demonstrated validity and reliability that measured the strength of preference of strategical information processing in each of the following five styles: visuo-spatial, analytical, social, categorical, and verbal.
2. Describe the sample of undergraduate students employed in this study on the selected demographic characteristics of age, gender, ethnicity, credit hours completed, and college major.
3. Determine if relationships existed between the strength of preference in each of the five strategical information processing styles measured with age and credit hours completed.
4. Determine if differences existed in the strength of preference in each of the five styles measured by gender, ethnicity, and college major.
5. Determine if models existed explaining a significant portion of the variance in each of the five strategical information processing styles measured from the following selected demographic characteristics: age, gender, ethnicity, credit hours, and college major.

Research Hypothesis

Underpinned on Craik and Lockhart's (1972) information processing theory, Baddeley and Hitch's 1974 model of working memory (as cited in Baddeley & Hitch, 1977), and Torgesen's Model (1996) of the information processing system, the researcher hypothesized that there were five different strategical information processing styles (SIPS) that individuals prefer to use when processing information. The five constructs in the hypothesized model are visuo-spatial, analytical, social, categorical, and verbal. In order to validate this hypothesis, the researcher developed an instrument to measure these five constructs. In the SIPS instrument, there were 20 indicators in each data set, which were designed to measure an individual construct. For example, indicators assessing visual strategies will validate the visuo-spatial construct.

The researcher purported the identification of five strategical information processing styles and has modified Torgesen's Information Processing Model (1996) to include the five styles, which are visuo-spatial, analytical, social, categorical, and verbal. Each style depends on the systems within working memory that the individual prefers to use when processing a stimulus. The SIPS are identified in Figure 1 in the shaded boxes. The model illustrates the relationships among the five strategical styles and the elements of the information processing system.

Visuo-spatial style. The researcher hypothesized that the visuo-spatial strategical information processing style existed and can be measured by the scaled items in the instrument specifically designed to measure this construct. Visuo-spatial processors selectively attend to the global characteristics of stimuli that involve imagery. These tasks sustain their attention enabling them to arrive at accurate

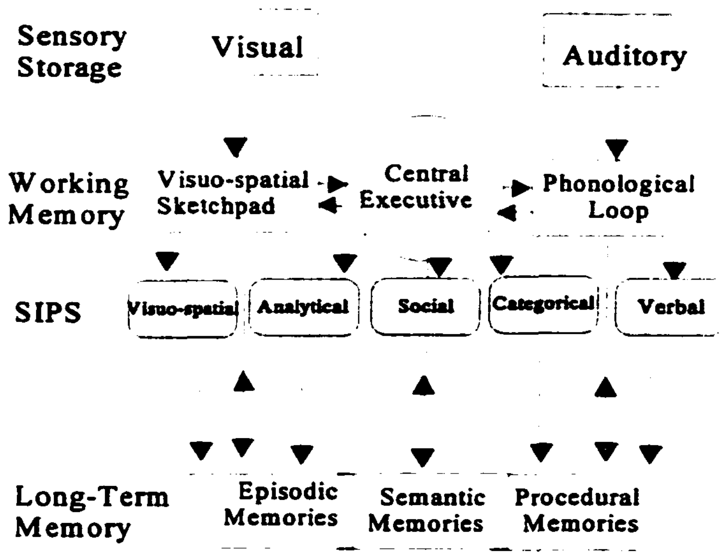

Figure 1. Hypothesized model of the five strategical information processing styles (SIPS).

solutions. Individuals who are visuo-spatial processors prefer to use their visuo-spatial sketch pads to encode information for short and long-term memory storage. However, they are good strategists and are able to select the best strategy for the task (Roberts, Gilmore, & Wood, 1997). They are parallel, continuous processors. They encode information simultaneously and they can store it in continuous networks (Clark & Paivio, 1991; Massaro & Cowan, 1993). Visuo-spatial individuals are continuous processors who make decisions based on a small amount of information. They have a well-developed procedural memory and referential connections (Paivio, 1991; Tulving, 1993).

Analytical style. The researcher hypothesized that the analytical strategical information processing style existed and can be measured by the scaled items in the instrument specifically designed to measure this construct. Analytical processors

selectively attend to stimuli that are presented in a logical order. When tasks make sense and require logical thinking, they sustain the attention of the analytical processor. They prefer to use their executive function to do quick mental calculations and perform tasks requiring analytical reasoning. Their emotions have very little influence on their executive function and they rely heavily on analytical strategies to solve problems. They are serial discrete processors who encode information in a logical step-by-step fashion (Rotenbery & Weinberg, 1999). As discrete processors, they store information in discrete packages until they have what they need to make a carefully calculated decision (Clark & Paivio, 1991; Massaro & Cowan, 1993). They have well-developed procedural and semantic memories (Tulving, 1993).

Social style. The researcher hypothesized that the social strategical information processing style existed and can be measured by the scaled items in the instrument specifically designed to measure this construct. Social processors selectively attend to global stimuli that involve relationships and emotions. Group and social tasks sustain their attention. Their executive function is strongly influenced by the limbic system. As a result of this influence, they encode information for short and long-term memory storages with emotional connections. As emotionally creative individuals, they are able to evaluate their own emotions as well as those of others. They have the ability to express emotions appropriately and can express their own perceptions of a situation through emotions (Averill, 1999). They are adept at solving complex emotional problems. They are parallel continuous processors who encode and store information simultaneously (Clark & Paivio, 1991; Massaro & Cowan, 1993). They have

well-developed episodic autobiographical memories (Gathercole, 1998; Sehulster, 1995; Tulving, 1993).

Categorical style. The researcher hypothesized that the categorical strategical information processing style existed and can be measured by the scaled items in the instrument specifically designed to measure this construct. Categorical processors selectively attend to the detailed characteristics of either visual or verbal stimuli. These individuals are attentive to tasks that require detailed, organized strategies. Individuals who are categorical processors prefer to use their executive function to plan, set goals, select strategies, and evaluate and revise their plans. They have a large repertoire of organization strategies that they use to encode and retrieve information. As serial, discrete processors, they encode information in a linear, organized manner and they reorganize their semantic memory as they encounter new stimuli. Similar to the verbal processors, they store information in discrete packages until they have what they need to make a decision or to reorganize their stores (Clark & Paivio, 1991; Massaro & Cowan, 1993).

Verbal style. The researcher hypothesized that the verbal strategical information processing style existed and can be measured by the scaled items in the instrument specifically designed to measure this construct. Verbal processors selectively attend to stimuli that involve lexical and semantic tasks. Lexical and semantic tasks sustain their attention. Individuals who are verbal processors prefer to use their phonological loops to encode information for short and long-term memory storages and rely on verbal strategies to learn new information and to solve problems. They are serial discrete processors (Rotenbery & Weinberg, 1999). They encode information one word at a

time and they store it in discrete packages until they have what they need to make a decision (Clark & Paivio, 1991; Massaro & Cowan, 1993; Sanders, 1990). They have large semantic and episodic memories (Sehulster, 1995; Tulving, 1993).

Significance of the Study

In spite of the inundation of research in the area of individual differences in information processing, there are no simple group self-assessments designed to measure strategical information processing styles. Most of the assessments are based on abilities rather than style. There is a need in the educational system for an instrument that can be used easily and efficiently to determine a student's strategical information processing style. Students must be aware of their styles in order to perform better in the classroom, to become self-directed learners, and to succeed in the dynamic workplace. Educators would benefit from an assessment that would aid them in discerning individual differences in their students and planning their curriculums accordingly. Thus, a valid, reliable instrument for appraising strategical information processing styles would be an asset for both students and teachers.

Glossary of Terms

Cognitive style: preferred approach to information processing (Hayes & Allison, 1998). Cognitive styles can be divided into the subcategories of learning styles, cognitive strategies, and cognitive abilities. Learning styles are defined as the methods consistently employed by individuals to interact with the learning environment. Cognitive strategies are tactics employed by learners to expedite knowledge gain (Smith & Ragan, 1999). Cognitive abilities involve the application of mastered content knowledge to performance (Hayes & Allinson, 1998).

Executive function: the controller of working memory (Baddeley, 1992, 1993, 1996).

Mental representations: transformed physical input from stimuli into codes that memory will accept (Massaro & Cowan, 1993).

Phonological loop: area of the brain that is responsible for verbal processing (Baddeley, 1992,1993,1996).

Schemata: mental representations of classes of people, objects, events or situations found in long-term memory (Atkinson, Atkinson, Smith, Bem, & Nolen-Hoeksema, 2000; Cross, 1999).

Visuo-spatial sketch pad: areas of the brain responsible for visuo-spatial processing (Baddeley, 1992, 1993, 1996).

CHAPTER 2: REVIEW OF THE LITERATURE

The purpose of this literature review was to identify stages in the information processing paradigm that are affected by individual differences in students and to apply this knowledge to the development of a strategical information processing style assessment. Such an assessment could be used by educators to predict and improve their students' academic performance. According to Jacobson (1998), "the current education system is in dire need of modification in order to keep pace with current technological advancement of society. As educators, we must consider the research and create an educational system that will meet the needs of a progressive society" (p. 579).

This literature review aspired to bridge research from the fields of cognitive psychology, neuropsychology, and educational psychology to the field of education. Using a reductionist approach, the first step in this endeavor was to review the theoretical foundation of the information processing paradigm that originated with the cognitive psychologists (Baddeley, 1993; Broadbent, 1958). Synchronously, the author will present research findings from the fields of neuropsychology (Posner & Raichle, 1994) and educational psychology (Bonner, 1988; Kalyuga, Chandler & Sweller, 1998). Cognitive psychologists postulate how the information processing system functions, the neuropsychologists attempt to identify the neurological structures that are responsible for these functions, and the educational psychologists attempt to discover ways to improve these functions in students. Researchers in all of these fields have identified areas of individual differences in the information processing system. The application of this empirical data to the area of education can assist educators in identify and evaluating

individual differences in their students. Assessments of individual differences can be used by educators to improve the students academic performance (Paivio, 1991).

This literature review is divided into seven major sections: the general characteristics of the information processing paradigm, the information processing stages of: attention, sensory memory, working memory, and long-term memory, individual differences in information processing, and the application of the information processing theory to education. The information processing theory contends that stimuli that enter the sensory system are processed in stages and substages. The stages include attention, sensory memory, working memory, and long-term memory. Attention can be divided into substages that include preattention, selective, and sustained attention. Working memory can be divided into three systems that include: the phonological loop, the visuospatial sketch pad, and executive control or function (Baddeley, 1992, 1993, 1996; Broadbent, 1958). Long-term memory can be divided into procedural memory, episodic memory, and semantic memory (Tulving, 1993). Individual differences in cognitive styles have been identified in the areas of perception (Gallagher, 1994; Massaro & Cowan, 1993), attention (Kok, 1999), working memory (Das, Naglieri, & Murphy, 1995; Kyllonen, 1993), and long-term memory (Clark & Paivio, 1991; Paivio, 1991).

The General Characteristics of The Information Processing System

In cognitive psychology, the information processing paradigm was used to postulate how the human brain functions (Baddeley, 1992, 1993; Broadbent, 1958; Massaro & Cowan, 1993). This model consists of several stages of processing: attention, sensory memory, working memory, and long-term memory. According to the cognitive theory of reductionism, each stage can be functionally divided into substages. For

example, long-term memory can be broken down into the substages of encoding, storage, and retrieval. Retrieval can be further divided into memory search and decision (Massaro & Cowan, 1993; Mecklinger & Muller, 1996).

As the information is transmitted through the stages of processing, it is transformed into representations by the processors or resources operating at that level. As the stimulus enters the sensory receptors, it is converted to a sensory representation. For example, a single green visual stimulus appears in the subject's field of view. The green color transmitted by the object is focused on the retina of the eye. As the green light waves impact the retina, the energy produced creates a pulse that transverses the optic nerve to the sensory receptors in the extra striated areas of the occipital lobe. The sensory receptors generate a sensory representation that is transmitted to the next processing stage depending on the demands of the task (Massaro & Cowan, 1993; Torgesen, 1996).

Even after being transmitted and transformed, the representations retain their integrity at the previous stage of processing. Thus multiple representations are maintained at each stage. Massaro and Cowan (1993) used the example of the tympanic membrane of the ear to explain this phenomena. Consider sound waves as the stimulus. When the sound waves collide with the tympanic membrane, they do not loose their integrity. They simply change direction as they bounce off of the membrane (Massaro & Cowan, 1993).

As information is transmitted through the information processing system, the transmission can be continuous or it can be discrete. In the continuous model, information is in the process of changing and moving continuously. In the discrete model, information does not flow to the next stage until processing is achieve.

Continuous or discrete processing depends on the nature of the task and the individual's cognitive style. According to Massaro & Cowan (1993), "continuously formed information sometimes may be transmitted in discrete packages when the tasks demands discourage the use of partial information and encourage delaying the response until more complete information is available" (p. 394).

Information processing can be serial or parallel. Sanders (1990) posited that discrete transmission requires serial processing and continuous transmission involves parallel processing. Discrete transmission results in serial processing, involving the sequential movement of the stimulus from one stage to the next. Discrete models involve computations that require step-by-step processing. At some stage in the discrete transmission, processing can be parallel especially in stages that require top-down activity such as familiarity. Continuous transmissions are associated with parallel processing. Serial processing occurs when one item is handled at a time and parallel processing involves handling multiple items at one time (Clark & Paivio, 1991; Massaro & Cowan, 1993). According to Clark and Paivio (1991), verbal representations are limited to serial encoding. When relating a story or giving a lecture, the story teller or lecturer relates information in a sequential manner. Carpenter, Georgopoulos, and Pellizer (1999) using monkeys as subjects, presented strong evidence verifying that motor tasks are processed serially. Nonverbal representations are examples of parallel processing. Distinct mental images are simultaneously encoded and can be spatially implanted to form a global structure. The distinct parts of a car fade together to form the whole car. Mental images can be encoded as "dynamic spatial transformations" (Clark & Paivio, 1991, p. 152) such as the movement of the car or the bouncing of a basketball.

Parallel processing can be uninhibited or it can be affected by interference. Massaro and Cowan (1993) identified two types of parallel processing: "capacity-free parallel processing" and "capacity-limited parallel processing" (p. 394). Capacity-free parallel processing involves processing that is free of interference. For example, a subject is instructed to select a yellow ball and the yellow ball is the only stimulus. Capacity-limited parallel processing is accompanied by interference or processing of irrelevant stimuli (Massaro & Cowan, 1993). The subject is instructed to select a yellow ball from an array of several different colored balls.

A. R. Luria described three functional units of human cognitive processing system. The first unit in the system involves arousal/attention and is located in the brain stem. The second unit involves information encoding, analysis, and storage by simultaneous and successive processes. The simultaneous processors are found in the occipital-parietal lobes of the brain. Simultaneous processing entails processing related elements. The frontal temporal areas of the brain are responsible for successive processing, which entails linear processing of stimuli. The third unit involves planning and organization and is located in the frontal cortex. Based on this theory, Luria developed the PASS model, which evaluated planning, attention, simultaneous and successive processes (Das et al., 1995; Sternberg & Kaufman, 1998).

The Information Processing Stage of Attention

Attention is the first stage in the information processing system examined in this study. This analysis of attention includes a description of selective attention and sustained attention followed by a review of the paradigms of how attention functions in the selection of stimuli, facilitation, and inhibition.

Successful learning results from the ability to be able to attend to the educational environment. Attention is required before any learning experience is possible since details from the environment must be combined to form the global presentation of an object or information to be processed (Treisman, 1993). According to Sergeant (1996), there were two major categories of attention: selective attention and sustained attention. Selective attention involves focusing attention on a particular input while synchronously ignoring task irrelevant stimuli (Harnishfeger, 1995; Sergeant, 1996). Sustained attention involves maintaining performance over time. Posner and Raichle (1994) have further divided selective attention into visual orienting attention and executive attention. Visual orienting attention is overt attention that involves saccades or eye movements that jump in rapid succession. Treisman (1993) referred to orienting as the preattentive stage. Orienting can also be observed in other modalities such heart rate and body movement. Graham (1992) described two types of orienting as presented in Sokolov's orienting theory: "nonsignal/generalized" orientation and "signal/localized" orientation (p. 4). The second category of selective attention as proposed by Posner and Raichle (1994) was executive attention, which is a covert attention that is required when individuals must categorize thought processes to correspond to a given set of instructions.

Selective Attention. The network for visual orienting selective attention, as presented by Posner and Raichle in 1994, involves circuitry that starts in the parietal lobe. According to Sergeant (1996), attention or arousal was locked in time to a stimulus. Attention is disengaged or released from its current focus by signals from the posterior parietal lobe. The parietal lobe than signals the superior colliculus in the midbrain to move the attention spotlight to the new location. Mirsky (1996) referred to this movement

as "shift" which he defined as "the capacity to switch attentional focus from one aspect of a stimulus complex to another in a flexible, efficient manner" (p.77). The pulvinar in the thalamus selects and enhances the content from the attended stimulus. Next, the selected content is sent to the prefrontal cortex of the brain for processing (Knight, Staines, Swick, & Chao, 1999; Posner & Raichle, 1994). Treisman (1993) contended that the networks or circuits described by Posner and Raichle (1994) contained several functional and anatomical parallel analyzers that are involved in the visual attention process. There is an analyzer for motion, color, and location. However, based on personal research, Duncan (1993) contended that "the action of the limited capacity system is to make available whole object descriptions for control of behaviour" (p. 57). Duncan posited that "selective attention maybe a state developing in concert across the multiple extra striate (of the occipital lobe) areas that deal with a selected objects different attributes" (p. 61).

According to Posner and Raichle (1994), studies involving patients with damage in the superior parietal lobe indicated that these patients lost the ability to zoom in and out or focus their attentional spotlights. The ability that is lost depends on the hemisphere that is damaged. Patients with left hemisphere damage neglected the smaller letters (details) when asked to draw a picture of a large letter constructed from small letters. Patients with right hemisphere damage report the small letters and omit the large one (Posner & Raichle, 1994).

In her description of selective attention, Treisman (1993) referred to visual orienting attention as preattention. Preattention involves an individual's first glance at an object yielding only its simple features (color, orientations, and shape). Preattention does not require access to working memory and is automatic. Automatic processing is

unlimited, parallel on different inputs, and effortless (Graham, 1992; Schneider & Shiffrin, 1977; Sergeant, 1996). Subjects are not aware of automatic processing, which is independent of intentions and processing resources (Ohman, 1992). According to Graham (1992), Sokolov's orienting theory defined preattention as "nonsignal or generalized" orientation.

According to Treisman (1993), unattention happened when a stimulus was ignored because attention was focused on another object in the individual's surrounding environment. Divided attention attends to the global features of the environment such as the dimensions of color and orientation. Focused attention is used for examining the details of the object. Mirsky (1996) defines focus as "the capacity to concentrate attentional resources on a specific task and to be able to screen out distracting peripheral stimuli" (p. 76). The attention window widens and narrows as the preattentive and attentive processes take place. Kok (1999) referred to Treisman's attention window as an attentional spotlight. If the attentional spotlight is actively focused on a stimulus, then visual stimuli outside the focused area stay unattended.

PET (Positron Emission Tomography) scans revealed evidence that the area of the brain activated during tasks requiring executive attention is the anterior cingulate gyrus. This area is activated when subjects must organize thought processes according to instructions such as those involved in the Stroop test. In the Stroop test, the names of the colors are written in colored ink that is not the same as the name of the color. For example, the word red is written in green ink. The Stroop test introduces conflict and requires effortful attentive processing (Kok, 1999; Posner & Raichle, 1994). The stimulus moves into the subjects conscious awareness. The subject becomes consciously

aware of the fact that the colors of the letters and names of the colors are incompatible. Naming the color of the ink used for the names of colors is recognized as part of a goal. The tasks requires access to working memory because of the incompatibility of the name of the color and the color of the ink used to write the word. This access to working memory dictates controlled information processing. Controlled information processing has a limited capacity, is conscious, voluntary, sequential, and effortful (Graham, 1992; Ohman, 1992; Schneider & Shiffrin, 1977; Sergeant, 1996). Subjects are able to regulate attentional processes in a way that allows them to choose the stimulus necessary to achieve a goal (Drose & Allen, 1994).

Sergeant (1996) contended that selective attention is closely associated with executive function. "Tasks require effort for them to be performed and resources are allocated according to the demands that they place upon the central resource pool. Priority assignment to and between tasks, their planning and coordination have become recognized as important functions of the attentional system" (Sergeant, 1996, p.62). According to Graham's description of Sokolov's orienting theory, a "signal/localized" orientation results from contemplation of a certain stimuli (Graham, 1992).

Sustained Attention. Posner and Raichle (1994) illustrated with PET scans that the network for sustained attention involves areas of the brain in the right frontal and parietal lobes. According to Knight et al. (1999), sustained attention to a stimuli was a function of the prefrontal cortex. Individuals with injury to the prefrontal cortex are not able to sustain attention among many other disabilities. The prefrontal cortex plays an important role in controlling the interaction with the outside environment.

PET scans revealed an increased activity in the prefrontal cortex as well as inactivity in the anterior cingulate gyrus (the site of increased blood flow in executive attention). Sustained attention decreases activity in the anterior cingulate gyrus, the site of executive attention, in order to facilitate faster handling of information involved in objective recognition by the orienting network (Kok, 1999; Posner & Raichle, 1994). Mirsky (1996) defined sustained attention as attention that "entails being able to stay on task in a vigilant manner for appreciable intervals" (p. 76). Sustained attention is defined as "a skill of maintaining controlled processing performance over time" (Sergeant, 1996, p.63). According to Broadbent (1958), attending to a task for long periods of time may resulted in the loss of attention. Sustained attention is an important function in relation to learning, since learning requires continuous processing over time. Regardless of how well-known the task is to the individual, "monotonous situations and lack of stimulation produce decreased efficiency" in learning and attention (Broadbent, 1958, p. 126). Knight et al. (1999) posited that sustained attention is used in "order to perform delay and working memory tasks" (p. 169).

Facilitation and Inhibition. Some of the major questions puzzling researchers about selective attention are: At what stage of attention are stimuli selected as relevant or irrelevant? Are stimuli identified and analyzed as relevant or irrelevant before or after selection? Some theories support early selection of stimuli before analysis and identification and are called early selection theories. Other theories support analysis and identification of stimuli before selection and are called late selection theories. Other questions puzzling researchers concern the processes of facilitation and inhibition and the part that these processes play in selective attention. Stimuli that are designated as

relevant are facilitated for further processing and those that are selected as irrelevant are inhibited and eventually dissipate. According to Neill, Valdes, and Terry (1995), facilitation or priming was the processing of relevant stimuli and inhibition or negative priming is the blocking of irrelevant stimuli from working memory.

One paradigm that is an early selection theory is Broadbent's Filter Theory. In 1958, Broadbent in his book, Perception and Communication, asserted that information entering the limited capacity system is filtered. Only the information that is intense or novel will be selected for processing. Schneider and Shiffrin (1977) contented that the basis of Broadbent's Filter Theory was that several stimuli are processed in parallel until they reach the filter. At this point the filter, acting like a channel, switches on or off. Thus selecting the stimuli that will reach the limited capacity processing system and inhibiting the stimuli that are irrelevant. The filtering occurs early in the processing system before identification and analysis of the stimuli (Graham, 1992; Neill et al., 1995). Duncan (1993) suggested that stimuli are selected based on an attentional template. This template specifies what information is important for goal selection.

Recent empirical research lends validity to Broadbent's early filter theory. Kok (1999) argued that there could be "independent selection processes" that are connected with the processing of relevant verses irrelevant stimuli. When told not to attend to certain visual and auditory stimuli (negative priming), subjects still showed electrocortical response in waveforms when the irrelevant stimuli moved into the field of view or were heard. These waves appeared early in the visual processing, which could mean early inhibiting or filtering. Recent experiments using spatial cuing indicate that processing for controlled as well as automatic visual attention happens early during the

task (Kok, 1999; Posner & Raichle, 1994). Neill et al. (1995) contended that negative priming depended on the physical feature of the ignored objective and the characteristics of the task to be performed. Subjects do not inhibit everything in the environment. The amount of information that can be inhibited has a limited capacity (Neill et al., 1995).

A late selection theory discussed by Schneider and Shiffrin (1977) in their article was Treisman's Attenuation Theory. In this theory, the filter under the control of the individual switches between attended and unattended channels allowing non attended as well as attended stimuli to be processed. The unattended information is attenuated or weakened. In support of Treisman's theory, Schneider and Shriffin (1977) contended that the locus of control for selective attention and divided attention occur late in the information processing system.

Another late selection model was Ohman's model of orienting (1992). A stimulus input enters a preattentive automatic stage. In this preattentive stage, the input can follow either of two routes. If the input is matched with long-term memory stores via an activated short term memory, then the subject is able to interpret the environment producing the stimulus. The signal route is activated and control is transferred to the central capacity system for further stimulus processing. The signal route results from the anticipation of a particular stimulus. However, if the stimulus cannot be matched to stored information, then the nonsignal route is activated and working memory is allocated to further analyze the stimulus. The nonsignal route is involuntarily summoned by an unique stimulus. In either situation, the stimulus moves into the consciousness and becomes the focus of attention. One shortcoming of Ohman's model was its failure to explain how irrelevant stimuli were inhibited (Ohman, 1992).

The time of stimuli selection and identification can depend on the individual characteristics of the object. According to Nicholls and Wood (1998), both the right and left hemispheres process words in word recognition exercises. However, the processing is done in different levels of attention according to the Attentional Advantage Model. The right hemispheres is slower because it processes the letters and the spatial characteristics; whereas, the left hemispheres is faster because it recognizes the whole word. Therefore, word recognition in the left hemispheres follows the late selection models that suggest that recognition takes place in the preattentive stage and is automatic. Word recognition in the right hemisphere follows the early selection model suggesting that word recognition results after selective attention and is controlled (Nicholls & Wood, 1998).

Bourgeois, Christman, and Horowitz (1998) proposed an attentional focus model consisting of two systems: one that categorizes and one that is more vigilant and individualizes. The investigators suggested that two processes are involved in the visual perception of individuals. The left hemispheres is involved in making categorical judgements such as deciding if the stimulus is male or female (stereotyping) and the right hemisphere is involved in making judgements about attributes such as individual traits of the stimulus (Bourgeois et al., 1998).

The Information Processing Stage of Sensory Memory

There are many theories in psychology involving memory and the number of memory systems existing in the human brain. Spear and Riccio (1994) estimated that there are a maximum of three memory systems. Contrary to Spear and Ricco, Tulving (1993) posited that there are five memory systems: procedural memory, perceptual

representation system, short term memory, and long-term memory that includes semantic memory and episodic memory. Torgesen (1996) theorized that the three human memory systems are sensory storage, working memory, and long-term memory.

Several memory systems have been classified corresponding to function (Spear & Riccio, 1994) and location (Bradshaw, 1989; Posner & Raichle, 1994). Each memory system is involved in the encoding, storage, and retrieval of information. The sensory storage is involved in attention and perceptual processing (Torgesen, 1996). Working memory consists of the executive function and two subsystems: the phonological loop and the visuospatial sketch pad (Baddeley, 1992, 1993, 1996). The executive function is located in the prefrontal cortex, the phonological loop includes several areas in the left hemisphere, and the visuospatial sketch pad is located in the right hemisphere (Bradshaw, 1989; Posner & Raichle, 1994). Executive function is goal-oriented and is important in problem solving. The phonological loop is the key language area in humans and the visuospatial sketch pad is responsible for spatial skills and imagery (Baddeley, 1992, 1993, 1996). Other researchers contended that the two components of long-term memory are declarative or explicit memory (Tulving's semantic and episodic memory) and nondeclarative or implicit memory (Bachevalier, Malkova & Beauregard, 1996; Ragland, Gur, Deutsch, Censits & Gur, 1995). Gathercole (1998) further divided episodic memory into autobiographical memory and episodic memory.

