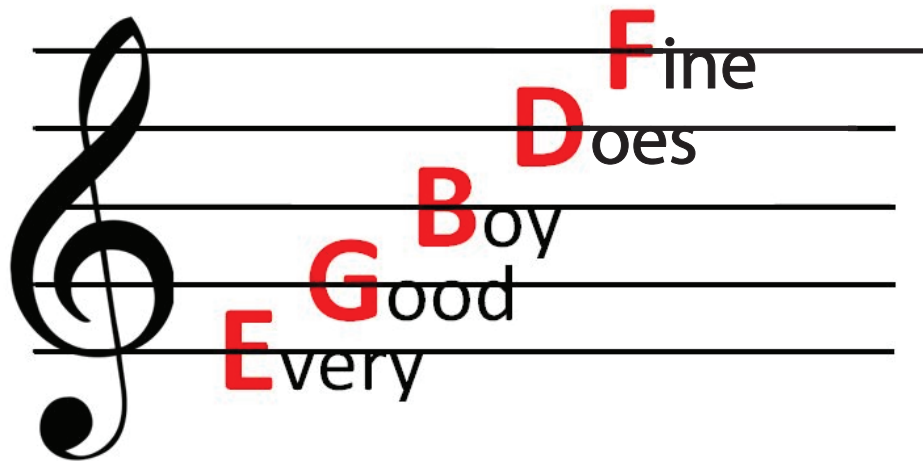


Mnemonics: Its History and Application



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Memory is a primary element in the panoply of cognitive components that are necessary for functioning in today's society. To facilitate the retention of vast amounts of data that are required in our culture, personal digital assistants (PDAs), cell phones, global positioning systems all have memory capabilities. Now, these devices are considered rather mundane. How could we function without access to memory tools that organize and display information that is so important in managing our affairs? How could today's society function if it merely had its own innate memory to rely on? Memory has become preeminent in navigating today's demanding and competitive environment.

Prior to today's prodigious memory devices, individuals relied on their own memory to provide them with the resources necessary to function effectively in their environment. A simple note written on the refrigerator door, car keys left on the kitchen table before retiring at night, special marks or tokens left in conspicuous locations all helped to remind the individual what he was not to forget. He did not rely on random access memory (RAM) or read only memory (ROM) in his computer or PDA to be a repository for his memories and thoughts. One's resident memory was the source for success in society. If he was really sophisticated, he would use mnemonic techniques to expand his powers of retrieval.

Mnemonics, "the science or art of improving the memory, as by the use of certain formulas...or other aids to help in remembering (Webster's, 1968)." This word is derived from the Greek words *mnemon* and *mnasthia* which mean "mindful" and "to remember" (Baine, 1986). The word mnemonics can be applied to numerous systems or techniques which facilitate the process of memory. The effective use of mnemonics provides a method for remembering and retrieving copious amounts of material without the use of any recorded data.

Some of the earliest references to mnemonics are found in Aristotle's *De Memoria et Reminiscentia*, which was written in 350 B.C. While this work is not a depiction of mnemonic

methods or techniques like those found in later works by Greek and Roman authors, Aristotle discusses the relationship between imagination and memory. In particular, he refers to memory as representing pictures or images which are visualized, bringing into focus dormant objects or topics. This reference to our memory's images is related to mnemonics by his passage, "for it is possible to put things before our eyes just as those do who invent mnemonics and construct images"(MIT, 2000). Aristotle saw two aspects of memory, an image which is visual in nature and an emotional component which relates the memory to the individual's experience (Carruthers & Ziolkowski, 2002).

This strangely spelled word, mnemonics, is associated with the Greek goddess Mnemosyne, who epitomized memory. Her union with Zeus, king of the Gods, produced the Nine Muses who presided over all the arts and sciences. Thus, half of all creativity had memory as its genesis (Buxton, 2004). The imaginative Greeks had a source for their mnemonic memory techniques and it was a goddess no less. The importance of an accurate memory did not escape them, even thousands of years ago. The foremost proponent of Mnemosyne was a Greek lyric poet, Simonides of Ceos.

Simonides is considered to be the father of mnemonics. He lived about 500 B.C. in Greece and was considered to be the premier orator of his time. His unique ability to memorize lengthy orations was facilitated by the mnemonic of using places and images to organize his speech. The contents (images) of his oration would be arranged in a mental framework (places) that would facilitate its retrieval. (Yates, 1994).

Very little is left of the writings of Simonides. Our view of him is based on the surviving records that were written hundreds of years after his death. Plutarch, in *De Gloria Atheniensium*, refers to Simonides analogy of painting as silent poetry and poetry as spoken painting; visualizing thoughts as images and places (Bolzoni, 1995). Cicero's *De Oratore* describes Simonides use of places and images, which were a component of memory, one of Cicero's five

parts of rhetoric. Two other portrayals of mnemonics are found in the anonymous *Ad. Herennium* and Quintilian's *Institutio Oratorio* (Yates, 1994). Simonides and his use of vivid mental images and placement left a distinct impact on the orators of Greece and Rome.

The treatise, *Rhetorica Ad Herennium*, written between 86 to 82 B.C., is considered to be the main source of early Greek thoughts on memory. The anonymous author was a teacher of rhetoric in Rome and it is the only Latin treatise on the subject that remains. It's influence on the art of memory was present from the first century before Christ through the Middle Ages into the Renaissance. It's references to "places" and "images" and the importance of memory for things and words, presents a structured plan for developing mnemonic techniques (Yates, 1994).

