POTENTIAL RELATIONSHIPS BETWEEN SENSORY MODALITY STRENGTHS AND MEMORY STRATEGIES

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Christina Pearl Coiner

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The following faculty have examined the final copy of this thesis for form and content, and recommend that it be accepted in partial fulfillment of the requirement for the degree of Master of Arts with a major in Communication Sciences and Disorders.

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Julie Scherz, PhD, Committee Chair

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Kathy Coufal, PhD, Committee Member

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Elaine Bernstorf, PhD, Committee Member

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ABSTRACT

This study explored the relationship between memory strategies and sensory modality strengths. Memory strategies are often taught by speech-language pathologists to individuals with memory impairments. Information about the relationship between memory strategies and individual differences could provide better direction for treatment approaches.

Forty participants, ages 21 to 88, were administered a number of memory assessments including letter and categorical fluency, recall and recognition memory, immediate and delayed story retelling and visual memory. After each memory test, participants were asked to report any strategies used to complete the task. After completion of all memory tasks, participants indicated strategies used from a short listing of possible memory strategies, as well as completed an open-ended portion to report any other strategies. Participants' sensory modality strengths were assessed using the *Swassing-Barbe Modality Index (SBMI)* and the *Visual Aural Read/Write Kinesthetic (VARK) Questionnaire*.

No significant relationship was found between sensory modality strength and memory strategies used to complete the various memory tasks. Individuals used a variety of memory strategies unrelated to their sensory modality strength and the type of memory task. Speech-language pathologists should be aware of their clients' individual differences and be prepared to teach an assortment of strategies to clients with memory impairments. Clients with a variety of usable strategies may be better equipped to employ those strategies in various situations like their typical adult peers.

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LIST OF ABBREVIATIONS

ABCD	Arizona Battery for Communication Disorders of Dementia
DTLA-4	Detroit Tests of Learning Aptitude, 4^{th} Edition
RAVLT	Rey Auditory Verbal Learning Test
SBMI	Swassing-Barbe Modality Index
TVCF	Test of Verbal Conceptualization and Fluency
VARK	Visual, Aural, Read/Write, Kinesthetic

CHAPTER I

INTRODUCTION

Speech-language pathologists and other professionals provide memory training to individuals with memory impairments. One major component of memory training is the re-training of memory strategies. Memory strategies are used to compensate for the limitations of working memory (Baddeley, 1986) and proficient thinkers implement a variety of strategies to improve memory in many situations (Pressley & El-Dinary, 1992). Although strategy use is important (Baddeley, 1998; Pressley & El-Dinary, 1992), learned strategies are often not generalized in functional, everyday situations (Parente & Herrmann, 1996; Pressley & El-Dinary, 1992). If there is a way to identify which strategies a client will most likely use based on the client's individual differences, the use of such strategies may be better generalized. This could provide more success for memory in everyday situations for individuals with memory impairments.

Learning styles have been used to tailor education programs to suit the learning preferences of students (Smith & Dalton, 2005). One type of learning style theory, sensory modality strength, focuses on how information enters our memory (i.e., visually, auditorily or kinestethetically). The use of sensory modality strength information to promote better teaching and learning environments has been suggested (Barbe & Swassing, 1988; Fleming, 2001; Tileston, 2004). Sprenger (2003) reported that it is important for individuals and teachers to be aware of sensory modality strengths to understand how they and their students remember and learn best. An individual's sensory modality strength may determine preferred ways to learn and handle problems. Learners have a visual memory preference, an auditory/verbal memory preference, or a kinesthetic/tactile memory preference (Sprenger, 2003). This information can aid in creating the best learning environments to enhance performance in academics or other learning experiences.

The link between memory strategies and sensory modality has been made. Kratzig and Arbuthnott (2006) examined learning style preference according to sensory modality and memory performance. Sprenger (2003) lists memory strategies that individuals with visual, auditory, and kinesthetic strengths may relate to. For visual learners, some of these strategies may be nonlinguistic representations, mind mapping, mental pictures, summarizing and note-taking (Sprenger, 2003, p. 70). Strategies described for auditory learners include mnemonics involving rhythm and rhyme, rehearsal, and discussion (Sprenger, 2003, p. 93). For kinesthetic learners, some common strategies may be mnemonic strategies that require movement, mind-mapping, and the use of manipulatives (Sprenger, 2003, p. 113-114). Sprenger (2003) describes the importance of teaching these strategies as they may not be learned independently.

Although a connection between sensory modalities and memory has been made (Kratzig & Arbuthnott, 2006; Sprenger, 2003), no known research has examined the relationship between sensory modality strength and the use of memory strategies on memory tasks. It is evident from previous research that sensory modality strength has an impact on learning. Knowledge regarding the type of strategies a memory-impaired individual would most likely use based on his or her sensory modality strength may provide better generalization of strategies into many situations.

The current study attempted to identify strategies that were typical for certain individuals based on their sensory modality strengths. Forty participants, ages 21 to 88, individually participated in a series of memory, memory strategy and learning style assessments. Assessments of memory included letter and categorical fluency tasks from the *Test of Verbal*

Conceptualization and Fluency (Reynolds & Horton, 2006), recall and recognition memory tasks from the *Rey Auditory Verbal Learning Test* (Schmidt, 1996), immediate and delayed story retelling from the *Arizona Battery for Communication Disorders of Dementia* (Bayles & Tomoeda, 1993) and visual memory from the *Detroit Tests of Learning Aptitude* (Hammill, 1998). After each memory task, participants reported any strategies used to complete the task. After completion of all memory tasks, participants indicated strategies used from a short listing of possible memory strategies, as well as completed an open-ended portion to report any other strategies. Participants' sensory modality strengths were assessed using the *Swassing-Barbe Modality Index* (Swassing & Barbe, 1979). Lastly, participants were asked to complete the *Visual Aural Read/Write Kinesthetic Questionnaire* (Fleming, 2001).

There was no significant relationship between sensory modality strength and memory strategies. Typical adults used a variety of memory strategies and combinations of memory strategies independent of the type of sensory modality strength they possess and the nature of the memory task. As professionals working with individuals with memory impairments, it may be necessary for speech-language pathologists to teach many different memory strategies for clients to use to complete various memory tasks. By providing clients with a selection of memory strategies they may gain the subconscious or conscious ability to implement those strategies in various situations like their adult peers without memory impairments.

CHAPTER II

LITERATURE REVIEW

Memory

According to Baddeley (1997), "human memory is a system for storing and retrieving information, information that is, of course acquired through our senses" (p. 9). In their model of memory, Atkinson and Shiffrin (1971) describe three stages of memory—sensory registers, short-term store and long-term store. Sensory input (auditory, visual, and haptic or kinesthetic) is detected and must be attended to before entering the short-term store (Baddeley, 1998). When information is given attention, it enters a short-term store that is comprised of three areas: temporary working memory, control processes (rehearsal, coding, and decisions) and retrieval strategies (Baddeley, 1998, p. 13).

Eventually, if given enough attention, information moves from short-term store to long-term memory (Baddeley, 1998). Long-term memory has been described as an interactive system with organized structure often related to a library or a computer (Baddeley, 1998; Farah & McClelland, 1992; Kolodner, 1984). To move to the long-term memory store, information must have meaning to the individual, which is determined through relevance, emotion, and patterns or connections (Tileston, 2004).

Working Memory

Baddeley and Hitch (1974) used the term "working memory" to describe temporary memory used in information processing. Working memory has a limited information processing capacity of seven digits, plus or minus two (Miller, 1956), about fifteen seconds without interference (Tileston, 2004), or two seconds with interference (Baddeley, 1986, 1998). Working memory is comprised of the phonological (or articulatory) loop, the visuo-spatial sketchpad, and the central executive (Baddeley, 1986; Baddeley & Hitch, 1994). Verbal information is held in the phonological loop. Visual and spatial information is held in the visuo-spatial sketchpad (Baddeley, 1986, 1998; Cowan, 1996). The central executive acts as a supervisor, with the ability to select strategies and integrate information from various sources (Baddeley, 1986). The central executive controls the phonological loop and the visuo-spatial sketchpad (Baddeley, 1998).

The phonological loop has been studied extensively and has been proven to be a way to refresh information in working memory so it is not dismissed (Baddeley & Hitch, 1994). The phonological loop uses subvocal rehearsal to hold and manipulate speech-based information (Baddeley, 1998; Baddeley & Hitch, 1994). Studies have revealed that the phonological loop is an important component in the acquisition and processing of language (Baddeley, 1993; Baddeley, Papagno, & Vallar, 1988).

Visual information is held in short-term memory, encoded and retrieved from long-term memory through the visuo-spatial sketchpad (Baddeley, 1986, 1998). Although there is evidence supporting the existence of a separate process for visual information versus phonological information, there is significantly less information available regarding the visuo-spatial sketchpad than the phonological loop (Baddeley, 1986; Baddeley & Hitch, 1994).

Retrieval

Retrieval of information from long-term memory relies heavily upon the organization of the information in the long-term memory store and the prevalence of retrieval cues (Baddeley 1998; Thomson & Tulving, 1970). Retrieval can depend upon context, mood and state of the individual, how information was classified and the use of retrieval cues (Baddeley, 1998).

Studies by Tulving & Pearlstone (1966) have demonstrated that cues can aid in the retrieval of items that would otherwise not have been retrieved.

Successful retrieval relies on systematic organization of information (Baddeley, 1998). According to Baddeley (1998), an organizational system structures what is being learned and relates new information to what is already known. According to a study by Glosser, Gallo, Clark and Grossman (2002) differences in memory performance among individuals with dementia was related to encoding processes. The authors of the study suggested that a failure to implement higher level organizational strategies at the time of learning can have a large impact on the success of individuals with memory problems in free recall tasks.

Common types of retrieval cues include visuals, smells, semantics, actions, and sounds (Baddeley, 1998). Retrieval cues can also be the strategies created during encoding, including mnemonics (Becker & Lim, 2003). However, specific retrieval cues are only effective in recall if they and their relation to the stored item are encoded at the same time as the item that is to be remembered (Tulving & Osler, 1968).

Memory Strategies

The limited capacity of working memory requires the use of encoding and retrieval strategies for successful memory performance (Baddeley, 1998). Proficient thinkers implement a variety of strategies to accomplish an assortment of objectives (Pressley & El-Dinary, 1992). Strategies are used to effectively solve math and logic problems, write, read, and memorize information (Pressley & El-Dinary, 1992). In particular, good memorizers employ a range of strategies such as mnemonics, rehearsal and chunking to improve memory in a variety of situations (Pressley & El-Dinary, 1992).

Discovering a useful memory strategy for encoding and retrieving information can increase memory performance drastically (Baddeley, 1986). In his study of memory strategies in free recall tasks, Eagle (1967) found that subjects using a strategy recalled significantly more words than participants who did not report using a memory strategy. Individuals differ in the types and frequency-of-use of strategies. However, those who use strategies performed better than those who did not use strategies in memory span tasks (Dunlosky & Kane, 2007). Devolder and Pressley (1989) report the use of memory strategies is extremely important for memory success across the lifespan.

According to Baddeley (1986), memory strategies are used to compensate for the limitations of working memory. Oxley & Norris (2000) stated “the more deliberate the memory process, the more likely memory strategies will be used as facilitators to compensate for limitations in the size of working memory” (p. 80). Memory performance depends on the use of cognitive strategies and the use of these strategies varies from situation to situation (Reder, 1988). Strategy selection has been shown to be important in many different memory tasks (Becker & Lim, 2003; Reder, 1987; Saczynski, Rebok, Whitfield, & Plude, 2007). Each strategy connects itself to the information about where it was learned, whether it was fun to use, its utility, and where and when to use the strategy. Good strategy users know strategies and identify where and when to use them (Devolder & Pressley, 1989).

Types of Memory Strategies

Common strategies used to aid memory performance are concentration, rehearsal, elaborating, self-testing, chunking, organization, self-questioning, mnemonics, visual imagery, external memory aids, visual and verbal coding, and association (Baddeley, 1998; Justice & Weaver-McDougall, 1989; Parente & Herrmann, 1996; Saczynski et al., 2007). Rehearsal is a common strategy used by individuals and in research (Baddeley, 1998; Bartz, 1972; Lehmann & Hasselhorn, 2007; Oxley & Norris, 2000; Shimizu, 1996; Tileston, 2004). According to Tileston (2004), rehearsal keeps information in working memory and transfers information to long-term memory. Rehearsal makes it possible to preserve information long enough for encoding, making this essential for encoding (Parente & Herrman, 1996). The type of rehearsal and the amount of time spent rehearsing are important (Bartz, 1972; Tileston, 2004).

Tileston (2004) described two types of rehearsal: rote and elaborate. Rote rehearsal is the deliberate repetition of information in the same way that it entered short-term memory. Rote rehearsal can be helpful for remembering information exactly the way it was presented. Alternatively, elaborative rehearsal requires the individual to give the information meaning by elaborating or integrating information with what is already known. Just as rote rehearsal keeps information exactly the same, elaborative rehearsal changes the information in some way.

Another type of rehearsal is subvocal rehearsal. Baddeley (1998) suggested that subvocal rehearsal was a part of an auditory imagery system, related to the articulatory loop. In fact, subvocal rehearsal is very common and automatic. In research, rehearsal-preventing distractions are introduced to eliminate the use of subvocal rehearsal in participants for the study of short-term versus long-term memory (Baddeley, 1998).

Chunking is another common strategy used for recall of information. According to Baddeley (1998), “the capacity of immediate memory is determined by the number of chunks rather than by the number of digits” (p. 27). It is easier to remember seven digits in chunks of two or three than seven individual digits (Parente & Herrmann, 1996). Baddeley (1998) describes an individual with amazing memory capacity who used chunking strategies to memorize long strings of letters and numbers. Chunking can be a helpful strategy for remembering letters and numbers (Baddeley, 1998).

Organization is another strategy used to remember items for recall. According to Tulving (1972), encoding is the conversion of a word into memory by relating it to other known words in memory. Alternatively, organization requires relating the word to other words in a list in some way. One type of organizational strategy classifies new information according to categories (Baddeley, 1998; Parente & Herrmann, 1996). Individuals can relate new items that are presented to each other by identifying categories and remembering the categories (Baddeley, 1998). Information organized into a hierarchy is easier to remember than information without categorical organization.

A self-questioning strategy involves creating an association between something to be learned and something familiar. Parente & Herrmann (1996) provided examples of questions to help individuals make connections with new items to items that the individual is already familiar. These include "What does it look like? What does it sound like? What does it smell like? What does it taste like? What does it mean the same thing as? What groups does it belong to? Who is it commonly associated with?" (Parente & Herrmann, 1996, p. 50). Associating new information with well-known information establishes multiple retrieval routes that allow for better recall.