In his 1993 publication, Parker reiterated Craik and Lockhart's (1972) explanation of the function of the sensory registers as collectors of external stimuli. According to Parker (1993), the sensory registers act like holding bins for stimuli. External stimuli enter the sensory registers whether the individual receives them consciously or

unconsciously. Blanton (1998) contended that the stimuli that have a better chance of being processed and sent to long-term memory are those that receive attention or those that the individual actively seeks out. Parker (1993) asserted that there is a direct connection between long-term memory and the sensory receptors. Thus stimuli that activate long-term memory directly by connecting to previously stored knowledge are candidates for further processing. Sensory receptors also connect directly to the autonomic nervous system; therefore, stimuli that induce feelings are candidates for storage in long-term memory (Parker, 1993).

Craik and Lockhart (1972) and Parker (1993) acknowledged that the format of information entering the sensory registers is based on modality. Although the researchers agreed on the time that visual information is retained in the sensory register, Craik and Lockhart (1972) contended that stimuli regardless of modality remain in the sensory registers for less than three seconds. Parker (1993) maintained that auditory stimuli remain in the sensory registers for four seconds and haptic stimuli remain for an indeterminate amount of time. Parker (1993) claimed that 99% of the information entering the register is lost or dumped. Craik and Lockhart (1972) referred to information loss from the sensory registers as decaying.

The Information Processing Stage of Working Memory

The second level of memory discussed by the researchers was short-term or working memory. The researchers agreed that for stimuli to enter short term memory, it must receive attention. If information receives continued or sustained attention, it will be recirculated or rehearsed. Information remains in short term memory for between 20-30 seconds (Craik & Lockhart, 1972; Kalyuga et al., 1998; Parker, 1993; Smith & Jonides,

1999). Consequently, information that does not receive attention is "dumped" or decays (Craik & Lockhart, 1972; Parker, 1993). Information can undergo two types of rehearsal, rote memorization which is encoding for working memory or elaborate rehearsal, which is encoding for long-term memory. In rote memorization, information is lost when attention is diverted. However, stimuli that are meaningful are connected to items in long-term memory (Atkinson et al., 2000; Parker, 1993).

Several researchers agreed that the capacity of short term memory is small or limited (Baddeley, 1992, 1993, 1996; Broadbent, 1958; Craik & Lockhart, 1972; Kalyuga et al., 1998; Parker, 1993). Parker (1993) referred to short term memory as a "conveyor belt with about seven slots" (p. 11) for information. The researchers agreed that learning is stressed when short term memory is overloaded. They contended that only a few items or chunks of data can be processed in working memory at one time. The working memory system has a limited capacity and can hold only a certain number of bites of information (Baddeley, 1992; Broadbent, 1958; Logie, 1999). Working memory is limited to a capacity of six or seven single syllable words (Hulme, Neton, Cowan, Stuart, & Brown, 1999). When more the seven single syllables of information are presented to working memory, the learner is unable to remember all of the presented data (Logie, 1999).

The model of working memory proposed by Baddeley and Hitch in 1974 consists of the phonological or articulatory loop, visuospatial sketch pad, and the executive function (as cited in Baddeley, 1992, 1993, 1996; Torgesen, 1996). The general function of the working memory system is the temporary storage and integration of internal and external information necessary to make a decision or solve a problem.

The phonological loop. The phonological loop provides a buffer for the temporary storage of verbal material as well as functioning as a language rehearsal system (Baddeley, 1992; Logie, 1999). The articulatory loop is important in language acquisition and speech comprehension (Baddeley, 1993). PET scans done by Posner and Raichle (1994) while individuals participated in lexical tasks, following a hierarchical design, illustrated the areas of the brain that make up the phonological loop. When the subject passively viewed words, areas in the primary visual cortex (occipital lobe) were activated. An increased lateral activity was demonstrated in the left hemisphere. Areas in both the temporal lobes of the right and left (Wernicke's area) hemispheres were activated when the subject listened to words. When speech was produced, bilateral areas of the motor cortex, the insular cortex and the middle cerebellum were activated as well as Wernicke's area in the left posterior temporal lobe. When subjects were instructed to generate verbs, several areas of the brain were activated. Activated areas included the left frontal cortex that included Broca's area, the anterior cingulate, the left posterior temporal lobe (Wernicke's area), and the right cerebellum (Posner & Raichle, 1994).

The second area activated in the verb generation task was the anterior cingulate. Posner and Raichle (1994) theorized that the anterior cingulate plays a role in internal selective attention. Smith and Jonides (1999) posited that the anterior cingulate functions to inhibit irrelevant stimuli in selective attention.

The activation of the cerebellum which plays an active part in motor skills by guiding motor performance and learning, was a surprise to the Posner and Raichle (1994) due to the cognitive nature of the task. Possibly this area is involved in "guiding a

cognitive learning process in which subjects acquire a new response to the presentation of words" (Posner & Raichle. 1994, p. 124).

Torgesen (1996) contended that the phonological loop is involved in "item coding and the process of translating sensory input into a representational form that can be efficiently stored in memory" (p.160). The loop functions in the verbatim storage of verbal information including the words as well as the sequence of the words in a list. Researchers theorized that the loop is composed of a phonological store and an articulatory control process (Baddeley, 1993; Torgesen, 1996). The store temporarily holds a memory trace or coded representation of the stimulus. This trace will decay in two seconds unless refreshed. Hulme et al. (1999) argued that the speech representations last three and sixth-tenths of a second (3.6s) for words and two and eight-tenths of a second (3.8s) for nonwords. The articulatory control serves as a processor that renews or establishes the trace by activating inner speech or visual areas of the brain. The processor can capture visual information such as concrete words in the phonological stores by silent rehearsal (Baddeley, 1993; Torgesen, 1996).

Due to the relationship between verbal temporary memory and the speech motor system, the repetition of an irrelevant word such as "the" in a forward digit span task will result in a serious disruption of memory (Baddeley, 1993; Logie, 1999; Torgesen, 1996). This phenomena is known as interference and is termed articulatory suppression. Articulatory suppression prevents the individual from transforming visual representations into phonological codes by subvocal rehearsal (Baddeley, 1993).

In the acoustic similarity effect, letters with similar sound features such as the letters v, t, and z are more difficult to recall than those with distinctive features such as r,

h, and s (Logie, 1995; Torgesen, 1996). With regard to the word length effect, a sequence of short words such as 'cat, sky, kid' is easier to remember than a sequence of long words such as 'automobile, encyclopedia, elephant' that take longer to pronounce. The articulatory control requires more time to process longer words because the longer the word, the longer it takes to pronounce the word. The temporary memory traces of the words at the beginning of the sequence decay before they can be established in memory (Logie, 1995, 1999; Torgesen, 1996). Logie (1999) contented that the phonological loop is important in counting and mental calculations.

In 1996, Torgesen cited the results of a factor analysis on various tests that researchers speculated measured the properties of the phonological loop. The forward digit span, word span, nonword repetition, and the sentence memory all load under the same construct indicating that these assessments are measuring the same item or the properties of the phonological loop. Research on the forward digit span and word span assessments shows a high correlation between the two assessments. The forward digit span and the nonword repetition and the forward digit span and the sentence repletion revealed only moderate correlation (Torgesen, 1996). Hulme et al. (1999) contended that there are two different processes involved in short term memory span for words and nonwords and for long and short words. Long-term memory processes are involved in the processing of words and nonwords. Nonwords have no long-term memory representations and are difficult to redintegrate. Thus subjects pause longer between successive nonwords than successive words. Whereas, memory span for long and short words results from variations in memory storage and not memory scan. The nonword

repetition has been used by several researchers to study language development and learning disabilities (Logie, 1999).

The visuo-spatial sketch pad. The second component of working memory is the visuospatial sketch pad. According to Brown and Kosslyn (1995), there are three levels of visual processing. The first or lower level is involved with preattention and includes visual areas in the occipital lobe. The intermediate level involves the organization of the input into perceptual groups that will identify the object and engages selective attention. As the global and detailed representation of the objects are processed, the areas of the brain in the inferior temporal cortex are activated. Mecklinger and Muller (1996) presented evidence that this processor is for color and shape and that there is a second processor for location and size situated in the parietal lobe. Smith and Jonides (1999) posited that spatial storage tasks activate the right premotor cortex. At the high level of specialization, the coded representations of the object are matched with images stores in memory (Brown & Kosslyn, 1995). Object storage activates cells in the ventral regions of the right prefrontal cortex (Smith & Jonides, 1999).

Bachevalier et al. (1996) contended that there are two neural circuits depending on the visual information. Information that is represented in procedural memory does not enter working memory but proceeds to the premotor supplementary motor areas. Information that involves object recognition and is a form of declarative memory, is identified in the visual cortex and the inferior temporal lobe. Next, a representation of the object sequentially activates neuron circuits in the medial temporal lobe, the diencephalon, and the prefrontal cortex. These three areas send signals to the basal

forebrain. Whenever the sample stimulus is experienced, these circuits are reactivated strengthening the representation (Bachevalier et al., 1996).

The executive function. According to researchers, executive function is located in the prefrontal cortex (Denckla, 1996; Grafman & Litvan, 1999; Posner & Raichle, 1994; Smith & Jonides, 1999). The neurons in the prefrontal lobes are richly connected to the limbic system as well as other areas of the brain. These rich connections give the executive function access to information from many areas of the brain as well as control over these areas (Barkley, 1996). Baddeley (1996) contended that " the frontal lobes are often involved in many executive processes, other parts of the brain may also be involved in executive" (p. 7). Consequently, the researcher contended that the executive function should be defined in functional rather than in anatomical terms (Baddeley, 1996).

The phonological loop and the visuospatial sketch pads are memory systems, each with a unique function. Each system can act as a short term memory system or a subsystem of the executive function. However, Lehto (1996) contended that executive function maybe more than one system. Executive function controls processing involved in cognition and metacognition and is linked to long-term memory (Baddeley, 1993). According to Borkowski and Burke (1996), executive function was the "maintenance and generalization of behaviors across time and settings" (p. 235). Executive function monitors and controls higher level processes involved in self-regulation such as developing and executing plans, organizing activities, conforming to rules of ethical and social behavior, flexibility in dealing with situations involving sudden changes, and evaluation of complex emotional situations (Borkowski & Burke, 1996; Eslinger, 1996; Grafman & Litvan, 1999).

Borkowski and Burke (1996) developed a model illustrating the processing stages used by executive function in a problem-solving task. First, the task is analyzed by the executive processor to determine the steps and the sequence of the steps involved in solving the problem. Next, the individual's processor selects and monitors strategies necessary to solve the problem. The final stage in the model is strategy revision based on feedback. Once the problem-solving task is complete, this feedback enables the individual to correct any mistakes and develop a revised mental model that can be used to solve problems in the future (Borkowski & Burke, 1996).

<u>The Information Processing Stage of Long-Term Memory</u>

The last stage of memory discussed in this review is long-term memory. Long-term memory stores consists of explicit declarative memories that can be divided into semantic memories and episodic memories. Semantic memories contain explicit knowledge of events such as information learned in school. Episodic memories contain explicit information about personal events such as high school graduation or an individual's birthday. Implicit, nondelcarative memory involves procedural, priming, conditioning and nonassociative memories. These memories involve direct performance and stimulate motor areas in the brain (Atkinson et al., 2000; Ragland et al., 1995; Tulving, 1993).

According to Ragland et al. (1995), the explicit declarative memory stores are in the median temporal lobe and the limbic region of the brain and primarily involve the hippocampus. The hippocampus is the primarily limbic structure involved in long-term memory storage. Long-term memory stores are lateralized with verbal declarative memory being stored in the left hemisphere and visual memory stores existing in the right

hemisphere (Ragland et al., 1995). Rotenbery and Weinberg (1999) contended that left and right asymmetry can be attributed to the design of the neuron patterns in the two hemispheres. The neuron connections in the left hemisphere are successive or serial. Therefore, the left hemisphere organizes information in a logical ordered format. Thus information stored in the left hemisphere can be used when performing sequential analysis. "That type of thinking strategy makes it possible to build a pragmatically convenient, but simplified model of reality based on probability forecasting and a search for concrete cause-and-effect relations" (Rotenbery & Weinberg, 1999, p. 45).

According to Tulving (1993), the two higher memory systems of long-term memory are the semantic memory and the episodic memory systems. These two memory systems are the last to develop in the human mind and their operations are dependent on the operation of the lower systems such as working memory. The semantic memory is formed by the acquisition and storage of concepts that make up the world. Tulving (1993) claimed that the knowledge found in semantic memory is implicit; that is, it influences cognitive activities without the individual's awareness of having the knowledge. Other researchers referred to semantic memory as declarative memory or explicit knowledge and define it as memory for factual information (Ragland et al., 1995). Semantic memory begins to develop prior to the development of the episodic memory system. Therefore, episodic memory is dependent on semantic memory. As episodic memory develops explicit knowledge, it is stored as personal events or as autobiographical memory (Gathercole, 1998, Tulving, 1993).

Tulving (1993) developed the "co-ordination hypothesis" (p. 293) which predicts that information is stored at different levels of memory and that the retrieval of

information is dependent on the level at which it was encoded. Information encoded by a lower memory system cannot be retrieved by a higher memory system. Information stored in working memory cannot be retrieved from semantic memory. It must be encoded in semantic memory in order to be retrieved from semantic memory (Tulving, 1993). Educators should consider this hypothesis when evaluating students. Students should be evaluated at the level of awareness that they were taught. When students are taught how to do a procedure, they will be able to do the procedure. However, they will not be able to trouble shoot the procedure unless they are aware of episodic events that could happen while performing the procedure.

Craik and Lockhart (1972) suggested that information that is rehearsed is encoded for long-term memory as long as is meaningful and undergoes deep processing. Deep processing involves intense analysis of the stimuli and leads to enhanced memory performance. The process of comprehension involves creating mental models that reflect the activation of semantic memory (Baddeley, 1996). Parker (1993) contended that stimuli that create an emotional jolt and connect directly to the autonomic nervous system have a better chance of being encoded for long-term memory. Stimuli that individuals consciously seek are contenders for processing and storage in long-term memory (Craik & Lockhart, 1972; Parker, 1993).

Craik and Lockhart (1972) asserted that information is maintained in long-term memory as memory traces. Parker (1993) referred to the organization of items in long-term memory as schemata. Craik and Lockhart (1972) claimed that the format of information in long-term is largely semantic. The researchers agreed that long-term memory has no known limit or capacity and that information is never lost; however,

overtime the accessibility or retrieval cues to the information are lost (Atkinson et al., 2000; Craik & Lockhart, 1972; Parker, 1993). According to Parker (1993), teaching strategies can serve as cues that enhance retrieval or accessibility to stored items.

Parker (1993) contended that items are encoded in memory as in words and pictures. Dual coding is one of the strategies that can be used by executive function to encode information for storage in long-term memory. According to Paivio's Dual Coding Theory (1991), the memory and comprehension of information are enhanced if the stimuli are encoded both verbally and as images. Paivio (1991) contended that there are three different networks found in memory. The referential networks connect words to nonverbal representations such as visualizing the word "boat" or labeling objects. The associative connections link words to other words, such as the words boat and lake, or images to other images such as the image of a boat to the image of a lake. The representational processes are activated by familiar stimuli or experiences (Paivio, 1991).

Clark and Paivio (1991) posited that for concrete words subjects used imagery more often than they used verbal strategies. For abstract words, subjects used verbal strategies more often than they used imagery strategies. Strategies using imagery correlated moderately with free and cued recall of both abstract and concrete words. The researchers found a high correlation between the use of verbal strategies, cued recall and abstract words and a low correlation between verbal strategies, cued recall and concrete words. In contrast, Drose and Allen (1994) argued that recognition performance (cued recall) was better for concrete sentences than for abstract sentences. Other researchers found a high correlation between concrete sentences and cued recall and concrete paragraphs and free recall in an accessible sample of undergraduate students taking a

reading education course at Texas A & M (Sadoski, Goetz, & Fritz, 1993). In the same study, Sadoski et al. (1993) found a high correlations between recall of concrete information and comprehension, a moderate correlation between concreteness and interest, and a low correlation between concreteness and familiarity.

In 1999, Holcomb, Kounios, Anderson, and West published a study using event-related potentials (ERP) to determine if concrete and abstract sentences stimulated different waveforms. The researchers concluded that both sentence concreteness and context play an important role in language comprehension. They also found that the ERP for concrete sentences is different than the ERP for abstract sentences. These finding support the Dual Coding theory and the contention that there are referential, associative, and representational networks and processors.

According to the Cognitive Schema Theory, researchers have explained the architecture of the long-term memory in terms of schemata. Bonner (1988) and Derry (1996) defined schema as structures used to represent knowledge in memory. According to Derry (1996), information in long-term memory is stored in the form of schemata. These schemata are presented to working memory where thinking and learning occur. In 1996, Derry divided schemata into memory objects, mental models and cognitive fields. The memory objects form the building blocks for mental models. According to Bonner (1988), these objects contain both declarative and procedural components. Kalyuga et al. (1998) referred to these memory objects as subelements that are linked together to form a single element. Once subelements combine to form a single element, they can be transferred to working memory without overload. Blanton (1998) referred to memory objects as isolated concepts that are connected together to form mental maps.

According to Derry (1996), mental models are organized patterns of memory objects that are constructed for the understanding of a certain phenomena. Kalyuga et al. (1998) theorized that subelements combine to form one element, such as lines and angles combine to form shapes. Blanton (1998) referred to mental models as mental maps that connected isolated concepts and relate them together to form a "deep abstract concept" (p. 171).

In her 1996 article, Derry referred to cognitive fields as mediators between learning and experiences. These patterns of memory activation occur in response to a particular experience and connect to familiar memory objects to build a memory model. According to Bonner (1988) and Mayer (1996), experiences contribute to the meaning and understanding of the active process of learning.

Blanton (1998) contended that learners must be aware of what they know, so that they can bridge new information to background knowledge which already exist in designated schemata. Bonner (1988) and Derry (1996) contended that schemata enable learners to make inferences to fill in gaps and complete mental models.

If schemata are activated automatically, then the load on working memory is reduced. According to Kalyuga et al. (1998), schemata are stored in memory with varying degrees of learning. The more assimilated a skill is, the more automatically it is performed. Bonner (1998) affirmed that there are three stages of skill acquisition: those concerned with declarative knowledge, those concerned with procedural knowledge, and autonomous skills. Once the individual reaches the autonomous stage, they can perform the skill without thinking about the tasks (Bonner, 1988). Schemata stored in the automatic form make limited demands on long-term memory and can be recalled without

a conscious effort. Such automatic schemata require less attention and allow working memory to work on other aspects of problem solving (Bonner, 1988; Kalyuga et al., 1998).

According to Robins and Mayer (1993), teachers should facilitate a learning environment that enables the formation of relational schemata. Schemata formation includes encoding terms, inducing relationships, applying relationships, and responding. During schemata formation, working memory should not be overloaded. The researchers found that students learned analogical reasoning skills best when presented with example problems, answers, and solutions. They described this presentations as a "schematic-low load" (Robins & Mayer, 1993, p. 533).

Individual Differences in Information Processing

Hayes and Allinson (1998) defined cognitive style as an individual's "preferred approach to information processing" (p. 847). Cognitive style is multifacet (Sternberg & Kaufman, 1998). When teaching students, the multifacet nature of cognition must be addressed (Howard-Rose & Winne, 1993). Cognitive styles can be divided into the subcategories of learning styles, cognitive strategies, and cognitive abilities. Learning styles are defined as the methods consistently employed by individuals to interact with the learning environment. Cognitive strategies are tactics employed by learners to expedite knowledge gain (Smith & Ragan, 1999). Cognitive abilities involve the application of mastered content knowledge to performance (Hayes & Allinson, 1998).

Individual differences in cognitive style result from processing variations in perception, attention, sensory processing, working memory, and long-term memory. An individual's cognitive style includes his/her perceptual biases, ability to select and inspect

environmental stimuli, and to sustain attention. Individual differences in working memory are observed in the subjects processing speed and accuracy and the ability to organize, interpret, and evaluate information. Self-schemata are used as a general knowledge base for processing and comprise individual differences in long-term memory's encoding, storage, and retrieval of information (Atkinson et al., 2000; Sternberg & Kaufman, 1998). The relationship of the information processing system to general intelligence (g) remains an enigma to researchers. General intelligence determines an individual's performance on psychometric or intelligence tests such as the Wechsler Adult Intelligence Scale, the Stanford-Binet Intelligence Test, the ACT or the Scholastic Assessment Test (SAT). Sternberg and Kaufman (1998) contended that general intelligence, which is determined by Intelligence Quotient (IQ) type tests, accounts for about 10% of the variation in individual differences in the area of success.

Perception. Two perceptual biases that affect information processing as well as cognitive style are identified by Massaro and Cowan (1993) as the belief bias and the decision bias. The belief bias is important in individual's interpretation of stimuli and results from an individual's perceptions. An example of a belief bias is an optical illusion. An individual's behavior is strongly affected by his/her belief bias (Massaro & Cowan, 1993). Gallagher (1994) contended that the belief systems of educators are affected by teacher efficacy, self-esteem, and self-efficacy. Teacher efficacy is the individual's belief that he/she can have a positive effect on students' learning and self-efficacy involves an individual's belief in his or her ability to perform as a teacher. Consequently, belief bias can affect the student's academic self-concept, motivation, and locus of control. A student's belief bias influences his cognitive style (Clark & Paivio,

1991). Miglietti and Strange (1998) found a higher self-efficacy and a more positive feeling among adult students in a community college math course than among traditional students in the same class. The learner centered design of the math class related significantly to the course outcomes of all of the students (Miglietti & Strange, 1998).

Durodoyle and Hildreth (1995) contended that there is a belief bias in the American Education system "highlighting the differences between African American and white children" (p. 241). African American children are more holistic learners with learning styles that are strongly influenced by their culture. The authors described the African American students as social, affective, harmonious, creative, and nonverbal learners (Durodoyle & Hildreth, 1995). As the result of focus group studies as a community college, Weissman, Bulakowski, and Jumisko (1998) concluded that black students have a difficult time when first entering a community college. These black students face negative stereotypes concerning their intellectual ability. The black students in the focus groups felt that they lacked the cognitive strategies needed to succeed in college (Weissman et al., 1998).

Decision bias is connected to locus of control, self-concept, and intrinsic motivation (Das, et al., 1995). In a quasi experimental study limited to women, Macrae, Schloerscheidt, Bodenhausen, and Milne (1999) determined that when executive function is dysfunctional, the subjects showed a memory bias toward stereotyping. When individuals divide their attention during encoding, the controlled executive function is inhibited. However, the automatic processes such as stereotyping are not affected. Individual schema knowledge is responsible for biases such as stereotyping. These structures are responsible for congruent or expected behavior that is automatic. Baddeley

(1996) contended that perceptual tasks, performed simultaneously with a random generation (working memory) task, illustrate that stereotyped schemata resulting from perceptual biases are automatically generated. When individuals encounter unexpected stimuli, they must call on executive function to reorganize their schemata or stereotypes will be automatically generated. This process is termed inconsistency resolution and it requires effort and resources (Macrae et al., 1999).

Attention. Individual differences in attention reflect cognitive abilities and different cognitive styles. As a result of research studies on individual differences in attention, several investigators contended that the ability to inhibit irrelevant stimuli is a source of individual differences in selective attention abilities (Dempster & Brainerd, 1995; Dempster & Corkill, 1999). Most empirical research involving selective attention employs tasks using negative priming or the introduction of irrelevant stimuli. An example of negative priming can be found when using a single word with multiple meanings such as "palm." When presented to a subject, all the meanings of the word are activated. The inhibition of the irrelevant meanings depends on the instructions for using the word. If the instructions include a sentence referring to a tree, then the inhibition of the irrelevant semantics occurs automatically and without intention or awareness (Harnishfeger, 1995). Neill et al. (1995) presented a model for negative priming in which the irrelevant stimuli are blocked from access to working memory by attention. The stimuli enter a system of declarative knowledge where associative knowledge is automatically activated. Next, attention selects the concepts that are to be processed in working memory and blocks irrelevant stimuli. Thus Neill et al. (1995) contended that inhibition or negative priming is not an attenuation but a blocking of stimuli. Kok (1999)

contended that there are individual differences based on age in the subject's ability to inhibit irrelevant stimuli. Selective attention is most efficient beginning in the adolescent years and decreases with age (Dempster & Corkill, 1999; Harnishfeger, 1995).

Sensory processing. Differences in sensory processing are measured in terms of cognitive abilities, a subgroup of cognitive style. Sensory processing involves visual or auditory inspection of the environment and is measured by individual assessments such as the Frequency Accrual Storage Test (FAST) and inspection time (IT) task. Pietsch and Vickers (1997) administered the FAST individually to 47 college students. The test involved exposing each subject to a number of light flashes successively, either on the right or left side of the subject. The subject must remember the sequence (left or right) and the number of flashes on each side. As a result of individual differences in limited memory capacity, the researchers postulated that macro stimulus information is represented in memory in discrete micro representation or clusters of an entire sequence of stimuli. For example, the subjects may group the stimuli as three flashes on the left, then two on the right. The all-or-none loss of these clusters due to interference and the limited capacity of working memory accounts for the variation in scores among participants (Pietsch & Vickers, 1997). Deary and Caryl (1997) argued that the FAST is a difficult task that involves the higher cognitive processing of working memory. Therefore, it is not a unique measurement of sensory processing speed. According to Deary and Caryl (1997), the inspection time (IT) task is a better measure of sensory processing. The IT task requires the subject to view two lines and determine as quickly as possible which line is longer. Deary and Caryl (1997) contended that the IT task

"provides a measure of the effective speed of intake of stimulus information and an index of limitations on the rate of stimulus processing" (p.397).

Using the IT task, Saccuzzo, Johnson, and Guertin (1994) found no ethnic differences in inspection times among children in second through sixth grade. Their study involved a sample of 160 children, stratified by gifted and nongifted categories. The categories were divided into ethnic subgroups of African American, Filipino, Latino/Hispanic, and white children (Saccuzzo et al., 1994).

Individual differences in visual processing correlated moderately with IQ-type test scores. Deary, McCrimmon, and Bradshaw (1997) found a correlation of .46 between the overall model for visual processing and psychometric test scores. The visual processing was measured using inspection time, visual change detection (VCD), and visual movement detection (VMD). The cognitive abilities were measured using the National Adult Reading Test, and the Alice Heim IV tests: Part I (verbal/numerical) and Part II (Diagrammatic reasoning). The correlations for the IT, VCD, and VMD with the Alice Heim part II were moderate to substantial ranging from .45 to .52 ($p < .001$). The correlation of visual processing with Alice Heim part II was in agreement with the result of other research studies that reported a high correlation between inspection time and performance/non-verbal IQ. When using adult subjects, the researchers found a significant negative correlation between general IQ and IT, performance IQ and IT, and low negative correlation between verbal IQ and IT (Kranzler & Jensen, 1989).

