Mnemonics: Master Your Mind and Unlock Total Recall

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Organization of Memory

The Art of Memory or Ars Memorativa ("art of memory" in Latin) is a general term used to designate a loosely associated group of mnemonic principles and techniques used to organize memory impressions, improve recall, and assist in the combination and 'invention' of ideas. It is sometimes referred to as mnemotechnics. It is an 'art' in the Aristotelian sense, which is to say a method or set of prescriptions that adds order and discipline to the pragmatic, natural activities of human beings. It has existed as a recognized group of principles and techniques since at least as early as the middle of the first millennium BCE, and was usually associated with training in rhetoric or logic, but variants of the art were employed in other contexts, particularly the religious and the magical.

Techniques commonly employed in the art include the association of emotionally striking memory images within visualized locations, the chaining or association of groups of images, the association of images with schematic graphics or notae ("signs, markings, figures" in Latin), and the association of text with images. Any or all of these techniques were often used in combination with the contemplation or study of architecture, books, sculpture and painting, which were seen by practitioners of the art of memory as externalizations of internal memory images and/or organization.

Because of the variety of principles and techniques, and their various applications, some researchers refer to "the arts of memory", rather than to a single art.

Principles

Visual sense and spatial orientation

Perhaps the most important principle of the art is the dominance of the visual sense in combination with the orientation of 'seen' objects within space. This principle is reflected in the early Dialexis fragment on memory, and is found throughout later texts on the art. Mary Carruthers, in a review of Hugh of St. Victor's Didascalion, emphasizes the importance of the visual sense as follows:

"Even what we hear must be attached to a visual image. To help recall something we have heard rather than seen, we should attach to their words the appearance, facial expression, and gestures of the person speaking as well as the appearance of the room. The speaker should therefore create strong visual images, through expression and gesture, which will fix the impression of his words. All the rhetorical textbooks contain detailed advice on declamatory gesture and expression; this underscores the insistence of Aristotle, Avicenna, and other philosophers, on the primacy and security for memory of the visual over all other sensory modes, auditory, tactile, and the rest."

This passage emphasizes the association of the visual sense with spatial orientation. The image of

the speaker is placed in a room. The importance of the visual sense in the art of memory would seem to lead naturally to the importance of a spatial context, given that our sight and depth-perception naturally position images seen within space.

Order

The positioning of images in virtual space leads naturally to an order, furthermore, an order to which we are naturally accustomed as biological organisms, deriving as it does from the sense perceptions we use to orient ourselves in the world. This fact perhaps sheds light on the relationship between the artificial and the natural memory, which were clearly distinguished in antiquity.

"It is possible for one with a well-trained memory to compose clearly in an organized fashion on several different subjects. Once one has the all-important starting-place of the ordering scheme and the contents firmly in their places within it, it is quite possible to move back and forth from one distinct composition to another without losing one's place or becoming confused."

Again discussing Hugh of St. Victor's works on memory, Carruthers clearly notes the critical importance of order in memory:

"One must have a rigid, easily retained order, with a definite beginning. Into this order one places the components of what one wishes to memorize and recall. As a money-changer ("nummularium") separates and classifies his coins by type in his money bag ("sacculum," "marsupium"), so the contents of wisdom's storehouse ("thesaurus," "archa"), which is the memory, must be classified according to a definite, orderly scheme."

Limited sets

Many works discussing the art of memory emphasize the importance of brevitas and divisio, or the breaking up of a long series into more manageable sets. This is reflected in advice on forming images or groups of images which can be taken in at a single glance, as well as in discussions of memorizing lengthy passages, "A long text must always be broken up into short segments, numbered, then memorized a few pieces at a time." This is known in modern terminology as chunking.

Association

Association was considered to be of critical importance for the practice of the art. However, it was clearly recognized that associations in memory are idiosyncratic, hence, what works for one will not automatically work for all. For this reason, the associative values given for images in memory texts

are usually intended as examples and are not intended to be "universally normative". Yates offers a passage from Aristotle that briefly outlines the principle of association. In it, he mentions the importance of a starting point to initiate a chain of recollection, and the way in which it serves as a stimulating cause.

"For this reason some use places for the purposes of recollecting. The reason for this is that men pass rapidly from one step to the next; for instance from milk to white, from white to air, from air to damp; after which one recollects autumn, supposing that one is trying to recollect the season."

