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Directing Attentional Resources Toward The Appropriate Information Processing System: A Test Of The Effect Of Processing Preference And Information Presentation Mode

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By

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Abstract

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Many studies have been interested in how people process information and follow instruction. The current study was developed to a add to the existing knowledge about working memory through having participants receive instructions in different presentation mediums. It was further theorized that two processing preferences, need for cognition and need for affect, may moderate the relationship between instructions and performance. These processing constructs represent an individual's motivation to experience cognitive-based earning or emotion. Both the processing preferences and presentation types have been linked to hemispheric specialization. It was also hypothesized that an individual's level of creativity may influence their performance on a task. Two models were developed for each performance outcome (time and error). A multiple regression for categorical and continuous variables was used to determine whether presentation types, and processing preference can predict the performance based time and error scores. It was found that only presentation type predicted performance. The results of the study along with specific relationships that were found, have major implications for future research on training and working memory.

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Introduction

One of the greatest mysteries known to humankind is how the brain works. People have been interested in the brain for thousands of years and some have worked their entire lives dissecting and decrypting how this chemically enriched sponge senses, perceives and interprets information. People have specific skills and abilities based on the wiring of their brains combined with their life experiences. Although everyone may process information differently, all gather the information from the senses either visually, auditorily, through taste, touch, or smell. Psychology and education professionals are constantly trying to find better ways of presenting information to people in order to increase task efficiency, accuracy and speed. Visual, written verbal and auditory modes of information presentation are common and individuals often are aware that they process information better when it is presented in one of the three modes or another. Since people exhibit presentational and processing preferences, it is legitimate to examine how to produce more efficient methods of presenting information, so that all individuals` learning needs can be met.

In addition to a preference for how information is presented, individuals also hold personality-based differences in their tendencies to engage in cognitively driven information processing or emotionally driven information processing (Sojka, & Giese, 2001). Individuals' personalities vary through levels of their need for cognition and need for affect. These constructs have been hypothesized to relate to hemispheric specialization, information processing, and creativity (Cacioppo, & Petty, 1982; Maio & Esses, 2001; Orstein, 1997; Herrman, 1995).

When one connects the concepts of preference for how information is presented (written verbal, visual or auditory) with the innate personal differences in processing style existing in people (cognitive or affect-driven), several possible relationships emerge. The present experiment attempts to determine if the need for cognition and need for affect moderate more efficient processing of auditory, visual and written verbal mediums. It is hypothesized that information processing style will interact with the way information is presented in order to facilitate speed and accuracy of task performance.

BRAIN-BASED INDIVIDUAL DIFFERENCES IN INFORMATION PROCESSING

In formulating the hypotheses for this project, it is necessary to discuss human information processing at both macro-levels (brain and hemispheric dominance) and micro-levels (memory systems). This section begins with a discussion of hemispheric specialization in the brain and culminates in a discussion of memory systems.

Hemispheric Specialization

All of our mental processes and abilities stem from one very important part of the body, the brain. It is the brain that helps control these processes and links them to the other senses of the body. Through research on hemispheric specialization, it is possible to see from where these processes stem and how they are linked.

Hemispheric specialization is the tendency for one part of the brain to be more actively involved in processing of specific types of information. Hemispheric specialization is present from birth (Sperry, 1985). There is research to suggest that the left hemisphere is the verbal processor and the right hemisphere is the visual processor

(Lang & Friestad, 1993). The most common manifest indicator of hemispheric dominance is handedness. Handedness was tested in relation to hemispheric dominance and it was found that right handers showed the expected pattern of hemispheric dominance with an advantage of the right hemisphere on a visuospatial task and an advantage of the left hemisphere on the verbal task. Left handers used their left hemispheres for the visuospatial task, but non-hemispheric dominance could be detected on the verbal task. Studies have shown that verbal processing is specialized in the left hemisphere of the brain (McKeever & VanDeventer, 1977). While this is more prevalent in right-handers, it also occurs in left-handers. The strength of this specialization is also determined by familial sinistrality. In a study by McKeever and VanDeventer (1977) they found that the familial sinistrality had an effect on left-handed subjects. Left-handed subjects showed better recognition of visual information through the right visual field. As with other studies however they found that although genetics and gender may moderate cerebral dominance there is a failure to adequately assess these variables (McKeever & VanDeventer, 1977). Smith, Meyers, & Kline (1989) found that left handed individuals have less lateralization for the differential processing of affect and cognition than right-handers. Females were found to have greater focal organization for the processing of emotion then males.

Handedness affects language processing because left handed individuals rely less on their left hemisphere to process language (Smith, Meyers, & Kline, 1989). They tend to have mixed hemispheric dominance. In right handed individuals, language can be broken down into four functions. They are motor (gestural) language, vocal (prosodic) language, meaning (semantic) language, and relational (syntactic) language. The right hemisphere is important for vocal language that depends on melody. It is also important in semantic language that involves verbal images produced by words. The right hemisphere is important in forming concepts from words and the inflection and timbre qualities of vocal language. It also contributes significantly to motor language. The left hemisphere is dominant for understanding the relationships between words. It is also important for understanding the meaning of words and being able to express the word for a visible object. In terms of speech, the left hemisphere is important for the timing, inflection, and timbre of vocal output. Overall, the right hemisphere seems to provide a visual image while the left hemisphere provides a semantic relationship. These two combined form the total concept of hemispheric dominance (Benson,1985).

A classic metaphor has been created to describe hemispheric specialization. Dr. Jekyll and Mr. Hyde can be thought of as the different hemispheres. Dr. Jekyll is the cultivated analytical left hemisphere and Mr. Hyde can be thought of as the emotional wild right hemisphere (Orstein, 1997). Sequential processing is associated with the left hemisphere and relates to thought that has an external focus. Left hemispheric dominance makes people tend toward analytical and reasoning processes. They learn through gaining knowledge. Relating preferences are from the right hemisphere and deal with thought that is internal to the individual. Right hemispheric dominant people have greater emotional awareness and respond better to feelings.

Through a variety of experiments it was found that the left hemisphere was activated more during writing, while the right hemisphere was activated for spatial functions like arranging blocks in space. The right hemisphere has also shown more activation when subjects read creative stories, while the left hemisphere showed more activation from technical passages (Orstein, 1997).

The hemispheres react differently to sounds. The left hemisphere is associated with interpretation of words or sounds, while the right hemisphere is associated with interpretation of tones and melodies (Orstein, 1997). When the left hemisphere is removed from the brain, the right hemisphere will adapt to create better auditory comprehension and better language comprehension (Zaidel, 1985).

Although initially emotion was thought to be processed mostly in the right hemisphere, the actual reality is a little more complicated. It has been found that negative emotions are processed in the right hemisphere, while positive emotions are processed in the left hemisphere (Orstein, 1997).

The right hemisphere is superior in novel tasks that involve logical reasoning. The right hemisphere is associated with learning from experience and remembering test items that may have been on another test. The right hemisphere is used for facial recognition and houses musical abilities that do not incorporate language (Bogen, 1985).

The left hemisphere has a specialization for sequential processing. Studies have shown that the left hemisphere is more active when dealing with typical instances within a category. In the category "vehicle", a car is typical while a sled is an atypical instance (Zaidel, 1985).

Reduced levels of brain wave activity in the alpha band have been found to correlate with whatever hemisphere is most engaged in a task. When writing a letter, the left hemisphere has the lowest alpha activity, and when putting together blocks the right hemisphere has the lowest alpha activity (Brown, Marsh, & Ponsford, 1985). The context in which language is used creates different reactions from the two hemispheres.

When looking at the word "fire" it can be used as a noun or a verb. In each instance, the hemispheres show different reactions from each other. Event related potentials or ERPs have confirmed that there is a left hemispheric dominance for language functions and a right hemispheric dominance for visual spatial functions.

All this research shows that the hemispheres of the brain contribute to information processing, but in different ways. There is a consistent link between the left hemisphere and verbal processing and the right hemisphere and visual/spatial processing. The right hemisphere is the main seat of emotion, while the left hemisphere is the main seat of logical thinking. Beyond the research explaining hemispheric dominance, the primary theory that underlies this study is the working memory model. The working memory model is a modality theory that separates memory and information processing into separate visual and verbal function. These are called the visuo-spatial sketchpad and the phonological loop (Baddeley, 1990). Auditory information is also stored in the phonological loop and is more similar to written verbal memory (Sharps, Price & Bence, 1996). Penny (1989) further stated that written verbal information is processed by visual and auditory modalities. This research shows that visual, written verbal, and auditory information is stored and processed through different systems while continually working together.

Working Memory Theory

Memory obviously plays a crucial part in all cognitive processes. It allows us to retrieve, retain, and recall information at a rapid pace. Without memory we would not understand or know the meanings of words, how to ride a bike, or even our own names. There are several theories about memory (Baddeley, 1998, 1990; Matlin, 1998;

Searleman & Herrman, 1994), and in order to understand how information in processed, we will focus on one of these theories more specifically.

Working memory theory stems from the work of Penny's (1989) theories of modality in short term memory. Modality theory explains that written verbal information is processed by two distinct auditory and visual modalities. The auditory modality encodes information in acoustic code and phonological code. Successive bits of information are strongly associated. In the visual modality, information is encoded phonologically and visually. Only information that occurs simultaneously is strongly associated. Modality theory is supported by five key findings: A.) It was found that the ability to perform two concurrent written verbal tasks was improved when different input modalities are employed relative to a single modality. B.) Memory is improved when different bits of information are presented to two sensory modalities rather then one. C.) Memory is affected by selective interference, or some things affect one aspect of memory but not others . D.) People tend to have a preference for one modality rather than how long it takes to present the information. E.) Short term memory deficits appear to be specific to different modalities.

Baddeley (1990) theorized the existence of working memory to explain how information is processed prior to long term storage. Working memory is controlled by the central executive (CE). The CE is responsible for the coordination of attentional resources, interfacing with the long term memory system, and the supervision of two internal systems known as the phonological loop and the visuospatial sketchpad. The phonological loop is responsible for manipulating speech-based information. It has two components, a phonological store and an articulatory control process. The phonological store holds speech-based information for a brief amount of time. The articulatory control process refreshes information in the phonological store and converts written material into phonological. Auditory memory is temporarily stored in the phonological store before decaying away. If rehearsal is performed, the articulatory control process can refresh the memory. It also can turn written language into a phonological code for storage. The visuospatial sketchpad is responsible for manipulating visuospatial images. It is useful for planning spatial tasks and for helping with orientation.

For the purposes of the present study, working memory is a key conceptual element. This research manipulates the use of the phonological loop and visuospatial sketchpad through various information presentation forms. Furthermore, it is hypothesized that one's innate processing preference style, cognitive or affect-driven, interacts with the central executive to facilitate processing and permanent storage of information. Thus, working memory theory provides a crucial theoretical foundation for the present research project.

PRESENTATION STYLE AND INFORMATION PROCESSING

Information can be presented in three different ways – verbally written, visually or auditorily. It is important to understand how information presented in each mode is processed.

Visual Information Presentation and Visual Memory

Visual memory is the encoding and storage of visual information that is captured through the sensory cells of the eyes into the brain. Items are sometimes coded in terms of their visual characteristics. Visual memory can result from information brought in from the eyes or it can be a result of mental imagery. In contrast to written verbal processing, which involves perceiving and processing information in terms of work patterns (Van Dusen, Spach, Brown, & Hansen, 1999), visual processing involves processing spatial characteristics of information and patterns. Associations are formed using dimensions, including color, size, shape and patterns. Many measurements only focus on one type of visual information, namely shape. Color, size, quantity, and shading are often not used and should be included in measuring visual memory (Van Dusen, Spach, Brown, & Hansen, 1999). People are usually poor at determining their own visual processing. They can not differentiate visual processing from other types of processing when they are doing a task that may require other skills.