Working memory. Assessment of individual differences in working memory are based on the evaluation of cognitive abilities, a subcategory of cognitive style. Individual differences in working memory are measured in terms of memory capacity and processing

speed. The capacity of working memory involves the amount of information that an individual can retain over a short period of time. The response time (RT) is the speed at which an individual can perform a number of basic cognitive processes, which include input, encoding, short term storage, and output (Baddeley, 1992, 1993; Saccuzzo et al., 1994).

Assessments of individual differences in working memory involve the evaluation of cognitive abilities using verbal (words or digits) or visual (images) information presented as either auditory or visual stimuli. In order to measure the total ability of working memory, researchers visually presented verbal information to subjects. Examples of the types of assessments used in this project were the digit or word span tests, sentence memory tasks, and association tests. The abilities of the subsystems of working memory can be measured by varying the type of information and the modality used in the assessment. The phonological loop is measured using verbal information introduced by auditory stimulation. The visuospatial sketch pad is measured using imagery and visual stimulation. Visuospatial tasks included those that involve object recognition and location and mental rotation. Since executive function controls both of these subsystems, it is evaluated in all three types of assessments (Baddeley, 1992, 1993, 1996).

Several empirical studies have compared the working memory ability to general intelligence, general knowledge (Kyllonen, 1993; Ragland et al., 1995), GPA (Vaquero, deAstudillo, & Niaz, 1996), and psychomotor abilities (Sassi & Green, 1998). Visual and verbal abilities have been compared to executive function's reasoning ability and strategy selection (Kyllonen & Christal, 1990; Ragland et al., 1995).

Empirical studies have compared working memory abilities to general intelligence. In these studies, general intelligence was measured using the Scholastic Assessment Test (SAT), Armed Services Vocational Aptitude Battery (ASVAD), or the Wechsler Adult Intelligence Scale-Revised (WAIS-R). Dark and Benbow (1994) correlated three working memory tasks with the performance on the SAT of an accessible sample of 11- to 14-years old males and females. The working memory tasks used in the study employed either verbal or digital stimuli and measured response time on a categorization task, a memory span task, and a paired association task. The researchers determined that there were no gender-related differences in the performance on the working memory tasks in the study. However, they concluded that the ability to manipulate information in working memory is moderately correlated with high SAT math score regardless of the stimulus (Dark & Benbow, 1994).

Another study correlating working memory ability and general intelligence was conducted by Kyllonen in 1993. Correlating the data from the Cognitive Abilities Measurement (CAM) Battery and the ASVAB, Kyllonen (1993) concluded that working memory is the general cognitive factor in information processing and that there is a general knowledge factor other than working memory. Both working memory and the general knowledge factor are responsible for individual differences in cognitive abilities. There was a high interscale correlation ($\underline{r}$ = .64 - .99) between the majority of the test parameters in each battery indicating that the parameters are measuring similar constructs. These results steered Kyllonen (1993) to conclude that there is a general knowledge factor. Ragland et al. (1995) arrived at a similar conclusion after performing a factor loading using the three factors of memory, executive function, and concentration. The

researchers found that the results of the WAIS-R loaded moderately across the three factors. Thus, they concluded as did Kyllonen (1993) that there was a general knowledge factor influenced by the processing abilities of memory, working memory, and concentration.

Using an item-by-item test analysis technique, Freedle and Kostin (1997) found ethnic differences between subjects' responses on individual test items on the SAT and the Graduate Record Exam (GRE). African American and white test takers were evenly matched by total verbal scores on each exam. The African American group performed better than the white group on the more difficult verbal items. The white examinees performed better on the easier verbal items. The researchers contended that cultural differences resulted in vocabulary differences. Perhaps the two different ethnic groups use different strategies for the more difficult terms. For the easy terms, both groups use a subvocal strategy. However, for the more difficult verbal items, the African American students used an induction strategy, which gave them an advantage over the white students. This strategy involved the utilization of partial knowledge about the word to determine its meaning. The authors contended that the "use of different strategies by different ethnic groups would certainly be consistent with the idea that different groups value, experience and act on the world in slightly different ways" (Freedle & Kostin, 1997, p. 429).

Stanovich and Cunningham (1993) theorized that individual differences in information processing are associated with individual differences in general knowledge rather than general intelligence. In a study involving 268 undergraduate college students, the researchers found that exposure to printed material, such as books and magazines,

accounted for 37.1% of the variance in general knowledge. Whereas, general cognitive ability accounted for only 5.1% of the variance in general knowledge. Stanovich and Cunningham (1993) concluded that a repetitious educational environment, such as in the classroom, has a greater effect on individual differences in general knowledge than does general cognitive ability.

Vasquero et al. (1996) correlated working memory ability with academic performance. Academic performance was measured using the results of criterion based examinations in the areas of chemistry, physics, and mathematics. The researchers reported a low to moderate correlation between working memory and academic performance ($r = .17 - .31$; $p < .02$). The assessment used to measure working memory was the Sentence Span Test, which is a measure of verbal skills. When the Figural Intersection Test, a test of visual skills, was used, the correlations between visual skills and academic performances were higher ($r = .22 - .36$; $p < .02$) than those between verbal skills and academic performance (Vaquero et al., 1996).

Investigators have noted individual differences in imagery abilities. Clark and Paivio (1991) contended that some students find it difficult to automatically generate images to facilitate memory and comprehension. Whereas, other students readily use imagery as a strategy to enhance memory and comprehension. Individual variations in imagery strategies can affect a student's ability to learn information. While strong verbal skills are necessary to form associative processes for abstract words, strong visual skills facilitate the integration of concrete words. In some cases forced image generation may have a negative effect on individuals who are not imagers (Clark & Paivio, 1991).

In support of Clark and Paivio, Kyllonen and Christal (1990) and Ragland et al. (1995) found a high correlation between nonverbal working memory and reasoning capacity. However, when examining the assessments used by Kyllonen and Christal (1990), the two tests with the highest correlations were both verbal reasoning tests. The researchers proposed that these tests were measuring different processes. In a study, exploring strategy selection in reasoning, Roberts et al. (1997) produced data that supports a correlation between visual memory and reasoning capacity. The researchers inferred that individuals with high spatial ability are better at selecting the most efficient reasoning strategies than individuals with low spatial abilities. The researchers found the high spatial group to be flexible and able to use either verbal strategies or visual strategies depending on the demands of the task. The high spatial group made fewer errors and were faster in the reasoning exercise than was the group with low spatial ability. The majority of the low spatial group chose to use the incorrect spatial strategy in spite of the fact that they were weak spatial strategists. The researchers reported a substantial correlation of .59 ($\underline{p} < .01$) between the correct strategy selection and high spatial ability. They found no correlation between verbal ability and strategy selection ($\underline{r} = .015$; $\underline{p} < .05$) which lead them to conclude that verbal intelligence did not determine strategy selection. The researchers performed a second study, involving senior citizens as subjects, that supported this conclusion. The spatial representations used by the high spatial group enabled them to develop and evaluate the correct strategy. The individual differences in strategy selection are based on the ability of the high spatial group to efficiently process the encoding and manipulating of the information presented (Roberts et al., 1997).

Working memory can also be evaluated in terms of cognitive style, which is an individual's prefered approach to thinking. Evaluation of executive function with regard to style is performed using self-assessments (Sternberg, 1997). Investigators used self-assessments to determine individual differences in goal-setting, planning, and strategy selection. They reported that independent variables such as motivation, personality, mood, gender, ethnic background, and job success influence working memory ability. Executive processing and strategy selection are based on several motivational factors. These factors are effort, self-esteem and the locus of control (Borkowski & Burke, 1996). Das et al. (1995) contended that individual differences in the cognitive process of planning can be linked to personality traits. Locus of control, self-concept, self-motivation, and strategy selection all affect planning. These personality traits and the cognitive processes for planning are located in the prefrontal lobe of the brain. Therefore, the researchers concluded that individual differences in planning can be considered a personality trait. Personality descriptors such as organized/disorganized, deliberate/confused, and decisive/indecisive are used to describe the individual differences in planners. Das et al. (1995) concluded that unlike hapless problem solvers, effective problem solvers have determined how to deal with or use their personalities to their profit. Good planners employ more strategies to solve problems, than do poor planners (Das et al., 1995).

Oaksford, Morris, Grainger, and Willliams (1996) posited that executive function is inhibited by a positive mood. Even though a positive mood facilitates creative problem-solving, it has a negative effect on analytical reasoning. The researchers found

that a neutral mood was best for performing analytical reasoning tasks (Oaksford et al., 1996).

Warrick and Naglieri (1993) contended that another source of individual differences in planning is gender-related. Using the PASS model (planning, attention, simultaneous, and successive processes), the researchers identified a slight gender difference in the area of planning in favor of females. However, Kranzler and Weng (1995) examined data from the PASS model and found a high interfactor correlation between attention, planning, and simultaneous processing. An examination of the tasks used to assess planning, attention, and simultaneous processing indicates that these tasks support the measurement of visual skills.

In an accessible sample of college students (mean age 24.01 years) from the University of Freeburg, Schweizer (1998) found gender-related differences in response times on a number ordering task and a figure ordering task. For both of these tasks, men responded faster than women. Despite these differences, the researcher did not find any differences in the correlation patterns between men's and women's reaction times and the results of their cognitive ability tests. Birenbaum, Kelly, and Levi-Keren (1994), found a significant difference in the performance scores for female verses male subjects (mean age 22.7 years) in an accessible stratified sample of 410 subjects who attended a vocational guidance clinic at the University of Tel Aviv. Males scored significantly higher ($t = 4.19$; $p < .001$) than females on the group spatial ability test administered by the researchers. The male subjects also outperformed the female subjects on a numerical ability test and the females outperformed the males on a rote memory task. The

researchers reported no sex-differences on tasks for verbal ability, inductive reasoning, perceptual speed and accuracy, and speed of closure (Birenbaum et al., 1994).

Delgado and Prieto (1997) agreed that there is a gender-related difference in mental rotation ability in support of males. In their study, the researchers found a moderate correlation between mental rotation and gender in favor of males. They also found a low correlation between object visualization and gender in favor of male subjects in the high spatial ability group. The researchers theorized that males make higher scores because they employ effective mental rotation strategies that are not accessible to females. However, investigators found evidence that spatial ability is one of the cognitive abilities that is inherited. Loehlin, Horn, and Willerman (1994) posited that there is a moderate correlation between fluid spatial abilities, the subscale of the Weschler IQ test, of biologically related mothers and their offspring. All of the other subscales of the IQ tests showed low to negligible correlations between the results of the mothers and their children's assessments (Loehlin et al., 1994).

Besides finding no ethnic differences in inspection time, Saccuzzo et al. (1994) found no ethnic differences in response time for working memory tests in a combined sample of gifted and nongifted children in second through sixth grade. However, the researchers did find a difference within the African American population. Gifted African American students had the fastest response times among the ethnic groups tested and nongifted African American students had the slowest response times. Regardless of ethnicity and academic classification, the younger children had longer response times than the older children (Saccuzzo et al., 1994).

Sternberg and Kaufman (1998) posited that general intelligence as determined by psychometric tests yields too narrow a view of intelligence. The data from conventional IQ type test is useful for predicting similar test scores and school grades but it is not a meaningful predictor of success. The researchers recommended a "multiple-abilities production model of school or job performance" (Sternberg & Kaufman, 1998, p. 492). Successful intelligence involves a lot more than success on a psychometric test. Successful intelligence involves the ability to adapt to the environment, to accomplish goals, and to select strategies necessary to succeed (Shepard, Fasko, & Osborne, 1999; Sternberg & Kaufman, 1998), which are the roles of executive function. Individual differences in successful intelligence can result from variations in the analytical, creative, and practical skills of executive function. Analytical skills enable the individual to recognize, interpret, decipher, and monitor problem solving. Creative skills enable the individual to generate new ways to solve problems. Practical abilities are necessary to implement successful solutions in a real world environment. Trawick (1992) investigated the level of self-regulation in a sample of community college students (mean age 22.7 years) enrolled in a remedial reading course. The investigator concluded that the students lacked cognitive processing strategies involved in goal-setting, planning, and task completion (Trawick, 1992). Besides successful intelligence, the Sternberg and Kaufman (1998) contended that emotional intelligence is another indicator of success. Successful individuals understand emotions and are able to express and control them (Sternberg & Kaufman, 1998).

Several investigations supported Sternberg and Kaufman's view of successful intelligence. Evaluation of complex emotional situations requires a high level of

information processing. Rueckert and Pawlak (2000) correlated the social and emotional skills of an accessible sample of male and female students (mean age 28.42 years) at Northeastern Illinois University. Using an inventory to evaluate social skills, the researchers found that women scored higher than men on the emotional and social subscales of the expression and sensitivity scales, and men scored higher on the emotional and social subscales of the control scale. However, a post hoc analysis indicated that the differences of the measurements on the emotional and social subscales of the sensitivity scale were the only significant differences found in the study (Rueckert & Pawlak, 2000).

In 1999, Averill correlated the results of the SAT and the Emotional Creativity Inventory from an available sample of 489 male and female undergraduates at the University of Massachusetts (mean age 20 years). The researcher used the SAT to determine intellectual ability and the Emotional Creativity Inventory to determine emotional creativity. The Emotional Creativity Inventory has three scales: preparedness, novelty, and effectiveness/authenticity. High scores in emotional preparedness are characteristic of individuals who evaluate their own emotions as well as those of others. High scores in effective/authenticity deals with the ability to express emotions appropriately and the expression of an individual's own perceptions through emotions. As a result of the study, Averill (1999) contended that there is a low positive correlation between emotional creativity and SAT verbal scores and a low negative correlation between emotional creativity and SAT math scores. There was a low correlation ($\underline{r} = .18$; $\underline{p} < .01$) between emotional creativity and academic performance, which was measured by overall grade point average. The investigator found that women scored

higher than men on the emotional preparedness and the effectiveness/authenticity scales. There were no sex-related difference on the novelty scale (Averill, 1999).

Short, Schatschneider, and Friebert (1993) contended that there is a moderate correlation between IQ and recall of word lists ($r = .44$; $p < .01$) as well as moderate correlation between specific strategy selection and recall of word lists ($r = .49$; $p < .01$) and general strategy selection and recall of word lists ($r = .44$; $p < .01$) for children in second, fourth, and sixth grades. They found a higher correlation between total correct responses on the digit span test and specific strategies used ($r = .52$; $p < .01$) than between IQ and total correct responses on the digit span test ($r = .44$; $p < .01$). The empirical data from this investigation indicated that accuracy on the digit span test correlates better with strategy selection than it does with IQ. These results illustrated that strategy use is an important facet of success. The researchers concluded that successful students are self-confident, internally motivated, and select and employ the right strategies (Short et al., 1993).

Long-term memory. Another source of individual differences in cognition is in the area of long-term memory. Long-term memory is composed of self-schema, a unique characteristic of each individual (Atkinson et al., 2000). Schamata are cognitive structures of pieces of information that are organized into meaningful concepts. Each individual's long-term memory is composed of various schemata such as schemata for verbal knowledge, events, and procedures (Cross, 1999). Sehulster (1995) categoried memory into three styles: verbal (semantic) memory, biographical (episodic) memory, and prospective memory (memory for schedules and personal order). Using a self-assessment containing 60 questions, Sehulster collected data from a sample of 327

undergraduate college students. The correlations between three memory types and the subscale items from the questionnaire were low. Forty-seven of the 60 items loaded on 12 factors. The internal consistency for the 12 factors ranged from .504 - .819. Canonical variable loadings were used to determine combination of memory styles (Sehulster, 1995).

Another aspect of long-term memory is memory for procedural knowledge, also known as procedural skills. In a study done in 1998 using a small sample of undergraduate at Purdue University, Sassi and Green compared individual differences in working memory ability with the psychomotor ability, and the speed of acquisition of communication skills. In a complex verbal task, Sassi and Green (1998) correlated the speed of information processing with the acquisition of communication skills. In the study, the speed of information processing and the capacity of working memory did not correlate with the speed of acquisition of communication skills. However, the correlation between the psychomotor ability and the speed of communication skill acquisition was high ($r = .76$; $p < .001$). When the complexity of the task was increased, the correlation between working memory capacity and the acquisition of communication skills improved as did the correlation between speed of processing and the acquisition of communication skills. These results lead the researchers to conclude that the influence of verbal working memory and speed of processing of procedural skills is dependent on the complexity of the tasks. In contrast, Schweizer (1998) argued that the complexity of a study devised by an increasing number of processing stages is not an allowable method of illustrating individual differences in cognitive ability. In his study, Schweizer (1998) measured the reaction time of three tasks performed at three different levels of

complexity. Next, he correlated the reaction time for each level of each task with the results of two cognitive abilities tests, the WAIS-R and Horn's Reasoning Scale. As the complexity of the task increased, the relationship between reaction time and cognitive ability decreased (Schweizer, 1998).

Application of the Information-Processing Theory to Education

With the advent of the information processing paradigm, the view of intelligence has expanded beyond the narrow concepts of performance on psychometric tests or a high grade point average. In today's environment, high scores on an intelligence test or a high GPA are not enough to ensure career success. Educators must consider the multifacet nature of cognitive styles and include its subcategories of learning styles, cognitive strategies and cognitive abilities in their educational paradigms (Shepard et al., 1999; Sternberg & Kaufman, 1998). Research from the fields of cognitive psychology, neuropsychology, and education psychology supports this concept. Individual differences in cognitive abilities result from variations in perception, attention, sensory processing, working memory, and long-term memory. These individual differences vary across age, gender, and culture. Therefore, educators should have an understanding of the information processing system and its subsystems and an awareness of individual differences. This knowledge can be used to improve educators' teaching skills and educational designs and to enhance students' success.

Shepard et al. (1999) contended that self-awareness and the characteristics of emotional success and executive function, such as strategy selection, are all becoming increasing important subcategories of intelligence. In order to become self-regulated learners, students must develop motivation, metacognition, self-efficacy, and self-esteem.

This process requires that students fully participate in their own learning. Jacobson (1998) agreed that teaching students how to use cognitive strategies improves their self-concepts and increases academic performance. Conscious use of cognitive strategies and metacognition enables students to develop a solid knowledge base. In order to ensure the intrinsic motivation of students, educators must recognize the students' individual levels as information processors (Cross, 1999).

Rittschof, Griffin, and Custer (1998), posited that the use of cognitive strategies provide insight into the student's method of active encoding. The researchers presented students with four different types of geographical maps to determine which map was the most effective teaching tool. The researchers categorized the cognitive strategies used by the individual students. Strategies fell into six major categories: acronym mnemonics, unspecified mnemonics, grouping, mental imagery, association, and rehearsal. Overall, 13% of the students had difficulty identifying strategies that they had used in the exercise (Rittschof et al., 1998).

Individual differences in experiences and strategy compensations result in variations in the breadth and arrangement of mental schemata. As students learn, they construct their own self-schema (Cross, 1999). Words describing emotions are linked by associative connections in semantic memory and by referential connections to the imagery system. There is a close connection between the imagery system in the right hemisphere and the limbic area of the brain. The limbic system is responsible for emotions. Activation of the emotional connections can effect a student's motivation and effort in school. Negative experiences and self-talk can result in poor test performance and negative academic self-concept (Clark & Paivio, 1991).

The information processing theory can be applied to the development of teaching strategies that can be used in teaching methods such as lecturing or in instructional designs. Parker (1993) discussed methods of applying information processing theory to lecturing. He suggested using teaching strategies that stimulate encoding into long-term memory and address individual differences in cognitive styles. Such strategies included advanced organizers, emotional jolts, and cues for emphasizing important knowledge. Strategies that enhance retrieval are elaboration, hierarchical organization, and imagery with words (Parker, 1993).

Several researches contended that the information processing theory can be applied to instructional design (Blanton, 1998; Bonner, 1988; Kalyuga et al., 1998). Blanton (1998) suggested that metacognition is an important strategy to apply in instructional design. Designers should use strategies that help learners to understand the purpose and relevances of the content of the program. Learners should connect to old and new knowledge. They should be encouraged to draw and test inferences. Effective teachers are models. These "reciprocal" teachers encourage students to accept responsibility for their own learning. Instructional designers should use these and other strategies, such as attention jolts and scaffolding to captivate individual learners. Hands-on experiences can clarify concepts presented by lectures or discussions. Bonner (1988) states that "the most natural way to learn is in an apprenticeship type environment where learning takes place in the content of doing" (p. 5).

Kalyuga et al. (1998) contended that the method of presentation used by instructional designers should be devised so as not to overload working memory and to capture the students' attention. Presentations should be suited to the knowledge level of

the learner. As a result of their research using the split attention method and redundancy experiments, these researchers showed that overload on working memory decreases the efficiency of learning (Kalyuga et al., 1998).

Bonner (1988) asserted that instructional design programs should include content that involves cognitive skills, such as problem-solving and metacognition. However, the researcher notes several differences between the ideologies of instructional design and cognitive psychology. The cognitive tasks analysis focuses on the cognitive skills necessary to do the job at various knowledge levels of the learner. Instructional design centers its tasks analysis around the expert level. The goals and objectives written by the cognitive psychologist are based on deduction and are content-oriented. Those of the instructional designer are based on induction and are performance-oriented. The Cognitive psychologists have no formal approach to evaluations; where as, instructional designers include both formative and summative evaluations in their programs. The cognitive psychologists are more interested in mental models and schemata. Instructional designers profile their learners based on social and cultural diversity and knowledge levels (Bonner 1988).

Instructional design is practical and efficient while cognitive psychology is engaged in the study of learning and cognition. However, instructional designers have included many aspects of cognitive theory in the framework of their instructional design programs (Bonner, 1988). Blanton (1998) contended that the cognitive theory is relevant "to the design of effective learning" (p. 171) which is the intent of instructional design. Smith and Ragan (1999) related the stages in Borkowski and Burke's model (1996) illustrating processing by executive function to methods that can be applied to the design

of instructional material for an educational setting. One of the steps that the authors proposed as part of a learning task analysis is to perform an information processing analysis. The analysis follows the stages in the executive function model. First, the designer should determine the cognitive and behavioral steps necessary to complete the task. This can be done by gathering all the information about the task, evaluating the goal, individual testing, review of the steps, evaluation by experts, and identifying the simplest path to achieve the goal. Next, the designer makes an overall evaluation of the data and revises the process until a "workable information-processing procedure" (Smith & Ragan, 1999, p. 71) is identified. By applying this theory to educational design, students are encourage to utilize and develop their own problem-solving skills or their executive function.

CHAPTER 3: MATERIALS AND METHODS

Population and Sample

The population to be used in this study consists of students enrolled at Our Lady of the Lake College (OLOL College) and Louisiana State University (LSU). The researcher collected data from a convenient sample. A convenient sample is a nonprobable sample that cannot be generalized to a population (Ary, Jacobs, & Razavieh, 1996; Rea & Taylor, 1997). The sample was collected from classes at Our Lady of the Lake College and at Louisiana State University. The students in the sample were tested using the researcher-designed, self-assessment of strategical information processing styles (SIPS). The sample was focused on undergraduate students. Class selection was based on the number of students in the class and the willingness of the professors to allow their students to participate in the study. By selecting classes with large numbers of students, the researcher was able to efficiently perform several field tests as well as the final data collection.

Sample Size Modification Based on Factor Analysis Needs. For the first field test performed in the study, the researcher relied on the recommended sample size of approximately 200 (Hair, Anderson, Tatham, & Black, 1995, 1998). The actual sample size of 233 was used for the first field test. This field test was designed to test the instrument's scoring scale, to examine the internal consistencies of the five constructs, and to determine patterns of factor loadings. As a result of the first field test, the instrument's scale was changed from an ipsative scale to an absolute scale. An ipsative scale is a forced format scale inwhich the numerical answers are ranked according to preference. Each number can be used only once per question. In this instrument in

order to convert the ipsative scale to an absolute scale, participants were allowed to use numbers more than once per question.

A sample of 156 participants was collected for the second field test. The second field test employed the instrument with the absolute scale and the purpose of this test was to verify that this scale produced reliable data. An exploratory factor analysis was performed on this data to identify factor loading patterns of the indicator variables and to redesign the instrument accordingly.

The researcher conducted an exploratory factor analysis on the data collected in field test three. A factor analysis requires a minimum of 100 observations. A ratio of five observations for every one item in the instrument is recommended (Hair, et al. 1995; Kotrlik, Bartlett, & Higgins, 1999). In the instrument used in the third field test, there were 70 indicator variables or items. The minimum sample size for a significant factor analysis of a 70 item scale is 350. Although the minimum sample size for the third field test was 350, a sample of 365 was used.

As a result of the third field test, the number of items in the instrument were reduced to 65. However, the sample size of the final data collection was 514 and larger than the 325 necessary to validate the instrument. Therefore, the sample was split into two groups. The first group contained the necessary 325 participants and was used to develop a model, which would be confirmed by the remaining sample of 189. In the final model, the number of indicator variables was reduced to 22. Therefore, only a sample of 110 was necessary to produce valid results.

Procedures

After a comprehensive review of the literature on the information processing system, the researcher hypothesized that there were five preferred strategical information processing styles or constructs. Based on this hypothesis, the researcher developed the strategical information processing styles (SIPS) instrument containing specific measurable descriptors for each of the five hypothesized constructs. The instrument is Appendix A, the graph is Appendix B, and the path diagram is Appendix C. The researcher completed an Institutional Review Board (IRB) form (see Appendix D) for Human Research Subject Protection as required by LSU and OLOL College (see Appendix E). The forms were completed and submitted to the LSU review board and to OLOL College. The IRB from each school required that a student consent form be issued to each student explaining the research project (see Appendices F and G). Written permission for data collection was also obtained from the participating professors (see Appendix H). After receiving approval from the review boards, the researcher conducted a pilot test to determine face and construct validity of the instrument. The instrument was revised based on the findings of the pilot test. Appendices I and J are the peer evaluations gathered during the pilot test. Next, the researcher conducted three field tests of the instrument. The first field test was performed using the original instrument with the ipsative scale (see Appendix A), the second field test was performed using the revised instrument with the absolute scale (see Appendix K), and the third field test was done using the instrument from field test two after several more revisions (see Appendix L). The information from the field tests was used to revise the instrument. In final data collection on the revised instrument (see

Appendix M), the sample was split and used to develop and confirm the final theoretical model. Figure 2 summarizes the steps followed as this research project.