Affect

The importance of affect or emotion in the art of memory is frequently discussed. The role of emotion in the art can be divided into two major groupings: the first is the role of emotion in the process of seating or fixing images in the memory, the second is the way in which the recollection of a memory image can evoke an emotional response.

One of the earliest sources discussing the art, the Ad Herennium emphasizes the importance of using emotionally striking imagery to ensure that the images will be retained in memory:

We ought, then, to set up images of a kind that can adhere longest in memory. And we shall do so if we establish similitudes as striking as possible; if we set up images that are not many or vague but active; if we assign to them exceptional beauty or singular ugliness; if we ornament some of them, as with crowns or purple cloaks, so that the similitude may be more distinct to us; or if we somehow disfigure them, as by introducing one stained with blood or soiled with mud and smeared with red paint, so that its form is more striking, or by assigning certain comic effects to our images, for that, too, will ensure our remembering them more readily."

On the other hand, the image associated with an emotion will call up the emotion when recollected. Carruthers discusses this in the context of the way in which the trained medieval memory was thought to be intimately related with the development of prudence or moral judgement.

"Since each phantasm is a combination not only of the neutral form of the perception, but of our response to it (intentio) concerning whether it is helpful or hurtful, the phantasm by its very nature evokes emotion. This is how the phantasm and the memory which stores it helps to cause or bring into being moral excellence and ethical judgement."

In modern terminology, the concept that salient, bizarre, shocking, or simply unusual information will be more easily remembered can be referred to as the Von Restorff effect.

Repetition

The well-known role of repetition in the common process of memorization of course plays a role in the more complex techniques of the art of memory. The earliest of the references to the art of memory, the Dialexis, mentioned above, makes this clear, "repeat again what you hear; for by often hearing and saying the same things, what you have learned comes complete into your memory." Similar advice is a commonplace in later works on the art of memory.

Techniques

The art of memory employed a number of techniques which can be grouped as follows for purposes of discussion, however they were usually used in some combination:

Architectural mnemonic

The architectural mnemonic was a key group of techniques employed in the art of memory. It is based on the use of places (Latin loci), which were memorized by practitioners as the framework or ordering structure that would 'contain' the images or signs 'placed' within it to record experience or knowledge. To use this method one might walk through a building several times, viewing distinct places within it, in the same order each time. After the necessary repetitions of this process, one should be able to remember and visualize each of the places reliably and in order. If one wished to remember, for example, a speech, one could break up the content of the speech into images or signs used to memorize its parts, which would then be 'placed' in the locations previously memorized. The components of the speech could then be recalled in order by imagining that one is walking through the building again, visiting each of the loci in order, viewing the images there, and thereby recalling the elements of the speech in order. A reference to these techniques survives to this day in the common English phrases "in the first place", "in the second place", and so forth. These techniques, or variants, are sometimes referred to as "the method of loci", which is discussed in a separate section below.

The primary source for the architectural mnemonic is the anonymous Ad Herennium, a Latin work on rhetoric from the first century BCE. It is unlikely that the technique originated with the author of the Ad Herennium. The technique is also mentioned by Cicero and Quintilian. According to the account in the Ad Herennium (Book III) backgrounds or 'places' are like wax tablets, and the images that are 'placed' on or within them are like writing. Real physical locations were apparently commonly used as the basis of memory places, as the author of the Ad Herennium suggests

"it will be more advantageous to obtain backgrounds in a deserted than in a populous region, because the crowding and passing to and fro of people confuse and weaken the impress of the images, while solitude keeps their outlines sharp."

However, real physical locations were not the only source of places. The author goes on to suggest

"if we are not content with our ready-made supply of backgrounds, we may in our imagination create a region for ourselves and obtain a most serviceable distribution of appropriate backgrounds."

Places or backgrounds hence require, and reciprocally impose, order (often deriving from the spatial characteristics of the physical location memorized, in cases where an actual physical structure provided the basis for the 'places'). This order itself organizes the images, preventing confusion during recall. The anonymous author also advises that places should be well-lit, with orderly intervals, and distinct from one another. He recommends a virtual 'viewing distance' sufficient to allow the viewer to encompass the space and the images it contains with a single glance.