Visual processing occurs in the primary visual cortex where there is parallel processing of motion, color and orientation. At higher levels of processing, recognition takes place in the inferior temporal cortex, while spatial computations occur in the posterior parietal cortex (Schnieder, 1998). The visual representation of a scene consists of one current attended to object, and up to three memorized objects.

The visual system uses long term memory to store relevant information for future analysis, such as changes in the environment. In their model of visual memory, Hollingworth and Henderson (2002) explain that a scene is first processed with a low level sensory system, which leads to higher levels of analysis. The brain's representation of these objects is stored on a map indexing the spatial layout. The spatial layout is an abstract visual representation, rather then sensory information. The process of indexing these representations helps consolidate them into long term memory. Visual information decays rapidly in short term memory if attention is taken away. When the individual experiences the same scene again he/she can use this spatial map as a reference.

Vogel, Woodman, & Luck (2001) did an experiment to test the memory capacity for features and conjunctions in visual working memory. They used various methods to make sure that there was no written verbal interference, limited encoding, and limited decision processes. The research built upon earlier work on the capacity of visual working memory done by Luck and Vogel in 1997. The authors state that since phonological coding is very slow for written verbal memorization, then presenting the stimuli quickly will discourage the use of written verbal encoding (Vogal, Woodman, & Luck, 2001). They used orientations and colors of objects to demonstrate the capacity and efficiency of human visual memory. They also compared the performance on the visual task with and without a concurrent written verbal load. They found that the visual memory was not likely to be affected by written verbal memory. Further experiments also show that encoding limitations did not distort the results. The results of the study showed that the average amount of information that can be stored in visual working memory is equivalent to three or four items. These items were very simple and the participants only had to remember one feature from each item. These results do not take into account high vs. low fidelity. They also don't take into account experience with visual memory tasks. Vogal, Woodman & Luck (2001) conducted more studies and found that complexity had no effect on capacity and up to sixteen features could be retained across four objects. This seems to show that the capacity for visual working memory is determined by the number of objects rather then features.

Visual versus Written Verbal Memory

The previous section discussed how purely visual information is processed.

however another type of information presentation involves written verbal information (e.g. words, sentences, paragraphs). Tests such as the Verbalizer-Visualizer questionnaire show the existence of two independent processing modalities, verbal fluency and vividness of imagery (Mcgrath, O'Malley, Dura, & Beaulieu,1989; Edwards, & Wilkins, 1981). Visual and written verbal information are stored in different parts of the brain. Allen, Wallace, & Loschiavo (1994) found that poor imagers favor analytic processing or looking at the word as separate letters and vivid imagers look at the word as a whole or holistic processing. Poor imagers perform more slowly when asked to transform reversed words. High rated imagery evoking words are learned more effectively then words high in meaningfulness. Encoding in dual processing creates a bottlenecking effect on information processing (Giesbrecht, Dixon. Kingstone, 2001).

The modality argument has been discussed since the 1970's by Alan Baddeley and his colleagues. In his theory of working memory he proposed that written verbal and visual information are stored separately in different subsystems (modalities) and are controlled by a central executive (Baddeley 1998). It has been found that written verbal working memory can store seven plus or minus two pieces of information at once. Further studies were done to find out the difference between the memory of orientations, locations, and names of objects.

Pezdek, & Evans (1979) found that when buildings were tied with their name, people were less likely to recognize the building but more likely to recognize where it was located. Individuals who knew the building's name were less likely to know what it looked like. This shows that when both the name and the physical properties of the building are shown, people focus on the written verbal information. This suggests that the physical features and name inventory are processed separately and time devoted to one hurts the recall of another.

Walker and Cuthbert (1998) tested the involvement of speech based and visual representations in remembering visual feature associations. They found that visual representations preserve information about the format of the association if the features belong to the same object. Shape-color associations must be linked to the same object or there is no memory. Written verbal representations are memorized regardless if they belong to the same object or not.

Rama, Sala, Gillen, Pekar, & Courtney (2001) investigated whether written verbal and nonspatial visual information are maintained in working memory by separate neural systems. The authors found that although there was no significant difference in the prefrontal activity in the comparison between famous faces and names, there was greater activity in the visual association and parietal areas. The results indicate that "there is a functional dissociation based on information type within the neural system that is responsible for working memory maintenance of written verbal and nonspatial visual information" (pg. 161). In other words, although information that contains both written verbal and visual mediums use the same structures in nonspatial situations, there does seem to be a hemispheric dissociation in the neural system based on information type. These separate structures show how operations in the brain are separated.

Visually encoded sentences are not disrupted by irrelevant speech. However, speech significantly disrupts verbally encoded sentences. Further, an irrelevant visual display disrupts performance on the visually encoded sentences. The reasons seem to be that visual memory is stored in a passive visual store, while written verbal memory is stored in a phonological store. The visual encoding of verbally presented material is effortful and uses rewired central executive resources. Interference is created because the storage centers are competing for the same resources (McConnel & Quinn, 1996). McConnel & Quinn (1996) introduced a line drawing task during word encoding and found that it interfered with both visually and verbally encoded tasks. If the drawings were not presented during encoding, then only the visual tasks were affected.

It seems clear that written verbal and visual processes are housed in different modalities even when some of the resources and processes are shared. Visual and written verbal processing systems are separated into different systems based on the information they are processing. Visual memory relies on the number of objects rather then features. When written verbal and visual information is processed together, memory for the visual features is usually less, due to the conflict. Since the evidence for a modality of written verbal and visual processing is stronger, human learners may need to be introduced to educational formats that utilize the modality they use best.

Auditory Processing

Research has also examined modality from the auditory processing perspective. Gelder & Vroomen (1997) found that memory for spoken word and for sounds was better than for visual presentations. They also found that spoken words and environmental sounds have their own specific origins, rather than being based on a common auditory component. The dual coding view states that auditory speech is coded once as sound and once as speech. The authors found support for a motor theory in which speech takes precedence over acoustics so that only acoustic material that can't be coded as speech is referred to as acoustic encoding. This experiment points to a speech processor that works outside of short term memory.

Sharps & Pollitt (1998) found that nonverbal, non musical auditory sounds from objects were constant with phonological loop processing, while pictorial stimuli of the objects were not. The recall of auditory stimuli was higher then written verbal stimuli but it did not differ from the recall of pictorial recall. The authors suggest that auditory and pictorial stimuli may be processed through an interaction of the phonological loop and visuospatial system resources. The result of Sharps & Pollitts' study shows that, even though both working memory systems are functionally distinguishable, they may work synergistically and with overlap in some situations. These situations may be visuospatial situations that include inherent semantic meaning and auditory situations with high levels of nonsemantic detail.

Cowen (1984) outlines research that indicates there are two storage mechanisms for auditory memory. As with visual information, there exists short and long term auditory storage. Short auditory storage decays in a fraction of a second. Sound is perceived louder as the duration is increased. These increased durations also improve the accuracy of sound pitch and loudness comparisons. Until the short auditory storage has decayed, the subject still believes that the stimulus is present. In fact, it can be thought of as a continuation of sensation and contains brief information from a sound segment. Each sound overwrites the information of the previous sound. Long term auditory storage requires the retention of auditory information from multiple unidentified speech sounds. Later recognition is helped with contextual cues. This storage lasts several seconds. It has been shown that there is an advantage for the recall of items within auditory as opposed to visual lists through the recency effect. The recall of auditory information is impaired if the individual must pronounce the word first. It has also been found that inclusion of a suffix disrupts auditory storage. Long suffixes are more problematic than short suffixes. Long auditory storage contains information from a sound sequence. While long auditory storage contains feature composites, short auditory stores contain relatively unanalyzed information.

Presentation Style, Memory and Learning

The affect of modality on memory has been analyzed in working memory through the dual-code theory. When words are presented both visually and auditorily there is no cognitive overload, because they use separate processing systems. However, Moreno and Mayer (2002) found that students learn better when presented with words and pictures rather then just pictures alone.

Penney (1989) defines a modality as separate auditory and visual processing streams. Penney outlines five different points of evidence for separate processing streams. People can perform two concurrent verbal tasks when both auditory and visual processing inputs are used instead of one. Different items need to be presented to two separate modalities instead of one. There are selective interference effects and recall is better if organized by modality then by time. Deficits are specific to each modality. Auditory memory is stored as both an acoustic code (echoic) and a phonological code. Auditory memory can be maintained without deliberate attention. Visual items are retained in the phonological code and a visual code. In the auditory code, successive items are strongly associated and in the visual code simultaneously items are strongly associated.

Research has been done on information processing and individuality. Boekaerts

(1982) found that students have different strengths in retrieving visuospatial and verbatim information. The author categorized different types of learners into bicognitives, verbalizers, visualizers, and undefinites. She concludes by stating that teachers need to determine their students' coping strategies and nurture them. Some students may learn poorly from pictures but are efficient in the use of verbal-organizational strategies. These student should be allowed sufficient time to transform pictorial information into written verbal statements (Boekaerts, 1982).

These varying studies help to show the differences between visual and auditory memory for language. They show that even though both processing systems work together they are separate modalities. Written verbal and auditory processing share many of the same processing resources and are closer related to each other then to visual processing.

The research on visual, auditory and written verbal memory is important to understand the current experiment, because if accurate data is to come from each of these three modalities there are certain rules that must be followed. Each modality can not mix with any of the others. This means that if the information provided is visual it cannot have any written verbal or auditory words associated with it. This also must be done while providing the same amount of information. The visual presentation must also be in picture form to provide a 3D representation that incorporates rotation, shape, quantity, shading, and color. These are all the things that make up a visual image. The written verbal elements must be able to be read and be identical to the auditory words in order to diminish any benefits one may have over the other.

The processing of information is organized, maintained, and directed by the brain and working memory. Our written verbal, visual, and auditory processing systems all interact against and with each other to process information. While these systems may interact with each other and working memory they may be moderated by other constructs. People are usually described as having some level of cognitively minded and emotionally minded personality. So, it would seem that everyone has some level of a need for cognition or a need for affect. The origins of these constructs in the brain may tie into visual, written verbal and auditory information presentation styles.

INDIVIDUAL DIFFERENCES IN INFORMATION PROCESSING STYLE

A variety of researchers have proposed that individuals use different styles when they process information and either encode or retrieve it from long term memory. Two such styles are a cognitive-driven style and an affect-driven style. These two styles will be discussed and related to task performance.

Need for Cognition

There are three individual variables in cognition: cognitive ability, cognitive style, and need for cognition (Maio & Esses, 2001). While each of the three is important it is easier to use need of cognition as a predictor of individuals' use of cognition. Need for cognition can be used to show if a participant is more likely to want to process information cognitively versus emotionally.

Cacioppo, & Petty (1982) developed the need for cognition scale based on Cohen's creation of the idea. The need for cognition is described as a "need to structure relevant situations in meaningful and interrelated ways. It also needs to make reasonable the experimental world (pg. 116)." This idea was derived from earlier gestalt theories in structuring the environment. The authors define it as the tendency of an individual to engage in and enjoy thinking. A short form of the need for cognition scale was created and validated by Cacioppo & Perry in 1984.