Mnemonics are strategies that cue our memories for better learning and recall of lists of items or instructions (Bellezza, 1981; Parente & Herrmann, 1996). Mnemonics are widely used and taught (Baddeley, 1998; Bellezza, 1981; Saczynski et al., 2007). The use of mnemonic devices has been proven to be more effective than rehearsal as a strategy for recall tasks. According to Baddeley (1998), people with jobs with a heavy memory load often develop their own mnemonics to help remember items. The use of mnemonics can aid in consistent retrieval of information in appropriate order (Baddeley, 1998).

Hill, Allen and Gregory (1990) examined the use of mnemonics in typical older adults during immediate and delayed word list recall tasks. The results of the study revealed that older adults use mnemonics as an encoding strategy and those adults who used mnemonics performed better in both immediate and delayed settings. Although it has been proven that organizational strategies such as mnemonics improve recall performance (Bellezza, Cheesman & Reddy, 1977), the use of these strategies is often not generalized to real-life situations (Pressley & El-Dinary, 1992; Sohlberg & Mateer, 1989). Most individuals who use strategies in test situations to enhance their performances do not generalize these strategies to everyday memory tasks such as memorizing a grocery list.

There are two types of mnemonics: verbal and visual (Baddeley, 1998). Verbal mnemonics include sentence, word, rhyme and story mnemonics (Baddeley, 1998; Parente & Herrmann, 1996). A word mnemonic creates a simple word to help remember the steps to a task or parts of a whole (Parente & Herrmann, 1996). An example of a widely used word mnemonic is “ROY G BIV” (red, orange, yellow, green, blue, indigo, violet) for the colors of the rainbow. Sentence mnemonics relate typically unrelated words by creating a sentence that includes the to-be-remembered words. Recalling unrelated words is easier if a sentence mnemonic is implemented, no matter how bizarre the sentence (Parente & Herrmann, 1996). Rhyming mnemonics are effective for training semantic information. According to Parente & Herrmann (1996), rhymes are difficult to create but can be a long-lasting strategy. An example of a common rhyme mnemonic is the familiar one used to remember the number of days in each month, “Thirty days hath September, April, June, and November...” (Baddeley, 1998).

The story mnemonic strategy has been reported as an effective technique for the elderly population because it allows the participant to recreate the context in which new information was learned (Bellezza, 1981; Drevenstedt & Bellezza, 1993). This aids in retrieval of information by organizing the learned information for recall. In their review of literature examining the story mnemonic strategy, Drevenstedt and Bellezza (1993) found four advantages of the story technique for the older learner. First, the story mnemonic strategy provides an effective encoding and retrieval framework that draws upon personal experience and knowledge. It is self-paced and does not require initiation on the part of the individual. Finally, it allows the individual to practice his or her narrative style.

According to Paivio (1976), memory performance is better with pictures than with words. Visual imagery mnemonics can be approached in different ways. One approach uses visual imagery of common locations in an obvious and consistent sequence. After the individual establishes those places, he or she must imagine to-be-remembered items in each of those places (Baddeley, 1998). The most common use of this approach is to imagine places in your home then visualize the to-be-remembered items in those places (Baddeley, 1998). This technique works well with concrete items, but success with abstract items depends on the strength of the image created. It is difficult to imagine abstract concepts like "truth" or "faith", for example, so an appropriate image must be generated to represent the concept (Baddeley, 1998).

Another approach to visual mnemonics uses pegwords (Baddeley, 1998). The pegword strategy uses rhyming words to represent numbers from one to ten, such as bun for one and shoe for two. This can be a helpful strategy in free or serial recall tasks, items in a sequence, and lists of items, such as groceries. For this approach, an image of the to-be-remembered word must be imagined interacting with the pegword in some way (Baddeley, 1998). For example, if an individual needs to remember the word “hat” as the first item on a list, he or she must visualize the hat interacting with a bun for number one.

An organizational strategy can involve the use of mnemonics, such as a story or alphabet mnemonic. In their study of organizational strategies in free recall, Bellezza, Cheesman and Reddy (1977) found better recall results in individuals who used a mnemonic organizational strategy. Baddeley (1998) described this approach as weaving words from a list into a story, then remembering the story. This linking of words into a story aids in recall, especially if the individual actively creates the story and its organization.

Baddeley (1986) examined the concept of high-imageability words and word pairs by studying concrete and abstract, high- and low- imageability words and word pairs in recall tasks. These studies revealed much higher recall performance with words that were concrete with high-imageability. The more concrete the image, the easier it is to imagine and remember. The effectiveness of visual imagery depends upon the ability to manipulate visuo-spatial images. Generating images can aid in remembering vocabulary if the images are meaningful to the individual (Pressley, Levin, Kuiper, Bryant & Michener, 1982). If the image is meaningful to the individual, the image will be remembered. However, if the image is meaningless, it is less likely to be remembered.

Individual Differences and Memory Strategies

Gender differences in memory have been studied, revealing that males typically have better visual-spatial skills than females and females have better verbal abilities than males (Halpern, 2000). Males were more likely to use imagery and were better at tasks that required judgment of movement than females. Li and O’Boyle (2008) studied cognitive strategies related to sex, native language, and college major. The study revealed that some differences in gender and college major were noted for 3-D mental rotation tasks and the strategies used to solve the tasks (Li & O'Boyle, 2008). Males majoring in the physical sciences performed better on the 3-D mental rotation tasks. A study of age differences and memory awareness did not show differences in older versus younger adult populations (Devolder, Brigham & Pressley, 1990). However, Cohn, Emrich and Moscovitch (2008), suggested that impaired strategic retrieval was responsible for memory deficits in older adults. Overall memory awareness may not differ in younger and older adults, but memory strategy use does differ in the different age groups (Cohn et al., 2008). This was supported by Brigham and Pressley (1988) as they showed that strategy use was an important component to successful memory performance and that older adults tended not to use powerful strategies. Beliefs about memory strategies motivated the use of such strategies. Devolder and Pressley (1992) suggested that older adults may have different beliefs from younger adults and that they may be unsure about when and where to use memory strategies.

Limited research has examined strategy use in memory-disordered populations. Adamovich and Henderson (1984) found that aphasic, right-brain-injured and closed head trauma participants used a variety of strategies to generate words during word fluency tasks. In studying a population with traumatic brain injury, Schefft, Dulay & Fargo (2008) found that the use of self-generated encoding procedures improved verbal memory and learning. Although there is limited research available, memory-disordered populations have shown use of different memory strategies and increased performance with the use of such strategies.

Teaching Memory Strategies

Memory problems can occur due to deficits in attention, encoding, storage, and retrieval (Sohlberg & Mateer, 1989). Since memory is a critical cognitive process for successful functioning in everyday activities, memory rehabilitation may be necessary for individuals with memory deficits. Training memory strategies can improve performance on immediate recall and working memory tasks in both younger and older adults (Carretti, Borella & De Beni, 2007). According to Parente and Herrmann (1996), retraining memory strategies has proven to be beneficial for individuals with traumatic brain injury.

Only some individuals with memory deficits are good candidates for retraining memory strategies. To learn memory strategies, an individual must have attention, interest, concentration, motivation, and the ability to rehearse (Baddeley, 1998; Parente & Herrmann, 1996). Attention, interest, and concentration are essential to memory and memory strategy training. If an individual is unable to preserve information in memory with rehearsal, strategy training is impossible (Parente & Herrmann, 1996).

Two approaches to memory rehabilitation have been used clinically: restoration and compensation (Sohlberg & Mateer, 1989). The restoration approach uses repetitive practice, drills, or exercises to help restore memory. However, studies have been unable to document enhanced functional memory when restoration techniques are implemented. New learning must take place for memory to improve (Parente & Herrmann, 1996). Simple mental exercise does not improve memory; all individuals must be taught some new method of processing to learn (Godfrey & Knight, 1988).

The compensation approach involves training strategies to compensate for memory deficits (Sohlberg & Mateer, 1989). Compensatory techniques can include the use of internal and external memory aids. Internal memory aids are strategies (such as mnemonics and rehearsal) that focus on enhancing the organization of items that are to be recalled. Sohlberg and Mateer (1989) divide external memory aids into three categories: “multicomponent organizational devices" such as memory notebooks and computers, "simple prospective memory devices" such as alarms and calendars, and "environmental modifications" like labels and posted reminders (p. 152).

Although strategies may be taught and used successfully in therapy, participants often do not generalize the use of learned strategies to other settings (Pressley & El-Dinary, 1992; Sohlberg & Mateer, 1989). To increase generalization of strategies, Pressley & El-Dinary (1992) discussed important components to consider when teaching memory strategies. Strategies should be introduced one at a time, the instructor should model the use of each new strategy, the instructor should explain when and where it is appropriate to use the strategy and the strategy should be practiced (Pressley & El-Dinary, 1992). Parente & Herrmann (1996) provide similar step-by-step processes for training memory strategies, including chunking, organization, mnemonics and mental imagery to support generalization (p. 47-55).

Training memory-monitoring skills is also an important aspect of memory instruction (Hertzog, 1992). Effective memory-monitoring aids in the adaptive use of strategies for acquiring and retaining information. Pressley and El-Dinary (1992) discussed the use of memory strategies both consciously and automatically. They reported that strategies can be learned and can become automatic through practice. Strategies that are automatic require much less metamemory, so practice of strategies is important to create automaticity (Oxley & Norris, 2000; Pressley & El-Dinary, 1992).

Metacognition

The use of memory strategies and awareness of the use of memory strategies requires metacognition (Bostrom & Lassen, 2006; Nelson, 1992). Among other things, metacognitive control includes the awareness and use of memory strategies as well as beliefs about specific strategies (Bostrom & Lassen, 2006). A metacognitive decision must be made to determine the best memory strategy to employ in a given situation. Individuals are able to adapt strategy selection to situations (Schunn & Reder, 1998; Schunn, Lovett, & Reder, 2001). Schunn and Reder (1998) reported that individuals have the ability to adaptively select strategies to accomplish different memory tasks. However, utilization of the most appropriate memory strategy for each situation requires metacognition (Pressley, Levin, & Ghatala, 1984). Decisions about strategies to use take up very little short-term memory capacity, especially in individuals who employ strategies often (Devolder & Pressley, 1989). Strategies that are automatic require less metamemory than those that are deliberate (Oxley & Norris, 2000; Pressley & El-Dinary, 1992).

There has been debate about whether all strategies are used consciously (Pressley & El-Dinary, 1992). Howe and O'Sullivan (1990) discussed both automatic and controlled strategies and indicated that these should not be considered separate processes. Pressley & El-Dinary (1992) suggested that strategies are potentially conscious and controllable and they become automatic through practice. Justice and Weaver-McDougall (1989) also suggested that individuals are able to report the strategies used for memory tasks after completing a task.

It is important to help individuals understand when to use a strategy and identify beliefs about the ability to implement a specific strategy (Pressley & El-Dinary, 1992). According to Elliot and Lachman (1989), if negative beliefs about memory performance and strategies are identified and improved, memory performance may be enhanced. Also, if negative personal beliefs about memory strategy use and performance are identified and eliminated, the use and effectiveness of the strategy can improve (Hertzog, 1992). Individuals may use more effective strategies if they are able to experience improved recall performance after using a strategy (Bjork, DeWinstanley & Storm, 2007).

The Study of Memory

In their review of memory tests, Lezak, Howieson, & Loring (2004) differentiated between memory tests based on the sensory modality that was assessed. Assessments of verbal, visual, and tactile memory were deemed to be different from one another. The majority of memory tests are verbal due to the ease of manipulation of verbal material (Baddeley, 1998). Common assessments of verbal memory include tasks that examine automatisms (the alphabet, common number series, days of the week), letter and digit span, word learning, verbal recall, recognition, verbal-fluency and story recall (Baddeley, 1998; Lezak, et al., 2004). Visual memory assessments include visual recognition, visual recall, design reproduction, visual learning and spatial orientation through the use of hidden objects. There are fewer known assessments of tactile memory; these include tactile recall and tactile recognition.

Retrieval of information, or remembering, occurs through the active process of recall (Lezak, et al., 2004). In recall tasks, participants must generate items from memory (Brown, 1976). Verbal recall tasks are used in many studies to provide information about an individual's ability to retrieve information (Baddeley, 1998; Lezak, et al., 2004).

There are different recall tasks that assess individuals' abilities to recall items in both immediate and delayed settings (Brown, 1976). Free recall is a task that presents participants with a list of items to remember and recall in any order (Baddeley, 1998). Serial recall also presents items in a list, but requires items to be recalled in the order they were presented. Cued recall tasks are similar to the previously explained recall tasks except that retrieval cues are provided to aid in recall (Tulving, 1976).

The serial position curve is a well-known phenomenon that describes typical performance on verbal recall tests (Baddeley, 1998). Participants typically remember the first few items and the last few items but forget many of the words in the middle (Baddeley, 1986, 1998). The first few words are often remembered due to the primacy effect, whereas the last few words are remembered due to the recency effect (Baddeley, 1998). The primacy effect occurs because concentration and rehearsal are often used to help aid in the recall of the first few items (Baddeley, 1986). The recency effect explains the recall of the most recent items in immediate recall tests only if the information is presented verbally, not visually (Baddeley, 1998). This is related to the phonological loop and its limited capacity (Baddeley, 1986, 1998). The recency effect is not observable in delayed recall tests because the information can only be held in the phonological loop for a short period of time (Baddeley, 1998). Involving participants in rehearsal-preventing tasks between presentation of items and recall can determine differences in short-term versus long-term memory stores (Baddeley, 1998; Glanzer & Cunitz, 1966). Rehearsal-preventing tasks allow researchers to better understand participants' short-term versus long-term remembering by eliminating the recency effect (Baddeley, 1986).

Recognition tasks provide a stimulus to trigger remembering (Lezak, et al., 2004). In a recognition test, participants are presented with items to choose from rather than generate (Brown, 1976). Retrieval by recognition is much easier than free recall (Baddeley, 1998; Lezak, et al., 2004).

Studies have examined how concepts and representations are organized in the brain using verbal-fluency tasks (Schwartz, Baldo, Graves & Brugger, 2003). Verbal-fluency (also referred to as word fluency) tasks require participants to retrieve words according to a certain criterion within a specified period of time (Boyle, Coelho & Kimbarow, 1991). Kay et al. (as cited by

Boyle, et al., 1991) reports that word fluency scores from head-injured patients are the best predictor of a patient's ability to return to work one year after discharge. Boyle, Coehlo and Kimbarow (1991) studied aphasics, right-brain-damaged, and neurologically normal participants' variability on word fluency tasks. The results of the study revealed variability in performance in all groups of participants. Due to this variability, word fluency tasks should be administered more than once to account for variability (Boyle, et al., 1991).