Turning to images, the anonymous author asserts that they are of two kinds: those establishing a likeness based upon subject, and those establishing a likeness based upon a word. This was the basis for the subsequent distinction, commonly found in works on the art of memory, between 'memory for words' and 'memory for things'. He provides the following famous example of a likeness based upon subject:

"Often we encompass the record of an entire matter by one notation, a single image. For example, the prosecutor has said that the defendant killed a man by poison, has charged that the motive for the crime was an inheritance, and declared that there are many witnesses and accessories to this act. If in order to facilitate our defense we wish to remember this first point, we shall in our first background form an image of the whole matter. We shall picture the man in question as lying ill in bed, if we know his person. If we do not know him, we shall yet take some one to be our invalid, but not a man of the lowest class, so that he may come to mind at once. And we shall place the defendant at the bedside, holding in his right hand a cup, and in his left hand tablets, and on the fourth finger a ram's testicles (Latin testiculi suggests testes or witnesses). In this way we can record the man who was poisoned, the inheritance, and the witnesses."

In order to memorize likenesses based on words he provides an example of a verse and describes how images may be placed, each of which corresponds to words in the verse. He notes however that the technique will not work without combination with rote memorization of the verse, so that the images call to mind the previously memorized words.

The architectural mnemonic was also related to the broader concept of learning and thinking. Aristotle considered the technique in relation to topica, or conceptual areas or issues. In his Topics he suggested

"For just as in a person with a trained memory, a memory of things themselves is immediately caused by the mere mention of their places, so these habits too will make a man readier in reasoning, because he has his premisses classified before his mind's eye, each under its number."

Graphical mnemonic

Because of the influence of the pioneering work of Frances Yates, the architectural mnemonic is often characterized as the art of memory itself. However, primary sources show that from very early in the development of the art, non-physical or abstract locations and/or spatial graphics were employed as memory 'places'. Perhaps the most famous example of such an abstract system of 'places' is the memory system of Metrodorus of Scepsis, who was said by Quintilian to have organized his memory using a system of backgrounds in which he "found three hundred and sixty places in the twelve signs of the zodiac through which the sun moves". Some researchers (L.A. Post and Yates) believe it likely that Metorodorus organized his memory using places based in some way upon the signs of the zodiac. In any case Quintilian makes it clear that non-alphabetic signs can be employed as memory images, and even goes on to mention how 'shorthand' signs (notae) can be used to signify things that would otherwise be impossible to capture in the form of a definite image (he gives "conjunctions" as an example).

This makes it clear that though the architectural mnemonic with its buildings, niches and three dimensional images was a major theme of the art as practiced in classical times, it often employed signs or notae and sometimes even non-physical imagined spaces. During the period of migration of barbarian tribes and the transformation of the Roman empire the architectural mnemonic fell into disuse. However the use of tables, charts and signs appears to have continued and developed independently. Mary Carruthers has made it clear that a trained memory occupied a central place in late antique and medieval pedagogy, and has documented some of the ways in which the development of medieval memorial arts was intimately intertwined with the emergence of the book as we understand it today. Examples of the development of the potential inherent in the graphical mnemonic include the lists and combinatory wheels of the Majorcan Ramon Llull. The Art of Signs (Latin Ars Notoria) is also very likely a development of the graphical mnemonic. Yates mentions Apollonius of Tyana and his reputation for memory, as well as the association between trained memory, astrology and divination. She goes on to suggest

"It may have been out of this atmosphere that there was formed a tradition which, going underground for centuries and suffering transformations in the process, appeared in the Middle Ages as the Ars Notoria, a magical art of memory attributed to Apollonius or sometimes to Solomon. The practitioner of the Ars Notoria gazed at figures or diagrams curiously marked and called 'notae' whilst reciting magical prayers. He hoped to gain in this way knowledge, or memory, of all the arts and sciences, a different 'nota' being provided for each discipline. The Ars Notoria is perhaps a bastard descendant of the classical art of memory, or of that difficult branch of it which used the shorthand notae. It was regarded as a particularly black kind of magic and was severely condemned by Thomas Aquinas."

Textual mnemonic

Carruthers's studies of memory suggest that the images and pictures employed in the medieval arts of memory were not representational in the sense we today understand that term. Rather, images were understood to function "textually", as a type of 'writing', and not as something different from it in kind.