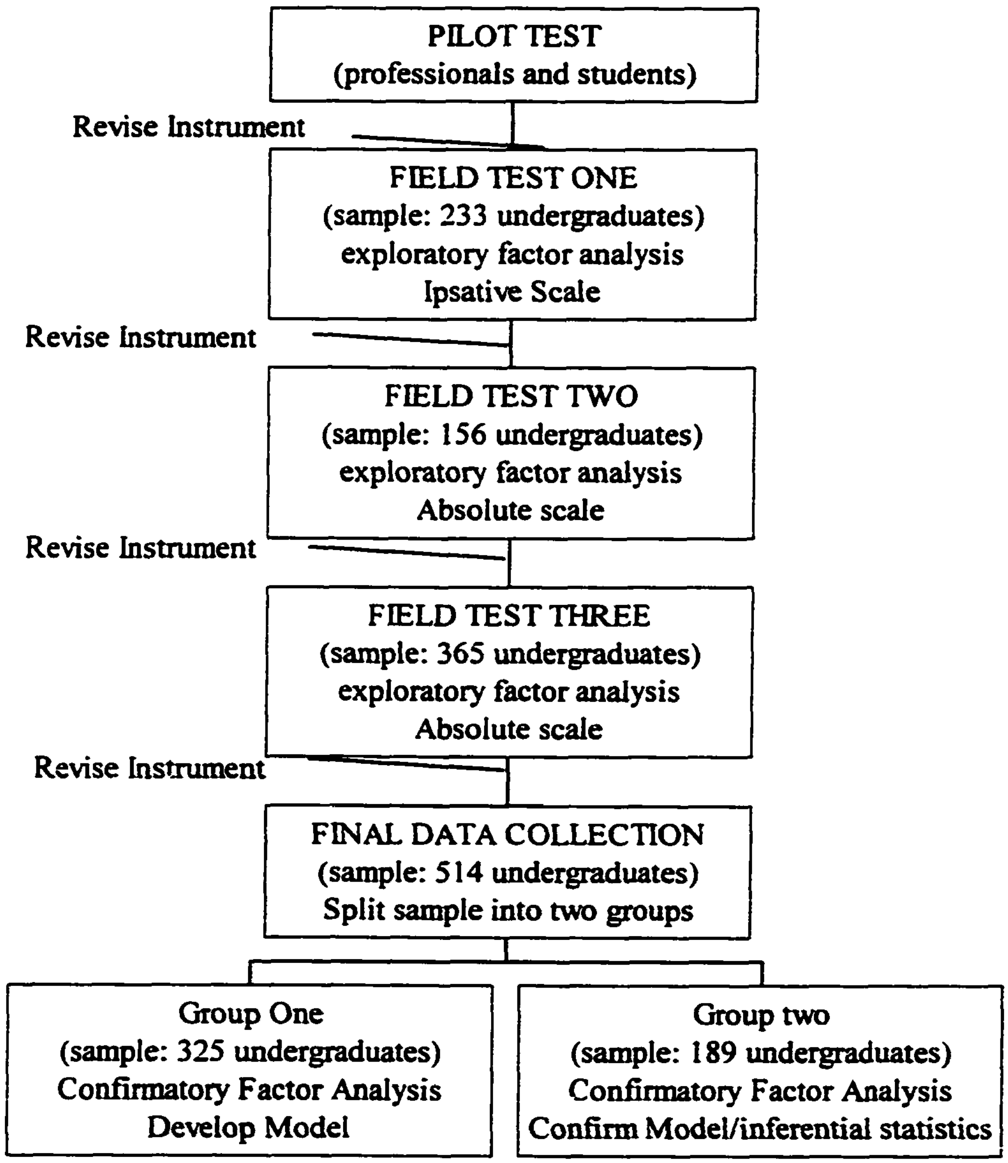

Figure 2. Flow chart of the procedures for this research project.

Instrument Development

The design of the strategical information processing styles assessment (see Appendix A) used in this study was based on a comprehensive review of the literature on the information processing system. The researcher developed the assessment to determine the preferred strategical information processing styles of college students. Each item in the instrument was developed based on a thorough review of the literature. The original instrument consists of 20 questions designed to evaluate individual differences in the strategical processing of information. The response pattern in the SIPS assessment is modeled after the Learning Style Inventory (Kolb, 1985). Each question contains five items that the respondent is required to rate on a continuum from least prefer to most prefer (Kolb, 1985). Each one of these five choices represents a different preferred strategical information processing style. The respondents must rank their five choices using a 1 (least prefer), 2 (seldom prefer), 3 (prefer), 4 (more often prefer), and 5 (most often prefer). The five responses for each question are ranked from 1 to 5, resulting in five individual items per question. Therefore, there are 20 questions in the assessment, each containing five items. One response in each question supports an individual strategical information processing style. Consequently, there are 20 items for each of the five strategical information processing constructs theorized in the confirmatory factor analysis.

Figure 3 illustrates an example question and ranked response pattern to be followed when completing the assessment. In the example, item "e" is the least preferred and item "d" is the most preferred. In the example question, number 5 is used for item "d", indicating that the individual's preferred strategy for processing

information is to 'visualize the concept' as he acts on the information. Each number is used only once per question in the original of the instrument.

However, after field test one, empirical data revealed that data collected using an ipsative scale failed exploratory factor analysis and yielded low internal consistencies. Thus the instrument scale was changed to yield absolute data by altering the directions for completing the instrument (see Appendix K). Rather than saying that ' Each number is used only once per question,' the directions were changed to say that 'Each response (number) can be used more than once for each situation.' The example question in Figure 4 illustrates the new directions.

The directions for completing the assessment were provided on the cover sheet. The directions assured the students that all answers are valuable, that there are no correct or incorrect responses, that all answers will be treated confidentially, and that the results will not be evaluated individually but as a group (Rea & Parker, 1997). The students were asked to provide the following demographic data: age, gender, ethnic background, credit hours completed, and major field of study. Once the instruments were completed, the individual mean scores for each construct were tallied and graphed using a linear radar graph as shown in the example in Figure 5. The radar graph is divided into five areas. Each area represents a different strategical information processing style. The highest mean score among the five constructs was converted to the individual's preferred strategical information processing style. The basic format of the radar graph was adopted from Herrmann (1994) and Learning Style Inventory (Kolb, 1985).

DIRECTIONS

For each question, rank each of the responses given according to which strategy you would prefer to use in the situation described. Use the following scale:

5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

1. **When I am presented with a new concept in one of my courses, I:**

3 a.	Verbalize the concept.	4 b.	Write down every detail.	2 c.	Interact with discussion and questions.	5 d.	Visualize the concept.	1 e.	Analyze the concept.

Figure 3. An illustration of a SIPS query using the ipsative scale.

DIRECTIONS

For handling each situation listed below, five strategies are provided. Using the scale below, indicate your level of preference for using each strategy in each situation. Each response (number) can be used more than once for each situation.

Level of Preference Scale
5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

1. **When I am presented with a new concept in one of my courses, I:**

3 a.	Verbalize the concept.	1 b.	Write down every detail.	4 c.	Interact with discussion and questions.	5 d.	Visualize the concept.	1 e.	Analyze the concept.

Figure 4. An illustration of a SIPS query using the absolute scale.

Figure 5 illustrates the radar graph used in conjunction with the results from the assessment to determine an individual's SIPS. The final mean scores from the assessment are plotted on the graph. Each line on the graph represents one unit beginning with zero at the center and counting outward to a maximum score of five. The minimum score for any one style is one and the maximum score is five. In the example, the indicator variables for each construct were averaged. The individual's mean scores from the SIPS assessment were visuospatial = 5, analytical = 3, social = 3.5, categorical = 3.0, and verbal= 2.0. Therefore, this individual's preferred strategical information processing style is visuo-spatial.

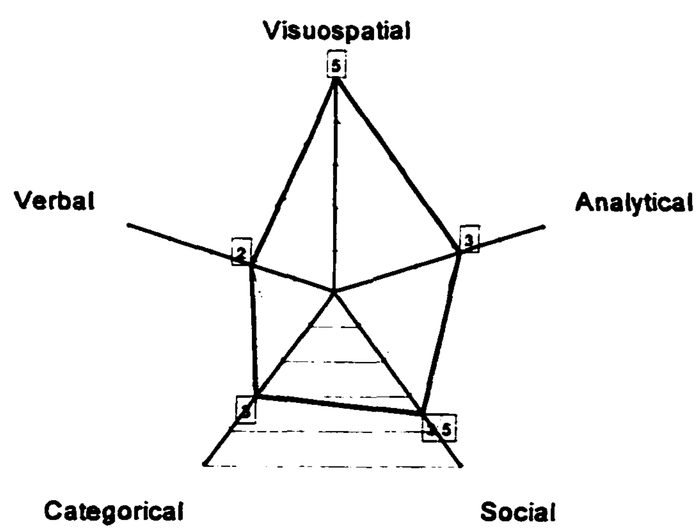

Figure 5. An illustration of the radar graph used for scoring SIPS assessment.

Pilot Test. A pilot test was conducted on the instrument to assess its face and construct validity. The results were employed to resolve unclear directions, unclear items, hostile or embarrassing items, the respondents' perceptions of items asked, and the time necessary to complete the assessment (Ary et al., 1996). The first step in the procedure for the pilot test was a peer review of the instrument's validity as well as its adequacy and clarity. The researcher asked colleagues who were familiar with the content of the investigation to examine the SIPS assessment. The SIPS instrument was reviewed by professionals in the fields of psychology and education.

The second step in the process was to select a small sample of students from the population. The researcher administered the assessment to the students as a group. As the subjects answered the questions, the investigator requested written feedback on each item and each question. Questions and items that the respondents found unclear, difficult or left blank were evaluated for possible elimination or revision (Ary et al., 1996).

Field Tests. After completing the pilot study and making necessary revisions to the instrument, the researcher conducted three field tests. The first field test was used to evaluate the scale of the instrument and the reliability of the constructs. As a result of this test, the instrument's scoring scale was changed from an ipsative scale to an absolute scale. The second and third field tests were used to evaluate the absolute scoring scale, the internal consistencies of the constructs, and to process a preliminary evaluation of the data generated by the assessment, including item and factor analyses. After each field tests, the indicator variables in the instrument were eliminated or redesigned to improve their measurement qualities. Also based on the results of the

field tests, the hypothesized verbal construct was eliminated from the final model. The indicator variables hypothesized to load on the verbal construct did not load on any one factor in a consistent pattern.

Final Data Collection

A confirmatory factor analysis was performed on the final data collection. Fletcher, David, Stuebing, Shaywitz, Shaywitz, Shankweiler, Katz, and Morris (1996) contend that a confirmatory factor analysis is the "most significant advance in construct validation research..." (p. 23). The confirmatory factor analysis was based on the researcher's hypothesis that there are four different strategical information processing styles.

As part of the confirmatory factor analysis, the researcher developed a measurement model consisting of the four hypothesized factors and the indicator variables that measure each construct. Each style is a construct and was used as a factor in the analysis. Next, the researcher split the final sample into two groups. Using group one, the researcher modified the model by deleting variables with insignificant factor loadings, variables with high normalized residuals, and variables indicated to be problematic by the Lagrange Multiplier and the Wald Test modifications indices. The chi-square and the goodness-of-fit indices were used to determine the overall fit of the model (Fletcher et al., 1996; Hair et al., 1995, 1998). Composite reliabilities were used to determine the internal consistency of each of the observable variables. After developing the final measurement model, the researcher confirmed the model using group two of the split sample of the final data collection.

The demographic data collected via the questionnaire included: age, gender, ethnicity, college major, and undergraduate credit hours completed to date. The five types of strategical information processing styles determined by the assessments plus the demographic data were used to describe the sample. The gender, ethnicity, and major are nominal categorical variables and were described by frequencies and percentages. Age and credit hours completed are continuous variables and were described using means and standard deviations.

Pearson product-moment correlation coefficient was used to determine if statistically significant relationships existed between the strategical information processing styles and age. The same correlation coefficient was used to determine if statistically significant relationships exist between the strategical information processing styles and credit hours completed. The practical significance of any statistically significant correlations was interpreted using the set of descriptors proposed by Davis (1971).

Inferential t-tests were used to determine if there were any significant differences between the means for each strategical information processing style by gender. Analyses of variance (ANOVA) with Bonferroni's post hoc mean separation test was employed to determine if significant differences existed among the means for each strategical information processing style by ethnicity and for each strategical information processing style by college major.

Separate multiple regression analyses were performed to determine if selected variables, namely, age, gender, ethnicity, college major, or credit hours completed, explained significant proportions of the variance in the strategical information

processing style scores. Dummy coding was used for the nominal variables of gender and ethnicity. The alpha level was set á priori at .05 for all statistical tests. In order for a variable to be declared as a significant explanatory variable, the variables must explain at least one percent of additional variance beyond the variance already explained by other variables.

CHAPTER 4: RESULTS AND DISCUSSIONS

In order to accomplish the first objective of this study, the researcher conducted a series of data collections and analyses. The first data collection involved a pilot study, which included an evaluation of the strategical information processing style (SIPS) instrument by two experts and a small group of college students. Next, the researcher conducted three field tests and then a final data collection. The first field test resulted in questionable data due to the ipsative design of the instrument's scale. The scale was converted to an absolute scale and the data was recollected. Although the instrument scale was redesigned, the results of field test two were problematic. Exploratory factor analysis of the data revealed erratic loadings of the variables on the five constructs and a low internal consistency for the social construct. The SIPS assessment was redesigned and a third data collection was performed. The data from this test was analyzed using exploratory factor analysis. The results of the exploratory factor analysis were more consistent than in the previous field test. However, the indicator variables loaded on four rather than five constructs. Therefore, a four factor model was developed using the results of the confirmatory factor analysis. The data from field test three could not be used to develop the measurement model because the social and visuospatial variables were revised between field test three and the final data collection. Therefore, the final sample was split into two groups. One group was used to develop the model and the other group was used to confirm the model.

Pilot Test

Before beginning the pilot study, the researcher submitted an Institutional Review Board (IRB) form to the designated personnel at Louisiana State University

(Appendix D) and at Our Lady of the Lake College (Appendix E). The project received exempted status from both schools. Along with the IRB form, the researcher was required to submit student consent forms (see Appendices F and G) to each institution. The student consent form included the following information: the title of the study, the performance site, the investigators, the purpose of the study, the subject inclusion, the number of subjects, the study procedures, the benefits, the risks, the right to refuse, privacy, and signatures. This form was issued to each student who participated in the study. Another form containing information similar to that in the student consent form was issued to the instructors who participated in the study. The instructors signed the forms and a sample form is included as Appendix H.

Once all of the forms were completed, the researcher distributed the SIPS assessment to two qualified professionals who volunteered to review the instrument. One of the professionals is a full professor at Our Lady of the Lake College with a doctorate in Psychology and the other professional is an Academic Counselor at Our Lady of the Lake College with a doctorate in Reading and Special Education. The professionals returned their written evaluations within two weeks.

The Psychology professor (see Appendix I) suggested that the responses to question 1 be revised. The evaluator contended that response c "verbalize my solution" could be done following any of the other responses. The researcher revised response c to read "vocalize my solution using the right words." Also the professor questioned responses d and e because of the overlapping of the initial verbs "reason" and "think." The researcher revised the response e substituting "rely" for "think." Next, the evaluator questioned the application of the responses in questions 2 and 6. The

researcher clarified how the student would apply the strategies in question 2. However, after examining question 6, the researcher decided to revise the responses. The verb "answer" was substituted for each beginning verb in each response. The rest of the wording was changed in each response to clarify the application of the strategy. The evaluator suggested that the terms "visual images" be substituted for "pictures" in response c and that "flow chart" be used rather than "chart" in response "b." The researcher made the suggested changes.

The Academic Counselor (see Appendix J) suggested that the wording "and maybe a few extras" be dropped from the response e in question 8. Choice "d" for question 18 and choice "a" for question 19 were cited as inconsistent with the rest of the responses and should be changed to descriptive adjectives. The researcher made the suggested changes.

While the professionals were reviewing the project, the researcher administered the assessment to a group of 11 students enrolled at OLOL College. The students ranged in age from 22 to 38-years old with a mean age of 24.4 years. The predominant gender was female, (n = 8 or 72.7%) and the remaining three students were male (27.3%). The ethnicity of the sample was 72.7% (n = 8) white, 9% (n = 1) black, 9% (n = 1) Asian, and 9% (n = 1) Hispanic. All of the students in the sample were majoring in Clinical Laboratory Science. The average number of undergraduate semester credit hours completed by the students was 134.6 and ranged from 80 - 184.

The students spent approximately 10 to 15 minutes completing the assessment. The researcher questioned each student individually about the assessment. Overall, the students agreed that the directions were clear, the questions were clear, and they had no

problems completing the questionnaire. Many of the students had to estimate the answer to the demographic question on page 1, which asked "undergraduate credit hours completed to date." They indicated that they were not certain of the exact number. One student remarked that the responses to the questions were repetitive. Several students commented that the assessment gave a true evaluation of their strategical information processing styles.

The mean scores in Table 1 indicated that the students tested in the pilot study were highly analytical strategical information processors. The mean score for the analytical style was 3.55 with a standard deviation of .37. The next strongest Strategical Information Processing Style (SIPS) exhibited by the group was the categorical style, which had a mean of 3.34 and a standard deviation of .44. The visuo-spatial and the verbal styles fell in the middle of the group with means of 2.80 and 3.00 respectively. The social style had the lowest mean, 2.56, and the largest standard deviation, .62.

Table 1

SIPS Scores for Student Sample Used in the Pilot Test

SIPS	Lowest Score	Highest Score	M	SD
Visuo-spatial	2.10	3.55	2.80	0.33
Analytical	3.15	4.20	3.55	0.37
Social	1.60	3.50	2.56	0.62
Categorical	2.60	3.85	3.34	0.44
Verbal	2.50	3.25	3.00	0.27

Note. n = 11.

Field Test One Using the SIPS Instrument with the Ipsative Scale

Three separate field tests were performed on the SIPS instrument. The first field test included a sample of 233 students and used the SIPS instrument with the ipsative scale. The purely ipsative scale, such as the one used in the SIPS instrument presented in this research, was modeled after the scales used by Kolb in his Learning Style Inventory II (LSI II) (Kolb, 1985) and the Gregorc Style Delineator (O'Brien, 1990). However, because of the ipsative nature of the instrument scale, the internal consistencies of the constructs were low (visuo-spatial .65, analytical .70, social .69, categorical .69, and verbal .43) and the exploratory factor analysis failed. Investigators have attributed the low internal consistency and test-retest reliabilities of the LSI II, (Cronwell & Manfredo, 1994; Cronwell, Manfredo, & Dunlap, 1991; Ruble & Stout, 1994; Rule & Grippin, 1998; Sims, Veres, Watson, & Buckner, 1986; Veres, Sims, & Locklear, 1991) and Gregorc Style Delineator (O'Brien, 1990, 1994) to the ipsative scales used to score these instruments. The internal consistency determination is problematic for ipsative scales because the internal consistency is dependent on the variance between items and the variance between individuals (Kerlinger, 1973, 1979). Ipsative scales yield scores that represent the relative difference or ranking ordering of a set of variables for a single person (intra-individual differences). These scores cannot be used to determine the variance between individuals as done by the Cronbach alpha determinations. For the ipsative scale, the means of all of the variables are the same for each individual respondent. There is no variability between individuals (Hicks, 1970; Ruble & Stout, 1994). The factor analysis failed because factor analysis is not appropriate for purely ipsative scales due to the negative intercorrelations of the scales

(Cronwell & Manfredo, 1994; Cronwell et al., 1991; Hicks, 1970; O'Brien, 1990; 1994; Ruble & Stout, 1994; Rule & Grippin, 1988; Sims et al., 1986; Veres et al., 1991).

Field Test Two Using the SIPS Instrument with the Absolute Scale

As a result of the findings of the field test using the ipsative scale, the researcher changed the scale of the SIPS instrument to an absolute scale by altering the directions for completing the instrument. Rather than saying that ' Each number is used only once per question', the directions were changed to say that 'Each response (number) can be used more than once for each situation.' The example question on the instrument's cover sheet illustrates the new directions. The revised instrument is in Appendix K.

The student sample used for the second field test was collected during the Spring 2001 semester. The sample included assessments collected from students in three classes taught at OLOL College and one class taught at LSU. The three classes taught at OLOL College were a Nursing Pharmacology course, an Anatomy and Physiology II course, and a survey Chemistry course. The course taught at LSU was a survey Microbiology course. The total number of instruments collected in the sample was 172. However, 16 of the instruments were incomplete and could not be used in the sample. The final sample consisted of 156 students.

Age of the Undergraduate Students. The respondents were asked to indicate their ages on the day that the survey was completed. The mean age for the students in the sample was 22.173 years (SD = 6.68), the youngest student was 18-years old and the oldest student was 54-years old. The majority of the students in the sample were 18, 19, or 20-years old (n = 64, 52.5%).

Gender of the Undergraduate Students. The majority of the undergraduate students who participated in this field test were female (n = 134 or 85.9%). The remaining 21 students were male (13.5%).

Ethnic Origin of the Undergraduate Students. One of the questions on the instruction page of the assessment asked the respondent to indicate his or her ethnic background by checking one of the following categories: Black or African American, Asian, Hispanic, Native American, White, or other. The majority of the students checked White (n = 126 or 80.8%). Other ethnic categories checked by the students were Black or African American (n = 24 or 15.4%), Asian (n = 2 or 1.3%), Hispanic (n = 2 or 1.3%), and Native American (n = 2 or 1.3%).

College Majors of the Undergraduate Students. On the instruction sheet of the assessment, students were asked to indicate their college majors. The sample included students with majors in 16 different categories. In order to report the information in a concise manner, the researcher grouped the majors into the following nine categories: Business, Arts and Sciences, Medical Sciences, Agriculture, Engineering, Communication, Design and Music, Education, and undecided. The number and frequency of students in each categories included: Business (n = 1 or .6 %), Arts and Sciences (n = 1 or .6%), Medical Sciences (n = 144 or 92.3%), Agriculture (n = 6 or 3.8%), and Communication (n = 1 or .6%). Only one student in the sample was undecided (n = 1 or .6%) with regards to a major. None of the students in this field test indicated Design or Music as a major.

Undergraduate Credit Hours. The students were asked to designate the number of undergraduate credit hours they had completed to date. The mean number of credit

hours was 33.4 (SD = 41.83). The number of credit hours ranged from 0 - 250. Some students noted on the questionnaire that they were working on a second undergraduate major which could account for the upper level of the range in credit hours. Over 78% of the students in the sample had taken less than 50 credit hours.

Exploratory Factor Analysis on Field Test Two

After completing the descriptive statistics on the field test two sample, the researcher conducted an exploratory factor analysis using SPSS. In order to improve the efficiency of the study, the researcher employed a number of steps to test each variable and determine its importance in the data set. The following criteria were used, together or individually, to determine which variables to eliminate and which variables to revise. The following steps were derived from Hatcher (1994) :

Step 1 involves the initial factor extraction from the unrotated factor matrix. In the rotated factor matrix, the first factor accounts for a large amount of the common variance. When a large number of factors are extracted, only the first few factors account for a large amount of the common variance and are important enough to retain (Hatcher, 1994).

Step 2 is to determine the number of important factors to be retained. The criteria that is often applied to determining the number of important factors is the eigenvalue, the scree test, the percent variance, and the interpretability of the factors. The eigenvalue is better suited for component analysis than for exploratory factor analysis. In component analysis, each variable's contribution to the variance is one. Whereas in factor analysis, each variable's contribution to the variance is based on its communality which is less than one (Hatcher, 1994). The second criteria used involves

interpretation of the scree plot, which is a graph of the eigenvalues for each factor. The scree test involves looking for a break between factors. According to Hatcher (1994), "factors that appear before the break are assumed to be meaningful and are retained for rotation; those appearing after the break are assumed to be unimportant and are not retained" (p. 82). On SPSS, the proportion of variance of each factor in the data set is listed with the eigenvalues. The first factor accounts for the largest proportion of the common variance. The remaining factors account for the rest of the common variance. To be considered an important factor, three criteria must be met. The factor must account for a certain amount of the variance, a minimum of three variables should load on that factor, and the variables loading on the factor must share "some conceptual meaning" (Hatcher, 1994, p. 92).

Step 3 involves the factor rotation. Rotating the factors redistributes the variance among factors to achieve a more meaningful pattern. The oblique rotation assumes that the factors are correlated with each other and clusters the variables more accurately around the factor axis (Hatcher, 1994). According to Hair et al., (1998), this rotation is used to obtain theoretically meaningful factors or constructs.

Step 4 involves interpretation of the rotated factors. Variables with loadings of .400 or greater are considered meaningful variables. If variables load significantly on more than one factor, they were dropped from the analysis and the rotation was repeated. The variables that grouped together were reviewed to determine which construct they represented. Next, the interpretability criteria was used to determine the acceptability of the factors. First, a minimum of three variables should load on the factor. Second, the variables that load on the factor should share some common

context. Third. the variables that load on different factors should measure different concepts. Fourth, in the rotated factor matrix, variables should have a high loading on only one factor and a negligible loading on all of the other factors. This concept is referred to by Hatcher (1994) as a "simple structure"(p. 86).

Following the steps listed above, the researcher performed an unrotated factor matrix and determined that five factors should be retained for the rotated factor analysis. The proportion of variance accounted for by each factor was: factor one 10%, factor two 7.5%, factor three 4.3%, factor four 3.6%, and factor five 3.5%. Although factor six accounted for approximately 3% of the variance, only two variables loaded on this factor. Therefore, factor six was not considered as a meaningful factor. More than three variables loaded on each of the first five factors. The proportion of variance accounted for by the first five factors was 29.5%. These findings are similar to the results of a rotated factor analysis performed by Sipps, Alexander, and Friedt (1995) and Thompson and Borello (1986) on the Myers-Briggs Type Indicator, which produced six factors that accounted for 27.4% of the variance.

Once the factor matrix was rotated using the oblique factor rotation, only one variable (14b) loaded significantly on two factors. This variable was excluded from the matrix. The factors were rotated again. Next, the researcher used the interpretability criteria to determine the acceptability of the factors. Factor one was labeled as the visuo-spatial construct. It was composed of eight variables that were predicted to measure the visuo-spatial construct and six variables predicted to measure the social construct. Factor two, a mixture of categorical, verbal, and analytical variables, was composed of five variables predicted to determine the categorical construct, five

variables predicted to determine the verbal construct, and two variables predicted to determine the analytical construct. Factor two was labeled as a categorical/verbal construct. Factor three was labeled as the analytical factor because it was composed of six variables measuring the analytical construct and only two variables measuring the categorical construct. Factor four was labeled as mixed because it was composed of three variables measuring the categorical construct, three variables measuring the analytical construct, one variable measuring the visuo-spatial, and one variable measuring the verbal construct. The final factor, factor five was labeled social because it was composed of four variables measuring the social construct, two variables measuring the verbal construct, and two variables measuring the analytical construct. Based on these results, the researcher reevaluated each variable and reconstructed the assessment accordingly. The wording in variables that loaded on a common factor was carefully analyzed. The wording of variables that did not load successfully was changed to match the wording in those variable that did load. For example, when "outline" was used in a variable, it loaded on the categorical construct. So indicator variables for the categorical construct were revised to include the word "outline." Variables that loaded successful on the visuo-spatial construct included words such as "pictures" or "images." Those variables that did not load significantly on the visuo-spatial construct were reconstructed to include the words "pictures" and/ or "images." Variables that loaded significantly on the analytical construct contained words such as "detailed," "step-by-step," and "consistent." The unsuccessful analytical indicator variables were redesigned to include these words. If none of the variables in a question

loaded successfully on any of the five constructs, then the entire question was deleted from the instrument. The findings are summarized in Table 2.

Table 2 illustrates the factor rotation for the exploratory factor analysis of the field test two sample using an absolute scale. Variables with negative loading of .400 or above were eliminated from the data sets because these variables lowered the internal consistency of the set. In the SIPS instrument, variables with negative factor correlations have the opposite meaning of the variables that loaded positively on the factor.