MacGregor (1999) researched how students learned from multimedia. She looked at how students navigated throughout a program to teach them about biology. Students with different cognitive profiles used different navigational strategies and focused their attention in different ways. These profiles were made up of three cognitive attributes. Prior knowledge, need for cognition, and sense of efficacy were all found to influence navigation. Students with a high level of need for cognition and more internal locus of control were able to structure their navigation in purposeful ways. They developed a deeper understanding of the domain, created more highly interconnected representations of the knowledge and demonstrated greater cognitive flexibility. Kardash & Noel (2000) found that organizational signals such as headings in text influence performance on recall measures. They also found that individuals with a high need for cognition had a better recall of text that had no signals. They found no significant differences between the group's recognition tasks, or on tasks that utilized text with signals. They conclude by stating that need for cognition influences elaborative and organizational processing.

Cognitive style is a large part of an individual's need for cognition. It helps determine how much emotion is used in the thought process. It also provides evidence that the need for cognition scale is correlated with the nonemotional aspects of an individual's thinking process. Cognitive style can be measured by contemporary scales, such as the Myers-Briggs. The Myer-Briggs creates 16 psychological types from four dimensions, extroversion-introversion, sensing-intuiting, thinking-feeling, and judging perceiving. Claxton, & McIntyre (1994) simplify the scales into sensing-intuiting and thinking-feeling, and further broke those down based on earlier work done by Jung. According to Jung (1971), cognitive style represents the combination of individuals preferred method of absorbing information with their preferred mode of decision making. The method of absorbing information can be broken into sensing and intuition while the method of decision making is broken into thinking and feeling. The resulting scales used by Claxton & McIntyre (1994) are sensing-thinking, intuition-thinking, intuition-feeling, and sensing feeling. People who prefer sensing are more likely to want hard facts and like a concrete reality. People who are intuitive prefer imagination and realities characterized by ideals and possibilities. People who prefer thinking rely on deductive logic and are more analytical, impersonal, and objective. People who prefer feeling emphasize human qualities and search for expressions of feeling. They are more empathetic and have greater sympathy. These four levels of the scales are innate and not learned. The four scales themselves have characteristics that distinguish themselves from each other. People classified as sensing-thinking like certainty and precision, have a concrete orientation in life and seek the right answers within. In contrast, a person with intuiting-thinking prefers ideas and inventiveness, are orientated toward discovery of alternatives, and seek to solve life's puzzles. Those classified as intuiting-feeling tend to rely on feelings and emotions. They tend to address life's "real" problems. Individuals classified as sensing-feeling prefer intense personal experience and like to get the job done so they can move on to the next event. Claxton, & McIntyre (1994) took the four scales and correlated them with the need for cognition scale. They found that participants who scored high on intuiting-thinking scored high on need for cognition. Participants who scored high on intuitive-feeling and sensing -thinking scored moderately on the need for cognition scale. Participants who scored high on sensing-feeling scored low on the need for cognition scale. These results indicate that people who had a high thinking score, scored high on the need for cognition scale, while people scoring high in feeling had a low need for cognition score. Ferguson, Chung & Weigold (1985) found that individuals with high need for cognition scores have reported less television watching and more reading of magazines and newspaper for their news. Tuten, & Bosnjak (2001) found that need for cognition was positively correlated to web usage for product information, current events and news, and learning and education. Low need for cognition was related to web usage for entertainment purposes.

Individuals with a high need for cognition (NFC) show an increased level of causal or explanatory thinking, and recall more actions (Lassiter, Briggs, & Slaw, 1991). They are more likely to make judgments about factual messages (Vankatraman, Marlino, Kardes, & Sklar , 1990). Crawford & Skowranski (1998) found that people who are high in need for cognition remember more stereotypical information than individuals who are low in need for cognition. (However, people low in need for cognition are more influenced by stereotypes. This perhaps shows a link to emotion consistent schema.)

Verplanken (1993) found that low NFC subjects exhibited search strategies that are more variable in amount of information assessed across alternatives, indicating heuristic strategies. Individuals who score high on need for cognition process information in a more focused manner and with greater depth. The quality of their selections are of higher quality and they are more successful at adaptive decision making (Levin, Huneke,

& Jasper, 2000).

Gulgoz (2001) found that the NFC score was a predictor of written verbal scores and study skill scores on a university entrance exam. He also found that when people are told that a task will be difficult they preformed worse if they scored low on the NFC scale. Individuals will a low NFC score read texts at a faster rate but did not necessarily process it better. High need for cognition scores showed that a lack of prior knowledge was not an issue. Individuals with high need for cognition may do better academically because they succeed in both coactive and collective tasks, while individuals with low need for cognition only do well on coactive tasks (Smith, Kerr, Markus & Staason, 2001).

Tidwell, Sadowski, & Pate (2000) found that need for cognition was positively correlated with written verbal ability and knowledge about people and events during the Vietnam War era. They also found that need for cognition contributes to the acquisition of knowledge beyond the contribution of written verbal ability.

The Big Five Factor model of personality explains five factors of personality: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness (Costa & McCrae, 1992). Sadowski, & Cogburn (1997) found a direct relationship between openness to experience and need for cognition. People high in need of cognition are intrinsically motivated, exhibit curiosity, and tolerant different ideas. Need for cognition was also related to conscientiousness since high NFC individuals are willing to engage in effortful thought.

Cognitively oriented people are more willing to enjoy newspapers, intellectual journals and intellectual debates. They think more rational then irrationally, and are intrinsically motivated. Although this is a type of mindset that can be argued as the opposite modality to affect, it doesn't mean that it isn't influenced by emotion. Emotion is a major force in how humans process information and on its strongest levels it can create the other modality of need for affect. It is more important though to understand how exactly emotion affects our processing system and how we process emotional information.

Emotion and Information Processing

Emotion creates chunks of experience through the processes of emotional magnification and resonance (Haviland, & Kahlbaugh, 1993). The amygdala is a central structure of emotion and is the interface between environmental and mental events on one hand, and mental events and emotional responses on the other (Cacioppo, Klein, Berntson, & Hatfield, 1993). The amygdala evaluates the emotional significance of simple sensory features, complex perceptions, and even abstract thoughts, and controls the expression of emotional reactions. Cacioppo, Klein, Berntson, & Hatfield (1993 found that we can shift quickly between two emotions, but not experience then at the same time.

Evidence for two separate but cooperative emotional and cognitive systems has been shown through the removal of the amygdala leaving a still functioning memory (Zajonc, Murphy, & Mcintosh, 1993). Destroying the hippocampus destroys the ability to create new memories, but emotion is still intact (Zajonc, Murphy, & Mcintosh, 1993). Emotional experience requires the individual to attend to something. Emotional experience can occur without a physiological reaction. Individuals with spinal cord injuries can report sexual orgasmic experiences without feeling being possible. This shows a purely cognitive state (Lewis, 1993), and a separation of the body and cognition that helps to prove modality theory.

Emotion effects information processing and memory. Lang & Friestad (1993) found evidence to suggest that positive messages are retrieved better verbally and negative messages are retrieved better visually. The effect of this message valence on information processing was shown to occur during the encoding stage. These data show that negative messages should be shown visually to a participant to elicit a disturbing reaction, while positive messages should be told to the participants. They found the effect to be stronger for the positive emotion-verbal correlation but this may have been due to the fact that participants recalled the messages in a written and oral verbal method. Positive emotions are a cue to explore the environments while negative emotion serves as a call for behavioral adjustment. People with a greater affect are more prone to detecting threats (Cacioppo & Gardner, 1999). Positive affect has been shown to promote creativity flexibility in problem solving and negotiation, and both efficiency and thoroughness in decision-making (Isen, 1993). Positive affect has been shown to increase a person's ability to take simple objects and accomplish tough tasks. Affect intensity is the level of reactivity and variability of emotion from an individual (Davidson, 1993). Davidson (1993) found that the emotion upset activated the right frontal anterior hemisphere, while happiness activated the left frontal anterior hemisphere. This was also true for punishments and rewards.

Need for Affect

The effect of emotion on processing is significant and regulated by motivation (Maio & Esses, (2001). If an individual is more open to emotion, then the effects on processing will be greater. The need for affect is one's motivation to approach or avoid emotional inducing situations. People have two distinct information processing systems. One system is based on affective experience and the other is analytical and based on rules of reasoning (Maio & Esses , 2001). Individual differences in emotion can be divided into emotional ability, emotional style, and need for affect. Emotional ability is measured by assessing the skill with which people perceive, regulate, utilize, ad express emotion. Emotional style can be assessed using measures of tendencies to experience intense emotions. Maio & Esses (2001) developed the need for affect scale to help measure this construct. The Need for Affect scale was develop to determine if emotionally-driven people process information differently then cognitively orientated people.

Working Memory and Cognitive or Emotion-Driven Processing Preference

Research into the construct of a central executive has been unclear about how the central executive works, but this experiment may show that personal processing preference is a resource within the central executive that helps manage information from the other two working memory systems. Baddeley's model of working memory explains that short term memory is not a unitary system, but is divided into three parts in which there is a controlling attentional system that supervises two subsidiary slave systems (Baddeley, 1990). The two subsidiary slave systems are the phonological loop and visuospatial sketchpad, which are responsible for auditory-verbal and visual images respectively. In the present experiment, visual, written verbal, and auditory presentation of information can be linked with one of the two subsidiary slave systems of working memory. The controlling attentional system or central executive coordinates attentional resources and supervises the phonological loop and visuospatial sketchpad, and interfaces with pre-existing stored information. When information is presented the appropriate subsystem phonological loop or visuospatial sketchpad attends to it. Information processing is controlled by the central executive. The central executive then takes this information and interfaces with long term memory. As information is retrieved from or encoded into long term memory, it is theorized that processing preference may occur. Processing preference uses either a cognitive filter or an affect-based filter to assist in long-term memory processing. These preferences allows for better organization in memory storage and easier retrieval. The central executive is believed to utilize processing preference as an aid for interfacing with the phonological loop and visuospatial, in order to enhance long-term memory storage and retrieval. Thus, there would be a definite link between need for cognition, need for affect and how information is processed through the working memory model. A high need for affect or high need for cognition may be wired to the central executive, which in turn has the resources to plan and coordinate one's attention toward the appropriate system of the phonological loop or visuospatial sketchpad.

THE ROLE OF CREATIVITY IN INFORMATION PROCESSING

Creativity is a factor that has not been examined as fully as needed in the literature but seems to be an important link between need for cognition and need for affect. "Creativity is the ability to produce work that is both novel (i.e., original, unexpected) and appropriate (i.e., useful, adaptive concerning task constraints)" (Sternberg, 1999, pg. 3). Creativity is made up of both cognitive and emotional elements that work together to produce an output. Creativity is affected by emotion as well as cognition, and serves as a resource to influence how we present material. It uses our levels of processing preference to help facilitate a creative output. Creativity has strong roots in the right hemisphere where both visual processing and emotion are primarily housed. The problem is that visual thinkers, artists, and emotional individuals are not the only ones who are creative. Scientists and logical thinkers are also creative. It is important to measure this construct within the present study in order to see how creativity affects visual. written verbal and auditory processing and contributes to task performance.

As it relates to variables of interest in the present study, creativity, in the literature, has both cognitive and emotional elements. Runco & Chand (1995) developed a theory of creativity that has motivation (intrinsic, extrinsic) and knowledge (procedural, declarative) interacting with problem finding, ideation, and evaluation. This theory shows how cognition and emotion are important in creativity. Knowledge is important in providing a framework and a decoding of environmental cues that fuel thoughts that may be related to the current task. Knowledge allows one to adjust procedures or think of new creative ideas based on what works and what doesn't work. This leads to divergent thinking. Further knowledge includes aspects of memory. People must also be intrinsically motivated to be creative which may entail some form of emotional element.