If such an assessment is correct, it suggests that the use of text to recollect memories was, for medieval practitioners, merely a variant of techniques employing notae, images and other non-textual devices. Carruthers quotes Pope Gregory I, in support of the idea that 'reading' pictures was considered to be a variation of reading itself.

"It is one thing to worship a picture, it is another by means of pictures to learn thoroughly the story that should be venerated. For what writing makes present to those reading, the same picturing makes present to the uneducated, to those perceiving visually, because in it the ignorant see what they ought to follow, in it they read who do not know letters. Wherefore, and especially for the common people, picturing is the equivalent of reading."

Her work makes clear that for medieval readers the act of reading itself had an oral phase in which the text was read aloud or sub-vocalized (silent reading was a less common variant, and appears to have been the exception rather than the rule), then meditated upon and 'digested' hence making it one's own. She asserts that both 'textual' activities (picturing and reading) have as their goal the internalization of knowledge and experience in memory.

The use of manuscript illuminations to reinforce the memory of a particular textual passage, the use of visual alphabets such as those in which birds or tools represent letters, the use of illuminated capital letters at the openings of passages, and even the structure of the modern book (itself deriving from scholastic developments) with its index, table of contents and chapters reflect the fact that reading was a memorial practice, and the use of text was simply another technique in the arsenal of practitioners of the arts of memory.

Method of loci

The 'method of loci' (plural of Latin locus for place or location) is a general designation for mnemonic techniques that rely upon memorized spatial relationships to establish, order and recollect memorial content. The term is most often found in specialized works on psychology, neurobiology and memory, though it was used in the same general way at least as early as the first half of the nineteenth century in works on Rhetoric, Logic and Philosophy.

O'Keefe and Nadel refer to "'the method of loci', an imaginal technique known to the ancient Greeks and Romans and described by Yates (1966) in her book The Art of Memory as well as by Luria (1969). In this technique the subject memorizes the layout of some building, or the arrangement of shops on a street, or any geographical entity which is composed of a number of

discrete loci. When desiring to remember a set of items the subject literally 'walks' through these loci and commits an item to each one by forming an image between the item and any distinguishing feature of that locus. Retrieval of items is achieved by 'walking' through the loci, allowing the latter to activate the desired items. The efficacy of this technique has been well established (Ross and Lawrence 1968, Crovitz 1969, 1971, Briggs, Hawkins and Crovitz 1970, Lea 1975), as is the minimal interference seen with its use."

The designation is not used with strict consistency. In some cases it refers broadly to what is otherwise known as the art of memory, the origins of which are related, according to tradition, in the story of Simonides of Ceos and the collapsing banquet hall discussed above.] For example, after relating the story of how Simonides relied on remembered seating arrangements to call to mind the faces of recently deceased guests, Steven M. Kosslyn remarks "his insight led to the development of a technique the Greeks called the method of loci, which is a systematic way of improving one's memory by using imagery." Skoyles and Sagan indicate that "an ancient technique of memorization called Method of Loci, by which memories are referenced directly onto spatial maps" originated with the story of Simonides. Referring to mnemonic methods, Verlee Williams mentions, "One such strategy is the 'loci' method, which was developed by Simonides, a Greek poet of the fifth and sixth centuries BC" Loftus cites the foundation story of Simonides (more or less taken from Frances Yates) and describes some of the most basic aspects of the use of space in the art of memory. She states, "This particular mnemonic technique has come to be called the "method of loci". While place or position certainly figured prominently in ancient mnemonic techniques, no designation equivalent to "method of loci" was used exclusively to refer to mnemonic schemes relying upon space for organization.

In other cases the designation is generally consistent, but more specific: "The Method of Loci is a Mnemonic Device involving the creation of a Visual Map of one's house."

This term can be misleading: the ancient principles and techniques of the art of memory, hastily glossed in some of the works just cited, depended equally upon images and places. The designator "method of loci" does not convey the equal weight placed on both elements. Training in the art or arts of memory as a whole, as attested in classical antiquity, was far more inclusive and comprehensive in the treatment of this subject.