Internal Consistency of the SIPS for Field Test Two

Using SPSS, the researcher determined the internal consistency of the complete model (80 variables) and the internal consistency of each of the five factors resulting from the exploratory factor analysis. According to Hair et al. (1996), for exploratory research .60 is the lower acceptable limit for this alpha. The internal consistency of a scale is "based on the average intercorrelation among items as well as the number of items" (Ruble & Stout, 1994, p. 11). It represents the portion of the variance that can be contributed to true scores and to systematic error (Ruble & Stout, 1994). Cronbach alpha scores, in conjunction with the results of the exploratory factor analysis, were used to eliminate items from each set that had low variances and decreased the alpha of the set. After eliminating these variables from the SIPS instrument, the final Cronbach alpha scores for each set were determined and the values are listed in Table 2. The overall alpha for the model is .84 and the alphas for the constructs ranged from .64 to .80.

Table 2

The Factor Rotations for the Exploratory Factor Analysis of the Data from Field Test Two

Variable	Predicted Construct	Oblimin Factor Loadings					α
		Visuo-spatial	Categorical/ Verbal	Analytical	Mixed	Social	
14e	Social	.612					.80
14c	Visuo-spatial	.595					
10a	Visuo-spatial	.572					
12d	Visuo-spatial	.571					
13c	Visuo-spatial	.503					
12c	Social	.478					
6b	Visuo-spatial	.476					
3e	Visuo-spatial	.454					
11b	Social	.450					
8e	Visuo-spatial	.445					
10c	Social	.442					
2e	Social	.422					
9a	Visuo-spatial	.421					
8b	Social	.414					
15c	Visuo-spatial	.407					
6a	Categorical		.566				.81
14a	Verbal		.562				
15a	Verbal		.535				
3d	Categorical		.525				
5b	Categorical		.523				

(table continues)

Variable	Predicted Construct	Oblimin Factor Loadings					α
		Visuo-spatial	Categorical/ Verbal	Analytical	Mixed	Social	
6d	Verbal		.518				
8c	Categorical		.510				
3a	Verbal		.464				
8d	Verbal		.426				
8a	Analytical		.413				
4d	Analytical		.410				
6e	Analytical			.577			.74
13b	Analytical			.555			
12e	Categorical			.467			
11d	Analytical			.467			
16d	Analytical			.440			
13d	Categorical			.439			
3c	Analytical			.421			
7b	Categorical				.667		.74
2b	Analytical				.599		
2a	Categorical				.525		
7a	Analytical				.524		
12a	Analytical				.461		
11c	Categorical				.433		
7c	Visuo-spatial				.421		
16c	Verbal				.404		
11a	Verbal					.517	.64
5e	Social					.507	

(table continues)

Variable	Predicted Construct	Oblimin Factor Loadings					α
		Visuo-spatial	Categorical/ Verbal	Analytical	Mixed	Social	
10d	Verbal					.505	
1d	Analytical					.477	
15e	Social					.437	
15d	Analytical					.413	
9e	Social					.407	

Note. n = 156. Only the variables with factor loadings of .400 or greater were included in the matrix.

Field Test Three Using the SIPS Instrument with the Absolute Scale

There were two reasons why the researcher conducted a third field test. The first reason was that the second field test examined only a small sample of students and contained a gender bias. The second reason was that the indicator variables in the instrument did not support the constructs and the low internal consistency of the social construct. Based on these results, the researcher redesigned the instrument (see Appendix L), and proceeded with a third field test. The new instrument contained 70 variables and used an absolute scale. Field test three involved a sample of 365 subjects, which satisfied the required ratio of five samples for every one variable for performing an acceptable factor analysis. Field test three included a sample of students from four different classes taught at LSU and one class taught at OLOL College. The subjects used at LSU included students in two large sociology classes, a large history class, and an accounting class. The data collection at OLOL College included students in an Anatomy and Physiology II class. The researcher reviewed the directions with each

class and emphasized that the responses could be used more than once per question. The students at both institutions were very cooperative and willing to participate in the study. A sample of 373 assessments were collected. However, eight of the instruments were incomplete and could not be used in the study. The final sample included data from 365 assessments.

Age of the Undergraduate Students. The same demographic information collected in field test two was collected in field study three. The respondents were asked their ages on the day that the survey was completed. The mean age for the students in the sample was 19.81 years (SD = 3.11), the youngest student was 18-years old and the oldest student was 42-years old. The majority of the students in the sample were 18, 19, 20, and 21-years old (n = 322, 88.2%).

Gender of the Undergraduate Students. The majority of the undergraduate students who participated in this field test were female (n = 229, 62.7%). The remaining 136 students were male (37.3%).

Ethnic Origin of the Undergraduate Students. Just as in field study two, the majority of the students designed their ethnic background as White (n = 295 or 80.8%). Other ethnic categories checked by the students were Black or African American (n = 38 or 10.4%), Asian (n = 14 or 3.8%), Hispanic (n = 8 or 2.2%), Native American (n = 3 or .8%), and other (n = 7 or 1.9%).

College Majors of the Undergraduate Students. The sample included students with several different majors. The numbers of majors in each category were: Business (n = 68 or 18.6 %), Arts and Sciences (n = 132 or 36.2%), Medical Sciences (n = 72 or

19.7%), Agriculture (n = 6 or 1.6%), Engineering (n = 23 or 6.3%), Communication (n = 11 or 3%), Design and Music (n=1 or .3%), Education (n = 23 or 6.3%), and undecided (n = 29 or 7.9%). Based on this information the largest group of majors were in the Arts and Sciences, which included the biological, chemical, mathematical, and social sciences, and the humanities.

Undergraduate Credit Hours. The mean number of credit hours was 34.1 (SD = 21.67). The number of credit hours range from 0 - 200. The majority of the students (51.2%) in the sample had taken 26 or fewer credit hours.

Exploratory Factor Analysis on Field Test Three

Following the steps outlined previously in this document, the researcher performed an exploratory factor analysis on the data collected in field test three. The first step was to perform an unrotated factor analysis and then determine the number of meaningful factors based on interpretation of the scree plot and the proportion of the variance of each factor. The scree plot revealed a break between factor four and factor five and a break between factor five and factor six. However, the proportion of the variance accounted for by factor four was 3.8%. Whereas, the variance accounted for by factor five was 3.2% and the variance accounted for by factor six was 2.7%. In the unrotated factor matrix, only one variable loaded on factor five and one variable loaded on factor six, indicating that factor five and factor six were not meaningful factors. Based on these results, the rotated factor analysis was performed using á priori four factor extraction.

The rotated factor analysis resulted in a strong analytical construct, a categorical construct, a visuo-spatial construct, and a social construct. Of the twelve variables that

loaded on the analytical factor, nine of the variables were predicted to measure the analytical construct and three were predicted to measure the verbal construct. All eight of the variables that loaded on the categorical construct were predicted to measure that construct. The nine variables that loaded on the visuo-spatial construct were predicted to measure that construct. Although only four social variables loaded on the social construct, the factor loadings of the variables on the social factor were high, ranging from .803 to .654. A careful examination of the indicator variables that loaded significantly on the social factor revealed that these variables contained terms such as "overwhelmed" and "nervous." Using these variables as guides, the wording of the nonsignificant social variables was changed to include "overwhelmed" and "nervous." These findings are in agreement with the speculation that the social strategical information processing style is influenced by emotions. Table 3 summarizes the variable loadings for each of the four constructs. The empirical evidence from field test three indicated that the indicator variables for the verbal construct loaded inconsistently on the analytical and the categorical construct and did not load on a common factor.

Internal Consistency of the SIPS for Field Test Three

Just as for field test two, the researcher determine the internal consistency of the whole model ($\alpha = .87$) and the internal consistency of each of the four constructs. Along with the results of the exploratory factor analysis, the Cronbach alpha scores were used to eliminate items from each set that had low variances and increased the alpha of the set. After eliminating these variables from the SIPS instrument, the final Cronbach alpha scores for each set were determined. The alpha values ranged from .73 to .80 and are listed in Table 3.

Table 3

The Factor Rotations for the Exploratory Factor Analysis of the Data from Field Test Three

Variables	Construct	Oblimin Factor Loadings				α
		Analytical	Categorical	Visuo-spatial	Social	
14b	Verbal	.656				.80
10b	Analytical	.635				
8c	Analytical	.612				
8a	Analytical	.588				
11b	Analytical	.585				
13b	Analytical	.548				
11d	Analytical	.528				
7b	Verbal	.501				
7c	Analytical	.493				
12d	Analytical	.462				
2b	Analytical	.446				
6c	Verbal	.441				
2a	Categorical		.763			.76
1b	Categorical		.760			
10a	Categorical		.736			
3c	Categorical		.527			
1c	Categorical		.481			
12b	Categorical		.469			
13d	Categorical		.451			
10e	Categorical		.434			

(table continues)

		Oblimin Factor Loadings				
Variables	Construct	Analytical	Categorical	Visuo-spatial	Social	α
5c	Visuo-spatial			.653		.73
5b	Visuo-spatial			.609		
4b	Visuo-spatial			.607		
10d	Visuo-spatial			.604		
9b	Visuo-spatial			.544		
8b	Visuo-spatial			.514		
13c	Visuo-spatial			.507		
9c	Visuo-spatial			.506		
12c	Visuo-spatial			.440		
4d	Social				.803	.74
1a	Social				.734	
3e	Social				.718	
11a	Social				.654	

Note. n = 365. Only the variables with factor loadings of .400 or greater were included in the matrix.

Final Data Collection

Using the data from the two previous field studies, the researcher revised the SIPS instrument (Appendix M) for the final data collection. Table 4 is a summary of the revisions that were made to the SIPS assessment throughout the study. The initial instrument contained 100 variables and used a forced format or ipsative scale. The final instrument contained 65 variables and employed an absolute rating scale. The empirical data collected in this study indicated that there are four rather than five strategical

information processing styles. Thus the variables in the final SIPS instrument were revised to measure four rather than five constructs.

Table 4

A Summary of the Changes Made to the SIPS Instrument

Test	N	Number of questions	Indicator Variables	Scale	Constructs Measured
Field Test One	233	20	100	Ipsative	5
Field Test Two	156	17	85	Absolute	5
Field Test Three	365	14	70	Absolute	4
Final Test	514[a]	13	65	Absolute	4

[a] The sample for the final test was split into two groups.

The final sample included students from a Pathogenic Microbiology class, three large Sociology classes, and an Emergency Medical Science class. The first four classes were held at LSU and the Emergency Medical Science class was held at OLOL College. Again as in the previous field studies, the researcher reviewed the directions with each class and emphasized that the responses could be used more than once per question. The students at both institutions were very cooperative and willing to participate in the study. Of the 520 assessments collected, only six were incomplete and could not be used in the study. Therefore, the final data collection included a sample of 514 assessments completed by undergraduate students. This sample was split into two groups: one group contained 325 students and the other group contained the remaining 189 students. The demographic data for each group in the split sample is described in the section entitled Splitting the Final Data Collection.

Age of the Undergraduate Students. The mean age of the students in the final sample was 19.65 years (SD = 3.72), the youngest student was 18-years old and the oldest student was 57-years old. Just as in the two previous field studies, the majority of the students in the sample were 18, 19, 20, or 21-years old (n = 453, 88.1%).

Gender of the Undergraduate Students. The majority of the undergraduate students who participated in this study were females (n =300 or 58.4%). However, a larger percentage of males (n = 209 or 40.7%) participated in the final sample than had in the two previous field tests.

Ethnic Origin of the Undergraduate Students. Just as in the two previous field studies, the majority of the students designated their ethnic background as White (n = 395 or 76.8%). Other ethnic categories indicated by the students were Black or African American (n = 69 or 13.4%), Asian (n =21 or 4.1%), Hispanic (n = 14 or 2.7%), Native American (n = 2 or .4%) , and other (n = 10 or 1.9%). Three students (.6%) did not designate any ethnic origin.

College Majors of the Undergraduate Students. The sample included students with 67 different college majors. The numbers of majors in each category were: Business (n = 53 or 10.3 %), Arts and Sciences (n =266 or 44%), Medical Sciences (n = 46 or 8.9%), Agriculture (n = 15 or 2.9%), Engineering (n= 48 or 9.3%), Communication (n = 28 or 5.4%), Design and Music (n = 18 or 3.5%), Education (n = 47 or 9.1%), undecided (n = 26 or 5.1%), and no response (n = 7 or 1.4%).

Undergraduate Credit Hours. The mean for the number of credit hours taken by the undergraduates in the student sample was 39.5 (SD = 35.6). The number of credit

hours ranged from 0 - 210. The majority of the students in the study had taken 26 or less credit hours.

Splitting the Final Data Collection

The final data sample of 514 instruments was randomly separated into two groups: one group containing 325 assessments and the other containing 189 assessments. The demographic data from one group (n = 325) was used to describe the group.

Age of the Undergraduate Students. The mean age for the students in the final sample was 19.64 years (SD = 3.91), the youngest student was 18-years old and the oldest student was 57-years old. Just in the previous samples used in this study, the majority of the students in the sample were ages 18, 19, 20, or 21-years old (n = 288, 88.6%).

Gender of the Undergraduate Students. The majority of the undergraduate students who participated in this study were females. However, the frequency of males (n = 133 or 40.9%) to females (n = 190 or 58.5%) in the group was almost identical to the frequencies of gender in the group containing 189 participants.

Ethnic Origin of the Undergraduate Students. Just as in all of the other samples used in this study, the majority of the students designated their ethnic background as White (n = 250 or 76.9%). Other ethnic categories indicated by the students were Black or African American (n = 42 or 12.9%), Asian (n = 18 or 5.5%), Hispanic (n = 7 or 2.2%), Native American (n = 1 or .3%), and other (n = 6 or 1.8%). One student did not designate an ethnic background (n = 1 or .3%).

College Majors of the Undergraduate Students. The sample included students with various college majors. The numbers of majors in each category were: Business (n = 31 or 9.5 %), Arts and Sciences (n =161 or 49.5%), Medical Sciences (n = 21 or 6.5%), Agriculture (n = 7 or 2.2%), Engineering (n= 30 or 9.2%), Communication (n = 21 or 6.5%), Design and Music (n = 12 or 3.7%), Education (n = 27 or 8.3%), undecided (n = 13 or 4.0%), and no response (n = 2 or .6%).

Undergraduate Credit Hours. The mean for the number of credit hours completed by the undergraduates in the student sample was 43.7 (SD = 38.2). The number of credit hours ranged from 0 - 200. The majority of the students in the study had completed 28 or less credit hours.

Confirmatory Factor Analysis of Split Sample

A confirmatory factor analysis (CFA) was performed on the data from group one in order to formulate a theoretical model. The model was then confirmed via a second confirmatory factor analysis using the data from the sample containing 189 students. The number of individuals in each sample group was determined using a five to one ratio of individuals in the sample to variables in the instrument (Hair et al., 1998; Hatcher, 1994; Kerlinger & Lee, 2000).

The SAS system's PROC CALIS procedure described in Hatcher (1994) was used to analyze the data. The models tested were composed of four latent variables or constructs and multiple indicator variables. A two-step process was used to accomplish the analyses. First, a measurement model was generated using confirmatory factor analysis. Then the model was modified using the criteria outlined by Hatcher (1994). Once the measurement model revealed an acceptable fit to the data, it was changed so

that it represented the theoretical model. Finally, the measurement model and the theoretical model were compared for goodness-of-fit and parsimony (Hatcher, 1994).

Measurement model. The measurement model describes the nature of the relationship between the constructs (latent variables) and the indicator variables that measure the constructs. The model presented in this study contained four constructs: visuospatial, analytical, social, and categorical. A minimum of three indicator variables were used to measure each construct (Hatcher, 1994).

The structure of the original measurement model was modified by deleting variables with nonsignificant factor loadings, variables with high normalized residuals, and variables indicated to be problematic by the Lagrange Multiplier and Wald test modification indices. According to Hatcher (1994), nonsignificant variables are those with the absolute value of the t statistic for factor loadings less than 1.96 ($p < .05$). The null hypothesis states that the relationship between each variable and its construct is zero. All variables with t statistics below 1.96 or low standardized factor loadings were eliminated from the model.

After eliminating the nonsignificant variables, the researcher examined the normalized residuals to determine which variables had residuals that were outside of the acceptable limits. Hair et al. (1998) contends that the acceptable limits for residuals is ±2.58 standard deviations. Since a sample of 365 was used for this study, 16 residuals may exceed ± 2.58 standard deviations strictly by chance. Variables with high residuals were eliminated from the model. Nine residuals in the model were outside of the acceptable limits indicating that the distribution of normalized residuals was

symmetrical. Kerlinger and Lee (2000) contend that the smaller the residuals, the better the data fits to the model.

The Lagrange Multiplier test was used to evaluate the decrease in chi-square that would occur by adding a new path to the model. The variables with high Lagrange values on two factors were eliminated because the theoretical model does not account for indicator variables to measure more than one latent variable (Hatcher, 1994).

The Wald test identifies unimportant paths or covariance that can be eliminated without affecting the chi-square significantly. Most of the problematic variables identified by the Wald test results also had insignificant or low standardized factor loadings (Hatcher, 1994). These variables were automatically dropped from the model. The original model contained 65 indicator variables. However, modification of this model resulted in a revised model containing 22 variables. According to Hatcher (1994), one of the necessary conditions for confirmatory factor analysis is that the model contain "a maximum of 20 - 30 indicator variables" (p. 260).

The problematic variables were eliminated from the model one variable at a time. Each time a variable was eliminated, the model was reconfigured. Once all of the problematic variables were eliminated, the model was evaluated for reliability, validity, and goodness-of-fit. The composite reliabilities for the factors were determined. This index indicates the internal consistency of the variables measuring a given construct and is parallel to the coefficient alpha (Hair et al., 1998; Hatcher, 1994). The composite reliabilites ranged from visuo-spatial .71 to analytical .77. All of the values, which are listed in Table 5, are greater than .60 and were within acceptable limits (Hatcher, 1994).

Convergent validity was determined using the standardized factor loadings for each remaining variable and the t statistic. Significant t tests and factor loadings illustrated that the indicator variables were actively appraising the designated construct. The ranges of the factor loadings for the latent constructs and their indicator variables were: visuospatial .407 to .751, analytical .390 to .751, social .420 to .834, and categorical .392 to .797. The ranges of the t values were all highly significant: visuo-spatial 6.85 to 10.84, analytical 6.41 to 13.65, social 7.14 - 15.85, and categorical 7.36 to 15.75. The factor loadings and t values are listed in Table 5 for each variable.

The discriminant validity of the model was determined by reviewing the covariance between the pairs of constructs. An examination of the covariance among exogenous variables (latent constructs) revealed that none of the confidence intervals between constructs include 1.0; therefore, the correlation between the constructs was weak and discriminant validity is demonstrated (Hatcher, 1998). The estimates, standard errors, and t tests are listed in Table 6.

After determining the reliability and validity of the model, the next step was to ascertain the goodness-of-fit of the model. Evaluating the overall goodness-of-fit of the model involved determining the absolute fit of the model, the incremental fit, and the parsimony. The absolute fit of the model is the degree to which the covariance matrix is predicted by the structural and measurement models (Hair et al., 1996). Indices used to evaluate the absolute fit of the model are the chi-square, the normed chi-square, and the Goodness of Fit Index (GFI). The chi-square for the model was χ^2 (203, $n = 325$) $= 356.7$, $p < .0001$. The normed chi-square, which is the ratio between chi-square and

Table 5

Characteristics of the Measurement Model

	Construct and Indicators	Standardized loadings	t	Composite Reliabilities
	Visuospatial			.72
1e	Use pictures and images to clarify the information.	.604	9.16***	
5c	Use drawings and images to explain the concept.	.407	6.29***	
9d	Use pictures to illustrate the information.	.751	10.84***	
13e	Use pictures to illustrate steps in the procedure.	.442	6.85***	
	Analytical			.73
4c	A planner.	.667	6.73***	
7c	Organized.	.751	13.65***	
9b	Take detailed notes.	.444	10.84***	
10d	Use an organized process to calculate the answer.	.390	6.41***	
11d	Consistent.	.581	10.08***	
13b	Follow the directions in a step-by-step manner.	.468	7.36***	
	Social			.75
1a	Become overwhelmed if there is too much to learn.	.621	11.14***	
3e	Get nervous when I am not sure of the answer.	.606	10.84***	
4d	Overwhelmed.	.834	15.85***	
6e	Get nervous because I usually get lost.	.420	7.14***	

(table continues)

	Construct and Indicators	Standardized loadings	t	Composite Reliabilities
10a	Get nervous if I am uncertain of the answer.	.475	8.19***	
13c	Am overwhelmed when the procedure has lots of steps.	.479	8.27***	
	Categorical			.78
1b	Outline the information.	.797	15.75***	
2a	An outliner.	.745	14.43***	
3c	Rely on the answer after outlining the information.	.392	6.73***	
5a	Make an outline before answering the questions.	.485	8.52***	
9a	Outline the information.	.738	14.25***	
13d	Make an outline of the procedure.	.425	7.36***	

Note. $n = 325$.
***$p < .001$.

Table 6

Covariance Among Exogenous Variables

Parameter	Estimate	Standard Error	Confidence Intervals	t[a]
Visuo-spatial/Analytical	.085	.076	-.067 to .237	1.12
Visuo-spatial/Social	-.015	.074	-.163 to .133	-0.21
Visuo-spatial/Categorical	-.181	.071	-.323 to -.039	-2.54
Analytical/Social	-.308	.065	-.438 to -.178	-4.71
Analytical/Categorical	.439	.059	.321 to .557	7.41
Social/Categorical	-.253	.064	-.381 to -.125	-3.94

[a] The t tests verify that the relationship between the variables is zero. For the t test to be significant, the confidence interval must include 1.0 (Hatcher, 1994).

the degrees of freedom, was 1.78. According to Hatcher (1994), the p values for the chi-square test should be greater than .05 and the ratio of chi-square/df should be less than 2. However, Hatcher (1994) contends that the chi-square/df ratio is affected by sample size and that the ratios for a model can vary based on sample size.

The other index that can be used to measure absolute fit is the GFI. The GFI is not dependent on sample size and is a comparison of the estimated residuals squared to the actual data. According to Hair et al. (1998), there is no threshold level for this value, although higher is better. The GFI for the measurement model was .911 and is listed in Table 7.

The indices that are used to measure the incremental fit of the model are the Bentler's Comparative Fit Index (CFI) and the Bentler & Bonett's (1980) Non-normed Index (NNFI). The incremental fit of the model compares the model to the null model. For the measurement model, the CFI was .900 and the NNFI was .887. These values were equal or close to the desirable value of .90 and indicated an acceptable fit (Hair et al., 1998; Hatcher, 1994) and are listed in Table 7.

Next, the parsimony of the measurement model was tested using the parsimony ratio (PR) and the parsimonious normed-fit index (PNFI). These indices signify the simplicity and the fit of the overall model. The PR value is determined by dividing the degrees of freedom of the model of interest by the degrees of freedom of the null model. According to the null model, there are no relationships between any of the variables. The PR of the model was .879 and the PNFI was .702. The higher the value for the PR, the greater the parsimony of the model. According to Hatcher (1994), the larger the

PNFI the more acceptable the data and the minimum acceptable values are between .50 and .60. The PR and PNFI are listed in Table 7.

Theoretical model. The theoretical mode is a combined model that consists of the measurement model and a structural model. The measurement model examines the constructs and the indicator variables that successfully measure these constructs. The structural model examines the relationships between the constructs themselves. The theoretical model is the same as the revised measurement model. Except in the theoretical model, the parameters of the variables with the highest factor loadings for each construct are fixed at one to ensure that the indicator variables best represent the construct. The construct is an unobserved variable and it has no established unit of measurement. "However, by fixing at one the path from the F variable to one of its manifest indicators, the unit of measurement for the F variable becomes equal to the unit of measurement for that indicator variable (minus its error term)" (Hatcher, 1994, p. 357).

Thus parameters for variables 9d (visuo-spatial), 7c (analytical), 4d (social), and 1b (categorical) were all set at 1.0. No other changes were made in the model. Table 7 summarizes the goodness-of-fit parameters for the theoretical model. The values of the CFI (.899), the NNFI (.887), and the GFI (.910) were acceptable (Hair et al., 1998; Hatcher, 1994; Fletcher et al., 1996; Barry Moser, personal communication March, 2001).

The chi-square difference test was used to evaluate the validity of the theoretical model by comparing this model to the measurement model. If there is no significant difference between the two models, then the observed relationships between the

Table 7

The Goodness-of-fit and Parsimony Indices of the Combined Models

Model	χ^2	df	GFI	CFI	NNFI	PR	PNFI
Null	1772.5	231					
Theoretical	362.49	207	.910	.899	.887	.896	.713
Measurement	365.70	203	.911	.900	.887	.879	.702

Note. GFI is the goodness of fit index; CFI is the Bentler's Comparative Fit Index; NNFI is the Bentler & Bonett's (1980) Non-normed Index; the PR is the parsimony ratio of the df of the Model divided by the df of the Null; and the PNFI is the James, Mulaik, & Brett (1982) Parsimonious Index.

constructs is successfully illustrated in the theoretical model. The chi-square for the measurement model was subtracted from the chi-square for the theoretical model: 365.70 - 362.49 = 3.21. The degrees of freedom for the difference test was determined by subtracting the degrees of freedom of the models: 207 - 203 = 4. The critical value for chi-square at 4 degrees of freedom was 9.49 ($p = < .05$). Therefore, the theoretical model was effective in justifying the relationships between the constructs. The theoretical model provided a fit to the data that was the same as the measurement model (Hatcher, 1994).

Confirmatory Factor Analysis of the Model

The theoretical model developed using the sample of 325 was confirmed using the final sample of 189. Twenty-two indicator variables and four latent constructs composed the final model. Thus a sample of 189 was adequate to maintain the five to one ratio of samples collected to variables in the instrument (Hair et al., 1998; Hatcher, 1994). No modifications were made to this final measurement model (see Figure 6).

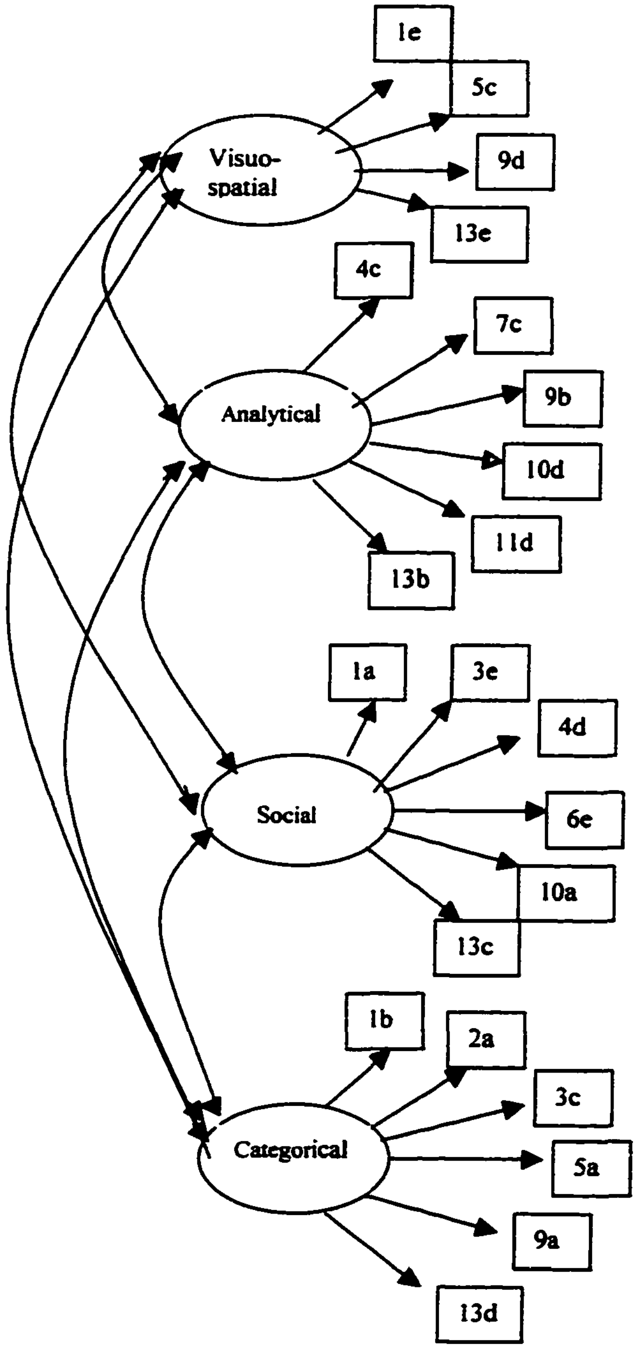

Figure 6. The measurement model for the final SIPS instrument.