The treatise was written with the purpose of instructing students in the art of rhetoric. According to the author, there are five components of oratory:

1. Invention — convincing the listener that your argument is plausible
2. Arrangement — maintaining clarity
3. Style — proper grammar
4. Memory — retaining the details in your mind
5. Delivery — the poised regulation of voice, appearance, and gesture

Memory was the component that was responsible for the retention of the subject's form, words, and arrangement. There are two types of memory: natural which is your own resident memory or artificial, which has to be strengthened with training and discipline. This artificial memory was also called mnemotechnics (Caplan, 1954).

Rhetorica Ad Herennium gives a very distinct presentation of the methods that are used for mnemonics. The artificial memory is comprised of backgrounds and images. Backgrounds are to be houses, arches, columns, or similar locations, all found in your natural memory. Images are all of the items that you wish to remember. The backgrounds were to be of a vivid nature and to be sequential so that they could be visualized backwards and forwards. These backgrounds or loci

could be used over and over again for new images as the need arose. They were to be of a Spartan nature so that they wouldn't compete with the images that were to be placed in them. The author draws an analogy between a wax tablet and a background. The images were to resemble objects, which could be subject-matter or words. These objects were to be items that were familiar to the orator and of an active or striking nature. The subject-matter would represent a general view of the topic and the words would represent each word to be memorized (Caplan, 1954). Thus the classic technique of places and images was the foundation for mnemonics and its use in Greece and Rome.

Marcus Tullius Cicero, born in 106 B.C., was one of the greatest orators of the Roman era. His philosophy and writings have left a deep and lasting imprint on Western thought and culture (Mitchell, 1991). A contributing factor in his rhetorical success was his use of mnemonic techniques and he writes about "the traditional system of places and images that the rhetorical handbooks teach" in *De Oratore*. In his volume, he refers to Simonides' introduction of the art of memory, corroborating history's recognition of Simonides as the father of mnemonics (May & Wisse, 2001, p. 92).

In his work, *De Inventione*, Cicero reaffirms the five components of rhetoric found in *Rhetorica Ad Herennium*: invention, arrangement, style, memory, and delivery. He saw memory as "a firm mental grasp of matter and words" (Hubbell, 1950, p. 21). Cicero would visualize each room in a house then place his objects or topics in various locations, providing a powerful mnemonic system contributing to his commanding oratory (Murphy & Katula, 1994). In *De Oratore*, Cicero refers to the images as representative of the facts to be memorized and the loci as positions of order with both representing a wax writing tablet (Yates, 1994).

Toward the end of the first Christian century, Marcus Fabius Quintilianus, also known as Quintilian, wrote *Institutio Oratoria*, a compendium of ancient theories on rhetoric and on education. He was one of Rome's most famous teachers of rhetoric and had flourished under

three emperors. In his work, there are five main categories in the art of rhetoric: precept, imitation, composition exercises, declamation, and sequencing. Within his category of precept is found the five components that were discussed in *Rhetorica Ad Herennium*: invention, arrangement, style, memory, and delivery (Murphy, 1987).

Quintilian uses Cicero's *De Oratore* as his primary source on memory and its application. He refers to memory as a gift of nature that can be improved by theory and practice. Like Cicero, his mnemonic method involved the same technique mentioned in *Rhetorica Ad Herennium*, places and images. Quintilian visualizes a house as the background or place with various images found in specific locations. As the orator presents his speech, he walks through the house and visualizes the objects to be remembered. If it is a particularly long speech, he suggests that the orator segment his speech in sections that are memorized individually and use an image that provides a synopsis of the entire speech. Quintilian saw the need for constant practice and the need to memorize verbatim. The use of speaker's notes was anathema to him; they promoted carelessness and created interruptions in the flow of speech (Kennedy, 1969).

Aurelius Augustinus, also known as St. Augustine, lived between 354 and 430 and was trained as an orator. He saw memory as a necessary component in living the Christian life and was passionate in Man's need to "come to God through a linguistic rejuvenation," which required "an active participation of the memory (Coleman, 1992, p. 61)." In his work *De Trinitate*, he makes a metaphor of memory as a seal, leaving its impression in wax. Augustine gave memory the supreme honor of being one of the three powers of the soul: memory, understanding, and will. To Augustine, these three elements comprise the Trinity in man (Yates, 1994).

Augustine's *Confessions* present to the reader his descriptions of numerous experiences from his past and present. His memory is inextricably entwined with places and images. His rhetorical skills required the use of mnemonics to provide a device for retrieving the subjects and

topics found in his writing (Yates, 1994). *Confessions* portrays memory as the identity and continuity of the self and as “the stomach of the soul” (Chadwick, 1986). His use of places and images, artificial memory, and the belief of memory’s affinity to God was part of his Christian spirituality and left a lasting legacy for theologians.