Two common types of verbal-fluency tasks are semantic and letter fluency. Semantic fluency requires participants to list items from a category, whereas letter fluency requires participants to list items that begin with a specified letter. Schwartz, et al. (2003) concluded that both semantic and letter verbal-fluency tasks employ semantics, revealing that letter fluency is not a purely phonemically based task.

Another common type of verbal memory assessment is story recall or retell. According to Lezak, et al. (2004), story recall tests "provide a measure of both the amount of information that is retained when the material exceeds immediate memory span, and the contribution of meaning to retention and recall" (p. 444). Story recall tests require an individual to listen to a story and retell the pertinent details from the story in immediate and delayed conditions. Story recall tests may also provide an auditory comprehension component.

The common ways to assess visual memory are through visual recognition tasks, visual recall, and visual learning. Like verbal recognition tasks, an individual is presented with items and later presented with a list of possible items to choose from. However, they are different as the items are presented visually. Visual recall tasks require individuals to recall items that were presented visually. Visual learning tasks are often presented using designs to-be-remembered and recreated (Lezak, et al., 2004).

The Study of Memory Strategies

The study of memory strategies is two-fold as both the use and effectiveness of strategies must be explored. Due to the unobservable nature of strategy use, self-report measures are necessary. Individuals have been shown to be able to report strategy use (Justice & Weaver-McDougall, 1989). However, self-report of memory strategy use and its perceived effectiveness requires metacognition.

Saczynski, et al. (2007) used two methods of self-report for measuring strategy use: self-generated reporting and endorsement. Self-generated reporting allows an individual to provide strategy information independently. Conversely, endorsement allows an individual to choose the strategy from a list of possible strategies (Saczynski, et al., 2007). While self-generated reports are ideal because they do not limit answers, endorsement allows individuals to recognize strategies they may have been unaware of in a self-generated condition. Saczynski et. al (2007) reported that both complex and less complex strategies are more frequently endorsed rather than self-generated.

Investigations of the effectiveness of memory strategies have been approached in different ways. One approach utilized self-report of strategy use compared to memory performance (Schunn & Reder, 1998). In another approach, participants were assessed, instructed in the use of a particular strategy or strategies, trained in the use of that strategy, then reassessed (Dunlosky & Kane, 2007).

Observation and investigations of participant's answers can reveal what strategy was used for recall (Baddeley, 1998). If individuals provide answers that are phonologically similar to the presented items (e.g. "p" for "b"), it is easy to understand that the strategy used was verbal

(Baddeley, 1998). Although less likely than verbal, if the individual produces the name of an item visually similar, then the strategy can be observed as a visual strategy (Baddeley, 1998).

Learning Styles

Learning styles describe an individual's preferred way to learn or approach a task (Cassidy, 2004; Kane & Boan, 2005; Smith & Dalton, 2005). In their study of learning styles, Smith and Dalton (2005) described learning styles as the typical way an individual attempts to learn knowledge, skills, or attitudes. Learning styles have limited supporting evidence but are widely considered helpful in meeting the needs of individual learners (Coffield, Moseley, Hall, & Ecclestone, 2004; Cook & Smith, 2006; Klein, McCall, Austin, & Piterman, 2007; Rayner, 2007). However, Dembo and Howard (2007) suggested that learning styles have not been proven valid and reliable and are not beneficial. They argued that there was no supporting evidence that proves that an understanding of learning styles improves learning (Dembo & Howard, 2007). Others suggest the best practice for using learning styles is a combination of multiple learning styles models and an educated use of each model (Desmedt & Valcke, 2004; Rayner, 2007). Understanding personal learning styles helps individuals comprehend the impact of both internal and external stimuli in relation to learning (Bostrom and Lassen, 2006).

Many studies have examined different learning styles models and how they are assessed (Bostrom & Lassen, 2006; Cassidy, 2004; Coffield, Moseley, Hall, & Ecclestone, 2004; Cook & Smith, 2006; Desmedt & Valcke, 2004; Hawk & Shah, 2007; Kane & Boan, 2005; Klein, McCall, Austin & Piterman, 2007; Smith & Dalton, 2005). These reviews reveal that learning styles are often considered synonymous with learning strategies, learning preferences, cognitive styles, thinking styles, and multiple intelligences.

Learning style, learning preference, and learning strategies are all related concepts that serve different purposes. Learning style describes an individual's habitual approach to learning whereas learning preference is the favoring of one mode of teaching to another (Sadler-Smith & Smith, 2004; Smith & Dalton, 2005). Learning strategies differ from learning styles as they are strategies an individual decides to use to approach a learning task (Bostrom & Lassen, 2006; Smith & Dalton, 2005). This is a planning activity that uses learning style and preference but also decides the best course of action to take to learn knowledge or a skill (Cassidy, 2004; Sadler-Smith & Smith, 2004; Smith & Dalton, 2005).

A popular organizational model of learning styles from Curry (1983) likens the models of learning styles to an onion. The outermost layer is instructional preference, the second is information processing, and the third is cognitive personality style. This onion model has been interpreted by Smith and Dalton (2005) as including the three different definitions of learning style, learning preference, and learning strategies. Their model has learning strategies as the outermost layer, followed by learning preference, and learning style as the innermost layer.

The differences between the terms learning styles and cognitive styles are difficult to discern. Cognitive styles are the way an individual perceives and processes information (Kane & Boan, 2005; Rayner & Riding, 1997). Cognitive styles are reported to have a neurological base, whereas learning styles are considered to be contextual (Kane & Boan, 2005). Learning styles can be identified while cognitive style can not be easily recognized by the individual (Kane & Boan, 2005). Cassidy (2004) defined cognitive style as "an individual's habitual mode of problem-solving, perceiving, and remembering" (p. 420). Cognitive styles can be applied during learning as a component of learning style (Cassidy, 2004; Riding & Cheema, 1991).

Measures of Learning Styles

After differentiating learning styles from the other terms related to the concept, it is appropriate to examine the different models and measures of learning styles. The extensive review of learning styles by Coffield, et al. (2004) discussed more than 70 models, each with different ideas about learning. There are many different ways of categorizing theories of learning styles (Kane & Boan, 2005; Rayner & Riding, 1997; Smith & Dalton, 2005). Claxton & Murrell (1987) categorized learning styles into four groups: personality characteristics, information processing, social interaction, and instructional preference.

Although there are many different learning styles models that fit into the aforementioned categories, the present study will focus primarily on instructional preference. Instructional preference is the mode through which learning occurs (Fleming, 2001). It deals with perceptual mediums as it is focused on the ways that individuals obtain and impart ideas and information (Fleming, 2001). The perceptual modes through which learning can occur are based on our senses (Barbe & Swassing, 1988; Fleming, 2001). According to Barbe and Swassing (1988), "A modality is any of the sensory channels through which an individual receives and retains information." (p. 1).

Sensory Modality Strengths as Learning Style

We use our senses to take in information from the environment. Particularly for memory and academic learning, we use the senses of sight, hearing, and touch (Atkinson & Shiffrin, 1971; Barbe & Swassing, 1988; Fleming, 2001). According to Fleming (2001), most individuals have a preference for one particular sensory mode while learning. Some individuals exhibit a strong preference for one sensory mode and relative weaknesses in other modes (Fleming, 2001,

p. 1). According to Barbe and Swassing (1988), adults are able to determine how they learn best based on the modalities of sight, hearing, and touch.

Individuals use all sensory modalities, but operate in one modality more than the others (Barbe & Swassing, 1988; Fleming, 2001; Lisle, 2007). A dominant modality is the way in which an individual processes information most efficiently (Barbe & Swassing, 1988). This can be easily observed in children until they learn to transfer information from one mode to another to accommodate different learning situations. Although most individuals have one sensory modality strength, not all individuals have one dominant modality. Individuals with a dominant modality often have a secondary modality to rely upon when the situation demands it. Individuals can also have strengths in multiple modes. Individuals with multimodal strengths are better able to adapt to different learning situations because they are more equipped with choices of strategies to use to approach learning tasks (Barbe & Swassing, 1988; Fleming, 2001).

There are many learning styles measures available for each of the different theories of learning styles. In addition, multiple measures exist to determine sensory modality strengths. The present study will utilize *VARK* (Visual, Auditory, Read/Write, Kinesthetic) (Fleming & Baume, 2006) and the Swassing-Barbe Modality Index (*SBMI*) (Swassing & Barbe, 1979) to determine sensory modality strengths.

VARK (Visual, Aural, Read/Write, Kinesthetic) Questionnaire

VARK (Visual, Auditory, Read/Write, Kinesthetic) is a model developed by Neil Fleming (2001). *VARK* examines four modalities through which individuals perceive and interact with learning materials. Fleming (2001) and Fleming & Baume (2006) made it clear that *VARK* examines only one aspect of learning style, instructional preference. *VARK* was created to be a quick survey for teachers and students to reflect upon their sensory modality strengths (Fleming & Mills, 1992).

Information regarding modes of learning can be beneficial to both students and teachers in any learning environment (Fleming & Mills, 1992). *VARK* was designed to be a useful tool for students and teachers, not to be used as a diagnostic or predictive inventory (Fleming, 2001). *VARK* is different from other modality questionnaires as it includes the modality of read/write, an important component to academic learning (Fleming & Baume, 2006). According to Fleming (2001), most teachers and students (not the general public) have multiple preferences in the read/write mode.

The most current version of *VARK* questionnaire is composed of 16 questions that describe a situation and asks the participant to choose one or more of four actions that he or she would take (Hawk & Shah, 2007). Each of the choices is either a visual, auditory, read/write, or kinesthetic solution. Totals of answers in each modality provide information about which modality is a strength.

VARK has an interactive website that allows individuals to take the *VARK* questionnaire online (www.*vark*-learn.com). The online version totals the answers and reports whether the participant is multimodal, visual, aural, read/write, or kinesthetic. Information regarding each of the strengths is available for participants to learn about their strengths. Use of the *VARK* online is free for use in schools and universities to promote better learning environments for students (Fleming & Baume, 2006).

The *VARK* has limited research to support it (Fleming, 2001). Some critics have found *VARK* difficult to validate statistically, but state that it has great educational value for teachers and students (Fleming & Baume, 2006). Due to the nature of *VARK*, information is primarily gained through critiques and self-reports (Fleming, 2001). Future research is needed about all aspects of *VARK*. Fleming (2001) does not promote use of *VARK* for research purposes due to its limited supporting research. However, it can provide information about how individuals prefer to learn.

Swassing-Barbe Modality Index

To determine sensory modality strengths, Swassing and Barbe created the *Swassing-Barbe Modality Index* (*SBMI*) (Barbe & Swassing, 1988). The *SBMI* is a matching-to-sample task, requiring participants to duplicate a sample presented by a tester (Swassing & Barbe, 1979). The same test is given three times to examine the three sensory modalities of visual, auditory, and kinesthetic (Swassing & Barbe, 1979). The *SBMI* is a quick assessment of an individual's sensory modality strength. Barbe & Swassing encourage use of the *SBMI* coupled with teacher observations (1988). Raw scores from the *SBMI* are converted into percentages of modality strengths, revealing the modality through which the participant performs best (Barbe & Swassing, 1988; Swassing & Barbe, 1979).

Although not widely reviewed in recent literature, the *SBMI* was standardized using a large sample of children and is considered valid and reliable (Barbe & Swassing, 1988). Some studies have used the *SBMI* to identify learning modality strengths in relation to reading, musical, math, and word-learning abilities in children (Sanders, 1996; Kampwirth & MacKenzie, 1989). However, no known studies exist about the use of the *SBMI* with adult populations. The *Swassing-Barbe Checklist of Observable Modality Strength Characteristics* has been created for use with adults (Barbe & Swassing, 1988). This can be a useful tool for adults, but it is based on self-report and perceptions like typical learning styles measures. This checklist is similar to

VARK as it targets specific situations and preferences in each situation. Information gained from the checklist would likely be gained from *VARK*.

Despite its limited research background, the *SBMI* can be a valuable tool because of its hands-on approach. It is different from many learning styles measures as it is not a questionnaire, but a task that examines the individual's actual performance while using different sensory modes (Barbe & Swassing, 1988). Another advantage of the *SBMI* is that it is a nonverbal test and only requires auditory comprehension of the words "heart," "circle," "square" and "triangle" (Swassing & Barbe, 1979). This may be useful working with memory, speech or language disordered populations.

Application of Sensory Modality Information

Many studies have discussed the importance of approaching teaching differently for every individual as every person's learning preference, style, and strength are different. Most individuals have a sensory modality preference when learning (Barbe & Swassing, 1988; Fleming, 2001; Tileston, 2004). Applying information about sensory modality strength and preference in learning environments can be beneficial to learners (Briggs, 2000). Tileston (2004) suggests that to reach slow learners, information must be re-taught in the individual's preferred modality.

In the literature, sensory modality strengths are considered visual, auditory, and kinesthetic (Barbe & Swassing, 1988; Sprenger, 2003). Sprenger (2003) differentiates between two types of visual learners: those with strong spatial and visualization skills and those who are print-oriented. *VARK* separates these into two completely different categories, visual and read/write (Fleming, 2001; Fleming & Mills, 1992).

Visual learners prefer maps, charts, graphs, diagrams, brochures, flow charts, highlighters, different colors, pictures, word pictures, puzzles, visual tools, underlining, pictures and posters (Fleming, 2001; Hawk & Shah, 2007; Tileston, 2004). Often, visual learners have difficulty remembering names and directions that are told to them (Fleming, 2001). They learn best when there are visual tools available. They also like to organize thoughts by writing them down (Tileston, 2004). Visual learners would rather read a story themselves instead of listening to someone else read it to them (Tileston, 2004).

Auditory learners prefer information that is heard or spoken (Fleming, 2001; Sprenger, 2003). They often enjoy explaining new ideas to others, attending lectures, discussing topics using a tape recorder, and listening to stories and jokes (Fleming, 2001; Hawk & Shah, 2007; Tileston, 2004). Auditory learners learn best when they can discuss, speak their answers, read notes aloud, and listen to instructors (Fleming, 2001). Individuals with an aural modality strength are often easily distracted by sounds (Tileston, 2004). According to Sprenger (2003), these learners often struggle with spelling because they spell phonetically, based on the sound in the words rather than the spelling rules.

Barbe and Swassing (1988) and Fleming and Mills (1992) found it necessary to define the term kinesthetic, also referred to as haptic (Atkinson & Shiffrin, 1971; Fleming, 2001). According to Barbe & Swassing (1988), the kinesthetic modality includes large and small muscle movements and the sense of touch. Fleming & Mills (1992) describe the kinesthetic modality as the way in which information from other modalities is connected to the student, through experience, example, practice, or simulation. Sprenger (2003) includes the senses of smell and taste as part of the kinesthetic category in a visual/auditory/kinesthetic model.