Memorization

Memorization or memorizing (also spelled memorisation or memorising) is the process of committing something to memory. The act of memorization is often a deliberate mental process undertaken in order to store in memory for later recall items such as experiences, names, appointments, addresses, telephone numbers, lists, stories, poems, pictures, maps, diagrams, facts, music or other visual, auditory, or tactical information. Memorization may also refer to the

process of storing particular data into the memory of a device.

The scientific study of memory is part of cognitive neuroscience, an interdisciplinary link between cognitive psychology and neuroscience.

Some principles and techniques that have been used to assist in memorization include:

Rote learning, a learning technique which focuses not on understanding but on memorization by means of repetition. For example, if words are to be learnt, they may be repeatedly spoken aloud or repeatedly written down.

A mnemonic, a type of memory aid. Mnemonics are often verbal, such as a very short poem or a special word used to help a person remember something, particularly lists, but they may be visual, kinesthetic or auditory. Mnemonics rely on associations between easy-to-remember constructs which can be related back to the data that is to be remembered. This is based on the principle that the human mind much more easily remembers spatial, personal, surprising, sexual or humorous or otherwise meaningful information than arbitrary sequences.

A Mnemonic link system, a method of remembering lists, based on creating an association between the elements of that list. For example, if one wished to remember the list (dog, envelope, thirteen, yarn, window), one could create a link system, such as a story about a "dog stuck in an envelope, mailed to an unlucky black cat playing with yarn by the window". It is then argued that the story would be easier to remember than the list itself. Alternatively one could use visualisation, seeing in one's mind's eye an image that includes two elements in the list that are next to each other. One could imagine a dog inside a giant envelope, then visualise an unlucky black cat (or whatever that reminds the user 'thirteen') eating a huge envelope. In order to access a certain element of the list, one needs to "traverse" the system (much in the same vein as a linked list), in order to get the element from the system.

A peg system, a technique for memorizing lists. It works by pre-memorizing a list of words that are easy to associate with the numbers they represent (1 to 10, 1-100, 1-1000, etc.). Those objects form the "pegs" of the system. Then in the future, to rapidly memorize a list of arbitrary objects, each one is associated with the appropriate peg. Generally, a peglist only has to be memorized one time, and can then be used over and over every time a list of items needs to be memorized. The peglists are generated from words that are easy to associate with the numbers (or letters). Peg lists created from letters of the alphabet or from rhymes are very simple to learn, but are limited in the number of pegs they can produce.

The Major system, a mnemonic technique used to aid in memorizing numbers which is also called the phonetic number system or phonetic mnemonic system. It works by converting numbers first into consonant sounds, then into words by adding vowels. The words can then be remembered more easily than the numbers, especially when using other mnemonic rules which call for the words to be visual and emotive.

The Method of loci, a technique for memorizing practiced since classical antiquity which is a type of

mnemonic link system based on places (loci, otherwise known as locations). It is often used where long lists of items need to be memorized. The technique was taught for many centuries as a part of the curriculum in schools, enabling an orator to easily remember a speech or students to easily remember many things at will.

The Art of memory, a group of mnemonic principles and techniques used to organize memory impressions, improve recall, and assist in the combination and 'invention' of ideas. This group of principles was usually associated with training in Rhetoric or Logic from the time of Ancient Greece, but variants of the art were employed in other contexts, particularly the religious and the magical. Techniques commonly employed in the art include the association of emotionally striking memory images within visualized locations, the chaining or association of groups of images, the association of images with schematic graphics or notae ("signs, markings, figures" in Latin), and the association of text with images. Any or all of these techniques were often used in combination with the contemplation or study of architecture, books, sculpture and painting, which were seen by practitioners of the art of memory as externalizations of internal memory images and/or organization.

Specialised forms of rote learning have also been used in Vedic chant since as long as three thousand years ago, to preserve the intonation and lexical accuracy of very long texts, some with tens of thousands of verses.

Mnemonic

A mnemonic device, is any learning technique that aids memory. Commonly encountered mnemonics are often verbal, such as a very short poem or a special word used to help a person remember something, particularly lists, but a mnemonic may instead be visual, kinesthetic or auditory. Mnemonics rely on associations between easy-to-remember constructs which can be related back to the data that is to be remembered. This is based on the principle that the human mind much more easily remembers spatial, personal, surprising, sexual or humorous or otherwise meaningful information, as compared to retrieving arbitrary sequences.