Continuing the influence of mnemonics and memory in Christian theology was Thomas Aquinas, who was born in 1225. He was a member of the Dominican Order and acknowledged Aristotle’s and Cicero’s relationship of images and memory; the critical importance of association and order. Aquinas, like Augustine, saw a relationship between memory and the soul. He referred to Heaven and Hell as “memory places” and used diagrams or “artificial memory” to portray their attributes. He referred to Cicero’s *de Inventione* and its four elements of virtue: justice, fortitude, temperance, and prudence; memory as a component of prudence. Aquinas saw “artificial memory” as a supplement for memory, strengthening prudence, allowing the prudential Christian access to Heaven and avoidance of Hell. Aquinas reiterated Cicero’s call for strengthening of memory through practice and application (Yates, 1994).

Aquinas studied under Albertus Magnus and together they wrote the *Summae*. This writing was used by the Order of Preachers within the Dominican Order to formulate the philosophical and theological definitions of their order. This work plainly delineated the virtues and vices of Christian life and structured the message to be given by The Order. The writers clearly understood the importance of mnemonics and discuss it at length in their manuscript.

The purpose of the Order of Preachers was to present to the public the message of the Dominican Order and “artificial memory” and “corporeal similitudes” was a critical element in its success. With the advent of Scholasticism and the rejection of the Dark Ages, the importance of memory and its impact on conveying theological dogma became preeminent. “The moral man who wished to choose the path of virtue, whilst also remembering and avoiding vice, had more to imprint on memory than in earlier, simpler times” (Yates, 1994, p. 86).

Ramon Lull was a contemporary of Thomas Aquinas and embraced the same zealous attitude toward religion and memory. Lull created his Art, which was based on the Trinity's presence in Man. The process of "knowing or finding out truth....training the will towards loving truth....and remembering the truth" were, as Augustine had observed, the three powers of the soul (Yates, 1994, p. 176). While his attempt at enlisting the Dominican Order as a conduit for his system failed, the Franciscan Order eagerly embraced Lull's artistic representation of the Universe and his mechanical devices portraying the relationship between God and Man. Thus, Aquinas' and Lull's systems were disseminated throughout Europe during the Medieval period (Hillgarth, 1971).

There was a profound difference in the origins of Lull's Art and the classical art of memory. The classical art of memory emanated from the rhetorical custom whereas Lull based his system on a philosophical tradition. Lull didn't rely on the traditional "corporeal similitudes", he based his Art on algebraic or scientifically abstract concepts. In addition to this relatively arcane configuration, Lull added the dimension of motion. Three geometrical figures are a recurring component in his art. The circle represents the heavens, the square represents the elements and the triangle represents the divinity. These figures were seen in his drawings that created structure to the creation of Man "from God, to the angels, the stars, man, animals, plants, and so on." Lull referred to the "Dignities of God" and used nine letters to denote their meaning. He created revolving disks that contained words or letters that could be rotated to produce new meanings or relationships. His art was meant to convert Jews and Muslims to Christianity and allow them to enter the Kingdom of Heaven (Yates, 1994). Lullism developed a cult during its time and continues to engage practitioners, who are found on today's Internet.

Giordano Bruno was born in 1548 and took his vows in the Dominican Order in 1563. His exposure to the teachings of Aquinas and his mnemonic methods provided the background on memory that evolved into his own "artificial memory." Bruno blended Lullism with its

moving figures and letters with the classical art of memory with its places and images. His Memory Wheel consisted of numerous rings, each with 30 images with five subgroups within them. The thirty segments found on his outer Memory Wheel related to Lull's "Dignities of God." The central wheel had images of the signs of the Zodiac, planets, mansions of the moon, and houses of the horoscope—occult images. Other wheels had images of stones, animals, birds, and vegetables. The orientation of his "Memory Wheel" was such that it represented inferior levels of creation; the lowest level being the innermost wheel. What was the purpose of his Memory Wheel? "The aim of the memory system is to establish within, in the psyche, the return of the intellect to unity through the organization of significant images" (Yates, 1994, p. 225)

Bruno was burned at the stake in 1600 for heresy. He had dropped out of the Dominican Order and had used occult images in his Memory Wheel; issues that did not amuse the Catholic Church. But his death was not about his flight from Dominicanism or renaissance magic; it touched on man's free thought and his inquiry into theological issues. The Catholic Church saw theology as their exclusive domain and over which they would exercise absolute authority. Bruno's view that Man should engage in a theological dialogue with the Papacy, that his Memory Wheel could be used as a moral compass was heretical (Gatti, 1999). His death was about philosophy but there were strong Catholic and Protestant fears about renaissance magic that helped to seal his fate (Yates, 1964).

Peter Ramus, also known as Pierre de la Ramée, was born 1515 and died in 1572, massacred as a Huguenot in the Massacre of St. Bartholomew. His demise at the hands of the Catholics made a place for him among the Protestants, who supported his pedagogical position that memory was not part of rhetoric. Ramus was a staunch advocate of memory and pursued a system that, he believed, was a new and better way of memorizing all subjects (Yates, 1994).

Ramus repudiated the classic form of places and images, "artificial memory," and supplanted it with "dividing and composing." His memory structure begins with "generals" and

proceeds to “specials.” He acknowledged the presence of spatial visualizations on the page of a book to be memorized in a schematic form in which an overview or “general” subjects would be presented followed by specific or “special” topics. His view of the teaching of any subject is one that follows a natural order, an inherent logic of the subject. In reality, there is a great deal of mysticism in Ramus’ dialectical order. He attempts to achieve a “natural form” or divine light; Ramus refers to Homer’s golden chain from Earth to Heaven.