Emotion contributes to creativity in a variety of ways. Experiencing pleasure in challenge is related to curiosity and problem solving (Frantom & Sherman, 1999). Openness to emotional states is linked to transformation ability and mood states accompany creative work (Heinrichs & Cupchik, 1985). Emotion can serve as a motivating force. It helps artists express their needs through their work. Frantom & Sherman (1999) found that affective instability has an effect on creativity. Affective instability increases creativity with no difference across men and women. Artists seem to prefer pictures that correspond to their own emotional styles (Heinrichs & Cupchik, 1985). Metaphors are used in poetry and art to express emotion. Emotion interacts with the brains rational system to create metaphors, scripts, narratives, and prototypes that fuels creativity. Lubart & Getz (1997) found that when a concept or image is perceived it activates emotion and cognitive memories of the concept. Each lead to separate sets of ideas. An analysis of two concepts is done by determining the link between them. Metaphors between two concepts are created based on the individual's attunement to emotion. Metaphors play a role in creative thinking by helping to develop novel associations between distant concepts. Some people listen closely to their emotions and some are deaf to their emotions. This attunement can be developed and changed through social experiences. Lubart & Getz (1997) found that metaphors formed through emotional based processes possess the highest creative potential. They also found that literature oriented students produced a greater number and quality of creative metaphors when using emotion centered adjectives, while science oriented students showed the best performance when using non-emotional adjectives. Economic oriented students showed intermediate results. This shows that emotion has a greater link to information processing in artists then scientists.

In 1978, Ned Herrmann presented his whole brain theory that, in part, hypothesized a link between creativity, working memory and brain functioning. The whole brain theory has been applied to teaching and learning, personality, team and leadership development, and creative thinking. Herrmann became an advocate for right brain vs. left brain learning (Herrmann, 1995). Support for whole brain theory ideas are based on previous research and can be linked to the foundations of the present experiment. In Herrmann's theory, he felt that the brain was split into four quadrants. Instead of the normal left hemisphere versus right hemisphere distinction, he split the brain based on the hemispheres and the limbic system. Herrmann felt that as the hemispheres were split by the corpus callosum, the limbic system is split by the hippocampal commissure. The lower right quadrant houses emotion, expression, and music. The lower left holds the common-sense elements of the left hemisphere and left limbic system. The upper right system houses the visual system, while the upper left houses the logical, factual, and verbal sections of the brain. In the center are the creative processes, which show a common link between the four quadrants. This conceptualization shows how creativity may greatly influence how we process information. Even Herrmann's book is outlined so that all the diagrams are in the left visual field and all the text is in the right visual field. This promotes the theory that people will learn visual material better if the information goes to the right hemisphere first and vice versa with written verbal information. At the center of whole brain theory, Herrmann places creativity, but he could has easily used the term central executive instead.

Even though whole brain theory and hemispheric specialization show how language, spatial ability, emotion, memory, and cognition are influenced and related, they don't define how they work. Each system is related by the biological regions that they share. Since they are all so interconnected, interference may occur. Each variable used in the present study interacts with others and shows specific relationships with performance that can't be ignored. Presentation style (visual, written verbal or auditory), information processing preference (cognitive vs. affect driven) and creativity are the key variables in this study. The goal of the project is to determine how each variable influences performance outcomes, such as speed and accuracy in processing.

The Present Study

The following experiment is based on an experiment done by Sojka, and Giese, (2001). They used the Need for Cognition scale, the Need for Affect scale, and the Style of Processing scale. Using an ANOVA, Sojka and Giese found that people who scored high on the cognition had a preference for written verbal information. People who scored high in affect had a preference for visual information. They also analyzed data on people who scored high on both scales. Sojka, and Giese found that those high in NFC and NFA are more like people who only scored high on cognition, except that the high/high group has more of a preference toward visual information. People who scored low on both scales seemed indifferent in their processing preference.

Based on the information discussed in this literature review related to hemispheric dominance and working memory functioning, a regression model can be used that tests the relationship between presentation type and participant performance using need for cognition and need for affect as mediating variables. Specifically, the model predicts that need for affect will positively relate to performance in the visual presentation mode. The need for cognition score will show a positive relationship with performance in the written verbal presentation mode. Auditory information seems to incorporate both visual and written verbal modality elements, but shares more resources with the written verbal modality. Given this information, Need for Cognition is predicted to positively relate to performance in the auditory presentation mode. There will also be three way interactions that show how both NFC and NFA work together to affect performance on the two performance variables of time and error. Creativity will be put into the model as a covariate since it is theorized that it will improve performance. Beyond the main regression model, individuals should also perform better on tasks when directions are presented in their preferred presentation mode.

Based on the relationships articulated above, the following specific hypotheses will be tested in this study: A.) The Need for cognition score will show a significant positive relationship with how fast the participants perform the task while receiving written verbal instructions. B.) Need for cognition score will be related to the number of errors the participants make on the task, while receiving written verbal instructions. C.) Need for affect score will show a significant positive relationship with how fast the participants perform the task, while receiving the visual instructions. D.) Need for affect score will relate to the number of errors the participants make on the task, while receiving visual instructions. E.) Need for cognition score will significantly relate to the amount of time the participants need to complete the task, while receiving auditory instructions. F.) Need for cognition score will significantly relate to the number of errors the participants make on the task, while receiving auditory instructions. G.) There will be a relationship between presentation mode and performance such that subjects in the auditory mode will take the most time to complete the task. H.) The 3 way interactions between NFC, NFA and presentation type will significantly relate to time needed to complete the task. I.) The 3 way interactions between NFC, NFA and presentation type will significantly relate to errors in task performance. J.) Creativity will be positively and significantly related to both performance variables: time and number of errors.

METHOD

Participants + Selection

The study consisted of 125 Embry Riddle University undergraduate and graduate students recruited from human factors and introductory psychology classes. There were 79 males and 46 females. Participants had normal or corrected vision. Participation was voluntary and anonymous. Volunteers received extra credit for their participation and were treated in accordance with the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 1992). Participants were given a need for cognition and need for affect scale to determine a processing preference group. These groups were ultimately not used and the scores were used as continuous variables.

Measures

Participants were pre-tested prior to the main experiment using three validated tests and a demographic questionnaire. The demographic questionnaire contained a number that became the participant's subject number for anonymity. The demographic questionnaire included class standing, age, sex, self-reported handedness, and major. The tests were presented in Excel format.

Tests:

<u>Need for Cognition Scale (NFC):</u> The need for cognition scale was developed by Cacioppo, Petty, & Kao in 1984. It is an 18 item survey utilizing a seven point Likert

response scale and has been validated (Capioppo, Petty & Kao, 1984). (see appendix B). The NFC scale measures the amount of motivation a participant has when processing cognitive information. Raw scores on the NFC scale range can from -54 to 54. For purposes of the present study, a high score was deemed to be any score above 10, which was the mean need for cognition score presented from a sample of college students in a prior unpublished study done by Frederick & Gosiewski (2003).

Need for Affect Scale (NFA): The need for affect scale was developed and validated by Maio, & Esses, in 2001. It is a 26 item survey utilizing a seven point Likert response scale (Maio, & Esses, 2001). (see appendix C). The NFA scale measures the amount of motivation a participant has related to the experience and expression of emotion. Raw scores on the NFA scale can range from -78 to 78. For purposes of the present study, a high score was deemed to be any score at or above 17, the mean need for affect score presented in a prior unpublished study done by Frederick & Gosiewski (2003).

Style of Processing Scale (SOP): The style of processing scale was developed by Childers, Houston, and Heckler in 1985. It is a 22 item survey utilizing a four point Likert response scale and has been validated (Childers, Houston, & Heckler, 1985). (see appendix D). The style of processing scale determines preference for written verbal or visual processing. It will be used to test hypotheses labeled J. and K. above. The SOP items will be divided into two sections, those that measure visual and those that measure written verbal processing. Scores on items in each section were summed to give each participant a preference score for written verbal or visual processing. The higher of the two scores became the participant's primary information presentation preference.

Measure of Creativity: The present study utilized a divergent thinking task to assess creativity, in which the individual has to think of as many creative uses as they can for a paper clip. They had five minutes to complete this task. This divergent thinking task measures the creative ability of the participant and is widely recognized as a valid measure of creativity (Sternberg, 1999). The creativity score was defined as the overall total number of original uses reported for a paper clip.

Performance Measures (DV): Participants followed written verbal, visual, or auditory instructions in order to complete a tinker toy structure. Two performance measures were collected.

Time:

Each participant was timed from the time they start the first step to the time finished with the structure.

Errors:

The researcher recorded each mistake after each step of the experiment. Steps were developed so that each was equivalent across presentation modes. If a step was completed wrong the researcher showed the correct interpretation of the direction and recorded the error.

Design

The experiment was a 3x4 between subjects design. The independent variables were instruction type (written verbal, visual, and auditory, see appendix A) Need for Cognition score, Need for Affect score and creativity score. Participants were first assigned to groups based on their scores on the NFC and NFA surveys. These groups were labeled high/high, high/low, low/high, and low/low. They then were assigned to a presentation condition. These NFC/NFA groups were ultimately not used in the final analysis and were instead converted into continuous variables. Each participant was exposed to only one of the three instruction mediums. The dependent variables were the time taken to complete the task, and number of errors made on the task.

Procedure

Participants were given a consent form and the survey packet during the beginning of the experiment. After the participants were given the consent form and demographic survey, they were instructed to complete the three surveys on excel. Their scores on the Need of Cognition and Need for Affect Scales determined whether they were grouped for processing preference. Prior to the experiment participants were also given a name of an item and told to write down as many uses for the item as they could generate. This information was used to determine the creative ability of the individual. Each group was then randomly assigned to the three testing scenarios (visual, written verbal, auditory). Participants were not randomly assigned after a course of time in order to even the sample sizes. The experimental part of the study was done using three separate Microsoft PowerPoint presentations. From these presentations, participants were instructed on how to build a Tinker Toy sculpture. The three presentations were in visual, written verbal, and auditory formats. The visual format showed digital pictures of the Tinker Toys in a step by step instructional manner. The digital pictures used in the study were taken with a Nikon coolpix 880 digital camera then mastered on Adobe Photoshop 7.0 and imported into Microsoft PowerPoint. The written verbal presentation was a step by step instruction of the building of the tinker toy structure written directly into PowerPoint. The Auditory presentation was exactly the same as the written verbal presentation except that the instructions were spoken. It was recorded and mastered by an individual unrelated to the project to limit emotional undertones. The PowerPoint programs were labeled in code and participants were randomly assigned to one of the three conditions. The participant was given a set of Tinker toys and told to follow the instructions and build the structure accordingly. The experimenter informed the participant that he/she could take as much time as needed, but once they proceeded on the slides they could not go back. The auditory slides were able to be replayed by pressing the audio indicator. Participants were also instructed that they had to must follow the instructions and build the structure step by step without going to the final instruction first. Before the final instruction was shown the participant was asked to signal the experimenter that they were done and ready for a final instruction. This whole process was timed and recorded by the experimenter. At the end of the each step, the experimenter examined the structure and recorded any errors made. When the task was completed, the participants were given a debriefing form. At anytime during the experiment the participant was free to leave without any form of punishment.

Power Analysis

Based on a previous study by using the Style of Processing scale (Childers, Houston, & Heckler, 1985), it was calculated that the present study would need an overall N of 150 to achieve a power of .70 or above. This number was used to guide sample size for the study. A preliminary analysis was computed after the first 60 participants were run (5 per cell) to more adequately estimate specific power and effects sizes for the present study. It was found that that power would be sufficient at 100 participants. In order to ensure valid results, 125 participants were actually used.