Kinesthetic learners prefer field trips, trial and error, teaching others, exhibits, samples, real-life examples, hands-on approaches, and using all of their senses (Fleming, 2001). They remember what was done rather than what was seen or heard and would rather participate than watch (Tileston, 2004). These types of learners are often hands-on, whole-body learners, and doodlers (Sprenger, 2003). In her study using an electronic inventory assessing visual, auditory, and kinesthetic learning styles, Lisle (2007) found that the lower age range had more kinesthetic learners than older age ranges.

In *VARK* (Visual, Aural, Read/Write, Kinesthetic), read/write is considered a modality preference (Fleming & Mills, 1992; Fleming & Baume, 2006). In other models, this is considered a print-oriented visual learner (Sprenger, 2003). Read/write learners prefer lists, essays, reports, textbooks, definitions, printed handouts, readings, manuals, taking notes, websites, and the library (Fleming, 2001; Hawk & Shah, 2007). These types of learners often do well with written exams. They tend to rewrite ideas and read notes repeatedly (Fleming, 2001).

Memory and Sensory Modality Strengths

Sensory modality and memory have been associated in research. According to Bostrom and Lassen (2006), memory strategies and learning styles are linked under the category of learning strategies along with emotional and cognitive strategies. The same sensory registers (auditory, visual, and kinesthetic) proposed as modalities for learning styles and modality strengths are also cited by Atkinson & Shiffrin in their model for memory (1971). Barbe & Swassing (1988), state that sensation and memory are very closely related. Even memory assessments are categorized according to sensory modality as verbal memory, visual memory, and tactile memory are assessed in different ways (Lezak, et al., 2004).

The use of sensory modality strength information to promote better teaching and learning environments has been suggested (Barbe & Swassing, 1988; Fleming, 2001; Tileston, 2004). It is important for individuals and teachers to be aware of sensory modality strengths to understand how they best remember and learn and to promote a better learning environment (Sprenger, 2003). In her book for teachers, Sprenger (2003) breaks down types of memory according to their sensory pathway in information processing. Learners have a visual memory preference, an auditory/verbal memory preference, or a kinesthetic/tactile memory preference (Sprenger, 2003).

The link between memory strategies and sensory modality has been made. Kratzig and Arbuthnott (2006) examined learning style preference according to sensory modality and memory performance. Sprenger (2003) lists memory strategies that individuals with visual, auditory, and kinesthetic strengths may relate to. For visual learners, some of these strategies may be nonlinguistic representations, mind mapping, mental pictures, summarizing and note-taking (Sprenger, 2003, p, 70). Strategies described for auditory learners include mnemonics involving rhythm and rhyme, rehearsal, and discussion (Sprenger, 2003, p. 93). For kinesthetic learners, some common strategies may be mnemonic strategies that require movement, mind-mapping, and the use of manipulatives (Sprenger, 2003, p. 113-114). Sprenger (2003) describes the importance of teaching these strategies as they may not be learned independently.

Dunlosky and Kane (2007) examined strategy use and individual differences, but not based on sensory modality or learning style differences. Devolder & Pressley (1989), discuss the use of strategies and cognitive styles. They suggest that some styles facilitate strategy use (Devolder & Pressley, 1989). However, no known study has explored the use of memory strategies and how it relates to sensory modality preference or strengths.

Statement of the Problem

Although the connection between sensory modalities and memory has been made, no known research has examined the relationship between sensory modality strength and the use of strategies for memory in retrieval and recall tasks. No known study has examined the relationship between sensory modality strength or individual differences in adults and their preferred memory strategies. This study attempted to identify any relationships between memory strategies for verbal fluency, visual memory and immediate and delayed recall tasks and sensory modality strengths in typical adults. The study also examined the relationships between performance on memory tasks and the strategies used to complete each task; sensory modality strengths and age, gender, education and occupation; performance on memory tasks and age, gender, education and occupation; performance on memory tasks and sensory modality strength; and relationships between tests.

CHAPTER III

METHODOLOGY

Participants

Forty participants ages 21 to 88 individually participated in a series of visual and verbal memory, memory strategy and learning modality assessments. There were four groups of ten participants. Participants aged 21-35 were placed in a young adult group, participants aged 36-50 were placed in a middle-aged adult group, participants aged 51-65 were placed in an older middle-aged adult group and participants aged 66 and older were placed in an older adult group. Each age group was comprised of five males and five females.

Participants were recruited through flyers and word-of-mouth primarily in Wichita, KS. An attempt was made to include an equal number of participants of different age groups, gender, education levels and occupation classifications. Participants without a high school diploma were excluded from the study. All participants were native English speakers to eliminate problems due to language differences.

All participants had no known cognitive deficits as revealed through self-report. Participants identified with a history of a condition affecting memory such as head injury, mental illness or other conditions were excluded from the study. Participants who reported a hearing or vision impairment were allowed to participate only when the impairment was corrected by hearing aids, eyeglasses or other means.

Procedure and Measures

Participants were informed about their rights as participants, signed an informed consent release and provided demographic information (Appendix A, Appendix B). Participants were evaluated with several assessments to determine sensory modality strength, categorical and letter verbal fluency, recall and recognition memory, story retelling, visual memory and memory strategies. Participants were reminded to use any strategies to enhance their memory performance during all memory tests. Table 1 contains the memory or learning component, rationale, assessment and tasks for the procedures of this study.

Table 1

Memory or Learning Component, Rationale and Assessment for Procedure

Memory or Learning Component	Rationale	Assessment
Word fluency	• provides information about semantic organization of information in long-term memory • measures working memory skills necessary for problem solving	Categorical Fluency and Letter Naming subtests from *Test of Verbal Conceptualization and Fluency (TVCF)*
Immediate and delayed recall	• provides information about memory in both immediate and delayed conditions • provides opportunities for both encoding and retrieval of auditory information	*Rey Auditory Verbal Learning Test (RAVLT)* Story Retell Immediate and Delayed subtests from the *Arizona Battery for Communication Disorders of Dementia (ABCD)*
Visual memory	• offers insight into different modality strengths and strategies used for different memory tasks • all other memory tasks for this study are highly verbal, whereas this task relies primarily on visual memory	Design Sequences subtest from the *Detroit Tests of Learning Aptitude (DTLA-4)*
Memory strategies	• can be used in therapy with individuals with memory deficits	Self-report survey and examiner observations
Sensory modality strength	• provides a better understanding of how a person prefers to learn	*Visual Aural Read/Write Kinesthetic (VARK) Questionnaire* *Swassing-Barbe Modality Index (SBMI)*

Immediate Story Retell

The first test administered was the Story Retell Immediate test from the *Arizona Battery for Communication Disorders of Dementia (ABCD)* (Bayles & Tomoeda, 1993) to assess immediate story retelling abilities. The Story Retell Immediate and Delayed subtests of the *ABCD* provided an opportunity to examine actual recall, as well as the strategies participants use for recall of information in story form. This subtest of the *ABCD* was chosen as it is widely used and is a standardized measure. Participants were read a short story then asked to retell the story. The examiner scored responses based on the seventeen pertinent details provided by the *ABCD* as a guide for scoring the retell. After retelling the story, participants were instructed to "remember this story because I will ask you to tell it to me again later."

Immediate Verbal Recall

Participants' immediate recall of lists of words was assessed using the *Rey Auditory Verbal Learning Test (RAVLT)* (Schmidt, 1996). The *Rey Auditory Verbal Learning Test* (*RAVLT*) provides both recall and recognition tasks. The *RAVLT* assesses verbal memory by providing participants with a list of fifteen words auditorily and requiring them to recall the words for five trials (Trial I-V), an interference trial (Trial B), a delayed recall trial (Trial VI) and a visual recognition memory trial. In this study, participants were provided trials from Form AB (Schmidt, 1996). Trials I-VI required participants to recall items from List A and Trial B required participants to recall items from Trial B.

For the *RAVLT*'s Trials I-V, participants were provided the following instructions "I am going to read a list of words. Listen carefully, for when I stop, you are to say back as many as you can remember. It doesn't matter in what order you repeat them. Just try to remember as many as you can." List A was read to each participant for each trial and participants were asked to recall items from the list. Participants were not provided any information regarding their performance recalling items on any trials. Upon completion of Trials I-VI, participants listened to List B and were instructed to recall the items. Immediately after completion of Trial B, participants were asked to recall items from Trial A.

Verbal Fluency

After the immediate recall component of the *RAVLT*, two subtests, the Categorical Fluency and Letter Naming subtests, from the *Test of Verbal Conceptualization and Fluency (TVCF)* (Reynolds & Horton, 2006) were administered. The *TVCF* is a standardized test designed to measure executive functions. The *TVCF* is comprised of the following four subtests: Categorical Fluency, Classification, Letter Naming, and Trails C. For the purposes of this study, only the verbal fluency subtests, the Categorical Fluency and Letter Naming subtests, were administered.

On the Categorical Fluency subtest, participants were instructed to generate as many items as possible in a category in thirty seconds. Participants identified items in five categories: animals, things to eat, things to go in a house, things you can ride on and things you wear. For the Letter Naming subtest, participants were instructed to name as many words that started with a certain letter (S, P, T, D) as possible in thirty seconds.

According to the *TVCF* administration guidelines, participants ages 60 and older are allowed one minute for generation of items in both the Categorical Fluency and the Letter Naming subtests. However, to keep consistency throughout testing and to measure differences in age and performance on tasks, all participants (including those over age 60) were only allotted 30 seconds to generate items for each category of the Categorical Fluency subtest and each letter of the Letter Naming subtest.

Visual Memory

Following the subtests of the *TVCF*, participants' visual memory was assessed with the Design Sequences subtest of the *Detroit Tests of Learning Aptitude (DTLA-4)* (Hammill, 1998). The *DTLA-4* is comprised of ten subtests that measure different mental abilities. The Design Sequences subtest measures visual discrimination and memory. For this task, participants were presented with a picture of a sequence of designs for five seconds. The participants were then instructed to recreate the sequence using cubes. Each cube had the same five, non-meaningful designs on its sides and one blank side. Presented sequences used the same five designs as displayed on the cubes. Participants arranged the cubes to match the previously-presented sequence. The sequences increased in length, starting with a sequence of two designs and ending with a sequence of six designs. If participants incorrectly sequenced designs or placed an incorrect design, they were allowed to re-study the sequence again (with the cubes covered) for five seconds and fix the mistake up to two extra times.

Delayed Recall, Recognition and Delayed Story Retell

To conclude memory testing, participants completed the delayed recall trial (Trial VI) of the *RAVLT*. Participants were instructed to recall the words from List A of the *RAVLT*. A recognition test is also provided as part of the *RAVLT* for clients to identify as many words recalled as possible either auditorily or visually. For the current study, only the visual recognition test was administered. After completion of the Trial VI, participants were provided the recognition list and instructed to put a check mark next to the words that were on the first list (list A).

The Delayed Story Retell task from the *ABCD* was the last memory test administered. Participants were instructed to retell the story told at the beginning of the testing session. The same seventeen details used for the immediate retell were used as criteria for scoring the delayed retell.

Memory Strategies

After each memory test, participants were asked to report the strategies they used to recall information for each specific task (Appendix C). After completion of all memory tests, participants were provided with a short listing of possible memory strategies as well as an open-ended portion to report any other strategies used or comments (Appendix D). This listing was created from the strategy survey used by Saczynski et. al (2007) to examine self-report of strategies used in multiple memory assessments. Participants were provided with a visual and/or verbal reminder of each of the memory tests as they were asked about strategies used for the particular test. The test administrator also recorded observations of strategies used during testing.

Sensory Modality Strength

Participants' sensory modality strengths were assessed using the *Swassing-Barbe Modality Index (SBMI)* (Swassing & Barbe, 1979). The *SBMI* is a test that does not require participants to be verbal. The *SBMI* determines which sensory modality (visual, auditory, and kinesthetic) an individual finds his or her strength. The *SBMI* examines individuals' sensory modality strengths using shapes that the participant must manipulate and arrange according to visual, auditory or kinesthetic directions. Participants were provided heart, triangle, circle and square objects. For the visual component, they were shown sequences of increasing length containing the four shapes and were instructed to recreate each sequence. For the auditory component, they were read the sequences of increasing length containing the four shapes and were instructed to recreate each sequence. For the kinesthetic component, they touched the sequences of increasing length containing the four shapes and were instructed to recreate each sequence. The examiner used both observations and results from the visual, auditory and kinesthetic testing conditions to determine modality strengths.

Lastly, participants were asked to complete the *Visual Aural Read/Write Kinesthetic (VARK) Questionnaire* (Fleming, 2001). *VARK* is a short, 16-question survey that provides participants with real-life situations. The questionnaire can be completed in a short amount of time and it determines through which modality (visual, aural, read/write and kinesthetic) individuals prefer to use to solve everyday problems. This questionnaire is different from most learning styles assessments as it focuses on modalities and includes read/write as a modality. Participants were provided the questionnaire and instructed to circle all answers that they felt applied to how they would handle each situation. Although the *VARK* has an interactive website that allows people to take the questionnaire online at www.vark-learn.com, the questionnaire was administered in paper form because it can be administered in any location without the need for internet access.

Upon completion of the tests, participants' sensory modality strengths were discussed, any questions were answered and participants were debriefed.

Research Questions

1. Is there a correlation between sensory modality strengths and memory strategies used to complete various memory tasks?
2. Does a relationship exist between performance on different memory tasks and memory strategies?
3. Is there a relationship between sensory modality strength and individual differences such as age, gender, education and occupation?

4. Is there a correlation between individual differences such as age, gender, education and occupation and performance on memory tasks?
5. Does a correlation exist between sensory modality strengths as determined by two different assessments (the *VARK* and the *SBMI*)?

CHAPTER IV

RESULTS

The main purpose of this study was to examine the relationship between sensory modality strength and the strategies typical adults use to complete memory tasks. Other purposes of this study were to examine relationships between performance on memory tasks and sensory modality strength; performance on memory tasks and the strategies used to complete each task; sensory modality strengths and age, gender, education and occupation; performance on memory tasks and age, gender, education and occupation; and relationships between tests.

Sensory Modality Strength and Memory Strategies

Strategies for memory tasks were self-reported by participants after the completion of the following memory tasks: the Categorical Fluency and Letter Naming subtests from the *Test of Verbal Conceptualization and Fluency (TVCF)* (Reynolds & Horton, 2006); *Rey Auditory Verbal Learning Test (RAVLT)* (Schmidt, 1996); Design Sequences subtest of the *Detroit Tests of Learning Aptitude (DTLA-4)* (Hammill, 1998)*;* and the Story Retell Immediate and Delayed tests from the *Arizona Battery for Communication Disorders of Dementia (ABCD)* (Bayles & Tomoeda, 1993). Strategies were then categorized based on type of strategy: visual, auditory, kinesthetic, semantic, or read/write. Table 2 contains reported memory strategies categorized by type of strategy.