The Ramist method begins to appear almost as mystical a conception as the Art of Ramon Lull, which imposes the abstractions of the Divine Dignities on every subject and thereby makes the ascent and descent (Yates, 1994, p. 236).

Ramus rejected imagery and imagination in the cultivation of memory and replaced it with his own dialectical order that saw abstract order or “natural form” in topics to be memorized.

Ramism, like Lullism, had connections with logic and intellect and saw a distinct structure in Man’s covenant with God (Yates, 1994)

Robert Fludd was from a privileged background in England and was born in 1574. He was a wealthy man of noble descent who was the son of a Knight. He was educated at Oxford and became a member of the College of Physicians of London. His patients included the British royalty and it is said that his writings were “the greatest expression and summation of Renaissance Christian Neoplatonist thought (Huffman, 1988, p. 3).” Fludd developed a keen interest in the Rosicrucian movement and ultimately became one of it’s most enthusiastic supporters. Their philosophy of concentration, meditation, and visualization contributed to his interest in theology and memory. He was a pious nobleman who was “deeply committed to the religious, philosophical, and scientific truth.” (Huffman, 1988, p. 2) It was this spiritual power that encouraged him to create his “Theatre Memory System.”

Fludd uses a complex mnemonic system to portray the macrocosm or man’s environment, which he saw as a reflection of God. This macrocosm was reflected in his “Theatre Memory System”, which is an actual stage which has five columns of different colors, five entrances, and

a battlemented terrace. Various items are placed on this stage in various locations to represent a multitude of subjects. His “square art” represented corporeal things such as men, animals, or earthly objects. His “round art” represented symbolic items such as gods, stars, virtues, vices, or other intangible items. There were to be two stages: the eastern theatre was to be light and bright, representing daylight, the western theatre was to be dark and obscure, representing the night. Fludd saw these theatres as representing the houses of the planets. The columns, entrances, and battlement provided loci for the round and square images that portrayed the mnemonic picture. Fludd saw his “Theatre Memory System” as a representation of the boundless domain of God and the Universe (Yates, 1994). This obsession with mnemonics and the macrocosm was seen in the illustrations used in many of Fludd’s writings (Yates, 1969)

Numerous other mnemonic systems have evolved since Fludd but they were far less sophisticated than his system. Richard Grey (1694-1771) developed a system where groups of words could be represented by acronyms and numbers could be represented by letters. Gregor von Feinaigle (1760-1819) developed a system that replaced numbers with letters that had similar features to Grey’s system to assist in recall. In 1893, James Copner used words for dates and letters for numbers, like Grey, but also had rhymes for remembering facts in biblical history. The importance of memory is confirmed by humanity’s perpetual attempts at creating the perfect “system” to encode our data (Yates, 1994).

This fascination with memory is based on the fact that, “memory is the relatively permanent record of the experience that underlies learning” (Anderson, 1995, p. 16). The process of memory has three components: acquisition or encoding, storage, and retrieval (Higbee, 1977). The first goal for an efficient memory is to achieve meaningful encoding; use preexisting knowledge to help in processing the new information. The second goal is to explicitly attach cues to the encoded material to allow for efficient retrieval. The third goal is to apply these techniques through practice (Thompson, Cowan, & Frieman, 1993). As the eminent German psychologist

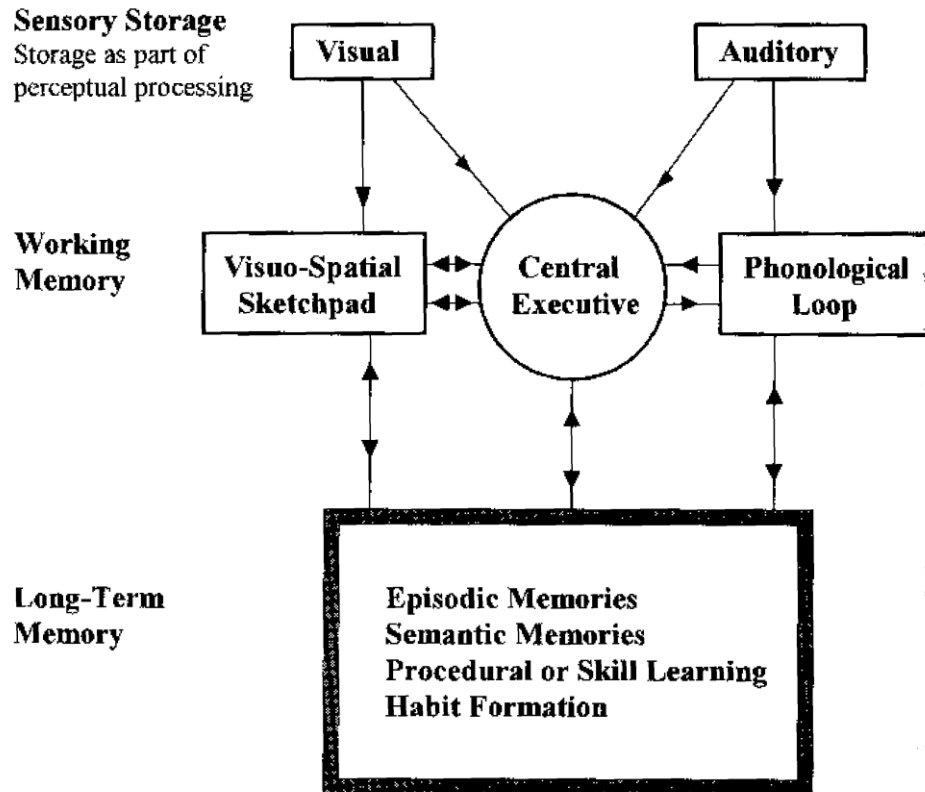
Hermann Ebbinghaus discovered in the 1880's, memories fade quickly. His famous "curve of forgetting" was a graphic portrayal of how rapidly we forget (Rupp, 1998).