Following the same procedure used in the confirmatory factor analysis of data from the sample of 325, the researcher determined the reliability and validity of the final model. The composite reliabilities ranged from visuospatial .60 to categorical .81. The reliability for the visuo-spatial construct was low but within acceptable limits (Hatcher, 1994). The reliabilities for the analytical, social, and categorical constructs were all acceptable. The composite reliabilities are listed in Table 8.

The convergent validity of the model was acceptable and was determined by examining the standardized factor loadings and the t tests. The ranges for the standardized factor loadings for each construct were: visuo-spatial .342 to .695, analytical .407 to .744, social .512 to .706, and categorical .463 to .795. All of the t test were significant ($p < .05$) and ranged from 3.81 to 12.15. The standardized factor loadings and the t tests results are summarized in Table 8.

The discriminant validity of the model was acceptable and is illustrated in Table 9. The covariance between the constructs was very weak. The highest covariance was between analytical and categorical. However, a quick determination of the confidence interval between the two constructs revealed that the interval did not include 1.0. According to Hatcher (1994), if the confidence interval does not include 1.0 then "it is very unlikely that the actual population correlation between F1 (any two factors) and F5 is 1.0" (p. 339). Therefore, the analytical construct did not measure categorical data.

The goodness-of-fit indices and the parsimony indices for the measurement and theoretical models are listed in Table 10. The absolute fit of the measurement model

Table 8

Characteristics of the Measurement Model for the Final Sample

	Construct and Indicators	Standardized loadings	t	Composite Reliabilities
	Visuospatial			.60
1e	Use pictures and images to clarify the information.	.430	4.79***	
5c	Use drawings and images to explain the concept.	.512	5.63***	
9d	Use pictures to illustrate the information.	.695	7.11***	
13e	Use pictures to illustrate steps in the procedure.	.342	3.81***	
	Analytical			.75
4c	A planner.	.579	7.76***	
7c	Organized.	.744	10.53***	
9b	Take detailed notes.	.586	7.87***	
10d	Use an organized process to calculate the answer.	.407	5.20***	
11d	Consistent.	.624	8.49***	
13b	Follow the directions in a step-by-step manner.	.482	6.27***	
	Social			.80
1a	Become overwhelmed if there is too much to learn.	.659	9.15***	
3e	Get nervous when I am not sure of the answer.	.565	7.60***	
4d	Overwhelmed.	.648	8.97***	
6e	Get nervous because I usually get lost.	.512	6.77***	

(table continues)

Construct and Indicators		Standardized loadings	t	Composite Reliabilities
10a	Get nervous is I am uncertain of the answer.	.661	9.19***	
13c	Am overwhelmed when the procedure has lots of steps.	.706	9.99***	
	Categorical			.81
1b	Outline the information.	.795	12.15***	
2a	An outliner.	.786	11.97***	
3c	Rely on the answer after outlining the information.	.463	6.22***	
5a	Make an outline before answering the questions.	.484	6.54***	
9a	Outline the information.	.718	10.60***	
13d	Make an outline of the procedure.	.558	7.71***	

Note. n = 189.
***p<.001.

Table 9

Covariance Among Exogenous Variables

Parameter	Estimate	Standard Error	Confidence Intervals	t[a]
Visuo-spatial/Analytical	-.394	.096	-.586 to -.202	-4.10
Visuo-spatial/Social	.041	.103	-.165 to .247	0.39
Visuo-spatial/Categorical	-.304	.095	-.494 to -.114	-3.19
Analytical/Social	-.285	.087	-.459 to -.111	-3.28
Analytical/Categorical	.543	.067	.409 to .668	7.79
Social/Categorical	-.098	.088	-.274 to .078	-1.12

[a] The t tests verifies that the relationship between the variables is zero. For the t test to be significant, the confidence interval must include 1.0 (Hatcher, 1994).

was acceptable with a χ^2 (203, n = 189) = 366.48, p < .0001, a normed chi-square value of < 2.0, and a GFI of .852. The incremental fit of the model was marginally acceptable with a CFI of .850 and a NNFI of .824. The parsimony of the model was acceptable, since the PR was .879 and the PNFI was .629.

The chi-square of the theoretical model was χ^2 (207, n = 189) = 368.70, p < .0001, the normed chi-squared was < 2.0, and the GFI was .851 indicating an acceptable absolute fit of the data to the theoretical model. The incremental fit of the model was marginally acceptable with a CFI of .847 and a NNFI of .830. Both of the parsimony indices were within acceptable limits (PR = .890 and PNFI = .640). The indices for the measurement and theoretical models are also listed in Table 10.

Table 10.

The Goodness-of-fit and Parsimony Indices of the Combined Models

Model	χ^2	df	GFI	CFI	NNFI	PR	PNFI
Null	1289.6	231					
Theoretical	368.70	207	.851	.847	.830	.896	.640
Measurement	366.48	203	.852	.850	.824	.879	.629

Note. GFI is the goodness of fit index; CFI is the Bentler's Comparative Fit Index; NNFI is the Bentler & Bonett's (1980) Non-normed Index; the PR is the parsimony ratio of the df of the Model divided by the df of the Null; and the PNFI is the James, Mulaik, & Brett (1982) Parsimonious Index.

The chi-square difference test, comparing the theoretical model fit to the measurement model fit, was 368.70 - 366.48 = 2.22. At 4 degrees of freedom, the critical value of chi-square at p < .05 is 9.4877. Thus the chi-square was not significant

at $p < .05$ and the theoretical model validly accounted for the relationship between the latent variables in the model.

Descriptive Statistics of the Split Sample

The demographic data from the group containing 189 assessments was used to describe the sample and to perform the inferential statistics required by the objectives of the study.

Age of the Undergraduate Students. The mean age for the students in the final sample was 19.67 years (SD = 3.39), the youngest student was 18-years old and the oldest student was 39-years old. Just in the previous field studies, the majority of the students in the sample were 18, 19, 20, and 21-years old (n = 165, 87.3%).

Gender of the Undergraduate Students. The majority of the undergraduate students who participated in this sample were females (n =110 or 58.2%). However, a larger percentage of males (n = 79 or 41.8%) participated in the final sample than had in the two previous field tests.

Ethnic Origin of the Undergraduate Students. Just as in the previous field studies, the majority of the students designated their ethnic background as White (n = 145 or 76.7%). Other ethnic categories marked by the students were Black or African American (n = 27 or 14.3%), Asian (n = 3 or 1.6%), Hispanic (n = 7 or 3.7%), and other (n = 7 or 3.7%). Only one Native American appeared in the sample. This student was included in the group "other."

College Majors of the Undergraduate Students. The sample included students in a number of different college majors. The numbers of majors in each category were: Business (n = 22 or 11.6 %), Arts and Sciences (n = 65 or 34.4%), Medical Sciences

(n = 25 or 13.2%), Agriculture (n = 8 or 4.2%), Engineering (n = 18 or 9.5%), Communication (n = 7 or 3.7%), Design and Music (n = 6 or 3.5%), Education (n = 20 or 10.6%), undecided (n = 13 or 6.9%), and no response (n = 5 or 2.6%).

Undergraduate Credit Hours. The mean for the number of credit hours completed by the undergraduates in the student sample was 32.5 (SD = 29.5). The number of credit hours ranged from 0 - 130. The majority of the students in the group had completed 26 or less credit hours.

Observations in the Sample of the Final Model

In order to complete the remaining objectives of the study, inferential statistics were performed using the means of the four latent constructs (visuo-spatial, analytical, social, and categorical) composing the confirmed model and the demographic data from the sample of 189 participants. To fulfill objective three, the Pearson product-moment correlation was used to determine if relationships existed between the strength of preference in each of the strategical information processing styles measured with age and credit hours earned. Objective four required separate inferential t tests and analyses of variance (ANOVA) to determine if differences existed in the strength of preference in each of the styles measured by gender, ethnicity, and college major. Multiple linear regression analyses (MRA) were performed to complete objective five and determine if models existed that explained a significant portion of the variance in each of the strategical information processing styles measured from the selected demographic characteristics of age, gender, ethnicity, credit hours earned, and college major.

To fulfill objective three, the Pearson product-moment correlation was used to determine if there was a relationship between the SIPS and age. The findings revealed

that for this sample, there was no relationship between the visuo-spatial construct and age and the categorical construct and age. However, there was a low negative relationship between the social construct (r = -.16) and age, and there was a low positive relationship between the analytical construct (r = .20) and age. Davis (1971) set of descriptors were used to interpret the correlation coefficients. The correlations coefficients for the four styles and age are listed in Table 11.

Also reiterated in Table 11 are the Pearson product-moment correlations showing the relationship between each SIPS and credit hours. In this study, no relationships are present between any of the SIPS constructs and credit hours earned (M = 32.46).

Table 11

Pearson Product-Moment Correlation Between the SIPS and Selected Variables

	Constructs (r)			
	Visuo-spatial	Analytical	Social	Categorical
Age	-.006	.200**	-.160*	.095
Credit hours	-.025	.037	-.035	.085

Note. n = 189.
* $p < .05$. ** $p < .01$

Independent t-tests were used to determine if there were any significant differences between the means of each SIPS by gender. For the visuo-spatial (t = 1.76, df 187, p =.08) construct, there was no significant difference by gender. The means of males (M = 2.92) and females (M = 2.71) for the rankings of the visuo-spatial variables

were not significantly different. However, there was a significant difference by gender for the analytical ($t = -4.26$, df 187, $p = <.001$), social ($t = -2.13$, df 187, $p = .035$), and categorical ($t = -4.72$, df 187, $p = <.001$) constructs. The mean rating by the females was higher than the males for the analytical, social, and categorical styles. The results of the t test analyses are listed in Table 12.

Table 12

Independent t test Statistics for SIPS by Gender

Construct/gender		M	SD	t	p
Visuo-spatial	Male	2.92	.818	1.76	.080
	Female	2.71	.858		
Analytical	Male	3.49	.757	-4.26	<.001
	Female	3.96	.737		
Social	Male	2.07	.948	-2.13	.035
	Female	2.38	.983		
Categorical	Male	2.66	.860	-4.72	<.001
	Female	3.29	.953		

Note. df = 187, males n= 79, females n = 110.

In order to complete objective four, a one-way analysis of variance (ANOVA) was used to determine if differences existed in the strength of preference in each of the four styles measured by ethnicity and by college major. The results of the first ANOVA indicated that the visuo-spatial ($F_{(4,184)} = .82$, $p < .514$), analytical ($F_{(4,184)} = 2.28$, $p < .062$), and categorical ($F_{(4,184)} = 1.75$, $p < .141$) constructs were not significantly different by ethnicity. However, for the social construct, there was a significant

different by ethnicity ($F_{(4,184)} = 3.30$, $p < .012$). The results of the ANOVA are listed in Table 13.

Table 13

ANOVA of SIPS by Ethnicity

Construct		SS	df	MS	F	p
Visuo-spatial	Between Groups	2.35	4	.59	.82	.514
	Within Groups	132.17	184	.72		
	Total	134.52	188			
Analytical	Between Groups	5.39	4	1.35	2.28	.062
	Within Groups	108.71	184	.59		
	Total	114.10	188			
Social	Between Groups	12.04	4	3.00	3.30	.012
	Within Groups	167.61	184	.91		
	Total	179.65	188			
Categorical	Between Groups	6.43	4	1.61	1.75	.141
	Within Groups	168.78	184	.92		
	Total	175.20	188			

Note. $n = 189$.

Utilizing the Bonferroni post hoc test, a significance difference ($p = .032$) was found between the Black ($M = 1.73$) and White ($M = 2.33$) ethnic groups. There were no significant differences between Black and Asian ($p = .386$), Black and Hispanic ($p = .260$) and Black and other ($p = 1.00$). Nor were there any significant differences between Whites and any of the other ethnic groups ($p = 1.00$). Figure 7 is a visual illustration of the significant and nonsignificant differences found between ethnicity. The means of the ethnic groups connected by a solid line are not significantly different from each other. The Bonferroni post hoc test, which can be used for any hypothesis

testing, utilizes pairwise comparisons of the means to determine if there is a significance difference. The Bonferroni test is not as liberal as the Duncan and the LSD tests nor as conservative as the Scheffe test. The results of the Bonferroni are comparable to those of the Tukey test (Charles J. Monlezun, personal communication, August 26, 1998).

Social Style by Ethnicity

White	Asian	Hispanic	Other	Black
M	M	M	M	M
2.33	2.94	2.64	1.81	1.73

Figure 7. Bonferroni post hoc test: social style by ethnicity.

The second ANOVA was used to determine if differences existed in the strength of preference in each SIPS by college major. No significance differences were found in the visuo-spatial ($F_{(9,179)} = .50$, $p < .871$), analytical ($F_{(9,179)} = 1.53$, $p < .140$), and categorical ($F_{(9,179)} = .98$, $p < .459$) styles by college major except for the social style ($F_{(9,179)} = 2.24$, $p < .022$). The results of the ANOVA are summarized in Table 14. When the Bonferroni post hoc test was employed, a significant difference ($p = .035$) was found between Education (M = 2.78) and Arts and Sciences (M = 1.94) majors. No other significant differences were found between any of the other majors.

In order to accomplish objective five and determine if models existed that explained a significant portion of the variance in each of the four SIPS measured from

Table 14

ANOVA of SIPS by College Majors

Construct		SS	df	MS	F	p
Visuo-spatial	Between Groups	3.32	9	.37	.50	.871
	Within Groups	131.20	179	.73		
	Total	134.52	188			
Analytical	Between Groups	8.15	9	.91	1.53	.140
	Within Groups	105.94	179	.59		
	Total	114.09	188			
Social	Between Groups	18.16	9	2.02	2.24	.022
	Within Groups	161.48	179	.90		
	Total	179.64	188			
Categorical	Between Groups	8.21	9	.91	.98	.459
	Within Groups	166.98	179	.93		
	Total	175.20	188			

Note. n = 189.

age, gender, ethnicity, credit hours, and college major, a stepwise multiple linear regression analysis (MRA) was performed. In a stepwise multiple regression analysis, each demographic characteristic is entered in sequence and its value is assessed. If the characteristic contributes to the model, then it is retained. Each time a variable is added to the model, all other variables in the model are reanalyzed and variables that no longer contribute to the model are deleted. The advantage of the stepwise entry of variable into the model is that the process yields the most parsimonious model containing a minimum number of predictor variables (Brace, Kemp, & Snelgar, 2000). Using the visuo-spatial construct as the dependent variable, the only significant demographic variable that was found to be a significant explanatory variable was gender (R^2 = .023; $F_{1,187}$ = 4.33,

p = .039). Age, ethnicity, credit hours earned, and college major were not significant predictors in this model. For the model employing the analytical construct as the dependent variable, the only significant variables were gender and age (R^2 = .117; $F_{2,186}$ = 12.27, p = < .001). Ethnicity, credit hours, and major were not significant variables in the model.

The only significant variables when the social construct was the dependent variable were college major and ethnicity (R^2 = .092; $F_{2,186}$ = 9.43, p = < .001). Age, gender, and credit hours were not significant variables in the model. For the model in which the categorical construct was the dependent variable the only significant variable was gender (R^2 = .102; $F_{1,187}$ = 21.34, p = < .001). The remaining variables age, ethnicity, credit hours earned, and college major were nonsignificant predictors of the variance in the categorical style. Table 15 summarizes the results of the MRAs.

Table 15

Stepwise Multiple Linear Regression Models

Dependent variable	Predicator variable(s)	β	p	R^2	F	df	p
Visuo-spatial	Gender	-.24	.039	.023	4.33	1 187	.039
Analytical	Gender Age	.41 .04	< .001 .014	.117	12.27	2 186	<.001
Social	Major Ethnicity	.09 .09	.025 .046	.092	9.43	2 186	<.001
Categorical	Gender	.59	< .001	.102	21.34	1 187	<.001

Note. n = 189.

CHAPTER 5: SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to develop an instrument that will assess strategical information processing styles. The researcher theorized that there were five different strategical styles based on individual differences in the information processing paradigm.

The objectives of the study were to:

1. Develop a self-assessment instrument with demonstrated validity and reliability that measures the strength of preference of strategical information processing in each of the following five styles: visuo-spatial, analytical, social, categorical, and verbal.
2. Describe the sample of undergraduate students employed in this study on the selected demographic characteristics of age, gender, ethnicity, credit hours completed, and college major.
3. Determine if relationships existed between the strength of preference in each of the five strategical information processing styles measured with age and credit hours completed.
4. Determine if differences existed in the strength of preference in each of the five styles measured by gender, ethnicity, and college major.
5. Determine if models existed explaining a significant portion of the variance in each of the five strategical information processing styles measured from the following selected demographic characteristics: age, gender, ethnicity, credit hours, and college major.

In order to achieve the purpose and the objectives of this study, the researcher developed an instrument to measure individual differences in preferred strategical information processing styles. Originally, the researcher theorized that there were five information processing styles: visuo-spatial, analytical, social, categorical, and verbal. However, as the study progressed empirical data validated only four information processing styles: visuo-spatial, analytical, social, and categorical. Although the verbal style is theoretically appealing (Baddeley, 1993; Logie, 1999; Posner & Raichle, 1993; Torgesen, 1996), the indicator variables designed to measure this style did not load significantly on a common construct. Therefore, the final instrument design excluded indicators for the verbal style. According to Nicholls and Wood (1998), word recognition takes place in both hemispheres of the brain. Perhaps, this explains why the verbal indicator variables loaded indiscriminately on the other four constructs.

Included in the research were a pilot study, three field tests, and a final data collection. The pilot study included data from a review of the instrument by the graduate committee, two peer reviewers, and a small sample of 11 students. Using the information from the pilot study, the researcher revised the original assessment and performed the first field test. The first field study included a sample of 233 students and used the SIPS instrument with the ipsative scale. Unfortunately, due to the nature of the ipsative scale, the internal consistencies of the constructs were low and the exploratory factor analysis failed.

As a result of these findings, the researcher changed the scale of the SIPS instrument to an absolute scale by altering the directions for completing the assessment. The student sample used for the second field test included 156 participants. The

internal consistencies of the constructs improved and ranged from .64 - .81. The indicator variables theorized to measure the verbal construct loaded with the indicator variables theorized to measure the analytical and categorical constructs and the internal consistency of the social ($\alpha = .64$) construct was low.

As a result of these findings, the researcher redesigned the instrument and performed a third field test. A sample of 365 students participated in the third field test. The internal consistencies of the constructs improved and the factor loadings of predicted variables improved tremendously. However, the exploratory factor analysis revealed that there were four rather than five factors. Consequently, the verbal factor was excluded for the study. Another problem with the instrument was that only four variables loaded significantly on the social construct. The SIPS was revised to increase the number of social indicator variables.

The final sample included 514 participants. Since the SIPS was revised between the third field test and the final sample, the final sample was randomly split and a confirmatory factor analysis was performed on each group. A confirmatory factor analysis was performed on the data from group one ($n = 325$) in order to formulate a model. The model was then confirmed via a second confirmatory factor analysis using the data from the sample containing 189 participants. The model developed using the first data set was confirmed using the second data set. Some of the indices for the second data set were marginally acceptable but the chi-square difference test comparing the theoretical model fit to the measurement model fit was not significant at $p < .05$. These results indicated that the theoretical model was validly accounting for the relationships between the construct variables in the paradigm.

The remaining objectives of the study were completed employing inferential statistics to analyze the effects of the demographic data collected in the final sample on the confirmed model. Correlation studies revealed that the mean scores of the analytical construct increased with age and that scores of the social construct were higher for younger student than for older students. No relationships were found between credit hours and the SIPS constructs. Independent t tests revealed that for the visuo-spatial construct, there are no significant differences by gender. However, there are significant differences by gender for the analytical, social, and categorical constructs. In each one of these styles, the means for females in the sample were higher than the means for males.

These findings are similar to those of Warrick and Nagelieri (1993), who found a gender difference in favor of females in the area of planning. Both the analytical and categorical styles involve some type of strategical planning. Several researchers also found gender differences in the areas of social preferences. Rueckert and Pawlak (2000), using an inventory to evaluate social skills, found that women scored higher than men on the emotional and social subscales of expression and sensitivity. Averill (1999) found that women scored higher than men on emotional preparedness and effective authenticity scales of the Emotional Creativity Inventory.

A one-way ANOVA revealed that there was no significant difference by ethnicity pertaining to how the participants ranked on the visuo-spatial, analytical, and categorical styles. However, for the social style, there was a significant effect by ethnicity. Post hoc testing revealed that the significance difference was between the Black and White ethnic groups. White students ranked themselves higher on the social

indicator variables than did Black students. Possibly this was a gender issue rather than an ethnic issue, since the social construct showed a significance difference between gender in favor of females. However, there were more Black females ($\underline{n}$ =19) participating than Black males ($\underline{n}$ = 8). This discovery was contrary to the findings of Durodoyle and Hildreth (1995) who theorizes that African American students differ from White students because African American students are more social.

A second one-way ANOVA revealed that there were no significance differences found in the visuo-spatial, analytical, and categorical styles by college major. However, for the social style, there was a significant difference between Education and Arts and Sciences majors. Further analysis of the data, revealed that 70% of the majors in Education are females; while only 55% of the majors in Arts and Sciences are females. This may explain the significant difference between the means for Education majors and Arts and Sciences majors.

A stepwise multiple linear regression analysis was performed using each style as the dependent variable. For the visuo-spatial model the only significant demographic variable was gender, which accounts for 2.3 % of the variance in the visuo-spatial style. With regard to the analytical model, the only predictor variables were gender and age. These variables accounted for 11.7% of the variance in the analytical style. College major and ethnicity were the only significant variables in the social model. Combined they accounted for 9.2 % of the variance in the social style. In the model for the categorical construct, 10.2% of the variance was accounted for by gender.

Conclusions

The most important finding in this study was the outcome of the confirmatory factor analysis resulting in an instrument to measure four out of the five strategical information processing styles. Although the study did not confirm the verbal style, there is strong theoretical evidence that this style exists and further research is needed to develop and evaluate new indicator variables that will measure this construct. Figure 8 is a revision of the original hypothesized model (see Chapter 1) minus the verbal style.

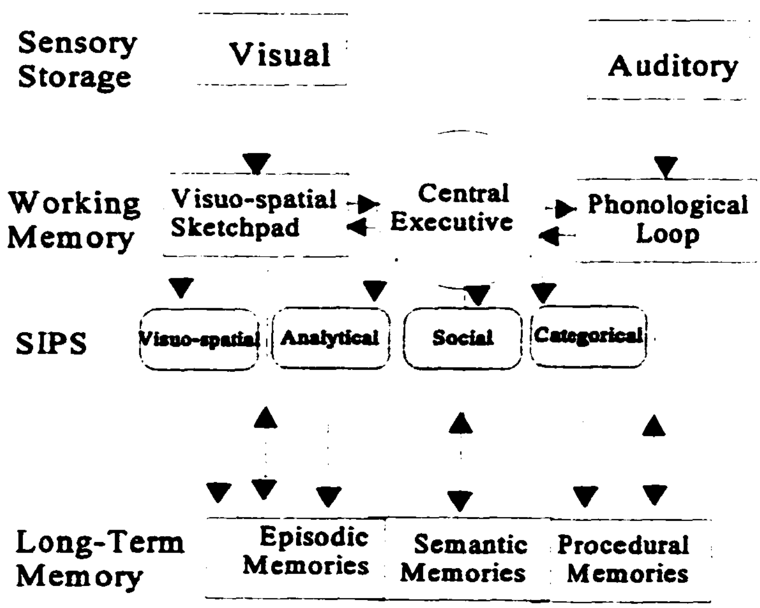

Figure 8. Revised hypothesized model of the five strategical information processing styles (SIPS).

The SIPS instrument can be improved by reducing the number of indicator variables and strengthening the visuo-spatial indicator variables. The SIPS instrument used in the final test contained 65 variables. However, the confirmed model, which was

developed by deleting variables from the larger model, contained 22 indicator variables and four latent constructs. The efficiency of the larger instrument could be improved by reducing the number of indicator variables in the assessment. Once the number of variables is reduced, confirmatory factor analysis should work very smoothly. According to Hatcher (1994), confirmatory factor analysis should be performed on models containing between 20 and 30 indicator variables.

The following conclusions are limited to the participants in this study. Gender differences were the most influential factor with regard to the strength of preference of strategical information processing styles. The results of the independent t tests and the stepwise multiple linear regression analyses revealed that gender effects the strength of preference in some way for each style. In this sample, females have a stronger preference for the analytical, social, and categorical styles. There was a significant relationship between gender and membership in the visuo-spatial and analytical groups. Gender was a significant predictor variable in the strength of preference of the visuo-spatial, analytical, and categorical strategical information processing styles.

Further Research

Continued research with the confirmed instrument is necessary to improve the indicator variables and to produce a smaller more efficient instrument. Once the SIPS instrument is amended, further research is needed to determine what influence the preference for a strategical information processing style has on cognitive abilities, visual processing abilities, general knowledge, and academic performance.

Underpinned on the theory of the information processing paradigm and validated by confirmatory factor analysis, the strategical information processing style assessment

should prove to be a useful tool for determining the strategies that individual students prefer to employ when processing information. Classroom use of this instrument will enhance the students' self-awareness and allow them to participate in their own learning. Once students are aware of their preferred strategical information processing styles, they may become cognizant of the different types of strategies that are available for success in the academic environment. After developing these strategies in the academic environment, the students will be able to continue to use these tools as they move into the dynamic workplace of the twenty-first century.

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APPENDIX A: STRATEGICAL INFORMATION PROCESSING STYLE INSTRUMENT

ASSESSMENT OF STRATEGICAL INFORMATION PROCESSING STYLE

Instruction Sheet

Directions: Different people process information in different ways. How people process information is related to individual differences in the learning process. Knowing your own strategical information processing style improves your self-awareness as a learner and can enhance your success as a student. Please complete the sentences based on the way that you prefer to handle information when it is presented to you.

- You must rank each item in the question on a scale from most preferred (5) to least preferred (1). Each number is used only once per question.
- All answers are valuable, so answer all questions.
- No correct or incorrect responses exist in the instrument.
- Your answers will be treated confidentially. The results of the assessments will be evaluated as a group. The last four digits of your social security number are requested and are critical for the purpose of matching test-retest results.