Table 2

Reported Memory Strategies Categorized by Type of Strategy

Strategy Type	Reported Memory Strategies
Visual	Visualization, mental images Looked out window Pictured items, designs, words, story, places, scene, events Image connections Mentally picture Watch speaker Pictured self in story Visualized items interacting together Looked for geometric similarities, visual patterns Visual Mnemonics
Auditory	Rehearsal Repetition, repeated words silently and aloud Sounded out words Listen carefully Chunking for rehearsal Made rhyme Used a cadence or rhythm Rehearsed patterns
Kinesthetic	Count on fingers Mentally "walk through" places
Semantic	Associated design with something familiar Word families Association with emotion, meaning, past experience, own life Remembered similarities Word families Thought of cause/effect Sequenced events Classify, group items, combined similar words Categories, themes Connection between meaning of words Created story with names Thought of flower names
Read/Write	Alphabetized, Alphabetical Abbreviated words to first letter, then made new words

Participants reported different strategies for different tasks. However, reported strategies were not related to the nature of the memory task. Table 3 contains the reported memory strategies and number of participants who reported the strategy.

Table 3

Memory Task, Nature of Task, and Reported Memory Strategies Groups Ranked in Order of Number of Participants

Memory Task & Nature of Task	Reported Memory Strategies	*N*
Categorical Fluency-*TVCF*	Semantic & Visual	18
• Semantic	Visual	13
• Auditory	Semantic	6
	Auditory	3
Letter Naming-*TVCF*	Semantic & Auditory	10
• Auditory	Semantic & Visual	6
• Semantic	No strategy	6
	Visual	6
	Semantic	5
	Auditory	5
	Visual & Auditory	2
RAVLT	Semantic, Visual, & Auditory	10
• Auditory	Auditory	10
	Semantic & Auditory	7
	Visual & Semantic	3
	Semantic	3
	Visual & Auditory	2
	Visual	2
	No strategy	1
Design Sequences-*DTLA-4*	Semantic	13
• Visual	Semantic & Auditory	12
• Kinesthetic	Semantic, Auditory & Visual	6
	Semantic & Visual	6
	Visual	3
Story Retell Immediate and Delayed-*ABCD*	Visual	14
	Visual & Semantic	9
• Semantic	Auditory	4
• Auditory	No Strategy	3
	Auditory & Visual	3
	Auditory, Visual & Semantic	3
	Semantic	2
	Auditory, Kinesthetic & Semantic	1
	Auditory & Semantic	1

Swassing-Barbe Modality Index and Memory Strategies

Sensory modality strength was determined using two measures: the *Swassing-Barbe Modality Index (SBMI)* (Swassing & Barbe, 1979) and the *Visual Aural Read/Write Kinesthetic (VARK) Questionnaire* (Fleming, 2001). Based on the *SBMI*, individuals were placed into five groups (Group 1: Auditory; Group 2: Visual; Group 3: Kinesthetic; Group 4: Kinesthetic and Visual; Group 5: Auditory, Kinesthetic and Visual). Participants were grouped based upon which modality the participant scored highest (i.e. Visual, Auditory, or Kinesthetic). If percentages for performance in each modality were equal or within one percentage point, they were placed in a separate group that included both or all three modalities (i.e. Kinesthetic & Visual or Auditory, Kinesthetic & Visual). No participants were placed in a Kinesthetic & Auditory group. Table 4 contains the *SBMI* sensory modality strength groups and number of participants in each group.

Table 4

Number of Participants in SBMI Sensory Modality Strength Groups

SBMI Group	*N*
Auditory	4
Kinesthetic	13
Visual	14
Kinesthetic & Visual	5
Auditory, Kinesthetic & Visual	4

Chi-square tests of independence were performed to examine the relationship between sensory modality strength as determined by the *SBMI* and strategies used to complete memory tasks. The chi-square tests indicated no significant association at the $p < .05$ level between *SBMI* sensory modality strengths and reported strategies used to complete the Categorical Fluency task, χ^2 (12, n = 40) = 11.93, p = .45; the Letter Naming task, χ^2 (24, n = 40) = 30.16, p = .18; the

RAVLT, χ^2 (32, *n* = 40) = 31.91, *p* = .47; Design Sequences-*DTLA-4*, χ^2 (16, *n* = 40) = 12.28, *p* = .73; and the Story Retell Immediate and Delayed-*ABCD*, χ^2 (32, *n* = 40) = 40.17, *p* = .15.

Visual Aural Read/Write Kinesthetic and Memory Strategies

After completion of the *VARK*, participants were placed into four groups based on the modality with the highest total of summed answers on the *VARK* questionnaire. If a participant's highest modality had the same number of answers as another modality (i.e., Visual, Auditory & Kinesthetic; Visual, Read/Write & Kinesthetic; Read/Write & Kinesthetic), they were placed into an "any combination" group. Table 5 contains the *VARK* sensory modality strength groups and number of participants in each group.

Table 5

Number of Participants in VARK Sensory Modality Strength Groups

VARK Group	*N*
Auditory	7
Read/Write	13
Kinesthetic	15
Any Combination	5

Chi-square tests of independence were performed to examine the relationship between sensory modality strength as determined by the *VARK* and strategies used to complete memory tasks. The chi-square tests indicated no significant association between *VARK* sensory modality strengths and reported strategies used to complete the Categorical Fluency task, χ^2 (9, *n* = 40) = 13.43, *p* = .14; the Letter Naming task, χ^2 (18, *n* = 40) = 22.36, *p* = .22; the *RAVLT*, χ^2 (24, *n* = 40) = 19.08, *p* = .75; and the Story Retell Immediate and Delayed-*ABCD*, χ^2 (24, *n* = 40) = 18.66, *p* = .77. The relationship between sensory modality strength as determined by the *VARK* and strategies used to complete the Design Sequences task from the *DTLA-4* was significant at the p < .05 level, χ^2 (12, *n* = 40) = 25.08, *p* = .01. Based on the observed percentages of the strategies used to complete the Design Sequences task, 100% of participants in the Auditory *VARK* group used only semantic strategies. Participants in other *VARK* groups used semantic strategies less than the auditory group (Read/Write, 15%; Kinesthetic, 27%; Any Combination, 0%). Table 6 contains the prevalence of strategy use among *VARK* sensory modality strength groups.

Table 6

Prevalence (%) of Strategy Use Among VARK Groups for the Design Sequences Task

	VARK Groups			
Strategies	Auditory	Read/Write	Kinesthetic	Combination
Semantic	100	15	27	0
Visual	0	15	0	20
Semantic & Auditory	0	31	47	20
Semantic & Visual	0	15	13	40
Semantic, Auditory & Visual	0	24	13	20

Sensory Modality Strength and Performance on Memory Tasks

Sensory modality strength, as determined by the *SBMI* (Barbe & Swassing, 1988) and *VARK* questionnaire (Fleming, 2001), was compared to performance on memory tasks to determine the relationship between sensory modality strength and performance on different types of memory tasks. One-way between groups analyses of variance (ANOVA) were conducted to explore the impact of sensory modality strength as measured by the *SBMI* and the *VARK* and performance on various memory tasks. Participants were divided into five groups according to their sensory modality strength determined by the *SBMI* (Group 1: Auditory; Group 2: Visual; Group 3: Kinesthetic; Group 4: Kinesthetic and Visual; Group 5: Auditory, Kinesthetic and Visual). Table 7 contains the means for performances on each memory task and *SBMI* groups. Table 8 contains the ANOVA for effects of sensory modality strength as determined by the *SBMI* on memory strategies for the five different memory tasks. Participants were divided into four groups according to their sensory modality strength determined by the *VARK* (Group 1: Auditory; Group 2: Read/Write; Group 3: Kinesthetic; Group 4: Any Combination). Table 9 contains the means for performances on each memory task and *SBMI* groups. Table 10 contains the ANOVA for effects of sensory modality strength as determined by the *SBMI* on memory strategies for the five different memory tasks.

Table 7

Performance on Memory Tasks and SBMI Sensory Modality Strength Groups

	Memory Task									
	TVCF CF		*TVCF* LN		*RAVLT*		*DTLA-4* DS		*ABCD* SR	
SBMI Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Auditory	66.25	21.27	38.00	7.83	61.25	23.59	126.25	19.05	28.00	3.92
Kinesthetic	74.85	15.72	43.54	14.03	68.46	18.31	125.54	16.83	27.92	5.38
Visual	72.93	12.59	37.86	10.83	71.00	17.96	133.86	11.74	28.07	5.90
Kinesthetic & Visual	88.60	12.36	50.40	11.57	79.80	12.99	140.20	2.58	29.60	2.07
Auditory Kinesthetic & Visual	64.25	9.78	39.75	6.18	68.00	16.51	130.50	21.88	27.50	1.73

Note. *TVCF* CF = *TVCF* Categorical Fluency; *TVCF* LN = *TVCF* Letter Naming; *DTLA-4* DS = *DTLA-4* Design Sequences; *ABCD* SR = *ABCD* Story Retell

Table 8

One-Way Analyses of Variance for Effects of SBMI Group on Memory Performance

Variable and source	*Df*	*SS*	*MS*	*F*
TVCF Categorical Fluency				
Between Groups	4	1711.65	427.91	2.06
Within Groups	35	7281.32	208.04	
TVCF Letter Naming				
Between Groups	4	697.08	174.27	1.29
Within Groups	35	4720.90	134.88	
RAVLT				
Between Groups	4	847.22	211.81	.65
Within Groups	35	11378.78	325.11	
DTLA-4 Design Sequences				
Between Groups	4	886.28	221.57	1.00
Within Groups	35	7745.50	221.30	
ABCD Story Retell				
Between Groups	4	13.05	3.26	.13
Within Groups	35	872.05	24.92	

Table 9

Performance on Memory Tasks and VARK Sensory Modality Strength Groups

	Memory Task									
	TVCF CF		*TVCF* LN		*RAVLT*		*DTLA-4* DS		*ABCD* SR	
VARK Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Auditory	80.29	5.71	41.86	8.76	80.43	12.74	138.71	11.63	29.86	2.91
Read/Write	75.85	16.04	43.69	12.19	70.46	14.48	133.38	11.52	28.38	1.08
Kinesthetic	70.80	16.48	41.73	11.25	64.00	20.83	126.27	18.45	26.93	6.49
Any Combination	69.80	18.34	34.40	16.47	72.20	18.25	129.6	12.54	28.80	2.05

Note. *TVCF* CF = *TVCF* Categorical Fluency; *TVCF* LN = *TVCF* Letter Naming; *DTLA-4* DS = *DTLA-4* Design Sequences; *ABCD* SR = *ABCD* Story Retell

Table 10

One-Way Analyses of Variance for Effects of VARK Group on Memory Performance

Variable and source	*Df*	*SS*	*MS*	*F*
TVCF Categorical Fluency				
Between Groups	3	562.65	187.55	.80
Within Groups	36	8430.32	234.18	
TVCF Letter Naming				
Between Groups	3	316.22	105.41	.74
Within Groups	36	5101.76	141.72	
RAVLT				
Between Groups	3	1328.26	442.75	.24
Within Groups	36	10897.75	302.72	
DTLA-4 Design Sequences				
Between Groups	3	835.14	278.38	1.29
Within Groups	36	7796.64	216.57	
ABCD Story Retell				
Between Groups	3	45.43	15.14	.65
Within Groups	36	839.67	23.32	

Participant's scores on the *TVCF's* Categorical Fluency and Letter Naming tasks were calculated by totaling the number of responses given for each appropriately named item. The *TVCF* manual provides severity ratings based on total responses for each subtest. Participants' severity ratings were calculated for both the Categorical Fluency and the Letter Naming subtests of the *TVCF*. There were no significant differences at the $p < .05$ level between *SBMI* groups and the Categorical Fluency task, *F* (4, 40) = 2.06, p = .11 and the Letter Naming task, *F* (4, 40) = 1.29, p = .29. Also, there were no significant differences at the p < .05 level between *VARK* groups and the Categorical Fluency task, *F* (3, 40) = .80, *p* = .50 and the Letter Naming task, *F* (3, 40) = .74, *p* = .53.

For the *RAVLT*, participants' total number of recalled words from the list of words for Trials I-VI was reported. There was not a significant difference at the p < .05 level between *SBMI* groups and the *RAVLT*, *F* (4, 40) = .65, *p* = .63. Also, there was no significant difference at the p < .05 level for *VARK* groups and the *RAVLT*, *F* (3, 40) = 1.46, *p* = .24.

Participants' scores for the *DTLA-4*'s Design Sequences task were calculated by totaling all of the correctly placed designs in all twelve sequences. There was not a significant difference between *SBMI* groups and the *DTLA-4*'s Design Sequences task, *F* (4, 40) = 1.00, *p* = .42. No significant difference was found between *VARK* groups and the *DTLA-4*'s Design Sequences task, *F* (3, 40) = 1.29, *p* = .29.

Performance on the Story Retell Immediate and Delayed task of the *ABCD* was calculated by summing the totals of both the immediate and delayed portions of the task. There was not a significant difference between *SBMI* groups and the Story Retell Immediate and Delayed task of the *ABCD*, *F* (4, 40) = .131, *p* = .97. No significant difference was found between *VARK* groups and the Story Retell Immediate and Delayed task of the *ABCD*, *F* (3, 40) = .65, *p* = .59.

Memory Strategies and Performance on Memory Tasks

One-way between groups analyses of variance (ANOVA) were conducted to explore the impact of reported use of memory strategies and performance on various memory tasks. There were no significant differences at the p < .05 level in memory strategies groups and the following task performance scores: Categorical Fluency task, F (3, 40) = .96, p = .42; Design Sequences-*DTLA-4*, F (4, 40) = .50, p = .74; and the Story Retell Immediate and Delayed-*ABCD*, F (8, 40) = 1.36, p = .25. There were significant differences at the $p < .05$ level in memory strategies groups and the Letter Naming task, F (6, 40) = 2.74, p = .03; and the *RAVLT*, F (7, 39) = 2.90, p = .02. For the Letter Naming task, post-hoc testing comparisons using the Tukey HSD test indicated that the mean score for participants who reported only auditory strategies was significantly higher than the mean scores for participants who reported no strategy and participants who reported only visual strategies. For the *RAVLT*, post-hoc testing comparisons using the Tukey HSD test indicated that the mean score for participants who reported a combination of visual and semantic strategies was significantly higher than participants who reported only visual strategies. The one participant who reported “No Strategy” for the *RAVLT* was excluded from the one-way ANOVA comparing the strategies and performance on this test. Table 11 contains performance means on each memory task and the memory strategies reportedly used to complete each task. Table 12 contains the ANOVA for effects of memory strategies on performance on each of the five different memory tasks.