What is the pathway, the roadmap, for these experiences of ours that become part of our memory? The initial input is in the form of iconic or echoic memory, which is deposited in our sensory memory area. These forms of memory last for milliseconds. The next stop is in short-term memory, which retains the information for approximately 15 seconds. As data is manipulated, working memory is implemented, which has access to long-term memory. Ultimately, our experiences are deposited in long-term memory, hopefully, to be retrieved at a later date (Torgesen, 1996).

While all components of the neurological system are important for cognitive functioning, working memory is considered the center of executive function. Working memory is short term memory with access to higher cognitive functions. "Working memory is a dynamic and active memory system associated with simultaneous processing and storage of information" (McNamara & Wong, 2003, p. 395). This system is a component of a larger paradigm, one that includes executive function. Denckla (1994) states that the term refers to "mental control processes that are proactive and include interference control, effortful and flexible organization, strategic planning, and preparedness to act (p. 118)." She also saw the close relationship with working memory, "highlighting, as it does, the delay between stimulus and response or maintenance of internal representations to guide actions (p. 119)."

Working memory provides temporary storage and manipulation of data that is integral with complex cognitive tasks such as language comprehension, learning, and reasoning. This structure requires simultaneous storage and processing of information. The central executive domain is considered the "computational arena," which controls the information relevant to the current task, both its maintenance and manipulation. The memory processing of the central executive area is facilitated by two supplemental systems: the visuo-spatial sketchpad, which manipulates

images and the phonological loop, which stores and releases speech-based information (Torgesen, 1996). Thus, working memory, “is...responsible for coordinating the activities of processing and storing information and for monitoring and coordinating attentional resources within the overall memory system” (McNamara & Wong, 2003). A graphic portrayal of this system is shown below.



After traversing this serpentine maze into long-term memory, memory can be strengthened by repeated rehearsal or practice. This process is called over learning. Although unsophisticated, this technique is commonly pursued by today’s students. This system can be effective if sufficient practice is engaged. Another important element in natural memory is meaningfulness. We remember things that are inherently meaningful or important to us (Rafoth, Leal, & DeFabo, 1993). An important element in developing our memory is seeing the similarities in previously encountered experiences (Schank, 1999).

Metacognition is another important aspect in effective natural and “artificial” memory. It has three underlying components that create a powerful source for assisting in memory and recall. Metaknowledge is the awareness of how memory works. Metamonitoring is the wisdom of knowing when something has or has not been retained. Metamemory is knowing how memory works and how to memorize effectively (Rafoth, Leal, & DeFabo, 1993).

A powerful supplement to natural memory is “artificial memory” or mnemonics. It is important to understand that mnemonics supplements the processes of learning; it does not replace them. The five main principles of mnemonics are:

1. Meaningfulness—mnemonics, through the use of rhymes, patterns, associations, etc. make material meaningful.
2. Organization—all mnemonics use a systematic way to record and retrieve material.
3. Association—all mnemonics use links to relate to anchors in the system.
4. Visualization—many mnemonics use visualization as a device for memory retrieval.
5. Attention and interest—mnemonics forces you to attend to the material and create significant associations.

Mnemonics provide a systematic procedure for enhancing memory. They are not a teaching method, however, they are extremely effective in helping people remember things (Mastropieri & Scruggs, 1998)

There are two main groupings for the various categories of mnemonic systems. The organizational group uses information you are already familiar with to allow you to learn new information. The first subset of this group is the single use group, which is focused on one target that has order. This subset consists of acrostics, acronyms and rhymes. The second subset of the organizational group is the multiple use group, which works well with many targets. This subset consists of peg-word and method of loci. The encoding group uses memorable representations to

symbolize numbers or abstract concepts and has two sections: name and keyword. The various descriptions and examples are found below (Bellezza, 1996).

Mnemonic Methods

1. Acrostics refers to the first letter of every word in a sentence that represents a name or other item to be remembered. For example:

Every Good Boy Does Fine—EGBDF for the notes of the treble clef.

My very excellent mother just served us nice pie—the nine planets in our solar system according to the distance from the sun: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.

Washington And Jefferson Made Many A Joke—the first seven American presidents:

Washington, Adams, Jefferson, Madison, Monroe, Adams, and Jackson

2. Acronyms refers to each letter of a word representing a name or other desirable item of information. For example:

HOMES—The Great Lakes: Huron, Ontario, Michigan, Erie, and Superior.

ROY G BIV—The colors of the visible spectrum: red, orange, yellow, green, blue, indigo, and violet.

ACRONYM—Abbreviated coded rendition of name yielding meaning.