Results

The data were analyzed using two separate multiple regression models predicting each of the performance variables: error and time. A regression analysis was selected as the optimal analytical strategy for the continuous level data in the project. The regression strategy was also valuable in determining if NFA and NFC mediate the relationship between presentation type and performance as predicted in the hypothesis statements presented previously. The NFC/NFA scores along with the presentation types and creativity score were included as independent variables in the analysis. The categorical data (presentation type) was dummy coded to create the presentation type vectors (ptype 1+2) and multiplied across the NFC/NFA scores to create four interaction vectors and two 3-way interaction vectors. These vectors determined if there was an interaction between each processing preference and a presentation type and/or an interaction between both NFC/NFA and a presentation type. The covariate of creativity was introduced into the model to determine if creativity also predicted a significant portion of the variance in the two dependent variables.

Two parallel sets of analyses were performed, one for each dependent measure.

The procedure for the analysis was taken from Pedhazur's (1997) instructions on analyzing categorical and continuous data (see chapter 14). Further understanding was taken from the methods section in a study that also utilized this procedure (Frederick & Hall, 2003). The procedure called for up to seven steps to be taken depending on the findings. The results are presented in Table 1 & 2. The first step was to examine the overall practical and statistical significance of the two whole regression models. Both models were practically and significantly significant. The model for time accounted for 53% of the variance in that variable, while the model for error accounted for 17% of the variance. Since the models were significant, the second phase of analysis involved testing the significance of the proposed interactions. This was done with a hierarchical regression in which the interactions were nested and compared against the presentation type vectors and the covariate of creativity. This was done by testing the $\Delta\underline{R}^2$ of the relationships for significance. A significant increase in $\underline{R}^2$ from the presentation type vectors and creativity to the interaction vectors would show a significant interaction relationship. The $\Delta\underline{R}^2$ for all the interaction vectors were not significant, even when a more liberal alpha value of .20 was used as suggested by Pedhazur (1997) (See Tables 1 & 2 and Figures 1 & 2 for specific information about changes in r-squared values). Since both sets of interactions were not significant, phase three explains that the lack of significance could be due to the fact that one regression coefficient could be used for the covariate variables. The significance of the common regression coefficient (b_c) was tested using a hierarchical regression to see if the covariate of creativity was significant. It was found that creativity added virtually nothing to the both of the models (see Tables 1 & 2). If creativity had been significant, it would have created intercepts with the interactions. Because b_c was not significant the only variables that are important predictors in the models are the presentation types. Phase 4 explains that the differences among the treatments of the categorical variables need to be tested for statistical significance. R^2 was computed for the presentation type vectors and they were found to be significant and hold most of the variance in both models.

Further analyses were done on both creativity and presentation type. A scatter plot was created to see if creativity had an influence on the dependent variables (see Figures 3 & 4). The results show that in both models the data points are not correlated with time or error. Since the presentation types were shown to be determining the outcomes related to task performance, a bar graph was created to compare the presentation types to the dependent measures (See Figures 5 & 6). Means and Standard deviations were also computed and are reported in Table 3. The results show that for both time and error, the visual presentation was the best followed by the written presentation and then the auditory presentation which created the worst performance outcomes.

Descriptives for Relevant Demographic Data

It was found that overall the participants found the experiment relatively easy (M = 3.65, SD = 9.30) with a 1 score being very hard, a 2 score being hard, a 3 score being average, a 4 score being easy, and a 5 score being very easy. Across the assigned presentation types, the written verbal presentation was thought of as the easiest (M = 4.20, SD =.69), the written presentation was the hardest (M = 3.23, SD = .90), and the auditory presentation fell in the middle (M = 3.53, SD = .93). This was interesting because the auditory presentation took participants the most time and created the most errors.

The scores from the style of processing survey show that most of the participants were defined as being visual learners (95 out of 125) and was supported by the individuals reporting that they learned best visually (90 out of 125). When difficulty was assessed between participants who were in the group exposed to their preferred presentation type ($M = 4.08$, $SD = .850$) and those that didn't ($M = 3.45$, $SD = .903$) it was found that difficulty was still rated as easy, although individuals who received a different presentation type reported that it was harder.

Discussion

A model was developed that attempted to explain how individuals use working memory to complete a task, while getting instructions in different presentation mediums. The model explains that within the working memory framework, how we process information is controlled by the central executive. The information from the presentation types would enter into working memory and get allocated to the visuo-spatial sketchpad or the phonological loop from the central executive (Baddeley, 1990). These are the fundamental aspects of working memory. This model uses the working memory concept, but adds a new element. It was theorized that two constructs, need for cognition and need for affect, may moderate the relationship between instructions and performance. These constructs represent an individual's motivation to experience cognitive-based learning or emotion. Need for cognition has been tied to the workings of the left hemisphere of the brain, while need for affect has been linked to right hemispheric processing (Cacioppo & Petty, 1982; Maio & Erres, 2001; Sojka, & Giese, 2001; Orstein, 1997). The two hemispheres of the brain are also specialized in how they process visual, written verbal and auditory stimuli. Within the proposed model, it was also theorized that creativity influenced individual task performance. Testing consisted of using visual, written, or auditory presentations to guide an individual as they constructed a Tinkertoy structure. Participant performance was defined as the time needed to complete the task and errors made on the task. These outcomes were regressed against scores on the need for cognition and need for affect scales. Individual's creativity scores were added as a covariate in the model. This study attempted to support Sojka & Giese's (2001) findings in an empirical fashion.

Using a multiple regression for continuous and categorical data it was found that both regression models for time and error were significant. The model for time showed that 52.9% of the variance had been explained. This means that presentation type, NFC, NFA, creativity, and the interactions account for over 50% of the possible reasons why the participants performed the way they did. The model for error was significant, but only accounted for 16.7% of the variance. With both models being significant, the interactions were analyzed. It was found that not only were the interactions not significant for both of the models but the $\Delta \underline{R}^2$ was close to zero (see Tables 1 & 2). This means that NFC & NFA did not significantly interact with the presentation types to influence performance, nor did they work together to influence performance. The covariate of creativity also had no influence on the model. Even scatter plots of the relationship of creativity with the performance measures showed no significant findings. Since the interactions and covariate both showed no significant relationship to the performance measures, attention was turned to the presentation types.

Interpretation of the role of presentation type in predicting performance showed that the presentation types for both models were significant predictors of performance and held a majority of the variance (see Figures 1 & 2). A bar graph and table of means was developed to determine the relationship between the presentation modes and the two performance variables (see Table 2).. Each presentation type was also split into the NFC/NFA groups for comparison (see Figures 5 & 6). The two graphs showed that individuals performed best when given visual instruction than in the other two presentation groups. In addition, performance by participants in the auditory presentation mode was worse than those individuals in the written presentation mode. Two ANOVA analyses with post hoc Bonferroni tests were run on both time and error to examine if significance differences occurred across presentation types. It was found that for both time and error, there was a significant difference between the auditory presentation versus the visual presentation modes and the written presentation versus the visual presentation modes ($p<.01$). Specifically, participants in the visual presentation mode made fewer errors on the task and took less time to complete the task than those in the other two groups. There was no significance for both time and error between auditory presentation and the written presentation modes. Although there was no significant interaction effect of NFC and NFA on performance and presentation type, the bar graph shows that the group low in both NFC and NFA did worse than the rest of the groups in all of the conditions. In contrast, the high NFC/high NFA group did better in completion time in all of the presentation types. These findings are consistent with Sojka & Giese's (2001) study. The only hypothesis that was then validated in the present study was that performance for individuals in the auditory presentation group would be the worst in both performance measures.

The lack of significance in the interaction vectors is unexpected, since most of the literature shows how visual processing is primarily housed in the right hemisphere while most written verbal and auditory processing is housed in the left hemisphere. These relationships have been recorded many times through split brain research, brain scans, and empirical testing. (Sperry, 1985; Lang & Friestad, 1993; & Orstein, 1997). These studies have also linked emotion and technical personalities to hemispheric dominance. It was understood that the visual presentation mode would be the most significant predictor of time and error, because the task was a spatial task. Visual processing and spatial ability both stem from the right hemisphere and studies have shown that it is usually the best presentation mode for instruction, although some students are better at others (Boekaerts, 1982). This study also supports the finding that students like visual instruction and find it easier to follow. The fact that the visual presentation was the best instruction mode does not affect the integrity of the study because one of the primary purposes of the study was to see if NFC and NFA moderated the effect of presentation type on performance outcomes. Although this mediating effect was not verified, the data indicate that NFC related to the performance variable of time. Those participants with high need for cognition scored the best in the written verbal condition. This is consistent with the numerous studies that were outlined that have linked NFC with written verbal processing.

Two problems in the present study were the failure of NFA scores to be statistically linked to the right hemispheric processing, or being able to use the NFA scale to label an individual as emotional. The NFA scale is a relatively new tool that has only been used once in the literature and may not accurately relate to NFC even though Maio and Esses, (2001) and Sojka and Giese (2001) in a single study did find a negative correlation between the two variables. This problem, tied with participants reporting that the task was moderately easy to average in difficulty, may have caused no relationships to be found between processing preference and performance outcomes.

In addition, the validated creativity measure of divergent thinking may also have been too subjective a method of testing creativity and may not have been an accurate tool to have used with this study. Although creativity has been linked to hemispheric processing preference, it was clearly not a factor in predicting performance in this study.

Conclusion

No significant mediating relationship could be found for processing preference on presentation type for performance. The study does show that students perform best with visual instruction on a spatial task but does not show that need for affect, need for cognition, or creativity influence performance. A link between these constructs and hemispheric specialization could not be validated. Participants did however have self-awareness of what presentation type elicited their best performance.

This study is important because it lays the groundwork for an area that has never been fully explored. In particular, the models tested in this experiment were never tested before in this or any other form. These constructs have never been linked before and may show relationships during a different task than was used in this study. Future manipulation of the tasks and design may be needed to determine if NFC and NFA do mediate performance from viewing different presentation types. This present study has shown the importance and influence of visual, written, and auditory presentation types on the performance of a spatial task.

Beyond, data collected for the model tested, the set contained auxiliary variables of interest that included a style of processing survey, information about handedness, gender, and experience with Tinkertoy building sets. Participants also self- reported their preferred instruction type. These variables were subjected to a correlation analysis to examined if any interesting relationships may existed among them that could then be tested in future studies. Some of the findings were as follows: There were negative and significant relationships between creativity score and Tinkertoy experience, creativity and

NFC, and creativity and the perceived difficulty of the task. The style of processing survey did validate whether a participant was consistent with what they put down as their preferred presentation type. People who scored high on NFC, were also more likely to score as written verbal learners on the style of processing test. These relationships show that some of the hypothesized relationships of the experiment may be valid and may have been obscured by other variables in the study. This experiment is an important step in understanding how our personalities and working memory influence our ability to perform on tasks. The importance of presentation type shows that educators must incorporate visual instructions in their lectures and remove sections of their lecture that are totally auditorily based. Further studies based on this model may lead to significant changes both how we design training for people and how we present information in order to facilitate task optimal performance.