Table 11

Performance on Memory Tasks and Memory Strategy Groups

	Memory Task									
Strategy	*TVCF* CF		*TVCF* LN		*RAVLT*		*DTLA-4* DS		*ABCD* SR	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
No Strategy	81.00	9.17	35.00	9.79					27.33	3.51
Auditory			55.20	14.13	67.80	13.53			22.50	8.06
Kinesthetic										
Visual	72.23	16.89	31.83	8.79	41.50	12.02	123.67	17.21	28.86	3.88
Semantic	66.33	12.58	41.20	8.87	68.67	6.35	135.54	11.54	26.00	2.83
Auditory & Semantic			42.90	12.48	62.29	23.94	129.75	17.55	32.00	-
Auditory & Visual			42.50	4.95	63.00	22.63			27.33	5.77
Semantic & Visual	76.61	15.24	43.67	6.47	95.50	3.54	130.17	17.20	30.67	3.20
Semantic Visual & Auditory					77.90	11.87	129.33	14.90	26.33	6.43
Auditory Kinesthetic & Semantic									29.00	-
Auditory Kinesthetic Visual & Semantic					83.67	4.62				

Note. *TVCF* CF = *TVCF* Categorical Fluency; *TVCF* LN = *TVCF* Letter Naming; *DTLA-4* DS = *DTLA-4* Design Sequences; *ABCD* SR = *ABCD* Story Retell

Table 12

One-Way Analyses of Variance for Effects of Memory Strategies on Memory Performance

Variable and source	*df*	*SS*	*MS*	*F*
TVCF Categorical Fluency				
Between Groups	3	663.06	221.02	.96
Within Groups	36	8329.92	231.39	
TVCF Letter Naming				
Between Groups	6	1802.81	300.47	2.74*
Within Groups	33	3615.17	109.55	
RAVLT				
Between Groups	4	5077.74	634.72	2.75*
Within Groups	35	7148.26	230.59	
DTLA-4 Design Sequences				
Between Groups	4	467.46	116.87	.50
Within Groups	35	8164.31	233.27	
ABCD Story Retell				
Between Groups	4	230.39	28.80	1.36
Within Groups	35	654.71	21.12	

*$p < .05$.

Sensory Modality Strength and Age, Gender, Education and Occupation

Age

Participants were grouped into four groups based on age (Group 1: 21-35; Group 2: 36-50; Group 3: 51-65; Group 4: 66-90). There were ten participants in each of the four age groups. Participants were divided into five groups according to their sensory modality strength determined by the *SBMI* (Group 1: Auditory; Group 2: Visual; Group 3: Kinesthetic; Group 4: Kinesthetic and Visual; Group 5: Auditory, Kinesthetic and Visual). A chi-square test of independence was performed to examine the relationship between sensory modality strength as determined by the *SBMI* and age. The chi-square test for independence indicated no significant association between sensory modality strength as determined by the *SBMI* and age, χ^2 (12, n = 40) = 13.52, p = .33.

Chi-square tests of independence were performed to examine the relationship between sensory modality strength as determined by the *VARK* and age. Participants were divided into four groups according to their sensory modality strength determined by the *VARK* (Group 1: Auditory; Group 2: Read/Write; Group 3: Kinesthetic; Group 4: Any Combination). The chi-square test for independence indicated no significant association between sensory modality strength as determined by the *VARK* and age, χ^2 (9, n = 40) = 3.22, p = .96.

Gender

There was an equal number of participants of each gender (20 males, 20 females). Participants were divided into five groups according to their sensory modality strength determined by the *SBMI* (Group 1: Auditory; Group 2: Visual; Group 3: Kinesthetic; Group 4: Kinesthetic and Visual; Group 5: Auditory, Kinesthetic and Visual). A chi-square test of independence was performed to examine the relationship between sensory modality strength as determined by the *SBMI* and gender. The chi-square test for independence indicated no significant association between sensory modality strength as determined by the *SBMI* and gender, χ^2 (4, n = 40) = 4.01, p = .41.

A chi-square test of independence was performed to examine the relationship between sensory modality strength as determined by the *VARK* and gender. Participants were divided into four groups according to their sensory modality strength determined by the *VARK* (Group 1: Auditory; Group 2: Read/Write; Group 3: Kinesthetic; Group 4: Any Combination). The chi-square test for independence indicated no significant association between sensory modality strength as determined by the *VARK* and gender, χ^2 (3, n = 40) = 5.90, p = .12.

Education

Participants self-reported their highest level of education by selecting from the following options: high school, some college, bachelor degree, some graduate school, graduate degree and post graduate. Table 13 contains the highest education level groups and the number of participants in each group.

Table 13

Number of Participants in Highest Education Level Groups

Education	*N*
High School	6
Some College	11
Bachelor Degree	9
Some Graduate School	9
Graduate Degree	4
Post Graduate	1

A chi-square test of independence was performed to examine the relationship between sensory modality strength as determined by the *SBMI* and education. The chi-square test for independence indicated no significant association between sensory modality strength as determined by the *SBMI* and education, χ^2 (20, n = 40) = 21.02, p = .40.

A chi-square test of independence was performed to examine the relationship between sensory modality strength as determined by the *VARK* and education. The chi-square test for independence indicated no significant association between sensory modality strength as determined by the *VARK* and education, χ^2 (15, n = 40) = 18.21, p = .25.

Occupation

Participants were asked the question "What is/was your occupation." Participant responses were then categorized into nine job classifications based on the United States' Equal Employment Opportunity Commission's *EEO-1 Job Classification Guide* (2006). This guide classifies occupations into nine categories (1: Officials and Managers; 2: Professionals; 3: Technicians; 4: Sales Workers; 5: Administrative Support Workers; 6: Craft Workers; 7: Operatives; 8: Laborers and Helpers; 9: Service Workers). No participant's reported occupation was classified as Technician, Operative or Laborer and Helper. Table 14 contains the nine occupation classifications and number of participants in each classification.

Table 14

Number of Participants in the Nine Occupation Classifications

Classification	*N*
Officials and Managers	1
Professionals	14
Technicians	0
Sales Workers	5
Adminstrative Support Workers	5
Craft Workers	7
Operatives	0
Laborers and Helpers	0
Service Workers	8

A chi-square test of independence was performed to examine the relationship between sensory modality strength as determined by the *SBMI* and occupation. Participants were divided into five groups according to their sensory modality strength determined by the *SBMI* (Group 1: Auditory; Group 2: Visual; Group 3: Kinesthetic; Group 4: Kinesthetic and Visual; Group 5: Auditory, Kinesthetic and Visual). The chi-square test for independence indicated no significant association between sensory modality strength as determined by the *SBMI* and occupation, χ^2 (20, n = 40) = 17.02, p = .65.

A chi-square test of independence was performed to examine the relationship between sensory modality strength as determined by the *VARK* and occupation. Participants were divided into four groups according to their sensory modality strength determined by the *VARK* (Group 1: Auditory; Group 2: Read/Write; Group 3: Kinesthetic; Group 4: Any Combination). The chi-square test for independence indicated a significant association between sensory modality strength as determined by the *VARK* and occupation, χ^2 (15, n = 40) = 27.18, p = .03. From the Auditory *VARK* group, more participants were Service Workers (71%) than other occupations. In the Kinesthetic *VARK* group, more participants were Professionals (47%) than other occupations.

From the Combination *VARK* group, more participants were Professionals (80%) than other occupations. Table 15 contains the prevalence of occupation groups and *VARK* sensory modality strength groups.

Table 15

Prevalence (%) of Occupation and VARK Sensory Modality Strength Groups

Occupation	*VARK* Groups			
	Auditory	Read/Write	Kinesthetic	Combination
Officials & Managers	0	8	0	0
Professionals	0	23	47	80
Sales Workers	14	8	13	20
Administrative Support Workers	0	30	7	0
Craft Workers	14	23	20	0
Service Workers	71	8	13	0

Memory Performance and Age, Gender, Education and Occupation

Reported demographics such as age, gender, highest education level achieved and occupation were compared with performance on memory tasks to determine if any differences exist between different groups of participants based on individual differences.

Age

One-way analyses of variance (ANOVA) were performed to examine the relationship between performance on each memory task and age (Group 1: 21-35; Group 2: 36-50; Group 3: 51-65; Group 4: 66-90). There were no significant differences at the $p < .05$ level in age groups and performance on the Categorical Fluency task, F (3, 40) = 2.19, p = .11 and the *RAVLT*, F (3,

40) = 2.44, *p* = .08. Significant differences were found at the p < .05 level for the following tasks: the Letter Naming task, *F* (3, 40) = 3.03, *p* = .04; Design Sequences-*DTLA-4*, *F* (3, 40) = 5.95, *p* = .00; and the Story Retell Immediate and Delayed-*ABCD*, *F* (3, 40) = 5.52, *p* = .00. For the Letter Naming task, post-hoc testing comparisons using the Tukey HSD test indicated that the mean score for Group 1 (21-35) was significantly different from Group 4 (66-90); Group 1 performed significantly better than Group 4. For the Design Sequences task, post-hoc testing comparisons using the Tukey HSD test indicated that the mean scores for Group 1 (21-35) and Group 2 (36-50) were significantly different from Group 4 (66-90); Group 1 and Group 2 performed significantly better than Group 4. For the Story Retell Immediate and Delayed task, post-hoc testing comparisons using the Tukey HSD test indicated that the mean scores for Group 1 (21-35), Group 2 (36-50) and Group 3 (51-65) were significantly different from Group 4 (66-90); Group 1, Group 2 and Group 3 performed significantly better than Group 4. Table 16 contains means for performances on memory tasks and age groups. Table 17 contains the ANOVA for effects of age on performance on each of the five different memory tasks.

Table 16

Performance on Memory Tasks and Age Groups

	Memory Task									
	TVCF CF		*TVCF* LN		*RAVLT*		*DTLA-4* DS		*ABCD* SR	
Age Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
21-35	79.30	15.04	47.00	10.30	77.80	15.85	141.10	5.28	29.80	2.62
36-50	76.70	17.44	46.10	11.28	73.70	17.25	134.10	11.24	28.70	4.19
51-65	75.90	12.32	38.10	12.81	70.00	15.94	131.70	10.45	30.40	4.09
66 and older	64.00	12.75	34.70	9.13	58.50	18.05	117.80	19.44	23.70	5.12

Note. *TVCF* CF = *TVCF* Categorical Fluency; *TVCF* LN = *TVCF* Letter Naming; *DTLA-4* DS = *DTLA-4* Design Sequences; *ABCD* SR = *ABCD* Story Retell

Table 17

One-Way Analyses of Variance for Effects of Age on Memory Performance

Variable and source	*df*	*SS*	*MS*	*F*
TVCF Categorical Fluency				
Between Groups	3	1389.88	463.29	2.19
Within Groups	36	7603.10	211.20	
TVCF Letter Naming				
Between Groups	3	1092.08	364.03	3.03*
Within Groups	36	4325.90	120.16	
RAVLT				
Between Groups	3	2067.80	689.27	2.44
Within Groups	36	10158.20	282.17	
DTLA-4 Design Sequences				
Between Groups	3	2862.28	954.09	5.95**
Within Groups	36	5769.50	160.26	
ABCD Story Retell				
Between Groups	3	278.90	92.97	5.52**
Within Groups	36	606.20	16.84	

*$p < .05$. **$p < .001$

Gender

One-way analyses of variance (ANOVA) were performed to examine the relationship between performance on each memory task and gender. There were no significant differences at the $p < .05$ level in gender groups and any task performance scores: Categorical Fluency task, *F* (1, 40) = 1.16, *p* = .30; the Letter Naming task, *F* (1, 40) = 2.66, *p* = .11; the *RAVLT*, *F* (1, 40) = 3.77, *p* = .06; Design Sequences-*DTLA-4*, *F* (1, 40) = 1.35, *p* = .25; and the Story Retell Immediate and Delayed-*ABCD*, *F* (1, 40) = 1.99, *p* = .17. Table 18 contains the means for performances on each of the memory tasks for gender. Table 19 contains the ANOVA for effects of gender on performance on each of the five different memory tasks.

Table 18

Performance on Memory Tasks and Gender

	Memory Task									
	TVCF CF		*TVCF* LN		*RAVLT*		*DTLA-4* DS		*ABCD* SR	
Gender	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Female	76.55	13.66	44.45	10.51	75.25	14.64	133.90	11.35	29.20	4.76
Male	71.40	16.52	38.50	12.50	64.75	19.27	128.45	16.61	27.10	5.21

Note. *TVCF* CF = *TVCF* Categorical Fluency; *TVCF* LN = *TVCF* Letter Naming; *DTLA-4* DS = *DTLA-4* Design Sequences; *ABCD* SR = *ABCD* Story Retell

Table 19

One-Way Analyses of Variance for Effects of Gender on Memory Performance

Variable and source	*df*	*SS*	*MS*	*F*
TVCF Categorical Fluency				
Between Groups	1	265.23	265.23	1.16
Within Groups	38	8727.75	229.68	
TVCF Letter Naming				
Between Groups	1	354.03	354.03	2.66
Within Groups	38	5063.95	133.26	
RAVLT				
Between Groups	1	1102.50	1102.50	3.77
Within Groups	38	11123.50	292.72	
DTLA-4 Design Sequences				
Between Groups	1	297.03	297.03	1.35
Within Groups	38	8334.75	219.34	
ABCD Story Retell				
Between Groups	1	44.10	44.10	1.99
Within Groups	38	841.00	22.13	

Education

One-way analyses of variance (ANOVA) were performed to examine the relationship between performance on each memory task and education. There were no significant differences at the $p < .05$ level in education groups and any task performance scores: Categorical Fluency task, F (5, 40) = 1.27, p = .30; the Letter Naming task, F (5, 40) = .49, p = .78; the *RAVLT*, F (5,

40) = 1.27, *p* = .30; Design Sequences-*DTLA-4*, *F* (5, 40) = .76, *p* = .59; and the Story Retell Immediate and Delayed-*ABCD*, *F* (5, 40) = .43, *p* = .82. Table 20 contains means for performances on memory tasks and education levels. Table 21 contains the ANOVA for effects of education on performance on each of the five different memory tasks.