The major assumption in antiquity was that there are two sorts of memory: the "natural" memory and the "artificial" memory. The former is inborn, and is the one that everyone uses every day. The artificial memory is one that is trained through learning and practicing a variety of mnemonic techniques. The latter can be used to perform feats of memory that are quite extraordinary, impossible for most people to carry out using the natural memory alone.

First letter mnemonics

One common mnemonic for remembering lists consists of an easily remembered acronym, or phrase with an acronym that is associated with the list items. The idea lends itself well to memorizing hard-to-break passwords as well. For example, to remember the colours of the

rainbow, use the mnemonic "Richard Of York Gave Battle In Vain".

Mnemonics for numerical sequences

Mnemonic phrases or poems can be used to encode numeric sequences by various methods, the most common using the number of letters in each word. For example, the first 15 digits of the mathematical constant pi (3.14159265358979) can be encoded as How I need a drink, alcoholic of course, after the heavy lectures involving quantum mechanics". A large number of so-called piems have been devised, some containing thousands of digits; see the article on "Piphilology" for examples in multiple languages.

Arbitrariness of mnemonics

A curious characteristic of many memory systems is that mnemonics work despite being (or possibly because of being) illogical or arbitrary. "Roy" is a legitimate first name, but there is no actual surname "Biv" and of course the middle initial "G" is arbitrary. Why is "Roy G. Biv" easy to remember in order to memorise the order that the seven colours of the rainbow appear? ROYGBIV can also be expressed as the almost meaningless phrase "Roy Great Britain the Fourth" again referencing "Roy" but using the GB national code for Great Britain and the Roman numerals for 4, viz: IV. The sentence "Richard of York gave battle in vain" is commonly used in the UK. Any two of the three months ending in -ember would fit just as euphoniously as September and November in "Thirty days hath...", yet most people can remember the rhyme correctly for a lifetime after having heard it once, and are never troubled by doubts as to which two of the -ember months have thirty days. A bizarre arbitrary association may stick in the mind better than a logical one.

One reason for the effectiveness of seemingly arbitrary mnemonics is the grouping of information provided by the mnemonic. Just as US phone numbers group 10 digits into three groups, the name "Roy G. Biv" groups seven colors into two short names and an initial. Various studies (most notably The Magical Number Seven, Plus or Minus Two) have shown that the human brain is capable of remembering only a limited number of arbitrary items in working memory; grouping these items into chunks permits the brain to hold more of them in memory.

Assembly mnemonics

In assembly language a mnemonic is a code, usually from 1 to 5 letters, that represents an opcode, a number.

Programming in machine code, by supplying the computer with the numbers of the operations it must perform, can be quite a burden, because for every operation the corresponding number must be looked up or remembered. Looking up all numbers takes a lot of time, and mis-remembering a

number may introduce computer bugs.

Therefore a set of mnemonics was devised. Each number was represented by an alphabetic code. So instead of entering the number corresponding to addition to add two numbers one can enter "add".

Although mnemonics differ between different CPU designs some are common, for instance: "sub" (subtract), "div" (divide), "add" (add) and "mul" (multiply).

This type of mnemonic is different from the ones listed above in that instead of a way to make remembering numbers easier, it is a way to make remembering numbers unnecessary (e.g. by relying on the computer's assembler program to do the lookup work.)

In foreign language acquisition

Mnemonics can be helpful in studying a foreign language, for example by adapting a foreign word that is hard to remember to a pre-existent phrase in the learner's native language - using folk etymology. Linguist Ghil'ad Zuckermann has proposed many Anglo-Hebraic lexical mnemonics for English-speaking students of Israeli Hebrew. For example, in trying to assist the learner to remember ohel, the Hebrew word for tent, Zuckermann proposes the memorable sentence "Oh hell, there's a raccoon in my tent". The memorable sentence "There's a fork in Ma's leg" may help the learner remember that the Hebrew word for fork is mazleg, and so forth. The notable linguist Michel Thomas taught students to remember that estar is the Spanish word for to be by using the phrase "to be a star". These are sometimes known as linkwords.

Mnemonic major system

The Major System (also called the phonetic number system, phonetic mnemonic system, or Herigone's mnemonic system) is a mnemonic technique used to aid in memorizing numbers.