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Table 1.1
Summary of hierarchical regression analysis for the dependent measure of time

Phase	Predictors	R^2	Adjusted R^2	ΔR^2	F (ΔR^2)	p
1	Presentation Type 1 Presentation Type 2 Creativity Interaction with NFC 1 Interaction with NFC 2 Interaction with NFA 1 Interaction with NFA 2 Interaction with Vector 1 Interaction with Vector 2	.529	.492	.529	14.328	.000

Phase	Predictors	R^2	Adjusted R^2	ΔR^2	F (ΔR^2)	p
2 nesting	Step 1 Presentation Type 1 Presentation Type 2 Creativity	.523	.511	.523	44.14	.000
	Step 2 Presentation Type 1 Presentation Type 2 Creativity Interaction with NFC 1 Interaction with NFC 2	.525	.505	.002	.280	.757
	Step 3 Presentation Type 1 Presentation Type 2 Creativity Interaction with NFA 1 Interaction with NFA 2	.525	.505	.002	.295	.745
	Step 4 Presentation Type 1 Presentation Type 2 Creativity Interaction with Vector 1 Interaction with Vector 2	.523	.503	.000	.056	.946

Table 1.2

Phase	Predictors	R^2	Adjusted R^2	ΔR^2	F (ΔR^2)	p
3	Step 1 Creativity	000	-.008	.000	.001	.982
	Step 2 Creativity Presentation Type 1 Presentation Type 2	.523	.511	.523	66.22	.000

Phase	Predictors	R^2	Adjusted R^2	ΔR^2	F (ΔR^2)	p
4	Step 1 Presentation Type 1 Presentation Type 2	.522	.514	.522	66.57	.000
	Step 1a Presentation Type 1 Presentation Type 2 Creativity	.523	.511	.001	.187	.666

Table 1.1&1.2. Summary of hierarchical regression analysis for the dependent measure of time

Table 2.1
Summary of hierarchical regression analysis for the dependent measure of Error

Phase	Predictors	R^2	Adjusted R^2	ΔR^2	F (ΔR^2)	p
1	Presentation Type 1 Presentation Type 2 Creativity Interaction with NFC 1 Interaction with NFC 2 Interaction with NFA 1 Interaction with NFA 2 Interaction with Vector 1 Interaction with Vector 2	.167	.101	.167	2.554	.010
2 nesting	Step 1 Presentation Type 1 Presentation Type 2 Creativity	.142	.121	.142	6.69	.000
	Step 2 Presentation Type 1 Presentation Type 2 Creativity Interaction with NFC 1 Interaction with NFC 2	.158	.123	.016	1.128	.327
	Step 3 Presentation Type 1 Presentation Type 2 Creativity Interaction with NFA 1 Interaction with NFA 2	.148	.112	.006	.402	.670
	Step 4 Presentation Type 1 Presentation Type 2 Creativity Interaction with Vector 1 Interaction with Vector 2	.142	.121	.007	.505	.605

Table 2.2

Phase	Predictors	R^2	Adjusted R^2	ΔR^2	F (ΔR^2)	p
3	Step 1 Creativity	002	-.006	.002	.237	.627
	Step 2 Creativity Presentation Type 1 Presentation Type 2	.142	.121	.140	9.90	.000

Phase	Predictors	R^2	Adjusted R^2	ΔR^2	F (ΔR^2)	p
4	Step 1 Presentation Type 1 Presentation Type 2	.141	.127	.141	10.05	.000
	Step 1a Presentation Type 1 Presentation Type 2 Creativity	.142	.121	.001	.115	.735

Table 2.1 & 2.2. Summary of hierarchical regression analysis for the dependent measure of error

Table 3
Means and Standard Deviations for Presentation Types for Time and Error

Presentation Type		Time	Error
Written	Mean	18.66	4.77
	N	43	43
	SD	4.16	2.55
Auditory	Mean	20.33	5.30
	N	40	40
	SD	3.89	3.18
Visual	Mean	11.54	2.83
	N	42	42
	SD	2.89	2.09
Total	Mean	16.80	4.29
	N	125	125
	SD	5.29	2.82

Table 3. Means and Standard deviations of Presentation type across time and error

Figure 1.

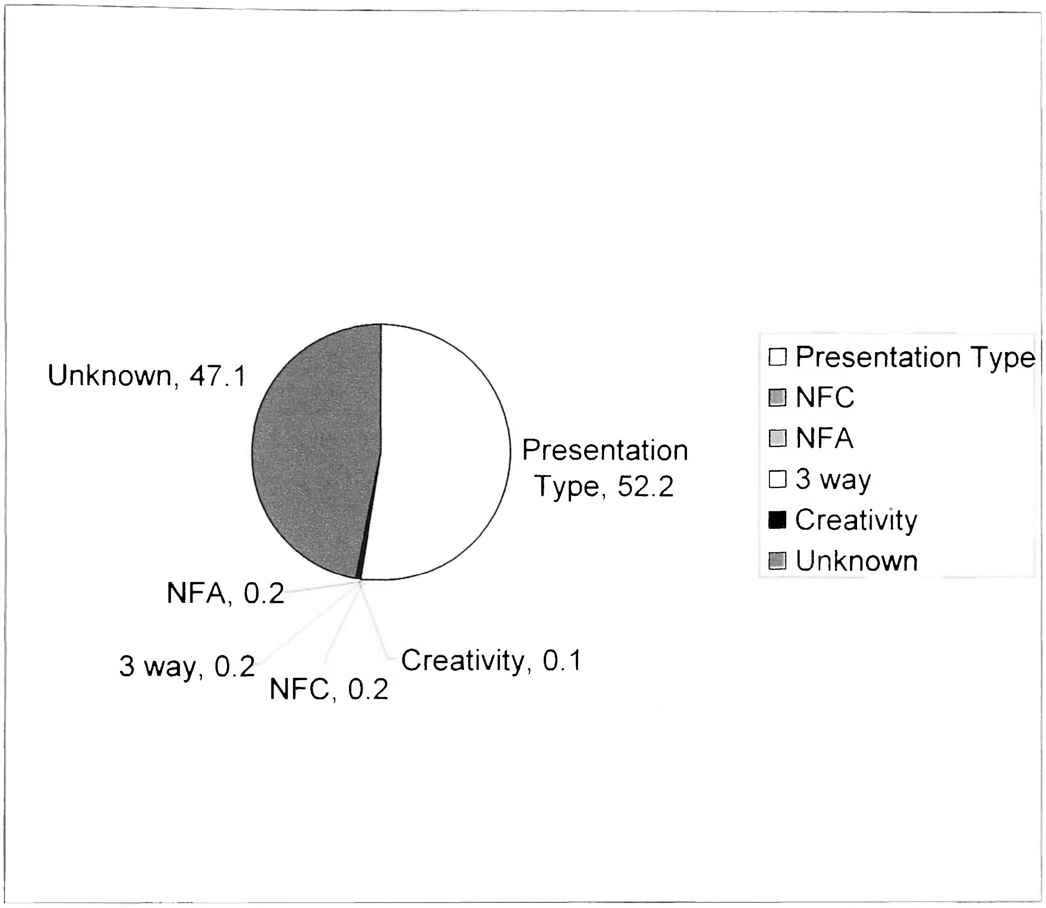


Figure 1. Whole model variance for time

Figure 2.

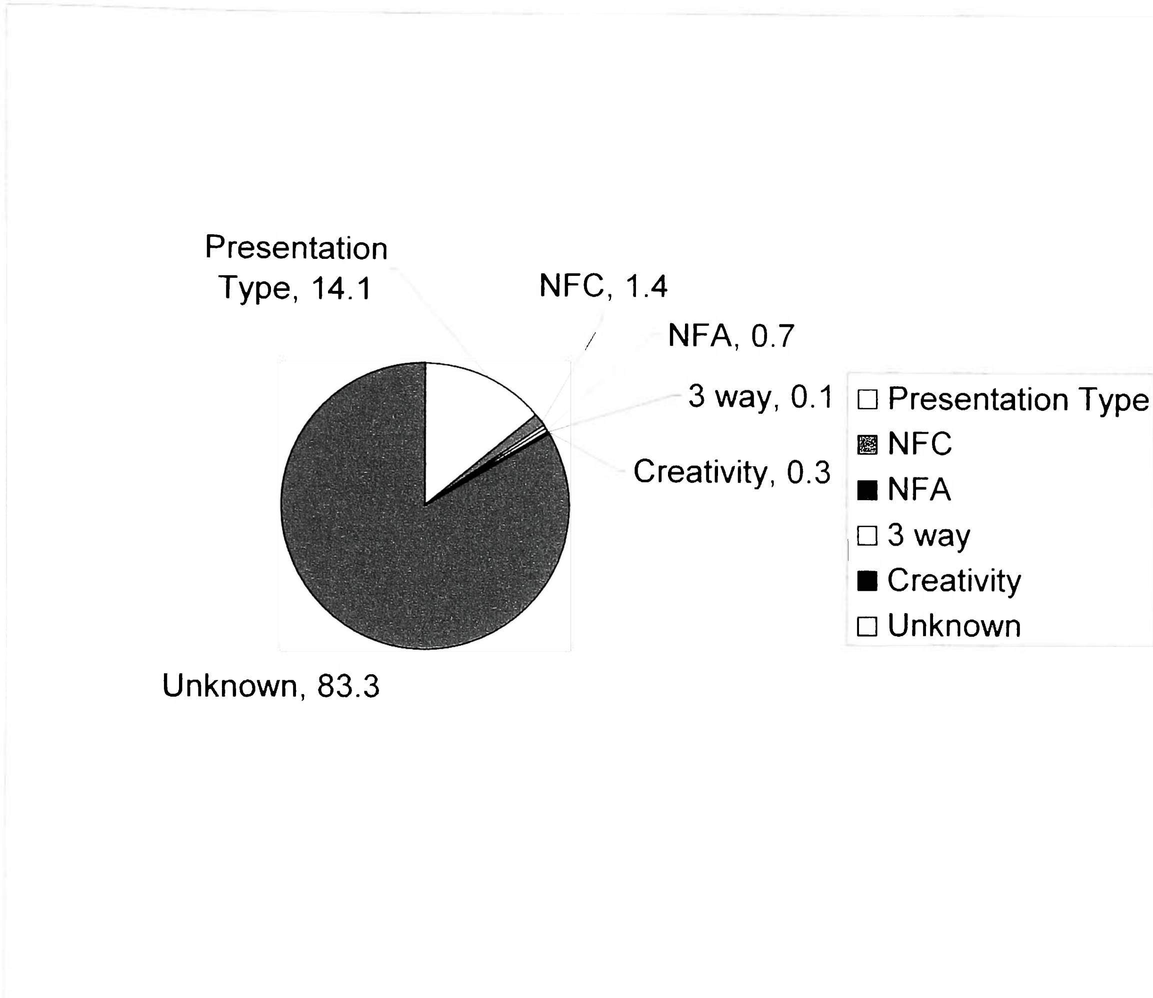


Figure 2. Whole Model Variance for Error

Figure 3.