Your age today:_______________ **Last four digits of SS#** ____ ____ ____ ____ **Gender:** (✓ Check one) □ male □ female **Your Major:** _______________ →	**Ethnic background:** (✓ Check one) □ Black or African American □ Asian □ Hispanic □ Native American □ White □ Other (specify:_______________) **Undergraduate Credit Hours completed to date:**__________ Thanks!

EXAMPLE QUESTION

DIRECTIONS

For each question, rank each of the responses given according to which strategy you would prefer to use in the situation described. Use the following scale:

5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

1. When I am presented with a new concept in one of my courses, I:

3 a.	Verbalize the concept.	4 b.	Write down every detail.	2 c.	Interact with discussion and questions.	5 d.	Visualize the concept.	1 e.	Analyze the concept.

In the above example, number '5' is used for item d. This means that my preferred strategy for processing information is to ' visualize the concept ' as I act on the information.

STRATEGICAL INFORMATION PROCESSING STYLE (SIPS)

DIRECTIONS

For each question, rank each of the responses given according to which strategy you would prefer to use in the situation described. Use the following scale:

5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

1. When trying to solve a problem such as working out conflicts in my class schedule for next semester, I:

___a.	___b.	___c.	___d.	___e.
Consult a friend or advisor.	Collect all of the details before making a decision	Vocalize my solution using the right words.	Reason out the solution before making a decision.	Think about the issue until the solution pops into my head.

2. When preparing for a written exam in one of my courses, I most often:

___a.	___b.	___c.	___d.	___e.
Organize the information into charts for comparison.	Outline the information.	Use pictures and words to increase my understanding of the concepts.	Develop sayings or phrases as learning aids.	Study with a friend or group of friends.

3. To help myself remember the exact order of items in a series such as the 9 numbers in a zip code, I:

___a.	___b.	___c.	___d.	___e.
Rehearse the numbers silently in a logical order	Relate the numbers to a familiar birthday.	Cluster the numbers into groups.	Memorize the names of the numbers.	Visualize the numbers as I rehearse them.

4. To remember to bring a special "prop" to class for an activity, I:

___a.	___b.	___c.	___d.	___e.
Write myself a note.	Evaluate the assignment logically.	Rely on my friend to remember.	Write the assignment in my planner.	Visualize the assignment and the activity.

5. If I am taking a test and the answer to a question just pops into my head, I:

___a.	___b.	___c.	___d.	___e.
Rely on the answer.	Rely on the answer if I am certain it is correct.	Rely on the answer if I can justify it logically.	Rely on the answer if I can explain it verbally.	Get nervous when I am not sure of the answer.

6. When answering a discussion question on an exam about a concept such as leadership, I:

___a.	___b.	___c.	___d.	___e.
Make an outline before answering the question.	Answer the question using a chart or diagram.	Answer the question using visual images.	Carefully choose the right words to explain my answer.	Answer the question without hesitation.

DIRECTIONS

For each question, rank each of the responses given according to which strategy you would prefer to use in the situation described. Use the following scale:

5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

7. When deciding if an issue such as biological cloning is ethically right or wrong, I:

___a. Instinctively feel that the issue is right or wrong.	___b. Base my decision on research and logic.	___c. Make a list comparing the pros and cons.	___d. Carefully choose words that describe my position.	___e. Discuss the issue with peers before deciding.

8. To begin writing a research paper for one of my course assignments, I:

___a. Find that getting started is hard.	___b. Make an outline and write the paper in a step-by-step process.	___c. Start early, and organize my time and the information.	___d. Like to write and have no problem getting started.	___e. Read pertinent articles then write the paper

9. When I want to remember directions to a new friend's apartment, I:

___a. Visualize the directions as I rehearse them.	___b. Draw a map using symbols for landmarks and arrows for turns.	___c. Write down street names in order indicating right or left turns.	___d. Write down the directions in a paragraph.	___e. Share directions with someone else and ask for help recalling them.

10. In preparing to give a class presentation for one of my courses, I:

___a. Use images and present the information in a spontaneous manner.	___b. Use charts to present the information in an organized manner.	___c. Have a friend listen to my presentation before I give it in class.	___d. Use overheads with lots of words to explain the concepts.	___e. Use an outline to present the information in a logical step-by step format

11. If I were teaching a course, I would:

___a. Use overheads with lots of words to present information.	___b. Use emotional jolts to present information.	___c. Use tables and/or charts to present information.	___d. Use a step-by-step procedure to present information.	___e. Use overheads with images to present information.

12. When I act on the instructional information given in one of my courses, I:

___a. Outline the information.	___b. Rewrite my notes.	___c. Discuss the information in a study group.	___d. Use pictures and images to illustrate the information.	___e. Group the information into categories.

DIRECTIONS

For each question, rank each of the responses given according to which strategy you would prefer to use in the situation described. Use the following scale:

5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

13. When I am required to perform a calculation in my head, I:

___a. Become flustered.	___b. Use a step-by-step method.	___c. Give the answer off the top of my head.	___d. Ask questions to be sure I have all of the information.	___e. Write down the calculation to determine the answer.

14. When considering how I act on instructional information, I:

___a. Listen to instructions.	___b. Look for comparisons	___c. Like visual instructions.	___d. Like information in a logical format.	___e. Engage in teacher assisted learning.

15. When I am required to perform a procedure such as a laboratory experiment, I:

___a. Use a trial and error approach.	___b. Follow the directions in a step-by-step manner.	___c. Write a description of the procedure to use as a guide.	___d. Ask a lot of questions because learning procedures is confusing.	___e. Organize the steps into a checklist that I can follow easily.

16. If my teacher presents a concept from multiple points of view, I:

___a. Process the point of view that is logical.	___b. Process the point of view that seems right.	___c. Explain the concept from each point of view in my own words.	___d. Visualize the concept from each point of view by using mental images.	___e. Compare and contrast each point of view.

17. When considering how I act on instructional information, I am:

___a. Practical.	___b. Creative.	___c. Emotional.	___d. Abstract.	___e. Analytical.

18. When considering how I act on instructional information, I am:

___a. Technical.	___b. Apprehensive	___c. Organized.	___d. Judging.	___e. Flexible.

19. When considering how I act on instructional information, I am:

___a. Decisive.	___b. Structured	___c. Spontaneous.	___d. Calm.	___e. Excitable.

20. When considering how I act on instructional information, I am:

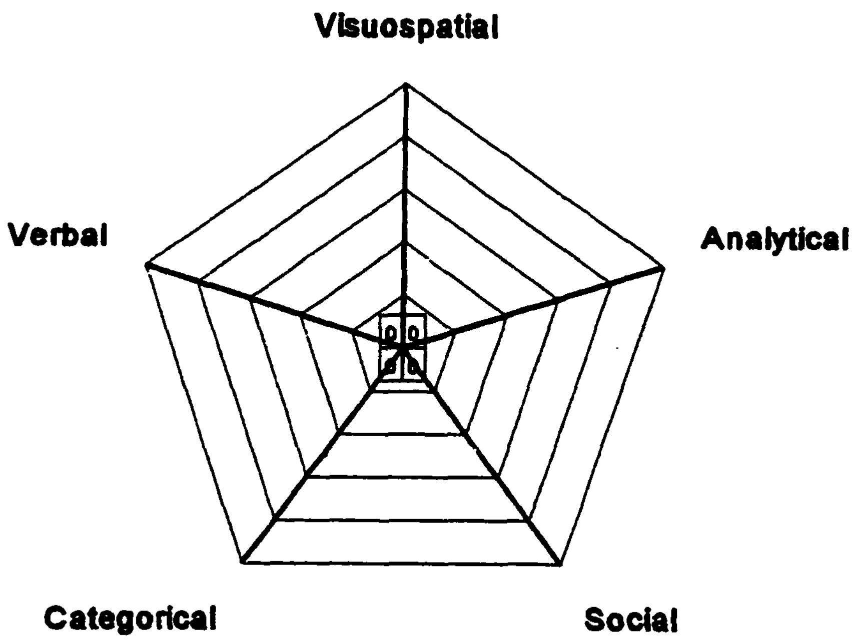
___a. Verbal.	___b. Sensitive to my feelings.	___c. Conservative.	___d. Detailed.	___e. A risk-taker.

It is critical that you have ranked every item in this assessment.
Please review the assessment to ensure that there are no empty blanks! Thanks!

APPENDIX B: GRAPH FOR PLOTTING STRATEGICAL INFORMATION PROCESSING STYLE

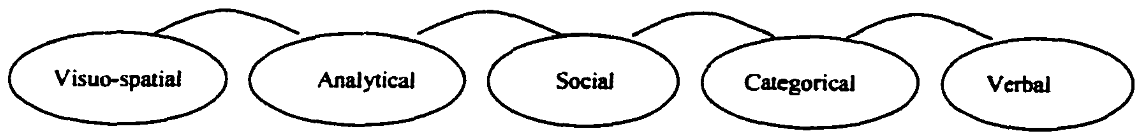
ASSESSMENT OF STRATEGICAL INFORMATION PROCESSING STYLE

Graph



<u>Directions:</u> Plot the total score from each numbered column on the correlating numbered axis. The total score from column 1 is plotted on axis 1 (categorical), from column 2 is plotted on axis 2 (verbal), from column 3 is plotted on axis 3 (visuo-spatial), from column 4 is plotted on axis 4 analytical and from column 5 is plotted on axis 5 (social). Each line on the graph represents 1 unit beginning with zero at the center and counting outward to a maximum score of 5. Your highest score on the graph represents your strategical information processing style.

APPENDIX C: PATH DIAGRAM FOR STRATEGICAL INFORMATION PROCESSING STYLE



Visuo-spatial	Analytical	Social	Categorical	Verbal
1e.	1d.	1a.	1b.	1c.
2c.	2b.	2e.	2a.	2d.
3e.	3a.	3b.	3c.	3d.
4e.	4b.	4c.	4d.	4a.
5a.	5c.	5e.	5b.	5d.
6c.	6a.	6e.	6b.	6d.
7a.	7b.	7e.	7c.	7d.
8e.	8b.	8a.	8c.	8d.
9a.	9c.	9e.	9b.	9d.
10a.	10e.	10c.	10b.	10d.
11e.	11d.	11b.	11c.	11a.
12d.	12a.	12c.	12e.	12b.
13c.	13b.	13a.	13d.	13e.
14c.	14d.	14e.	14b.	14a.
15a.	15b.	15d.	15e.	15c.
16d.	16a.	16b.	16e.	16c.
17b.	17e.	17c.	17a.	17d.
18e.	18a.	18b.	18c.	18d.
19c.	19d.	19e.	19b.	19a.
20e.	20c.	20b.	20d.	20a.

APPENDIX D: INSTITUTIONAL REVIEW BOARD FORM (LSU)

HSSC accession #:_________ **LSU Proposal #:**________

LSU INSTITUTIONAL REVIEW BOARD (IRB) for 388-8692; FAX 6792
HUMAN RESEARCH SUBJECT PROTECTION Office:117B David Boyd Hall

APPLICATION FOR EXEMPTION FROM INSTITUTIONAL OVERSIGHT

Unless they are formally qualified as meeting the criteria for exemption from Institutional Review Board (IRB) oversight, ALL LSU research/projects using living humans as subjects, or samples or data obtained from humans, directly or indirectly, with or without their consent, must be approved in advance by the LSU IRB. This Form helps the PI determine if a project may be exempted, and is used to request an exemption.

NOTE: Even when exempted, the researcher is required to exercise prudence in protecting the interests of research subjects, obtain informed consent if appropriate, and must conform to the Ethical Principles and Guidelines for the Protection of Human Subjects (Belmont Report), 45 CFR 46, and LSU Guide to Informed Consent; (Available from OSR or http://www.osr.lsu.edu/irb)

Instructions: Complete checklist, pp 2-4; if exemption appears likely, see instructions, p.4. If not, submit IRB applicaton.**

Principal Investigator Beverly A. Farrell Student? Y Y/N
Ph: 225-768-1706 E-mail bfarrell@ololcollege.edu Dept/Unit VED

If Student, name supervising professor Joe W. Kotrlik Ph: 388-5753
Student Mailing Address 340 Little John Dr. Baton Rouge 70815 Ph 225-275-7613

Project Title The Development of an Instrument to Assess Strategical Information Processing Style
Agency expected to fund project None

Subject pool (e.g. Psychology Students) Undergraduate students

Circle any "vulnerable populations" to be used: (children <18; the mentally impaired, pregnant women, the aged, other). Projects with incarcerated persons cannot be exempted.

I certify my responses are accurate and complete. If the project scope or design is later changed I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU institutions in which the study is conducted.

PI Signature Beverly A. Farrell Date 9/22/00 (no per signatures)

==

Screening Committee Action: Exempted X Not Exempted ____

Reviewer S. Kim MacGregor Signature S. Kim MacGregor Date 10/13/2000

Comments____
cc PI (signed face page only); Dr. C. Graham (application with protocol) 117B David Boyd Hall, LSU.

Help available from Dr. Charles Graham, 388-8692 cgraham@lsu.edu or any screening committee member.

Part A: DETERMINATION OF "RESEARCH" and POTENTIAL FOR RISK

This section determines whether the project meets the Department of Health and Human Services definition of "research" and if not, whether it nevertheless presents more than "minimal risk" to humans that makes IRB review prudent and necessary.

1. Is the project a systematic investigation designed to develop or contribute to generalisable knowledge?

(Note "systematic investigation" includes "research development, testing and evaluation"; therefore some instructional development and service programs will include a "research" component).

YES__x__ Go to Part B: Project constitutes research

NO_____ Go to 2

2. Does the project present physical, psychological, social or legal risks to the participants reasonably expected to exceed those risks normally experienced in daily life or in routine diagnostic physical or psychological examination or testing? You must consider the consequences if individual data inadvertently become public.

YES____ Check C2 and stop here: IRB review required

NO_____ Check C1: Apply for exemption from IRB oversight

Part B: EXEMPTION CRITERIA FOR RESEARCH PROJECTS

This Part establishes whether the project is confined to research activities that may be exempted from IRB oversight.

Please answer each question 1-5; although a single exemption criterion may be sufficient to exempt a project, some projects contain several elements that may be met by different criteria.

#1. Is this research conducted in established or commonly accepted educational settings, AND does the research involve normal educational practices (e.g. research on regular and special education strategies or research on the effectiveness of, or comparison among instructional techniques, curricula or

classroom management methods)? (NOT exempt merely because conducted at a university or school)

YES_x Check C1 & go to #2: This exemption criterion is satisfied
NO__ Go to #2: This exemption criterion is not applicable

#2. Will this research use educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior?

YES _X_ Go to 2.1

NO_____ Skip to #3: (Criterion not applicable)

2.1 Will minors (<18y) be subjects AND does this research use survey procedures, interview procedures, or observation of public behavior in which the observer participates?

YES____ Check C2, and skip to #3: IRB review probably required

NO__X__ Go to 2.2

2.2 Is the information recorded in such a manner that human subjects can be identified directly, or indirectly through identifiers (such as a code) linked to the subjects?

YES____ Go to 2.3

NO__X__ Skip to #3: This exemption criterion is satisfied

2.3 Will any inadvertent disclosure of individual human subjects' responses have the potential to place the subjects at risk of criminal and civil liability, or be damaging to the subjects' financial standing, employability or reputation?

(The collection of sensitive data regarding the subjects' (or relatives' or associates') possible substance abuse, sexuality, criminal history or intent, medical or psychological condition, financial status, or similarly compromising information are examples of instances which will require an answer of YES):

YES____ Go to 2.4

NO_____ Skip to #3: This exemption criterion is satisfied

2.4 Are the human subjects elected or appointed public officials or candidates for public office?

YES____ Check C1, go to #3: Exemption criterion satisfied
NO_____ Check C2 and go to #3: IRB review probably required

#3. Does this research involve the collection or study of existing* data, documents, records, pathological or diagnostic specimens? (*"existing" implies a retrospective study)

YES____ Go to 3.1

NO__X__ Skip to #4: (Criterion not applicable)

3.1 Is this material or information publicly available, or will it be recorded in such a manner by the investigator that the subjects cannot be identified directly, or indirectly through identifiers linked to the subjects?

YES__ Check C1 & go to #4: Exemption criterion satisfied

NO__ Check C2 & go to #4: IRB review probably required.

#4. Is this a taste or food evaluation or food acceptance study?

YES____ Go to 4.1

NO__X__ Skip to #5: (criterion not applicable)

4.1 Will only wholesome foods without additives be consumed? OR any food ingredients (including additives) consumed will be demonstrably at or below the level, and for a use found to be safe; are agricultural chemicals or environmental contaminants demonstrably at or below the level found to be safe by the Food and Drug Administration or approved by the Environmental Protection Agency or the USDA Food Safety and Inspection Service?

YES ____ Check C1 & Go to #5: Exemption criterion satisfied

NO, or unsure_____ Check C2 & go to #5: IRB review may be required

#5. Does the project include ANY research activity with human subjects not exempted under one or more of the above criteria?

YES___ Check C2: IRB review required

NO__X_ Check C1; Go to Part C and proceed accordingly

Part C: PRELIMINARY EVALUATION of EXEMPT STATUS by Investigator:

C1 _X__ C2 ____ If C1, or C1 AND C2 are checked, seek exemption

If only C2 is checked, IRB review is required: obtain instructions from Sponsored Research or Web address on p 1.

Exemption Applicant: Send 2 copies of completed form, a brief project protocol (adequate to evaluate risks to subjects and to explain your responses to Parts A & B), instruments, and the consent form to ONE member in the most closely related department/discipline or to IRB office.

HUMAN SUBJECTS SCREENING COMMITTEE MEMBERS can assist & review:

COLLEGE OF ARTS AND SCIENCES:

Dr. Northup *	(Psych)	388-4112
Dr. Williamson*	(Psych)	388-1494
Dr. Geiselman *	(Psych)	763-2695
Dr. Deseran	(Socio)	388-1113
Dr. Honeycutt	(Speech)	388-6676
Dr. Dixit	(Comm Sc./Dis)	388-3938

MASS COMMUN/SOC WK/AG:

Dr. Nelson	(Mass C)	388-6686
Dr. Archambeault	(Soc Wk)	8-1374
Dr. Kim	(Soc Wk)	388-1109
Dr. Rose	(Soc Wk)	388-1015
Dr. Biswas	(Marketing)	388-8818
Dr. Keenan*	(Hum Ecol)	388-1708
Dr. Belleau	(Hum Ecol)	388-1535

ED/LIBRARIES/INFO SCI

Dr. Kleiner	(Middleton)	388-4016
Dr. Taylor	(Admin&Fnd)	388-2193
Dr. Saia	(Lab Sch)	388-3221
Dr. Landin*	(Kinesiol)	388-2036
Dr. MacGregor	(ELRC)	388-6900
Dr. Munro*	(Curric & I)	388-2352
Dr. Fuhrmann	(Dean-EDU)	388-1258
Dr. Paskoff	(Lib/Sci)	388-1480

(* = IRB member) irbexem.wpd (1/12/2000)

** IRB application materials available from IRB office, or from IRB web site (fill in forms with your word processor)

APPENDIX E: INSTITUTIONAL REVIEW BOARD FORM (OLOL COLLEGE)

HUMAN SUBJECTS OFFICE (HSO)

AUTHORIZATION #________________

A COMPLETE SET OF ALL PROTOCOL INFORMATION MUST BE SUBMITTED TO THE OFFICE OF HUMAN SUBJECTS
FOR BOARD REVIEW-ORIGINAL AND 11 COPIES EXEMPT REVIEW - ORIGINAL

*****ONLY TYPEWRITTEN PROTOCOLS WILL BE accepted

Beverly A. Farrell	Director	Clinical Laboratory Science	225-765-1706
NAME OF PRINCIPLE INVESTIGATOR	TITLE	DEPT	PHONE

PROJECT TITLE ___ The Development of an Instrument to Assess Strategical Information Processing Style ___

PROPOSED DATES OF STUDY: October 2000 ___ THROUGH: April 2001 ___

SOURCE OF FUNDING: ___ None,

None			
NAME OF CO-INVESTIGATOR	TITLE	DEPT	PHONE

James B. Davis

DIRECTOR, INSTITUTIONAL RESEARCH

INVESTIGATOR'S ASSURANCE

I certify that the information provided in this application is complete and correct

I understand that as Principle Investigator, I have ultimate responsibility for the conduct of the study, the ethical performance of the project, the protection of the rights and welfare of human subjects, and strict adherence to any stipulations imposed by the OLOL COLLEGE IRB.

I agree to comply with all Our Lady of the Lake College policies and procedures, as well as with all applicable federal, State, and local laws regarding the protection of human subjects in research, including, but not limited to, the following:

- performing the project by qualified personnel according to the approved protocol,
- implementing no changes in the approved protocol or consent for without prior HSO approval (except in an emergency, if necessary to safeguard the well-being of human subjects),
- obtaining the legally effective informed consent from human subjects or their legally responsible representative, and using only the currently approved, stamped consent form with human subjects,
- promptly reporting significant or untoward adverse effects to the HSO in writing within 5 working days of occurrence,
- if I will be unavailable to direct this research personally, I will arrange for a co-investigator to assume direct responsibility in my absence. This person will be named as co-investigator in this application, or I will advise HSO by letter, in advance of such arrangements.

Beverly A. Farrell	10/4/00
Principle Investigator	Date

FACULTY SPONSOR'S ASSURANCE

By my signature as sponsor on this research application, I certify that the student or guest investigator is knowledgeable about the regulations and policies governing research with human subjects and has sufficient training and experience to conduct this particular study in accord with the approved protocol. In addition,

- I agree the project will be performed by qualified personnel according to approved protocol,
- I agree to meet with the investigator on a regular basis to monitor study progress.
- Should problems arise during the course of the study, I agree to be available, personally, to supervise the investigator in solving them.
- I assure that the investigator will promptly report significant or untoward adverse effects to the HSO in writing within 5 working days of occurrence.
- If I will be unavailable I will arrange for an alternate faculty sponsor to assume responsibility during my absence, and I will advise the HSO by letter of such arrangements.

		VED/LSU	388-5753
Faculty Advisor	Date	Dept	Phone

1. **Statements or objectives for conducting this research project (What do you hope to learn?).**

1. **Develop a self-assessment instrument with demonstrated validity and reliability that measures the strength of preference of strategical information processing in each of the following five styles: visuo-spatial, analytical, social, categorical, and verbal.**
2. **Describe the sample of undergraduate students employed in this study on the selected demographic characteristics of age, gender, ethnicity, credit hours completed and college major.**
3. **Determine if a relationship exists between the strength of preference in each of the five strategical information processing styles measured and age.**
4. **Determine if a relationship exists between the strength of preference in each of the strategical information processing styles measured and credit hours completed.**
5. **Determine if differences exist in the strength of preference in each of the five styles measured by gender, ethnicity and college major.**
6. **Determine if models exist explaining a significant portion of the h of the five strategical information processing styles measured from the following selected demographic characteristics: age, gender, ethnicity, credit hours, and college major.**

2. SUBJECT POPULATION. **(Describe the criteria have you established for subject selection).**

Undergraduate students who are 18 or over.

Can these subjects be described as a vulnerable population?_______Yes_____x____No
(If YES, provide additional, acceptable justification for use of these subjects.)

What is the

Minimum number of subjects you need to validate the study? ___500_____
Maximum number of potential subjects you plan to recruit? __500______
Maximum number you will include in the study? ___500_____

How will you recruit subjects? (If you are advertising or using flyers, please attach a copy)

Attend specific classes and ask students to participate.

3.. **Describe how you will determine group assignments (random vs criteria) and number of subjects to be assigned to each group, the number of groups needed, provisions for controls, or any other clarifying information regarding subject population you feel is appropriate.**

There will be no group assignments. The data collected from the convenient sample will be used to validate the instrument.

(Please provide a description of all procedures you plan to use during the course during the course of this research, in lay language. Without a complete description of all procedures the OLOL IRB will not be able to review the protocol)

In this study, the researcher will conduct a pilot test, a field test, and a final data collection using the SIPS instrument. The face and construct validity of the instrument will be determined using professionals in the fields of psychology and education. After pilot testing the instrument, the researcher will administer the assessment to a convenient sample of undergraduate students. The data collected in this field test will be used to conduct exploratory and confirmatory factor analyses. The instrument will be revised based on the results of the factor analyses. The undergraduate student sample used in the field test will be described by the selected demographic characteristics of age, gender, ethnicity, credit hours completed, and college major. Specific inferential and descriptive statistics will be generated using the field test data.

In the final data collection, the researcher will use the findings to evaluate the reliability of the instrument by using the test retest method and perform a final confirmatory factor analysis to verify the theoretical model. The instrument will be administered to a convenient sample of undergraduate students on two different occasions, approximately four weeks apart. The data collected at the first meeting will be used for the factor analysis and the first half of the instrument reliability analysis. The data collected at the second meeting will be used to complete the reliability analysis. Just as in the field test, the student sample will be described by the selected demographic characteristics of age, gender, ethnicity credit hours completed, and college major. Specific inferential statistics will be used to determine the differences and relationships of the selected demographic variables to the strategical information processing styles.

4. BENEFITS. (Describe realistic benefits to subjects and general population).

The ability to assess individual differences in information processing would be of a great benefit to both educators and students.

5. RISKS. (Identify which of the following risks subjects might encounter if they decide to participate in this research? Place a check mark beside all that apply.)

Physical	_______	Social	_______
Psychological	_______	Other	_______
Deception	_______	None	___x___

Describe reasonable risks that are associated with this protocol.

6. PRECAUTIONS. (Describe all precautions you have taken to eliminate or reduce reasonable risks. If you are using deception in this study, please justify why and be sure to attach a copy of your debriefing form.)

Deception is not used in this study.

7. **LOCATION of Experiments. (Please be specific as possible.)**

The data will be collected from samples on the LSU and OLOL College campuses. The data will be collected and analyzed at the College in the Science Building (5345 Brittany Drive)

8. **PROTECTION OF DATA.**

Will data be confidential? __x____Yes _______No Anonymous? _______Yes ____x___No
Will data be coded in any way? __x____Yes _______No
If YES, explain reason (e.g., ensure confidentiality of sensitive information, to follow-up initial contacts, collect data, etc.) and describe the method you will use for coding data.

The data will be collected in the form of surveys. Surveys once received by the College will be stored in a locked file and handled confidentially by those involved with the study.

Will you be videotaping subjects? ________Yes ___x_____No
audio-taping? ________Yes ___x_____No
Where will identifiable information (e.g., coded data, pictures, tapes, etc.) be stored? (If not applicable, please indicate n/a)
N/A
Who will have access to identifiable information? (If not applicable, please indicate n/a.)
N/A
Where will codes lists be stored? (If not applicable, please indicate n/a.)
N/A

How is the location(s) secured during your absences? (If not applicable, please indicate n/a.)
N/A

How will identifying information (e.g., code lists, pictures, tapes, etc.) be destroyed? (If not applicable, please indicate n/a.)
N/A

What is the latest date on which identifiable data (e.g., code lists, pictures, tapes, etc.) will be destroyed? (If not applicable, please indicate n/a.)
The data will be retained indefinitely since it cannot be linked to the individual participants.

NOTE: **Research date which cannot be linked in any way to an individual participant of the project may be retained indefinitely.**

ATTACH A SAMPLE OF ALL INSTRUMENTS, SURVEYS, DRAWINGS, ETC. you will use in this study. If you are (or will be) developing the questionnaire, etc., please provide a general description of the instrument. If you are using interview procedures, please include a general script of the interview.