3. Rhymes such as:

I before E, Except after C/ Or in rhyming with A/ As in neighbor and weigh

Thirty days hath September, April, June, and November/ When short February's done/

All the rest have thirty-one

4. Peg-word system is used for memorizing sequences by initially assigning a word to a number, for example:

one=bun

two=shoe

three=tree

four=door

This establishes the framework for the items to be memorized. These words are related to the memorized items which gives them the required sequence. This is very effective because if one item is forgotten, the rest of the sequence is intact. For example, if the items to be remembered are dog, cat, lemon, and tire you could visualize a dog eating a bun standing next to a cat with shoes on under a tree with lemons hanging from it and a tire crashing through a door.

5. Method-of-loci requires the mnemonist to visualize a familiar area, which is typically their home or place of employment. All of the items to be remembered are placed in a specific location within this area.
6. Name mnemonic is used for remembering names. The mnemonist relates a feature that is real or imagined of a person's appearance with sounds found in the person's name. For example, you could relate a mustache with the name Mike and silver coated teeth with Stilson. Visualizing these words with Mike Stilson's picture would provide the name.
7. Keyword mnemonics are used when lists of related items must be memorized. The mnemonist uses a familiar, similar sounding, keyword that is related to the object to be remembered. The keywords are then placed in an interactive picture or sentence. When the data is required, the keyword is retrieved and the image or sentence is visualized or repeated and the information is found. For example, you could relate the word broke with Baroque and box to Bach. This would create the image of a broke man in a box. This would retrieve the concept of Bach as a Baroque composer (U. of V., 2000).

These are all examples of what are commonly called fact mnemonics. They are used on a one to one basis to remember facts (Higbee, 1987).

More recent developments in the field of mnemonics has produced a system that deals with processes rather than rote facts. This new system is called process mnemonics and it was created by Masachika Nakane, a Japanese educator. He named this new system Yodai mnemonics. This scheme was developed for the purpose of providing readily retrievable mediators for recalling and learning the structured cognitive processes necessary in problem solving. It is extremely complex (Higbee, 1987).

This unique and powerful system of fact mnemonics, which has existed for thousands of years, is primarily a dormant tool in the educational community of today. The author's discussion with many educators, who are overwhelmed with the content of today's instructional environment, struggling to align their curriculum with Michigan's MEAP test, and besieged by the administration's micromanaging of the classroom atmosphere, has indicated that mnemonics are not a priority item. Neither the individuals he talked to nor his numerous relatives who are in the field of education use mnemonics routinely.

Understanding the developmental processes of children is critical in evaluating their metacognitive strengths and weaknesses in particular their metamemory skills. In the educational setting, the child must determine what is to be studied, how they are going to study and for how long, and what method they are going to use. In short, they must establish a *memory strategy*, which is a voluntary act of "remembering or learning information" (Rafoth, Leal & DeFabo, 1993, p. 15). This process follows a developmental progression. Typically, their study strategy starts with naming followed by deliberate rehearsal or rote repetition of material. Then, the child develops semantic grouping, associative linkages, and self-testing. Ultimately, elaboration or creating visual or verbal connections, adding meaning to the material, are utilized (Rafoth, Leal & DeFabo, 1993).

Using the naming strategy at about the age of two, children do not use deliberate or conscious strategies to aid their memories. When asked to remember objects, the child will point, look, or name the object, which requires very little processing time. These strategies are used only under direct instruction and with familiar objects (Rafoth, Leal & DeFabo, 1993).

By the age of about six, the child will engage in rehearsal. This is a generic name for various memory strategies. Rehearsal strategies consist of: writing spelling words numerous times, repeating a phone number before dialing it, and reciting multiplication facts out loud to classmates while studying. These rehearsal strategies become more sophisticated as the child gets older. Rather than writing or repeating one word at a time, the child will use a list of items and increase the number of items (Rafoth, Leal & DeFabo, 1993; Rupp, 1998).

Children begin to organize data by various means and engage in self-testing at around the age of ten. These groups could be based on the object's appearance, classification, use, semantic features, color, or any similar attributes. By grouping the items, the child is establishing meaningful groupings that provide internal references for cataloging. Using practice tests and flashcards, the child assesses his need for further study. Initial efforts may not give impetus for the younger student to reexamine the material; older students typically engage in further study when self-testing indicates a weakness (Rafoth, Leal & DeFabo, 1993).

Elaboration strategies add meaningful connections to the material to be studied. This is a strategy that students do not undertake until they become adolescents. Mnemonics falls under this category and, if left to their own devices, is not effective for students unless instruction in mnemonics is given by their teacher, textbooks, or other instructional material. A major deficit in initial student generated elaboration strategies is their lack of intensity and memorability; they are ineffective (Rafoth, Leal & DeFabo, 1993).

In an attempt to assess memory strategy acquisition and its relationship to organic development and instructional exposure, the Munich Longitudinal Study was begun in 1984 and

continued until 1993. A unique component of this study is that the German educational system has three tiers. The advanced students are placed in the Gymnasium; the average performing students are placed in the Realschule; and the poorly achieving students are placed in the Hauptschule. Three distinct cohorts were evaluated. This study originally involved 204 four-year-old children and lasted for nine years with a resulting group of 186. It was believed that a longitudinal study would be much more accurate in its evaluation of strategy acquisition than the existing cross-sectional studies. It was determined that memory strategies in early grade school children show a “production deficiency” which is followed by “utilization deficiencies” in later grades. Strategic behavior is usually accomplished by the eighth or ninth grade. Strategy development was slow and continuous regardless of the educational tract of the student. Recall performance also increased continuously during this same period. As would be expected, the smarter students performed at higher levels of strategy use and recall performance however, “there was no evidence that group differences changed as a function of different educational experiences (Schneider, Stefanek, & Knopf, 2002, p. 758).” Their verbal memory performance was relatively unaffected by differences in educational environments.