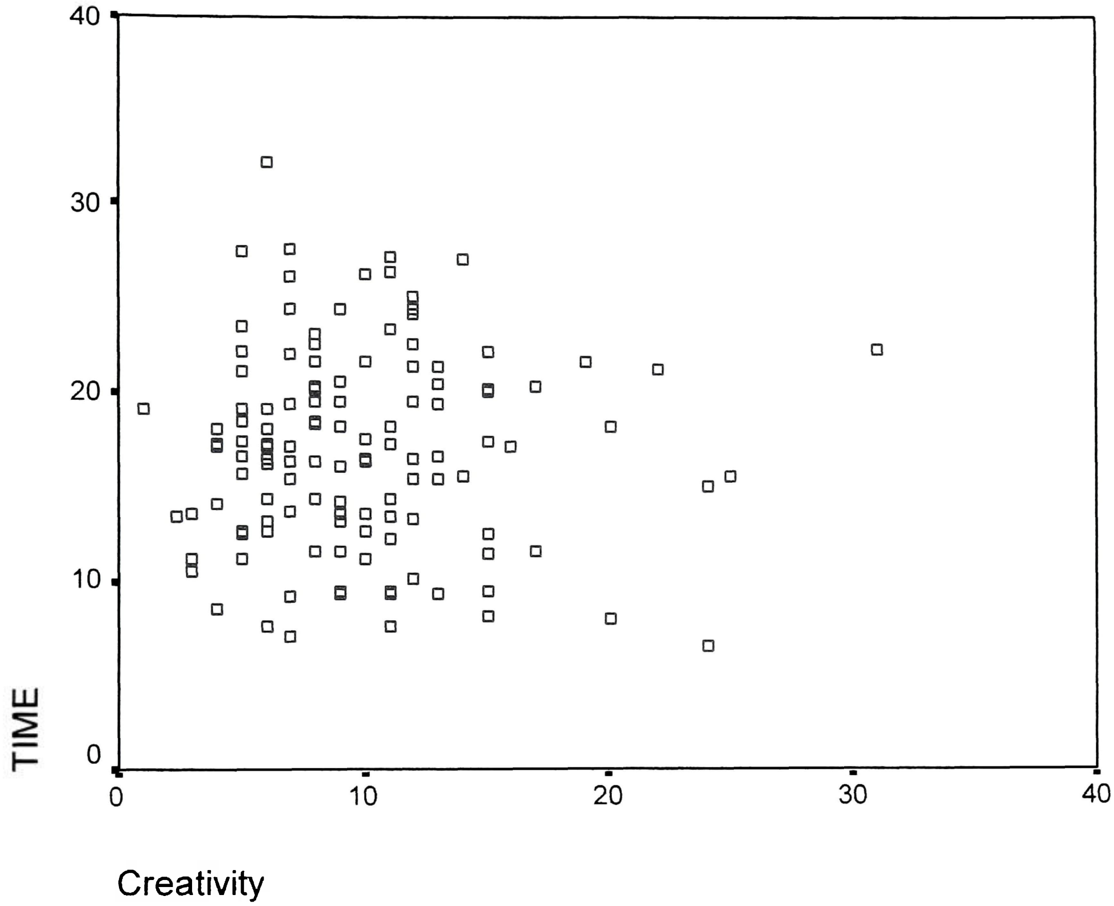


Figure 3. Scatter plot of the relationship between time and Creativity

Figure 4.

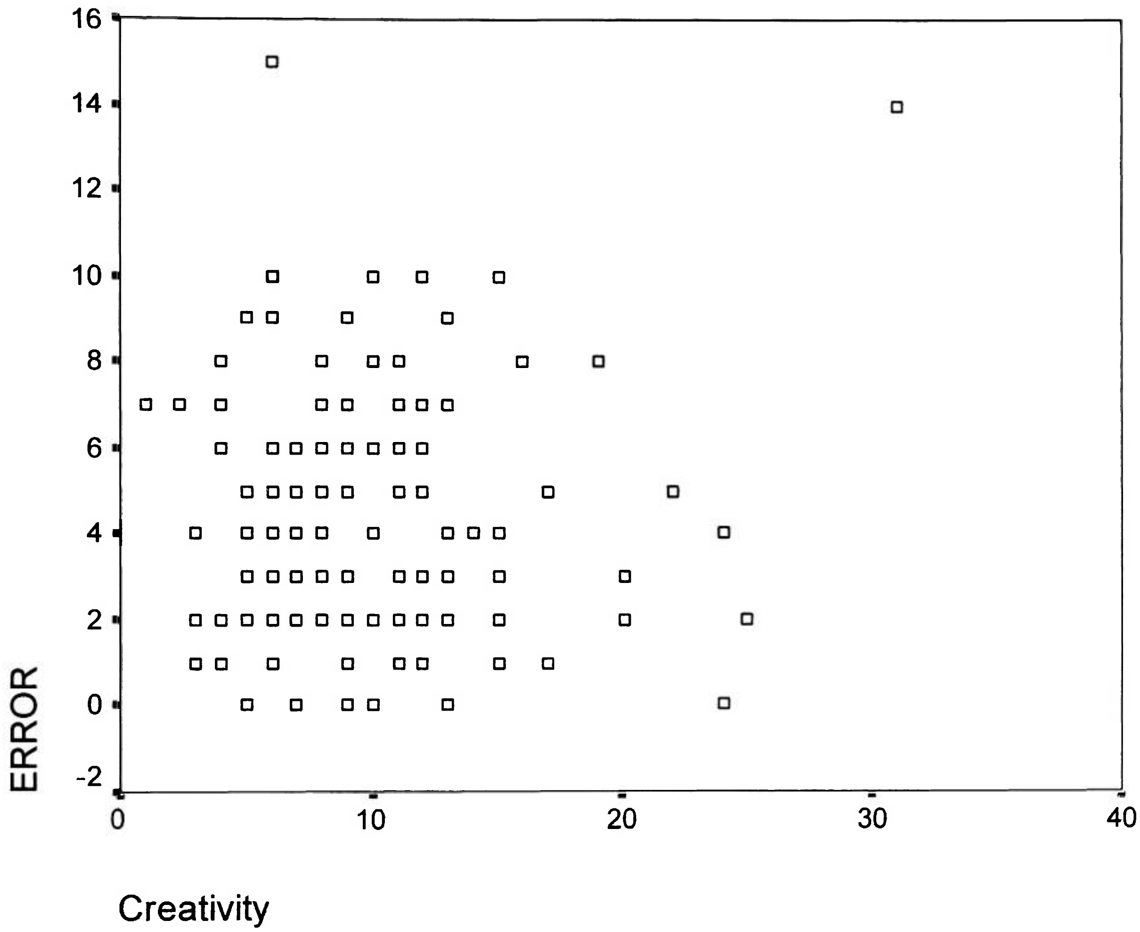


Figure 4. Scatter plot of the relationship between error and creativity

Figure 5

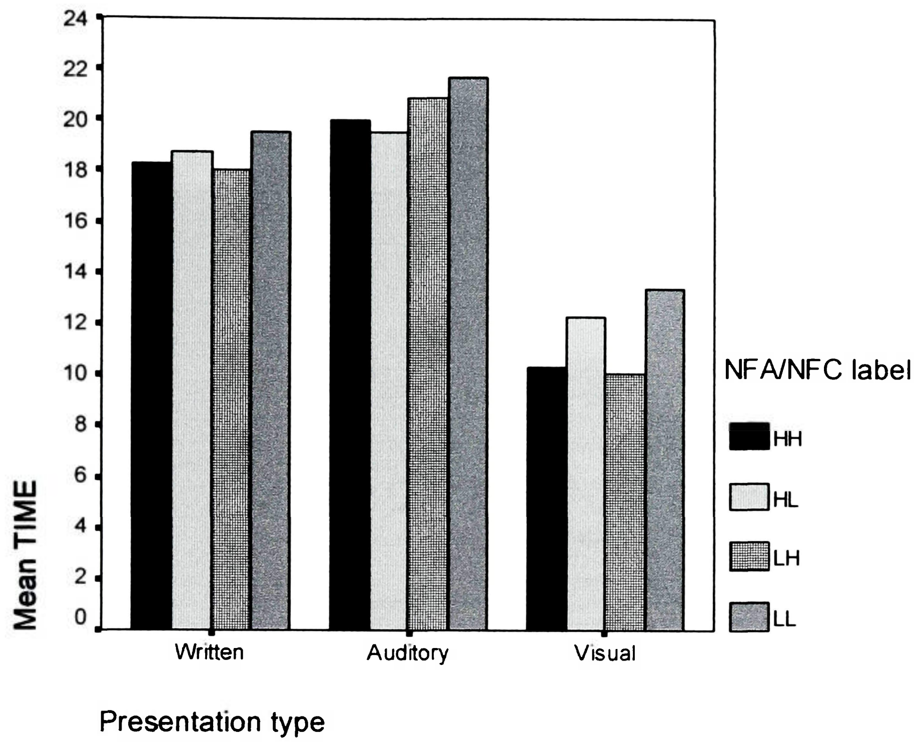


Figure 5. Mean time of each NFC/NFA group by presentation type

Figure 6

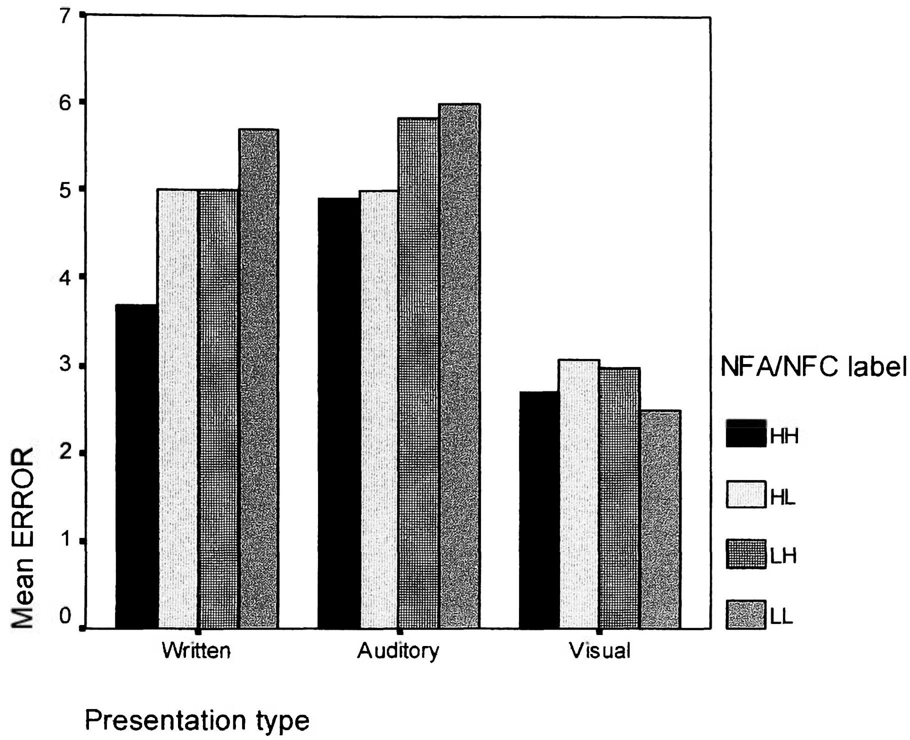
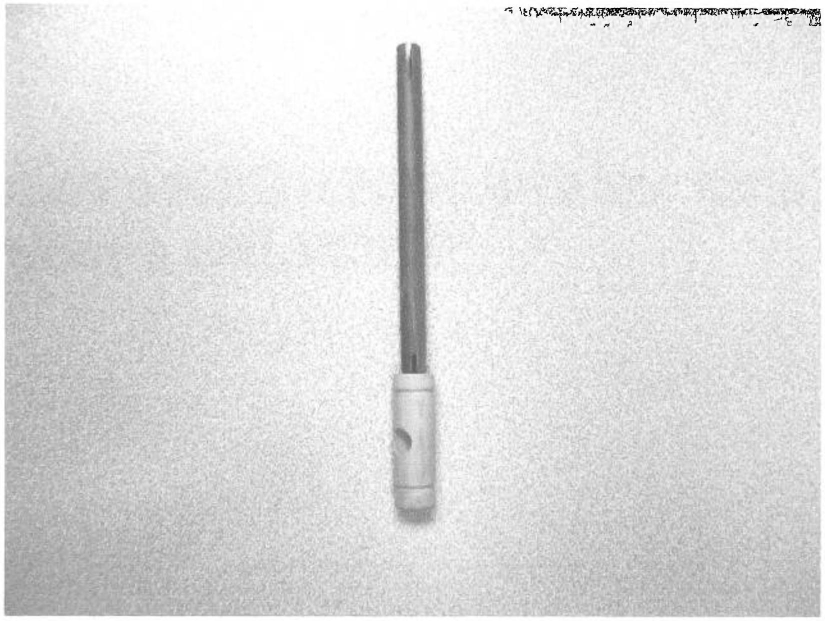


Figure 6. Mean errors of each NFC/NFA group by presentation type

Appendix A

Presentation Types

Section 1
Step 3



Appendix A: Visual Presentation Type

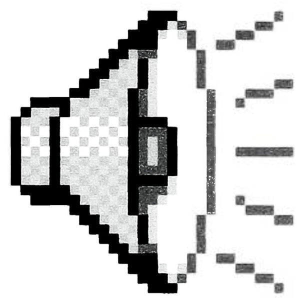
Section 1
Step 3

- **Insert a RED STICK into the hole at the end of a CYLINDER.**

Appendix A: Written Presentation Type

Section 1
Step 3

Click on horn for auditory instructions



Appendix A: Auditory Presentation type (monotone voice read exact wording of written presentation.)