ATTACH A COPY OF ALL INFORMED CONSENTS AND/OR INFORMATION DOCUMENTS you have developed for use is this study. Be sure each form is applicable to the proposed procedures and that the form contains all of the requirements for compliance with the regulations regarding informed consent.

APPENDIX F: STUDENT CONSENT FORM (LSU)

STUDENT CONSENT FORM (Nonclinical)

1. Study Title:	The Development of an Instrument to Assess Strategical Information Processing Style
2. Performance Site:	Louisiana State Univerity and Agricultural and Mechanical College
3. Investigators:	The following investigators are available for questions about this study, M-F, 8:00 a.m. - 4:30 p.m. Beverly Farrell 768-1706 Dr. Joe Kotrlik 388-5753
4. Purpose of the Study:	The purpose of this study is to develop an instrument to assess Strategical Information Processing Styles in undergraduate students.
5. Subject Inclusion:	Undergraduate college students who are 18 or older.
6. Number of subjects:	500
7. Study Procedures:	The study includes a field test of the instrument and a final data collection on the revised instrument.
8. Benefits:	The ability to assess individual differences in information processing would be of great benefit to both educators and students.
9. Risks:	There are no risks.
10. Right to Refuse:	Subjects may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.
11. Privacy:	Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law.

NONCLINICAL CONSENT FORM

12. Signatures:

The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Charles E. Graham, Institutional Review Board, (225) 388-1492. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

____

Signature of Subject Date

APPENDIX G: STUDENT CONSENT FORM (OLOL COLLEGE)

STUDENT CONSENT FORM (Nonclinical)

1. Study Title:	The Development of an Instrument to Assess Strategical Information Processing Style
2. Performance Site:	Our Lady of the Lake College
3. Investigators:	The following investigators are available for questions about this study, M-F, 8:00 a.m. - 4:30 p.m. Beverly Farrell 768-1706 Dr. Joe Kotrlik 388-5753
4. Purpose of the Study:	The purpose of this study is to develop an instrument to assess Strategical Information Processing Styles in undergraduate students.
5. Subject Inclusion:	Undergraduate college students who are 18 or older.
6. Number of subjects:	500
7. Study Procedures:	The study includes a field test of the instrument and a final data collection on the revised instrument.
8. Benefits:	The ability to assess individual differences in information processing would be of great benefit to both educators and students.
9. Risks:	There are no risks.
10. Right to Refuse:	Subjects may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.
11. Privacy:	Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law.

NONCLINICAL CONSENT FORM

12. Signatures:

The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Charles E. Graham, Institutional Review Board, (225) 388-1492. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

____

Signature of Subject Date

APPENDIX H: INSTRUCTOR CONSENT FORM

INSTRUCTOR CONSENT FORM (Nonclinical)

1. Study Title:	The Development of an Instrument to Assess Strategical Information Processing Style
2. Performance Site:	Louisiana State University and Agricultural and Mechanical College
3. Investigators:	The following investigators are available for questions about this study, M-F, 8:00 a.m. - 4:30 p.m. Beverly Farrell 768-1706 Dr. Joe Kotrlik 388-5753
4. Purpose of the Study:	The purpose of this study is to develop an instrument to assess Strategical Information Processing Styles in undergraduate students.
5. Subject Inclusion:	Undergraduate college students who are 18 or older.
6. Number of subjects:	500
7. Study Procedures:	The study includes a field test of the instrument and a final data collection on the revised instrument.
8. Benefits:	The ability to assess individual differences in information processing would be of great benefit to both educators and students.
9. Risks:	There are no risks.
10. Right to Refuse:	Subjects may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.
11. Privacy:	Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law.

NONCLINICAL CONSENT FORM

12. Signatures:

The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Charles E. Graham, Institutional Review Board, (225) 388-1492. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

____

Signature of Subject Date

APPENDIX I: PSYCHOLOGY PROFESSOR'S EVALUATION

PILOT STUDY
PROFESSIONAL'S EVALUATION

Demographic Data:

Name: Marion F. Cahill	**Date:** 10-9-00
Academic Position: Professor of Psychology and Nursing	**Years in Position:** 26 years teaching Psychology
Academic Credentials (Name University or College and major field of study)	
B.S. Degree John Hopkins University	**Major:** Nursing
M.S. Degree Columbia University	**Major:** Family Relations Concentration Psychology
Ph. D. Columbia University	**Major:** Family Relations Concentration Psychology

EVALUATION OF SIPS

Comments on Specific Questions:

Question Number	Item Letter	Comment

General Comments:

General Comments:

In abstract, question terms "convenient sample".

Instrument:

Question 1: Rethink.

Question 2: What about application?

Question 6: What about application?

Should all questions be asked inthe samp order for example all questions start out with visuo-spatial options?

Thank you for participating in this study. You input is a valuable measure of the validity of the instrument.

APPENDIX J: ACADEMIC COUNSELOR'S EVALUATION

PILOT STUDY
PROFESSIONAL'S EVALUATION

Demographic Data:

Name: Phyllis L. Simpson	**Date:** 10/10/00
Academic Position: Academic Counselor/ Instructor	**Years in Position:** 1970
Academic Credentials (Name University or College and major field of study)	
B.S. Degree Louisiana State University	**Major:** English
M.S. Degree Southeastern Louisiana University	**Major:** Reading/English
Ph. D. Louisiana State University	**Major:** Reading/Secondary Education

EVALUATION OF SIPS

Comments on Specific Questions:

Question Number	Item Letter	Comment
19	a.	Choice seems to be inconsistent with the other four descriptive adjectives.
8	e.	Wording for "and maybe a few extras" was a bit confusing.
18	d.	Choice seems to be inconsistent with the other four descriptive adjectives.

General Comments:

General Comments:

I think the SIPS assessment is a very creative and thorough assessing tool for helping students recognize their individual information processing styles. The measurable descriptors for each of the five hypothesized constructs have been thoroughly researched and appear to be quite valid indicators.

Although the SIPS assessment is modeled after the Learning Style Inventory (Kolb, 1985), I find that the five strategical information processing styles (Visuo-spatial, Analytical, Social, Categorical, Verbal) of SIPS could indeed prove much more beneficial to the student overall than the four stages described by Kolb (divergent, assimilating, converging, accommodating). I also recognized some similarities in the SIPS assessment with other learning style inventories (Barsch, 1996; Ducharme & Watfore, 1994); however, the SIPS assessment for Information Processing appears to be an assessment tool that could provide much more in terms of individualized thought processing and long term memory storage.

I really like the SIPS assessment, and since I daily work with College students who do indeed have thought processing difficulties with technical, medically-oriented material, I look forward to being able to utilize the SIPS assessment in the future.

Thank you for participating in this study. You input is a valuable measure of the validity of the instrument.

APPENDIX K: REVISED STRATEGICAL INFORMATION PROCESSING STYLE INSTRUMENT USED IN FIELD TEST TWO

ASSESSMENT OF STRATEGICAL INFORMATION PROCESSING STYLE
Instruction Sheet

Directions: Different people process information in different ways. How people process information is related to individual differences in the learning process. Knowing your own strategical information processing style improves your self-awareness as a learner and can enhance your success as a student. Please complete the sentences based on the way that you prefer to handle information when it is presented to you.

- You must rank each item in the question on a scale from most preferred (5) to least preferred (1). Numbers can be used more than once per question.
- All answers are valuable, so answer all questions.
- No correct or incorrect responses exist in the instrument.
- Your answers will be treated confidentially. The results of the assessments will be evaluated as a group. The last four digits of your social security number are requested and are critical for the purpose of matching test-retest results.

Your age today:______________ **Last four digits of SS#** ____ ____ ____ ____ **Gender:** (✓ Check one) □ male □ female **Your Major:** ________________ →	**Ethnic background:** (✓ Check one) □ Black or African American □ Asian □ Hispanic □ Native American □ White □ Other (specify:________________) **Undergraduate Credit Hours completed to date:**__________ Thanks!

EXAMPLE QUESTION

DIRECTIONS

For handling each situation listed below, five strategies are provided. Using the scale below, indicate your level of preference for using each strategy in each situation. Each response (number) can be used more than once for each situation.

Level of Preference Scale
5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

1. When I am presented with a new concept in one of my courses, I:

3 a.	Verbalize the concept.	1 b.	Write down every detail.	4 c.	Interact with discussion and questions.	5 d.	Visualize the concept.	1 e.	Analyze the concept.

In the above example, number '5' is used for item d. This means that 'visualize the concept' is my most often preferred strategy. 'Write down every detail' and 'analyze the concept' are my two least preferred strategies. In this example nothing was rated as preferred.

STRATEGICAL INFORMATION PROCESSING STYLE (SIPS)

DIRECTIONS

For handling each situation listed below, five strategies are provided. Using the scale below, indicate your level of preference for using each strategy in each situation. Each response (number) can be used more than once for each situation.

Level of Preference Scale

5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

---

1. When trying to solve a problem such as working out conflicts in my class schedule for next semester, I:

___a Consult a friend or advisor before making a decision.	___b Collect all of the details before making a decision.	___c Write down the conflicts and the solution before making a decision.	___d Reason out the solution before making a decision.	___e Think about the issue until the solution pops into my head.

2. When preparing for a written exam in one of my courses, I most often:

___a Organize the information into charts for comparison.	___b Outline the information.	___c Use pictures and words to increase my understanding of the concepts.	___d Rewrite the information.	___e Study with a friend or group of friends.

3. When considering how I act on instructional information, I am:

___a Precise.	___b Sensitive to my feelings.	___c Logical.	___d Detailed.	___e A risk-taker.

4. To remember to bring a special "prop" to class for an activity, I:

___a Write down the assignment on a piece of paper.	___b Question the reason for the assignment.	___c Rely on my friend to remember the assignment.	___d Write the assignment in my planner.	___e Visualize the assignment and the activity.

5. If I am taking a test and the answer to a question just pops into my head, I:

___a Rely on the answer.	___b Rely on the answer after comparing all of the details.	___c Rely on the answer if I can justify it logically.	___d Rely on the answer if I can explain it verbally.	___e Get nervous when I am not sure of the answer.

6. When considering how I act on instructional information, I am:

___a Practical.	___b Creative.	___c Emotional.	___d Decisive.	___e Analytical.

7. When answering a discussion question on an exam about a concept such as leadership, I:

___a Make an outline before answering the question.	___b Answer the question using a chart or diagram.	___c Answer the question using drawings to explain the concept.	___d Answer the question using my own words to explain the concept.	___e Answer the question without hesitation.

8. When considering how I act on instructional information, I am:

___a Rational.	___b Apprehensive.	___c Organized.	___d Determined.	___e Flexible.

9. When I want to remember directions to a new friend's apartment, I:

___a Use visual landmarks to remember the direction.	___b Draw a map using symbols for landmarks and arrows for turns.	___c Write down the directions indicating left or right turns and distances.	___d Write down the directions in a paragraph.	___e Share directions with someone else and ask for help recalling them.

10. When giving a presentation in one of my classes, I:

a	b	c	d	e
___a Use images and present the information in a spontaneous manner	___b Use charts to present the information in an organized manner	___c Involve the class in the presentation through discussion.	___d Use overheads with lots of words to explain the concepts	___e Use an outline to present the information in a logical step-by step format

11. If I were teaching a course, I would:

a	b	c	d	e
___a Use overheads with lots of words to present information.	___b Use games and group projects to present the information.	___c Use tables and/or charts to present information.	___d Use a step-by-step procedure to present information.	___e Use overheads with pictures and graphics to present the information.

12. When I act on the instructional information given in one of my courses, I:

a	b	c	d	e
___a Outline the information	___b Rewrite my notes.	___c Discuss the information in a study group.	___d Use pictures to illustrate the information	___e Group the information into categories.

13. When I am required to perform a calculation in my head, I:

a	b	c	d	e
___a Become flustered.	___b Use a step-by-step method.	___c Give the answer off the top of my head.	___d Think through the key points of the calculation.	___e Talk myself through the calculation.

14. When considering how I act on instructional information, I am:

a	b	c	d	e
___a Decisive.	___b Structured.	___c Spontaneous	___d Systematic	___e Excitable.

15. When considering how I act on instructional information, I:

a	b	c	d	e
___a Listen to the instructions.	___b Like specific organized instructions.	___c Like visual instructions	___d Like instructions in a logical format.	___e Like one-on-one instructions.

16. When I am required to perform a procedure such as a laboratory experiment, I:

a	b	c	d	e
___a Use a trial and error approach.	___b Follow the directions in a step-by-step manner.	___c Write a description of the procedure to use as a guide.	___d Ask a lot of questions because learning procedures is confusing.	___e Organize the steps into a checklist that I can follow easily

17. If I am taking a test and the answer to a question just pops into my head, I:

a	b	c	d	e
___a Rely on the answer	___b Rely on the answer after comparing all of the details.	___c Rely on the answer if I can justify it logically	___d Rely on the answer if I can explain it verbally	___e Get nervous when I am not sure of the answer.

It is critical that you answered every item in this assessment.
Please review the assessment to ensure that there are no empty blanks!

Thanks for participating in this project.

APPENDIX L: REVISED STRATEGICAL INFORMATION PROCESSING STYLE INSTRUMENT USED IN FIELD TEST THREE

ASSESSMENT OF STRATEGICAL INFORMATION PROCESSING STYLE

Instruction Sheet

Directions: Different people process information in different ways. How people process information is related to individual differences in the learning process. Knowing your own strategical information processing style improves your self-awareness as a learner and can enhance your success as a student. Please complete the sentences based on the way that you prefer to handle information when it is presented to you.

- You must rank each item in the question on a scale from most preferred (5) to least preferred (1). Numbers can be used more than once per question.
- All answers are valuable, so answer all questions.
- No correct or incorrect responses exist in the instrument.
- Your answers will be treated confidentially. The results of the assessments will be evaluated as a group. The last four digits of your social security number are requested and are critical for the purpose of matching test-retest results.

Your age today:_______________ **Last four digits of SS#** ____ ____ ____ ____ **Gender:** (✓ Check one) □ male □ female **Your Major:** _________________ →	**Ethnic background:** (✓ Check one) □ Black or African American □ Asian □ Hispanic □ Native American □ White □ Other (specify:________________) **Undergraduate Credit Hours completed to date:**__________ Thanks!

EXAMPLE QUESTION

DIRECTIONS

For handling each situation listed below, five strategies are provided. Using the scale below, indicate your level of preference for using each strategy in each situation. <u>Each response (number) can be used more than once for each situation</u>.

Level of Preference Scale
5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

I. **When I am presented with a new concept in one of my courses, I:**

3 a.	Verbalize the concept.	1 b.	Write down every detail.	4 c.	Interact with discussion and questions.	5 d.	Visualize the concept.	1 e.	Analyze the concept.

In the above example, number '5' is used for item d. This means that ' visualize the concept ' is my most often preferred strategy. 'Write down every detail' and 'analyze the concept' are my two least preferred strategies. In this example nothing was rated as preferred.

STRATEGICAL INFORMATION PROCESSING STYLES (SIPS)

DIRECTIONS

For handling each situation listed below, five strategies are provided. Using the scale below, indicate your level of preference for using each strategy in each situation. Each response (number) can be used more than once for each situation.

Level of Preference Scale

5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

---

1. When studying for a written exam in one of my courses, I:

___a. Become overwhelmed if there is too much to learn. ___b. Outline the information. ___c. Group the information into categories. ___d. Rewrite the information. ___e. Study with a friend or group of friends.

---

2. When considering how I act on information presented in my courses, I am:

___a. An outliner. ___b. Concerned. ___c. Logical. ___d. Detailed. ___e. A risk-taker.

---

3. If I am taking a test and the answer to a question just pops into my head, I:

___a. Rely on the answer if I can visually explain it. ___b. Rely on the answer after comparing all of the details. ___c. Rely on the answer after outlining the information. ___d. Rely on the answer if I can explain it verbally. ___e. Get nervous when I am not sure of the answer.

---

4. When considering how I act on information presented in my courses, I am:

___a. Practical. ___b. Creative. ___c. A planner. ___d. Overwhelmed. ___e. Analytical.

---

5. When answering a discussion question on an exam about a concept, such as democracy, I:

___a. Use a step-by-step format to explain the concept. ___b. Use a chart or diagram to explain the concept. ___c. Use drawing and images to explain the concept. ___d. Use precise details to explain the concept. ___e. Use past experiences to explain the concept.

---

6. When giving a presentation in one of my classes, I:

___a. Use images and present the information in a spontaneous manner. ___b. Use charts to present the information in an organized manner. ___c. Use a detailed structured format to present the information. ___d. Use overheads with lots of words to present the information. ___e. Use a logical step-by-step format to present the information

---

7.	**When I want to remember directions to a new friend's apartment, I:**								
___a.	Use visual landmarks to remember the directions.	___b.	Write down the precise directions.	___c.	Follow the directions in a step-by-step format.	___d.	Use a map to outline the directions.	___e.	Share directions with someone else and ask for help recalling them.
8.	**When considering how I act on information presented in my courses, I am:**								
___a.	Orderly.	___b.	Excitable.	___c.	Organized.	___d.	Scientific.	___e.	Astonished.
9.	**If I were teaching a course, I would:**								
___a.	Use overheads with lots of words to present information.	___b.	Use games and group projects to present the information.	___c.	Use tables and/or charts to present information.	___d.	Use a step-by-step procedure to present information.	___e.	Use a systematic structured approach to present the information
10.	**When I act on the lecture information given in one of my courses, I:**								
___a.	Outline the information.	___b.	Take detailed notes.	___c.	Ask questions to clarify the information.	___d.	Use pictures to illustrate the information.	___e.	Group the information into categories.
11.	**When I am required to perform a mathematical calculation in my head, I:**								
___a.	Get nervous if I am uncertain of the answer.	___b.	Use a step-by-step method to calculate the answer.	___c.	Give the answer off the top of my head.	___d.	Use an organized process to calculate the answer.	___e.	Give the precise answer.
12.	**When considering how I act on information presented in my courses, I am:**								
___a.	Decisive.	___b.	A diagrammer.	___c.	Spontaneous.	___d.	Consistent.	___e.	Inquisitive.
13.	**When considering how I act on instructional information, I:**								
___a.	Listen to the instructions.	___b.	Like specific organized instructions.	___c.	Like visual instructions.	___d.	Like instructions in an outline format.	___e.	Like one-on-one instructions.
14.	**When I am required to perform a procedure such as a laboratory experiment, I:**								
___a.	Use a trial and error approach.	___b.	Follow the directions in a step-by-step manner.	___c.	Write a description of the procedure to use as a guide.	___d.	Ask a lot of questions because learning procedures is confusing.	___e.	Organize the steps into a checklist that I can follow easily.

It is critical that you answered every item!
Please review the assessment to ensure that there are no empty blanks!
Thanks for participating in this project.

APPENDIX M: FINAL STRATEGICAL INFORMATION PROCESSING STYLE INSTRUMENT

ASSESSMENT OF STRATEGICAL INFORMATION PROCESSING STYLE

Instruction Sheet

Directions: Different people process information in different ways. How people process information is related to individual differences in the learning process. Knowing your own strategical information processing style improves your self-awareness as a learner and can enhance your success as a student. Please complete the sentences based on the way that you prefer to handle information when it is presented to you.

- You must rank each item in the question on a scale from most preferred (5) to least preferred (1). Numbers can be used more than once per question.
- All answers are valuable, so answer all questions.
- No correct or incorrect responses exist in the instrument.
- Your answers will be treated confidentially. The results of the assessments will be evaluated as a group. The last four digits of your social security number are requested and are critical for the purpose of matching test-retest results.

Your age today:____________ **Last four digits of SS#** ___ ___ ___ ___ **Gender:** (✓ Check one) □ male □ female **Your Major:** ____________ →	**Ethnic background:** (✓ Check one) □ Black or African American □ Asian □ Hispanic □ Native American □ White □ Other (specify:____________) **Undergraduate Credit Hours completed to date:**________ Thanks!

EXAMPLE QUESTION

DIRECTIONS

For handling each situation listed below, five strategies are provided. Using the scale below, indicate your level of preference for using each strategy in each situation. Each response (number) can be used more than once for each situation.

Level of Preference Scale
5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

1. **When I am presented with a new concept in one of my courses, I:**

3	a.	Verbalize the concept.	1	b.	Write down every detail.	4	c.	Interact with discussion and questions.	5	d.	Visualize the concept.	1	e.	Analyze the concept.

In the above example, number '5' is used for item d. This means that 'visualize the concept' is my most often preferred strategy. 'Write down every detail' and 'analyze the concept' are my two least preferred strategies. In this example nothing was rated as preferred.

STRATEGICAL INFORMATION PROCESSING STYLES (SIPS)

DIRECTIONS

For handling each situation listed below, five strategies are provided. Using the scale below, indicate your level of preference for using each strategy in each situation. Each response (number) can be used more than once for each situation.

Level of Preference Scale

5 = most often prefer
4 = more often prefer
3 = prefer
2 = seldom prefer
1 = least prefer

---

1. When studying for a written exam in one of my courses, I:

- ____a. Become overwhelmed if there is too much to learn.
- ____b. Outline the information.
- ____c. Group the information into categories.
- ____d. Relate my experiences to the new information.
- ____e. Use pictures and images to clarify the information.

---

2. When considering how I act on information presented in my courses, I am:

- ____a. An outliner.
- ____b. Amazed.
- ____c. Inventive.
- ____d. Anxious.
- ____e. A risk-taker.

---

3. If I am taking a test and the answer to a question just pops into my head, I:

- ____a. Rely on the answer because I trust my gut feelings.
- ____b. Rely on the answer after using a step-by-step procedure to determine its correctness.
- ____c. Rely on the answer after outlining the information.
- ____d. Rely on the answer if I can mentally picture the solution.
- ____e. Get nervous when I am not sure of the answer.

---

4. When considering how I act on information presented in my courses, I am:

- ____a. A summarizer.
- ____b. Creative.
- ____c. A planner.
- ____d. Overwhelmed.
- ____e. Unpredictable.

---

5. When answering a discussion question on an exam about a concept, such as democracy, I:

- ____a. Make an outline before answering the question.
- ____b. Use a chart or diagram to explain the concept.
- ____c. Use drawing and images to explain the concept.
- ____d. Use precise details to explain the concept.
- ____e. Use past experiences to explain the concept.

---

6. When I want to remember directions to a new friend's apartment, I:

- ____a. Picture the directions in my mind.
- ____b. Write down the precise directions.
- ____c. Follow the directions in a step-by-step format.
- ____d. Use a map to outline the directions.
- ____e. Get nervous because I usually get lost.

---

7. When considering how I act on information presented in my courses, I am:

___a	Orderly	___b	Excitable	___c	Organized.	___d	Impatient.	___e	Astonished.

8. If I were teaching a course, I would:

___a	Use overheads with lots of words to present information.	___b.	Use games and group projects to present the information.	___c.	Use tables and/or charts to present information.	___d.	Use my experiences to present the information off the top of my head.	___e.	Use a systematic structured approach to present the information

9. When I act on the lecture information given in one of my courses, I:

___a	Outline the information.	___b	Take detailed notes.	___c.	Ask questions to clarify the information.	___d	Use pictures to illustrate the information.	___e.	Group the information into categories.

10. When I am required to perform a mathematical calculation in my head, I:

___a	Get nervous if I am uncertain of the answer.	___b	Use a step-by-step method to calculate the answer.	___c.	Give the answer off the top of my head.	___d	Use an organized process to calculate the answer.	___e.	Picture the steps in my mind as I calculate the answer.

11. When considering how I act on information presented in my courses, I am:

___a	Nervous.	___b	A diagrammer.	___c.	Spontaneous.	___d	Consistent.	___e.	Imaginative.

12. When considering how I act on instructional information, I:

___a	Listen to the instructions.	___b.	Like specific organized instructions.	___c.	Like visual instructions.	___d	Like instructions in an outline format.	___e.	Like instructions that are <u>not</u> overwhelming.

13. When I am required to perform a procedure such as a laboratory experiment, I:

___a	Use a trial and error approach.	___b.	Follow the directions in a step-by-step manner.	___c.	Am overwhelmed when the procedures has lots of steps.	___d	Make an outline of the procedure.	___e.	Use pictures to illustrate the steps in the procedure.

It is critical that you answered every item!
Please review the assessment to ensure that there are no empty blanks!

Thanks for participating in this project.

VITA

The author, Beveriy Allain Farrell, was born in New Iberia, Louisiana, and is the eldest of the ten children of Anna Louise Schwing Allain and Richard Stephens Allain, Sr.

After graduating from Mt.Carmel Academy in New Iberia, the author attended Spring Hill College in Mobile, Alabama, on an academic scholarship. She graduated from Spring Hill with a bachelor's degree in biology. After graduation, Beverly was granted an internship in Clinical Laboratory Science at Crawford Long Hospital in Atlanta, Georgia. Upon completion of this one year internship, Beverly took and passed the national certification examination for Clinical Laboratory Scientists sponsored by the American Society for Clinical Pathologists. Beverly worked for several months in the clinical laboratory at Crawford Long Hospital before transferring to Ochsner Hospital in New Orleans. After working at Ochsner Hospital for a short time, the author accepted an teaching assistant in the Clinical Laboratory Science master's program at Louisiana Tech University. The author graduated from Louisiana Tech with a master's in clinical chemistry.

The author moved to Baton Rouge and married Thomas Richard Farrell, who was completing his master's in physical education at Louisiana State University. Upon moving to Baton Rouge, the author accepted a position as an instructor at Louisiana State University Medical School and taught in the Clinical Laboratory Science program at Earl K. Long Hospital. After several years of teaching and five children, the author retired for two years to be a stay home mom. When the youngest child entered pre-school, Beverly returned to work. She worked for a short time at Doctor's Hospital and

Dyncare Laboratories before accepting a position as an instructor to teach in the Clinical Laboratory Scientists program at Louisiana State University, Baton Rouge Campus. Eventually the Clinical Laboratory Scientists program was moved to the Medical Center in New Orleans. Therefore, the author worked for a short time doing research in the Biochemistry department at Louisiana State University before accepting employment in the clinical laboratory at Our Lady of the Lake Regional Medical Center.

At Our Lady of the Lake, Beverly served as the Program Director for the Clinical Laboratory Scientist program. In this position, the author was responsible for the administration of the program as well as teaching clinical laboratory sciences. In 1997, the Clinical Laboratory Scientist program moved from the Medical Center to Our Lady of the Lake College. Beverly continued as program director for the Clinical Laboratory Scientist program and developed a new program: the Clinical Laboratory Technician program. Students completing the Clinical Laboratory Scientist program earn a bachelor's degree and those completing the Clinical Laboratory Technician program earn an associate program. Both of these programs are accredited by the National Accrediting Agency for Clinical Laboratory Sciences. Besides being the director for Clinical Laboratory Sciences at Our Lady of the Lake College, Beverly is an active member in both the state and national organizations for Clinical Laboratory Sciences.

DOCTORAL EXAMINATION AND THESIS REPORT

Candidate: Beverly Allain Farrell

Major Field: Vocational Education

Title of Thesis: The Development of an Instrument to Assess Strategical Information Processing Style

Approved:

Joe W. Kotrlik
Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Donna H. Redmann

Geraldine H Holmes

Date of Examination:

June 18, 2001