Mnemonics, in innumerable studies, has proven it’s efficacy in improving the memory processes of students, whether they are gifted, average, or impaired. Through the use of mnemonic strategies, children can utilize the three R’s of effective memory techniques. They can reconstruct, relate, and retrieve the data through the use of acrostics, acronyms, rhymes, pegwords, method of loci, or keywords (Scruggs & Mastropieri, 1989). This system allows all students to achieve a higher level of self-efficacy that Bandura found so important in students’ achievement.

Studies have shown that gifted students can spontaneously develop effective strategies to assist them in learning verbal material (Scruggs & Mastropieri, 1984, 1985). With the addition of instruction in the use of mnemonics, bright students perform at even higher levels. Their ability

to transfer the use of these strategies across learning situations and engage in complex elaborations is an ability that average students do not frequently display (Scruggs & Mastropieri, 1988). The natural ability of gifted students to facilitate information processing in an efficient and effective manner is strengthened by mnemonic instruction (Wang & Thomas, 1996).

Knowledge of vocabulary is considered to be a prime component in prose comprehension. Keyword mnemonics was used in instruction of vocabulary during an experiment in an urban school with general and special education students. After memorizing the keywords for each word, the students provided the definitions for the assigned vocabulary words. The general education students increased their vocabulary score from 2.9 (pre-test) to 8.6 (post-test). The special education students increased their vocabulary score from 2.8 (pre-test) to 10.0 (post-test) achieving superior performance to the general education students. While only three classrooms with a total of 74 students took part in this experiment, the implications of this study are significant (Uberti, Scruggs & Mastropieri, 2003).

“Students with learning disabilities often struggle with memory tasks” (Swanson, 1987, p. 3). This weakness has a significant effect on the LD child who attempts to learn new vocabulary in his English class. Poor vocabulary impacts reading, listening comprehension, and good conversational skills (Poloway, Smith & Miller, 2003). During a six week period, a high school teacher used pictorial and keyword mnemonics to instruct eight of her LD students. The pictorial mnemonic consisted of an interactive picture that portrayed similarly sounding images, e.g. *truculent* would be an image of a truck driven by an aggressive truck driver. Keyword mnemonics were acoustically similar words that would evoke the meaning of the word, e.g. a group of dishonest men could represent *mendacity*. A comparison of the results of the control group and the experimental group were impressive. The control group using memory only learned 49% of the vocabulary whereas the experimental group, using mnemonics, had learned

92%. The experimental group had learned almost twice as many words as the control group (Terril, Scruggs & Mastropieri, 2004).

“Problems with attention, memory, and higher-order-thinking skills are common among adolescents and young adults with learning and behavioral disabilities” (Rivera & Smith, 1997; Shaywitz & Shaywitz, 1992). The use of mnemonic strategies has been shown to improve thinking skills and problem solving for all groups (VanReusen, Deshler & Schumaker, 1989; Scruggs & Mastropieri, 1991). To provide a framework and understanding of their IEP goals, the acronym I PLAN was taught to special education high school students. The I PLAN strategy steps are: Inventory strengths, weaknesses, goals, choices for learning; Provide your inventory information; Listen and respond; Ask questions; and Name your goals. When the goals that the students discussed at their conferences were compared to those that were recorded on their IEPs, the students using the I PLAN acronym repeated 86% of their IEP goals whereas the students who did not use the I PLAN acronym repeated only 13%. The knowledge of their structured IEP goals allowed the student to more effectively manage communication during their school conferences. This mnemonic device provided a cognitive strategy for important processes that the student should know (Lombardi & Butera, 1998).

To determine the efficacy of pictorial mnemonics in improving the performance of 20 LD inner-city students at a midwestern junior-high school, an experiment was implemented in a history class. The teacher used pictorial mnemonics for two of the chapters and traditional methods for the other two chapters for the entire class. Test results for the chapters utilizing pictorial mnemonics averaged 62.4% whereas traditional methods averaged 46.8%. These results strongly suggest that LD students can experience dramatic scholastic improvement through the use of mnemonic strategies (Scruggs & Mastropieri, 1989).

“The most frequent empirical findings in research on learning disabilities (LD) have recorded qualitative differences in the cognitive functioning of students with LD compared to

their peers without LD” (Swanson, Cooney & O’Shaughnessy, 1998, p. 144). These deficiencies affect phonological processing (Torgesen, et al., 2001), memory processing (Swanson et al., 1998), and social information processing (Sridhar & Vaughn, 2000). Voluminous amounts of research indicate that verbal working memory deficiencies are the primary reason for below-average reading performance (Swanson & Siegel, 2001). Swanson (1993, 1999) believes that executive functioning may also be impaired with the LD student that is separate from his language-specific processing problems. The implications of these weaknesses impact not only the scholastic efforts of the impaired but, also, their daily activities (McNamara & Wong, 2003).