Table 20

Performance on Memory Tasks and Highest Education Level Groups

	Memory Task									
	TVCF CF		*TVCF* LN		*RAVLT*		*DTLA-4* DS		*ABCD* SR	
Education Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
High School	63.50	13.13	37.00	11.03	67.00	13.51	127.83	11.99	27.00	3.52
Some College	75.18	13.98	40.18	9.93	70.64	20.83	125.09	22.87	27.73	4.86
Bachelor Degree	75.78	13.51	42.33	13.17	59.89	16.65	135.00	7.57	27.78	7.50
Some Graduate School	80.67	15.80	45.00	8.63	77.78	12.95	136.00	9.03	28.22	2.99
Graduate Degree	65.75	20.87	39.50	22.19	73.25	22.28	131.75	15.37	30.75	2.06
Post Graduate	80.00		51.00		89.00		138.00		32.00	

Note. *TVCF* CF = *TVCF* Categorical Fluency; *TVCF* LN = *TVCF* Letter Naming; *DTLA-4* DS = *DTLA-4* Design Sequences; *ABCD* SR = *ABCD* Story Retell

Table 21

One-Way Analyses of Variance for Effects of Education on Memory Performance

Variable and source	*df*	*SS*	*MS*	*F*
TVCF Categorical Fluency				
Between Groups	5	1413.53	282.71	1.27
Within Groups	34	7579.44	222.93	
TVCF Letter Naming				
Between Groups	5	363.34	72.67	.49
Within Groups	34	5054.64	148.67	
RAVLT				
Between Groups	5	1926.26	385.25	1.27
Within Groups	34	10299.74	302.93	
DTLA-4 Design Sequences				
Between Groups	5	863.28	172.66	.76
Within Groups	34	7768.49	228.49	
ABCD Story Retell				
Between Groups	5	53.06	10.61	.43
Within Groups	34	832.04	24.47	

Occupation

One-way analyses of variance (ANOVA) were performed to examine the relationship between performance on each memory task and occupation. There were no significant differences at the $p < .05$ level in occupation groups and any task performance scores: Categorical Fluency task, F (5, 40) = .31, p = .90; the Letter Naming task, F (5, 40) = 1.04, p =

.41; the *RAVLT*, *F* (5, 40) = .98, *p* = .45; Design Sequences-*DTLA-4*, *F* (5, 40) = .48, *p* = .79; and the Story Retell Immediate and Delayed-*ABCD*, *F* (5, 40) = .95, *p* = .46. Table 22 contains means for performance on memory tasks by occupation classification. Table 23 contains the ANOVA for effects of occupation on performance on each of the five different memory tasks.

Table 22

Performance on Memory Tasks and Occupation

	Memory Task									
	TVCF CF		*TVCF* LN		*RAVLT*		*DTLA-4* DS		*ABCD* SR	
Occupation	*M*	*SD*	*M*	*SD*	*M*	*M*	*SD*	*M*	*SD*	*M*
Officials & Managers	75.00	-	44.00	-	59.00	-	117.00	-	34.00	-
Professionals	74.57	15.57	41.50	12.76	70.21	20.87	131.64	12.56	27.64	6.10
Sales Workers	67.40	18.42	31.20	9.94	56.40	19.26	126.80	26.03	25.60	4.22
Administrative Support Workers	70.60	18.04	40.80	14.36	72.00	14.28	134.60	9.84	28.40	3.65
Craft Workers	77.43	18.73	44.57	12.25	70.71	14.30	128.14	17.01	27.57	3.82
Service Workers	76.00	9.89	45.25	8.14	77.63	14.64	135.38	13.02	30.25	3.41

Note. *TVCF* CF = *TVCF* Categorical Fluency; *TVCF* LN = *TVCF* Letter Naming; *DTLA-4* DS = *DTLA-4* Design Sequences; *ABCD* SR = *ABCD* Story Retell

Table 23

One-Way Analyses of Variance for Effects of Occupation on Memory Performance

Variable and source	*df*	*SS*	*MS*	*F*
TVCF Categorical Fluency				
Between Groups	5	395.43	79.09	.31
Within Groups	34	8597.54	252.87	
TVCF Letter Naming				
Between Groups	5	717.66	143.53	1.04
Within Groups	34	4700.31	138.25	
RAVLT				
Between Groups	5	1535.14	307.03	.98
Within Groups	34	10690.86	314.44	
DTLA-4 Design Sequences				
Between Groups	5	563.83	112.77	.48
Within Groups	34	8067.95	237.29	
ABCD Story Retell				
Between Groups	5	108.27	21.65	.95
Within Groups	34	776.83	22.85	

Relationships Between Tests

A chi-square test for independence examined the relationship between the *TVCF* severity ratings for two of its subtests: the Categorical Fluency and Letter Naming subtests. The chi-square test for independence indicated a significant association between the severity ratings of the two subtests of the *TVCF*, χ^2 (20, n = 40) = 52.05, p = .00. Table 24 contains the prevalence of severity ratings of the *TVCF*'s Categorical Fluency and Letter Naming tasks.

Table 24

Prevalence (%) of TVCF's Categorical Fluency and Letter Naming Severity Ratings

	Categorical Fluency Rating				
Letter Naming Rating	MMI	BA	A	HA	S
MMI	100	9	0	0	0
BA	0	27	33	0	0
A	0	64	66	14	66
HA	0	0	0	57	33
S	0	0	0	14	0
VA	0	0	0	14	0

Note. MMI = Mildly to Moderately Impaired; BA = Below Average; A = Average; HA = High Average; S = Superior; VS = Very Superior

A chi-square test for independence was performed to examine the relation between sensory modality strength as determined by the *SBMI* and sensory modality strength as determine by the *VARK*. The chi-square test for independence did not indicate a significant relationship between sensory modality strengths as determined by the *SBMI* and the *VARK*, χ^2 (12, n = 40) = 9.48, p = .66.

CHAPTER V

DISCUSSION

This study examined relationships between sensory modality strengths and strategies used to complete memory tasks. Also, this study examined relationships between performance on memory tasks and sensory modality strength; performance on memory tasks and the strategies used to complete each task; sensory modality strengths and age, gender, education and occupation; performance on memory tasks and age, gender, education and occupation; and relationships between tests. This chapter provides an interpretation of the results, limitations of the study and future directions for research.

Interpretation of Results

Sensory Modality Strength and Memory Strategies

Memory strategies reported by participants changed for each memory task (Table 3). This finding relates to research from Pressley and El-Dinary (1992) stating that proficient thinkers implement a variety of strategies to accomplish an assortment of activities. Also, this finding is consistent with research indicating that the use of strategies varies from situation to situation (Reder, 1988).

For the Categorical Fluency task from the *Test of Verbal Conceptualization and Fluency (TVCF)* (Reynolds & Horton, 2006), a majority of participants reported either semantic and visual strategies or visual strategies. This subtest from the *TVCF* is focused on naming items in a category. Semantic and visual strategies are expected for this type of task as participants generated items within a category. As expected, more participants used a combination of semantic and auditory strategies to complete the Letter Naming task from the *TVCF* (Reynolds & Horton, 2006). For the *Rey Auditory Verbal Learning Test (RAVLT)* (Schmidt, 1996) half of the participants used either a combination of semantic, visual and auditory strategies or only an auditory strategy. A majority of the participants used only semantic or a combination of semantic and auditory strategies to complete the Design Sequences task from the *Detroit Test of Learning Aptitude (DTLA-4)* (Hammill, 1998). Although this was a visual and kinesthetic task, many participants named the shapes and repeated them, making the task an auditory and semantic task. Interestingly, for the Story Retell Immediate and Delayed components of the *Arizona Battery for Communication Disorders of Dementia (ABCD)* (Bayles & Tomoeda, 1993), the highest reported memory strategies were either only visual or a combination of visual and semantic strategies. Although the story was presented auditorily, many participants reported visualizing the story instead of using an auditory strategy to remember the story.

According to participants' performance on the *Swassing-Barbe Modality Index (SBMI)* (Swassing & Barbe, 1979), 14 of 40 participants' sensory modality strengths were visual and 13 of 40 participants' sensory modality strengths were kinesthetic. According to the *Visual Aural Read/Write Kinesthetic (VARK) Questionnaire* (Fleming, 2001), no participants had a visual sensory modality strength. However, the *VARK* includes an additional sensory modality: Read/Write (Fleming, 2001). On the *VARK*, 15 of 40 participants were highest kinesthetically and 13 of 40 were highest in the read/write category.

Only one significant relationship between sensory modality strength and memory strategies was found. On the Design Sequences subtest of the *DTLA-4*, all participants in the Auditory *VARK* group used only semantic strategies. This may suggest that there is a relationship between sensory modality strength and memory strategies. However, no expected relationships (Auditory *VARK* group used auditory strategies, etc.) existed for the *DTLA-4* or any other memory tasks. Only one of ten comparisons (*SBMI* and five memory tasks, *VARK* and five memory tasks) of sensory modality strength and memory strategies revealed a significant relationship. This relationship could be accounted for by the lack of reliability of sensory modality strength assessments and issues with measures reliant upon self-report such as memory strategies.

According to all other memory strategy comparisons and sensory modality strength information, participants' reported memory strategies are not related to their sensory modality strength as determined by the *SBMI* and *VARK*. Each individual participant used different strategies to complete the various memory tasks. Participants were not consistent in the type of strategy used between memory tasks or in using strategies related to the nature of the memory tasks.

The results of this study indicate that typical adults employ a variety of memory strategies for different memory tasks unrelated to the type of memory task, their personal sensory modality preferences or success with the strategy. As the results of this study indicate, there is no method for identifying when an adult will use a particular memory strategy. This finding is consistent with research suggesting that when retraining memory strategies that it is important to teach when to use a strategy (Pressley & El-Dinary, 1992). It is important when retraining memory strategies in adults to understand that each person chooses strategies individually unrelated to personal learning preferences or factors related to memory tasks.

It is evident from this study that adults rely on a variety of memory strategies and use them without considering the nature of the memory task, how they prefer to learn or how successful the strategy was for him or her in the past. Speech-language pathologists and other professionals who provide services to individuals with memory problems should consider teaching multiple memory strategies for many different memory tasks in various settings. Many teachers teach in their sensory modality strength because it comes naturally (Sprenger, 2003). It is important for professionals to be aware of their personal sensory modality strengths and their client's strengths so that information can be taught in all sensory modalities. It can also be beneficial for these professionals to understand the types of memory strategies they prefer so that they teach not only those strategies, but a variety of strategies.

It has been proven that decisions about strategies take very little short-term memory capacity (Devolder & Pressley, 1989). By training many different strategies, these professionals can provide their clients with the ability to employ various strategies for different memory tasks in multiple situations similar to how typical adults use memory strategies. Because learned memory strategies are often not generalized into everyday situations (Pressley & El-Dinary, 1992; Sohlberg & Mateer, 1989), it is important to practice these strategies. By providing clients with a selection of memory strategies they may gain the subconscious or conscious ability to implement those strategies in various situations like their adult peers without memory impairments.

Sensory Modality Strength and Performance on Memory Tasks

Participants were placed into groups based on the sensory modality strength they scored highest on for the *SBMI* and the *VARK*. No sensory modality group as determined by the *SBMI* or *VARK* was significantly different from the other groups in performance on memory tasks. For a primarily auditory task such as the *RAVLT*, participants who were determined auditory learners did not perform significantly better than participants in other groups on that task. As a whole, participants in the Kinesthetic and Visual group from the *SBMI* performed better on all memory tasks. According to sensory modality strength groups from the *VARK* and performance on memory tasks, the participants in the Auditory group performed highest on all but one task.

The results of this study conflict with previous research suggesting that a dominant modality is the way in which an individual processes information most efficiently (Barbe & Swassing, 1988; Fleming, 2001; Lisle, 2007). Individuals do not necessarily perform best when information is presented in their sensory modality strength. In fact, participants in this study who performed well on one memory task typically performed well on all memory tasks. Also, participants who did not perform well on one memory task typically did not perform well on all memory tasks. This suggests that performance is impacted by memory strategies or by simply higher memory abilities in some individuals for all memory tasks.

Another possible explanation to this finding is that individuals who are very efficient in their sensory modality strength are able to use their efficiency in their modality strength and change the nature of the task to suit their sensory modality strength. For example, a participant who is very efficient visually may create an image in his or her mind to remember auditory information. This explanation would be consistent with research regarding sensory modality strengths (Barbe & Swassing, 1988; Fleming, 2001). However, results regarding memory strategies and performance on memory tasks do not suggest that this is the case.

Memory Strategies and Performance on Memory Tasks

Participants reported the strategies used to complete the memory tasks and these strategies were categorized based on the type of strategy: visual, auditory, kinesthetic or semantic. Research has revealed that individuals who use strategies perform better on memory tasks when compared to those who do not use strategies (Dunlosky & Kane, 2007; Eagle, 1967). Findings in this study are inconsistent with previous research; no trend was evident regarding memory strategies and performance on tasks. Participants who reported using no memory strategies did not perform significantly lower than participants who reported various memory strategies. Interestingly, on the Categorical Fluency subtest of the *TVCF*, participants who reported "no strategy" performed higher than participants using any other strategies or combination of strategies (Table 11). Although these findings are inconsistent with previous research, it is important to note that reporting memory strategies requires metacognition. The participants who reported "no strategy" may not have been consciously aware of the strategies they used to complete the tasks (Bostrom & Lassen, 2006; Oxley & Norris, 2000; Pressley & El-Dinary, 1992).

For the Categorical Fluency subtest of the *TVCF*, the Design Sequences subtest of the *DTLA-4* and the Story Retell subtest of the *ABCD*, type of strategy did not impact performance on the tasks. For the Letter Naming subtest of the *TVCF*, participants who only used auditory strategies performed significantly better than participants who reported using only visual strategies. This would be expected for a task like the Letter Naming task, as participants with a strategy manipulating sounds in words would produce more words starting with a sound versus participants who simply tried to visualize objects beginning with that sound. For the *RAVLT*, participants who used a combination of visual and semantic strategies performed significantly higher on the task than participants who used only a visual strategy. There are many strategies possible for a task such as the *RAVLT* but it is not surprising that a strategy that incorporates semantic information would be easier to recall.

Sensory Modality Strength and Age, Gender, Education and Occupation

There were no significant relationships between age, gender, education and occupation and sensory modality strength as determined by the *SBMI* and the *VARK*. Twenty-three of 40 participants were either placed in a visual group or a group with a combination of visual and other modalities. As our society becomes more technological, it would be expected for more individuals to have a stronger visual sensory modality because current technology is predominantly visual (e.g. computers, videos, text messaging on cell phones). According to the *VARK*, most participants were kinesthetic. Eight of 10 participants in the youngest age group (ages 21 to 35) were placed in the Visual, Kinesthetic & Visual or Auditory, Kinesthetic & Visual groups based on their scores from the *SBMI*. As our society becomes more advanced technologically, it would be expected that individuals would prefer information presented visually as it is presented in many ways throughout our culture. Three young male participants noted to the examiner that they play video games. These participants also performed well on all memory tasks, especially on visual and kinesthetic tasks like the Design Sequences task. It is not surprising that individuals who play video games and have done so for years performed better on visual and kinesthetic components of the assessments.