The system works by converting numbers into consonant sounds, then into words by adding vowels. The system works on the principle that images can be remembered more easily than numbers.

The system

Each numeral is associated with one or more consonants. Vowels and the consonants w, h and y are ignored. These can be used as "fillers" to make sensible words from the resulting consonant sequences.

The groups of similar sounds and the rules for applying the mappings are almost always fixed, but

other hooks and mappings can be used as long as the person using the system can remember them and apply them consistently. The magician Derren Brown, for instance, chooses the number 5 to map to the f and v sounds because the word 'five' uses both of those sounds.

Each numeral maps to a set of similar sounds with similar mouth and tongue positions. The link is phonetic, that is to say, it is the consonant sounds that matter, not the spelling. Therefore a word like action would encode the number 762 (k-ch-n), not 712 (k-t-n); and ghost would be 701 (g-z-t), while, because the gh in enough is pronounced like an f, the word enough encodes the number 28 (n-f). Similarly, double letters are disregarded. The word missile is mapped to 305 (m-z-l), not 3005 (m-z-z-l). To encode 3005 one would use something like mossy sail. Often the mapping is compact. Hindquarters, for example, translates unambiguously to 2174140 (n-d-qu-r-t-r-z), which amounts to 7 digits encoded by 8 letters, and can be easily visualized.

For most people it would be easier to remember 3.1415927 (the number known as pi as:

MeTeoR (314) TaiL (15) PiNK (927)

Short term visual memory of imagined scenes allows large numbers of digits to be memorized with ease, though usually only for a short time.

Whilst this is unwieldy at first, with practice it can become a very effective technique. Longer-term memory may require the formulation of more object-related mnemonics with greater logical connection, perhaps forming grammatical sentences that apply to the matter rather than just strings of images.

The system can be employed with phone numbers. One would typically make up multiple words, preferably a sentence, or an ordered sequence of images featuring the owner of the number.

The Major System can be combined with a peg system for remembering lists, and is sometimes used also as a method of generating the pegs. It can also be combined with other memory techniques such as rhyming, substitute words, or the method of loci. Repetition and concentration using the ordinary memory is still required.

An advantage of the major system is that it is possible to use a computer to automatically translate the number into a set of words. One can then pick the best of several alternatives. Such programs include "Rememberg" or the freeware "2Know".

History

A different memory system, the method of loci was taught to schoolchildren for centuries, at least until 1584, "when Puritan reformers declared it unholy for encouraging bizarre and irreverent images." The same objection can be made over the major system, with or without the method of

loci. Mental images may be easier to remember if they are insulting, violent, or obscene (see Von Restorff effect).

Pierre Hérigone (1580-1643) was a French mathematician and astronomer and devised the earliest version of the major system. The major system was further developed by Stanislaus Mink von Wennsshein 300 years ago. It was later elaborated upon by other users. In 1730, Richard Grey set forth a complicated system that used both consonants and vowels to represent the digits. In 1808 Gregor von Feinaigle introduced the improvement of representing the digits by consonant sounds (but reversed the values of 8 and 9 compared to those listed above). The system described in this article was popularized by Harry Lorayne, a best selling contemporary author on memory.

Practice

Memory feats centred around numbers can be performed by experts who have learned a 'vocabulary' of at least 1 image for every 1 and 2 digit words which can be combined to form narratives. To learn a vocabulary of 3 digit numbers is harder because for each extra digit 10 times more images need to be learned, but many mnemonists use a set of 1000 images. Combination of images into a narrative is easier to do rapidly than is forming a coherent, grammatical sentence. This pre-memorisation and practice at forming images reduces the time required to think up a good imaginary object and create a strong memorable impression of it. The best words for this purpose are usually nouns, especially those for distinctive objects which make a strong impression on a variety of senses (e.g. a "Lime" for 53, it's taste, its smell, its colour and even its texture are distinctive) or which move (like an "arrow" for 4). For basic proficiency a large vocabulary of image words isn't really necessary since, when the table above is reliably learned, it is easy to form your own words ad hoc.