A key element in research findings of LD students is their inability to access verbal codes required for reading; verbal memory is impaired (Shankweiler & Crain, 1986; Swanson, 1987; Vellutino & Scanlon, 1987). “Verbal codes may be defined as descriptors that aid the placement and storage of a stimulus in long-term memory” (Swanson, 1987, p. 4). When students are required to access a stimulus they must access the correct code. If they are unable to accomplish this they suffer from an *retrieval deficiency* (Swanson, 1991). This paradigm is known as the accessibility hypothesis (Swanson, et al, 1991). The obverse side of the coin is poor encoding or *storage deficiency* (Swanson, et al, 1991). Evidence suggests that the problem may reside in the retrieval mechanism; when provided with cues, LD students perform as well as regular students (Swanson, et al., 1991; Torgesen & Goldman, 1977; Wong, 1978).

McNamara and Wong (2003) have discovered through their research with LD children that their problems are multifarious. In addition to the well known deficit of phonological processing, they also exhibit difficulties in processing academic, episodic, procedural, and common object information. These weaknesses point to poor executive functioning and inappropriate search strategies required to retrieve relevant information. Of interest is the fact that when given cues for retrieval, the LD students performed at the same level as their non-LD peers.

The use of mnemonics and the application of its three Rs: reconstruct, relate, and retrieve can assist regular education and, in particular, special education students in processing and retrieving information that is critical for their success in school. With evidence of inappropriate search strategies and weak cueing of retained data, the LD student, who represents 43.2% of children classified as special education students (Wagner & Blackorby, 2002), can reap tremendous benefits from the improved encoding and retrieval cues produced by mnemonic strategies. Acrostics, acronyms, keywords, peg-words, method of loci, face mnemonics, and keywords all provide improved encoding and retrieval links that help today's student deal with the vast amount of material that are found in today's curricula. Memory strategies that have been used for thousands of years can help today's students master the skills essential for success..

To effectively implement a mnemonic strategy with students, the instructor should follow the following steps:

1. Tell the students about the purpose of the instruction and the rationale for the strategy training. Inform the students that this instruction will be beneficial for them and that their use of the strategies will result in better performance.
2. Provide instruction in the strategy and in positive attributions toward strategy usage. Demonstrate, model, and lead students using many examples to ensure their complete understanding of the mnemonic process during the strategy component training.
3. Provide models during which examples and thinking processes are said aloud. Demonstrate how you proceed with your thinking while generating a strategy for specific examples.
4. Allow students opportunities to practice orally and provide corrective feedback. Practice several examples with the class as a whole. Encourage brainstorming during

the development of the keyword and interactive picture phase. Allow students to work in small groups and practice generating strategies and brainstorming.

5. Arrange guided practice with relevant feedback on both strategy usage and attribution feedback. Give students additional items to practice using the mnemonic and attribution strategies. Provide corrective feedback and allow opportunities for students to share their thinking with one another about how they developed their strategies.
6. Provide generalization instruction, practice, and feedback. Use different types of materials to demonstrate how the strategy can be applied across content areas and various types of factual information.
7. Include positive reinforcement and positive attribution training for completing the tasks and for remembering the information correctly. Provide review and practice with information that was learned using strategies.

These techniques are memory strategies not comprehension strategies. Comprehension strategies should include content elaboration, prior knowledge activation, manipulation, coaching and questioning, or prediction and verification (Mastropieri & Scruggs, 1998; Berninger & Abbott, 1994).

Since visual associations are critical in the efficacy of mnemonics, proper implementation of this component should:

1. Show the images interacting; include a visual and associative element. Rather than having two or more stationary images, the images should interact with each other. If you are using a dog and a broom in your mnemonics, the dog should be sweeping with the broom, not standing next to it.

2. Create vivid mental images; ones that are clear, distinct, and strong. The dog sweeping with the broom should be bathed in bright sunlight and creating clouds of dust.
3. Have a bizarre component to them; possibly. Research has not proven the superiority of unusual relationships creating a stronger retrieval base. Thinking of a dog riding a broom on a sunny day through a dust storm may not be more effective than the previous dog sweeping.
4. Make abstract materials concrete; use a concrete image for an abstract word. Trying to visualize the concept of happiness, anger, despair, or joy is much more difficult than visualizing dog, broom, apple, or car. Using images that have a strong relationship to the abstract concept are effective. A smiling face could represent happiness; a man standing erect with his fist in the air could represent anger; a woman slouching in a chair with her head in her hands could represent despair; and children sitting with each other eating ice cream could represent joy.

These techniques will add to the powerful memory strategies of mnemonics, however, the teacher should use these techniques to supplement other instructional methods (Higbee, 1977).

The advance of technology has provided our society with a plenitude of electronic devices to educate, monitor, entertain, and record. They have become a critical element in our society and one that has provided the technical superiority of those cultures that have embraced their use. They are a pervasive influence at all levels of our civilization; from the perigee to the apogee. Like the old saying, "God made Man, but Sam Colt made them equal," today's inexpensive electronic tools have contributed to the world's march towards egalitarianism. Still, in this sea of equality, a defining measure of success is often man's mastery of memory. As Aristotle said over 2,000 years ago, "for it is possible to put things before our eyes" empowering mnemonics to make a critical difference in success or failure.

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