The *SBMI* presents a sequence of four shapes with increasing length and difficulty first visually, then auditorily and lastly kinesthetically. The *SBMI* uses the same sequences for the visual test, the auditory test and the kinesthetic test. The only participants who mentioned that they noticed the sequences were the same young males in the kinesthetic and visual group. These three participants mentioned that they remembered the sequences for the kinesthetic part of the *SBMI* from the visual part of the test. They reported remembering the visual part, which aided them in completing the kinesthetic part of the *SBMI*. However, they did not perform better on the auditory component of the *SBMI* even though the sequences were the same for all three sections of the *SBMI*. In fact, their performances on the auditory portion of the *SBMI* were much lower than on the visual and kinesthetic parts. These participants used their visual memory to perform better on the kinesthetic part of the test but did not use their visual memory for the auditory part.

There was a significant correlation between occupation and *VARK* sensory modality strength. A high percentage (71%) of individuals in the Auditory group were Service Workers. This finding suggests that these individuals deal with primarily auditory information or that they chose their profession because they do not prefer visual information. Many Service Workers (e.g. Security Guards, Counter Attendants, Waiters, Janitors) do not use technology as often as other occupations would. As previously stated, technology is predominantly visual.

Another significant correlation between occupation and *VARK* sensory modality strength was found with participants in the Combination group. Eighty percent of participants in the Combination group were Professionals. This is consistent with previous research suggesting that individuals who have success in school have multiple sensory modality strengths (Fleming, 2001). Individuals who are classified as Professionals (e.g., Accountants, Dentists, Psychologists, Teachers) are in their profession because they have completed higher education.

Memory Performance and Age, Gender, Education and Occupation

There were no significant differences between gender, education and occupation and performance on memory tasks. Gender was not significantly related to performance on memory tasks. However, as a group, the female participants performed better than the male participants on all memory tasks. Results regarding occupation revealed no consistent, noticeable differences in performances among different occupations.

Although not significant, when examining the results regarding highest education level and performance on memory tasks, a trend is evident. The post graduate, some graduate school or graduate degree education groups were consistently the highest groups according to mean performance. Participants in the some college and bachelor degree groups were consistently either third, fourth, or fifth place in highest performance to lowest performance. The high school group placed sixth in a ranking of the performance on three of five tests and fifth place on the two remaining tests. It is important to note that there was only one participant in the post graduate group. This difference in performance for participants in different education groups could be due to more exposure to and practice with memory tasks throughout higher education. Also, participants who achieved higher education levels may already have had success with memory, making them comfortable with memory tasks and good candidates for higher education.

There were significant differences between age and performance on the memory tasks. The results of this study suggest that younger adults perform better on memory tasks than older adults. Even with results that were not significant, a clear trend in the data revealed that the oldest group had the lowest mean scores on all memory tasks. On almost all tests, the trend started with the youngest group with the highest means, followed by the middle-aged group and the older middle-aged group. The group with the lowest means was the oldest group on all memory tasks.

The differences between the groups suggest that participants in the oldest group may not use effective strategies, are not able to perform as well as younger individuals or have not had recent practice with memory tasks due to retirement from their occupation or other factors. The suggestion that participants in the oldest group did not use effective strategies is consistent with previous research (Devolder and Pressley, 1992). However, no significant difference was found between memory strategies and age in this study. Individuals' abilities to complete memory tasks may decline with age. It is important to consider other factors such as retirement and length of time since attending school when examining performance of the oldest age group. Also, the time constraints of the tests may have made a difference in performance for the oldest age group. The participants used strategies and completed the memory tasks, but they may have performed better on the tasks if there were not strict time limits.

Relationships Between Tests

This study used the *SBMI* (Swassing & Barbe, 1979) because it did not rely on self-report and the *VARK* (Fleming, 2001) due to its supportive research. These tests each report that they determine sensory modality strength but results from each of the tests revealed no relationship between the tests. After completion of the assessments, the examiner discussed the participants' sensory modality strengths as determined by the *VARK* and the *SBMI*. Typically, participants agreed with their sensory modality strengths as determined by the *SBMI*. Participants did not often agree with their results from the *VARK*. Although the results from the *SBMI* were more accepted by participants, the *SBMI* does not provide any standardized measures from which to compare participant performance.

After completion of the *SBMI* a majority of participants were placed into either a Visual group or a group consisting of Visual with another modality (Kinesthetic & Visual or Auditory, Kinesthetic & Visual). However, no participants scored highest visually on the *VARK*. Also, participants in the *VARK*'s Auditory group scored highest on all but one of the memory tasks whereas the *SBMI*'s Kinesthetic and Visual group scored highest on all of the memory tasks. Results regarding the relationship between sensory modality strength as determined by the *VARK* and the *SBMI* and performance on each memory task indicate that the *SBMI* and the *VARK* are not comparable measures of sensory modality strength.

Limitations

A major limitation for this study is a lack of reliability of learning styles assessments. There is a limited number of learning styles assessments that examine sensory modality strength.

These assessments do not have strong research evidence to support their use and typically require self-report. The *SBMI* was chosen because it does not use self-report measures, it is hands-on and nonverbal. However, the *SBMI* has not been standardized. Changes to the *SBMI* may provide better results. For example, for each modality (visual, auditory and kinesthetic) participants are provided the same sequence. Because of this, examinees may remember the sequence from a previous modality. This does not provide an accurate outcome when examining through which modality the examinee performs best. Given these circumstances, it is difficult to determine sensory modality strength and its relationship to how a person memorizes information.

A limitation of comparing memory strategies and sensory modality strengths was that individuals in the Read/Write group according to the *VARK* were not able to use reading or writing memory strategies. These strategies would have been external and this study was examining internal strategies. Many individuals in the study asked to write down information for the memory tasks but this was not allowed. Although this is not a major limitation, it may have required individuals who use read or write strategies to use strategies they typically do not use.

Another limitation of the study is that memory strategies used were reliant upon self-report. The study was designed to provide participants with multiple opportunities for generation and recognition of possible memory strategies used throughout testing. This method for determining strategies used for memory tasks was based on research (Saczynski et. al, 2007). Reporting memory strategies requires metacognition and despite the implementation of measures to increase participants' knowledge of possible memory strategies, relying on self-report is a limitation. Participants often selected strategies when provided with a listing of strategies that they did not provide when asked to explain the strategies they used. This was consistent with previous research debating whether memory strategies are used consciously (Pressley & El-

Dinary, 1992; Howe & O'Sullivan, 1990; Saczynski et. al, 2007). It is evident that participants may be unaware of all of the strategies that they use for tasks as the strategies may be subconscious.

This study was aimed at providing information helpful for generalization of memory strategies in everyday situations for individuals with memory impairments. However, the assessments used examined memory in a controlled situation without much meaningful information (e.g., lists of words, unfamiliar designs, etc.). A limitation of this study was that the memory tasks available, and therefore used for this study, were not functional.

Future Directions

This study was limited in its number of participants. Although the participants were matched for age and gender, they were not matched for education and occupation. Further research using a larger sample of participants with better-matched participants based on education and occupation may provide more information. However, the same result may be found with a bigger sample size because memory strategies and sensory modality strengths are highly individualized, change over time, rely on self-report and require metacognition. A longitudinal study examining how memory strategies or sensory modality strengths change over time may provide revealing information about individual differences and memory. This could also provide information about younger and older adults and their abilities to learn new strategies. Future research could also examine the impact of teaching strategies with sensory modality strengths.

Further research is necessary to examine the type of memory strategies used and the impact those strategies have on performance of memory tasks. The results from this study suggest that there may be a relationship between the type of strategy used for tasks and the performance of that task. This study used a small sample, requiring further investigation of this research question.

Another future direction of this study could be to find or create more functional memory assessments. Assessments of memory often require individuals to recall information in a controlled situation that is not meaningful or functional for everyday living. Future research could use more functional memory assessments for a better understanding of the strategies used in everyday situations.

This study was limited in its identification of relationships between sensory modality strength and memory strategies, age, gender, education, and occupation because of the lack of reliable results provided by the sensory modality strength assessments. It would be helpful to find a sensory modality strength assessment for adults that does not rely on self-report (e.g., the *VARK)* and is valid and reliable. Individuals may not be aware of their actual sensory modality strengths so self-report may not be an adequate measure of sensory modality strength. If further researched and possibly changed, the *SBMI* may prove to be a respectable assessment of sensory modality strengths because it does not rely on self-report. Further research into sensory modality strengths and how to adequately assess them is required.

Conclusions

The results of this study indicate that typical adults employ a variety of memory strategies to complete memory tasks unrelated to how they learn best or if a memory task is presented visually, auditorily, or kinesthetically. Although information about how a person learns best is helpful, it may be best to provide information in a variety of modalities for any given individual.

This information can be useful for Speech-Language Pathologists and other professionals who work with individuals to improve memory. According to this study, such professionals should teach their clients a variety of memory strategies to use in different situations. Typical adults use a variety of memory strategies and combinations of memory strategies independent of the type of sensory modality strength they possess and the nature of the memory task. As a professional working with individuals with memory impairments, it may be necessary to teach many different memory strategies for clients to use to complete various memory tasks. By providing clients with a selection of memory strategies they may gain the subconscious or conscious ability to implement those strategies in various situations like their adult peers without memory impairments.

Age, gender, education and occupation do not have an effect on how a person learns best or his or her sensory modality strength. Memory strategies do have an impact on performance of memory tasks but this impact is not fully examined in this study. Performance on memory tasks is not related to sensory modality strength, gender, education or occupation. However, older adults (over age 65) do not perform as well as younger adults on all memory tasks. Keeping an active memory is very important after retirement.

Sensory modality strength and learning styles as a whole are difficult to assess. The two sensory modality strength assessments used in this study, the *SBMI* and the *VARK*, do not provide the same sensory modality strength information. There was no relationship between sensory modality strengths as determined by the *VARK* and the *SBMI*.

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APPENDICES

APPENDIX A

SAMPLE TESTING DOCUMENT: INFORMED CONSENT

Department of Communication Sciences and Disorders
Wichita State University
Wichita, KS 67260-0075
(phone) 316-978-3240
(fax) 316-978-3291
csd@wichita.edu
www.wichita.edu/csd

College of Health Professions

You are invited to participate in a study of memory strategies and learning styles/sensory modality strengths. We hope to learn if there is a relationship between an individual's learning preferences and the strategies they use for memory tasks.

You were selected as a possible participant in this study because we are using an adult population 21 years of age or older who have at least a high school education.

If you decide to participate, you will complete a series of memory tasks and learning style tests and report the strategies you used for the memory tasks. There are five short memory tasks that each should take between two and fifteen minutes to complete. You will complete a short survey describing the strategies you used for the memory tasks. Last, there will be two tests that will be administered to examine sensory modality strengths, or your learning preferences. The first test will take about 20 minutes to complete and the second will take about ten minutes to complete. In total, testing will take about one and a half hours to complete.

There are no known possible risks to participants. The length of testing may cause physical and mental discomfort. One break will be offered to decrease this discomfort. The study provides the benefit of knowledge of personal sensory modality strengths and strategies used for memory tasks that you may have been previously unaware.

Any information obtained in this study in which you can be identified will remain confidential and will be disclosed only with your permission.

Participation in this study is entirely voluntary. Your decision whether or not to participate will not affect your future relations with Wichita State University and/or the Wichita State University Speech-Language Hearing Clinic. If you agree to participate in this study, you are free to withdraw from the study at any time without penalty.

If you have any questions about this research, you can contact us at: Christina Coiner (316) 978-3289 or Julie Scherz, PhD (316) 978-5344. If you have questions pertaining to your rights as a research subject, or about research-related injury, you can contact the Office of Research Administration at Wichita State University, Wichita, KS 67260-0007, telephone (316) 978-3285.

APPENDIX A (continued)

You are under no obligation to participate in this study. Your signature indicates that you have read the information provided above and have voluntarily decided to participate.

You will be given a copy of this consent form to keep.

____ ________________
Signature of Participant Date

____ ________________
Witness Signature Date

APPENDIX B

SAMPLE TESTING DOCUMENT: DEMOGRAPHIC REPORT

Start:_______________ End:_______________

1. Age: _________

2. Gender:
   _______ Female
   _______ Male

3. Which hand is your dominant hand?
   _______Left
   _______Right

4. Highest Education Level:
   _______ High school
   _______ Some college
   _______ Bachelor's degree
   _______ Some graduate school
   _______ Graduate degree
   _______ Post graduate

5. If you attended college, what is/was your college major(s)?
____

6. What is/was your occupation?____

7. What are your hobbies/interests?____

____

8. Have you experienced any neurological (brain) problems that might affect memory (e.g. head injury)?

   _______ YES
   _______ NO

9. Are you taking any medication that might affect memory? (Please note that some cholesterol lowering medications, sleeping pills, and seizure medications may cause memory loss).

   _______ YES
   _______ NO

10. Do you have any vision or hearing deficits that are not corrected by glasses or hearing aids?

   _______ YES
   _______ NO

11. Many people have techniques that they use to remember things. Please list and explain any strategies you use to help yourself remember:

____

____

____

APPENDIX C

SAMPLE TESTING DOCUMENT: STRATEGY GENERATION SELF-REPORT

Many people have techniques that they use to remember things. Please list any strategies you used to help your performance in the following memory tasks:

ABCD Story Retelling Immediate

____

____

____

RAVLT Immediate Recall

____

____

____

TVCF Categorical Fluency

____

____

____

TVCF Letter Naming

____

____

____

APPENDIX C (continued)

DTLA-4 Design Sequences

RAVLT Delayed Recall

ABCD Story Retelling Delayed

APPENDIX D

SAMPLE TESTING DOCUMENT: STRATEGY RECOGNITION SELF-REPORT

Please read the following lists of strategies and place a check mark next to any strategies you used for each of the memory tasks (check all that apply). The tasks are in the same order as they were presented during testing. If you are unsure about any of the tasks or have any questions, please ask.

ABCD Story Retelling Immediate

_______No strategy
_______Concentration
_______Pictured story
_______Related story to own life
_______Repetition
_______Pictured self in story
_______Other:____

RAVLT Immediate and Delayed Recall and Recognition

_______No strategy
_______Concentration
_______Repetition/Rehearsal
_______Pegwords (pictured the words related to numbers)
_______Pictured words
_______Created rhymes
_______Organized words into categories
_______Chunking (put words in groups)
_______Word mnemonics (created a simple word with the first letters of each of the words)
_______Created a story using the words
_______Other:____

TVCF Categorical Fluency

_______No strategy
_______Concentration
_______Pictured items
_______Pictured self using items
_______Other:____

TVCF Letter Naming

________No strategy
________Concentration
________Pictured items
________Sounded out words
________Word families
________Other:____

DTLA-4 Design Sequences

________No strategy
________Pictured designs
________Repetition
________Associated design with something familiar
________Other:____

ABCD Story Retelling Delayed

________No strategy
________Concentration
________Pictured story
________Related story to own life
________Repetition
________Pictured self in story
________Other:____