Appendix B

Need for Cognition scale

NFC Scale

INSTRUCTIONS: **Your answers to the questions should reflect the manner in which you typically engage in each of the tasks mentioned. There are no right or wrong answers; we only ask that you provide honest and accurate answers. Please answer each question by circling one of the seven possible responses.**

(–3 = strongly disagree), (-2 = moderately disagree), (-1 = slightly disagree), (0 = neutral), (1 = slightly agree), (2 = moderately agree), and (3 = strongly agree).

ITEM	RESPONSE						
1. I would prefer complex to simple problems.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
2. I like to have the responsibility of handling a situation that requires a lot of thinking.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
3. Thinking is not my idea of fun. *	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities. *	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
5. I try to anticipate and avoid situations where there is likely chance I will have to think in depth about something. *	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
6. I find satisfaction in deliberating hard and for long hours.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
7. I only think as hard as I have to. *	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
8. I prefer to think about small, daily projects to long-term ones. *	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
9. I like tasks that require little thought once I've learned them.*	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
10. The idea of relying on thought to make my to the top appeals to me.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)

(−3 = <u>strongly disagree</u>), (-2 = <u>moderately disagree</u>), (-1 = <u>slightly disagree</u>), (0 = <u>neutral</u>), (1 = <u>slightly agree</u>), (2 = <u>moderately agree</u>), and (3 = <u>strongly agree</u>).

ITEM	**RESPONSE**						
11. I really enjoy a task that involves coming up with new solutions to problems.	**(-3)**	**(-2)**	**(-1)**	**(0)**	**(1)**	**(2)**	**(3)**
12. Learning new ways to think doesn't excite me very much.*	**(-3)**	**(-2)**	**(-1)**	**(0)**	**(1)**	**(2)**	**(3)**
13. I prefer my life to be filled with puzzles that I must solve.	**(-3)**	**(-2)**	**(-1)**	**(0)**	**(1)**	**(2)**	**(3)**
14. The notion of thinking abstractly is appealing to me.	**(-3)**	**(-2)**	**(-1)**	**(0)**	**(1)**	**(2)**	**(3)**
15. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.	**(-3)**	**(-2)**	**(-1)**	**(0)**	**(1)**	**(2)**	**(3)**
16. I feel relief rather than satisfaction after completing a task that required a lot of mental effort.*	**(-3)**	**(-2)**	**(-1)**	**(0)**	**(1)**	**(2)**	**(3)**
17. It's enough for me that something gets the job done; I don't care how or why it works.*	**(-3)**	**(-2)**	**(-1)**	**(0)**	**(1)**	**(2)**	**(3)**
18. I usually end up deliberating about issues even when they do not affect me personally.	**(-3)**	**(-2)**	**(-1)**	**(0)**	**(1)**	**(2)**	**(3)**

Appendix B. Scale was in electronic format

Appendix C

Need for Affect Scale

NFA Scale

INSTRUCTIONS: **Your answers to the questions should reflect the manner in which you typically engage in each of the tasks mentioned. There are no right or wrong answers; we only ask that you provide honest and accurate answers. Please answer each question by circling one of the seven possible responses.**

(–3 = strongly disagree), (-2 = moderately disagree), (-1 = slightly disagree), (0 = neutral), (1 = slightly agree), (2 = moderately agree), and (3 = strongly agree).

ITEM	RESPONSE						
1. If I reflect on my past, I see that I tend to be afraid of feeling emotions.*	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
2. I have trouble telling the people close to me that I love them.*	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
3. I feel that I need to experience strong emotions regularly.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
4. Emotions help people get along in life.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
5. I am a very emotional person.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
6. I think it is important to explore my feelings.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
7. I approach situations in which I expect to experience strong emotions.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
8. I find strong emotion overwhelming and therefore try to avoid them.*	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
9. I would prefer not to experience either the lows or highs of emotion.*	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
10. I do not know how to handle my emotions, so I avoid them.*	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
11. Emotions are dangerous—they tend to get me into situations that I would rather avoid.*	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)

(–3 = strongly disagree), (-2 = moderately disagree), (-1 = slightly disagree), (0 = neutral), (1 = slightly agree), (2 = moderately agree), and (3 = strongly agree).

ITEM	**RESPONSE**						
12. Acting on one's emotions is always a mistake.*	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
13. We should endulge our emotions.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
14. Displays of emotion are embarrassing. *	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
15. Strong emotions are generally beneficial.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
16. People can function most effectively when they are not experiencing strong emotions.*	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
17. The experience of emotions promotes human survival.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
18. It is important for me to be in touch with my feelings.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
19. It is important for me to know how others are feeling.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
20. I like to dwell on my emotions.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
21. I wish I could feel less emotion. *	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
22. Avoiding emotion helps me sleep better at night.*	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
23. I am sometimes afraid of how I might act if I become too emotional.*	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)
24. I feel like I need a good cry every now and then.	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)

Appendix C. Scale was in electronic form

Appendix D

Style of Processing Survey

Style of Processing Scale

INSTRUCTIONS: The aim of this exercise is to determine the style or manner you use when carrying out different mental tasks. Your answers to the questions should reflect the manner in which you typically engage in each of the tasks mentioned. There are no right or wrong answers; we only ask that you provide honest and accurate answers. Please answer each question by circling one of the four possible responses. For example, if I provided the statement, I seldom read books," and this was *your* typical behavior, even though you might read say one book a year, you would circle the "ALWAYS TRUE" response.

ITEM RESPONSE	Always True	Usually True	Usually False	Always False
1. I enjoy doing work that requires the use of words. (W)	1	2	3	4
2. There are some special times in my life that I like to relive by mentally "picturing" just how everything looked (P)	1	2	3	4
3. I can never seem to find the right word when I need it (W)	1	2	3	4
4. I do a lot of reading (W)	1	2	3	4
5. When I'm trying to learn something new, I'd rather watch a demonstration than read how to do it (P)	1	2	3	4
6. I think I often use words in the wrong way (W)	1	2	3	4
7. I enjoy learning new words (W)	1	2	3	4
8. I like to picture how I could fix up my apartment or a room if I could buy anything I wanted (P)	1	2	3	4
9. I often make written notes to myself (W)	1	2	3	4
10. I like to daydream (P)	1	2	3	4
11. I generally prefer to use a diagram rather than a written set of instructions (P)	1	2	3	4
12. I like to "doodle" (P)	1	2	3	4
13. I find it helps to think in terms of mental pictures when doing many things (P)	1	2	3	4
14. After I meet someone for the first time, I can usually remember what they look like, but not much about them (P)	1	2	3	4
15. I like to think of synonyms for words (W)	1	2	3	4

ITEM RESPONSE	Always True	Usually True	Usually False	Always False
16. When I have forgotten something I frequently try to form a mental "picture to remember it (P)	1	2	3	4
17. I like learning new words (W)	1	2	3	4
18. I prefer to read instructions about how to do something rather than have someone show me (W)	1	2	3	4
19. I prefer activities that don't require a lot of reading (W)	1	2	3	4
20. I seldom daydream (P)	1	2	3	4
21. I spend very little time attempting to increase my vocabulary (W)	1	2	3	4
22. My thinking often consists of mental "pictures" or images (P)	1	2	3	4

Appendix D. Scale was in electronic format

Appendix E

Testing materials (consent, debriefing, demographic questionnaire)

Michael E. Gosiewski
Dr. Christina Frederick-Recascino, Academic Advisor
Embry-Riddle Aeronautical University
Human Factors and Systems
Daytona Beach, FL 32114

The experiment you are about to participate is designed to investigate the interaction of processing preference and information type. You will be given four tests and then asked to follow a series of Powerpoint instructions. This will allow you to create a Tinkertoy structure. After each slide you asked to get the researchers permission to proceed. You will also be asked to provide some basic demographic information about yourself and answer a question at the end of the experiment. Your entire participation should run approximately 45 minutes.

All information that you provide will be held in confidence by the researcher and at no time will your name be reported along with your responses. There are no known risks associated with this experiment and you are free to withdraw at any time. Your voluntary participation is most appreciated by myself and by the University. Please feel free to ask questions to myself or the experimenter.

If you would like a summary of the researcher's findings or have any further problems or questions please contact me at: zoot35@aol.com

Statement of Consent

I have been adequately informed of the intent of this experiment. My participation is voluntary and I understand that I may withdraw my participation at any time.

Participant's name (please print):____

Signiture:_______________________________Date:________________________

Appendix E. Consent form

Demographic Questionnaire

Principle Investigator: **Michael Gosiewski**

Participant #:

1. Sex: **MALE** **FEMALE**

2. Age:

3. Class Standing (circle one): Freshman Sophomore Junior Senior

4. What is your Dominant hand? **LEFT** **RIGHT**

(Based on which hand your write with, use to open objects, initiate reaching behaviors)

5. When receiving information that you need to learn, how do you like it presented to you? **VISUALLY (PICTORALY)** **WRITTEN** **SPOKEN**

6. Did you every play with Tinkertoys: **YES** **NO**

6A. If yes, rate your experience:

1 = very little, **2 = sometimes,** **3 = often,** **4 = very often**

7. What is your major:

Appendix E. Demographic Questionnaire

Debriefing Form

The experiment you have just participated in was designed to see how your processing preference affects how well you use follow information types. You received instructions in one of three information types. The information types were written, visual, or auditory. The four tests prior to the experiment were designed to find your level of need for cognition, need for affect, creativity, and style of processing. Every individual had some level of hemispheric dominance. A left brain person is more analytical, more logical, and has more of the brains language resources while a right brain person is more emotional and visually orientated. Need for Affect and Need for cognition are designed to discover an individual's motivation to avoid or approach thinking or emotion. The researcher believes that he will find that people that are more cognitively orientated will use verbal instruction more effectively then people that are more emotionally orientated. Individuals that are more emotionally orientated will use visual instruction more effectively then people who are cognitively oriented.

The results of this study can be incorporated across many fields and disciplines. It can be used to create more efficient displays, training programs, and interfaces. It can also be used to create more entertaining video games and increase performance in schools.

If you have any further questions, comments, or in sites feel free to contact me at zoot35@aol.com

Thank you for your participation, time and patience.

Sincerely,

Michael E. Gosiewski

Appendix E: Debriefing form