Indexing Sequences

Mnemonics often centre around learning a complete sequence where all objects in that sequence that come before the one you are trying to recall must be recalled first. For instance, if you were using the mnemonic "Richard of York gave battle in vain" for the colours of the rainbow; (red, orange, yellow, green, blue, indigo and violet) to remember what colour comes after indigo you would have to recall the whole sequence. For a short sequence this may be trivial; for longer lists, it can become complicated and error-prone. A good example would be in recalling what is the 53rd element of the periodic table. It might be possible for some people to construct and then learn a string of 53 or more items which you have substituted for the elements and then to recall them one by one, counting them off as you go, but it would be a great deal easier and less laborious/tedious to directly associate element 53 with, for example, a lime (a suitable mnemonic for 53) recalling some prior imagining of yours regarding a mishap where lime juice gets into one's eye - "eye"

sounding like "I", the symbol for Iodine. If you were remembering element 53 in the process of recalling the periodic table you could then recall an image for 54, for instance thinking of a friend called "Laura" (54) in the lotus position looking very Zen-like in order to remind yourself that element 54 is Xenon.

Mnemonic link system

A mnemonic link system, sometimes also known as a chain method, is a method of remembering lists, based on creating an association between the elements of that list. For example, if one wished to remember the list (dog, envelope, thirteen, yarn, window), one could create a link system, such as a story about a "dog stuck in an envelope, mailed to an unlucky black cat playing with yarn by the window". It is then argued that the story would be easier to remember than the list itself.

A probably more effective method rather than creating a story is to actually link each element of the list with the following, seeing in one's mind's eye an image that includes two elements in the list that are next to each other. For example, if we wanted to easily memorize the last list one would imagine his or her dog inside of a giant envelope, then one would "see" an unlucky black cat (or whatever that reminds the user 'thirteen') eating a huge envelope. The same logic should be used with the rest of the items. The observation that absurd images are easier to remember is known as the Von Restorff effect, but was refuted as a mnemonic technique by several studies (Hock et al. 1978; Einstein 1987). Important is not the absurdness but the established interaction between the two words. By combining this method with others, like the Peg system and the Major system (which is used to retain numbers), we can easily get what some people call a trained memory.

However, in order to access a certain element of the list, one needs to "traverse" the system (much in the same vein as a linked list), in order to get the element from the system.

Mnemonic dominic system

The mnemonic dominic system is a mnemonic system used to remember sequences of digits similar to the mnemonic major system. It was invented and used in competition by several-time memory world champion Dominic O'Brien.

Differences from the major system

Uses people and actions to represent numbers rather than objects.
For each pair of digits define an action in addition to a person.
Combines people together with actions to create large number 'chunks'.

Encoding pairs of digits as people

Using the dominic system every pair of digits is first associated with a person. Dominic O'Brien feels that stories and images created using people are easier to remember. This encoding is carried out ahead of time and the people are reused, since it can take quite some time.

To perform this encoding, each digit is associated with a letter using the table below. These letters then become the initials of the person representing this number. People will often use quite a loose definitions of initials, using the initial letters of a phrase describing a person.

Number -- 1 2 3 4 5 6 7 8 9 0
Mnemonic -- A B C D E S G H N O

Encoding pairs of digits as actions

Once each pair of digits has been associated with a person one can then cheaply create a corresponding set of actions or for each person. For example, if one had chosen to represent AE as the physicist Albert Einstein one might use a corresponding action of writing on a blackboard.

Usage

Once the mappings of pair of digits are in place a sequence of digits can be converted into a story by first encoding pairs of digits as people or actions and the chaining these people and actions together.

For example, one might remember the number 2739 as follows: First 27 would be encoded BG and then as , then 39 would be encoded as CN and then Chuck Norris. Using the first two digits as a person and the second two as an action, one creates the image of Bill Gates delivering a roundhouse kick. Similarly 3927 might be converted into the image of Chuck Norris writing software could represent 3927.

Longer numbers become stories. The long number 27636339, for example, could be chunked into 2763 6339 and then converted into BGSC SCCN. If the memorizer has also associated Santa Claus delivering presents with SC, then the chunk 2763 would represent Bill Gates delivering presents while 6339 would represent Santa Claus performing a roundhouse kick. The remembered story, therefore, could be that Bill Gates delivered presents and then got roundhouse kicked by Santa Claus.

This might be combined with the loci system to have certain events happen at locations along a pre-remembered path.

Packs of cards

Although the Dominic system is a method for remembering long sequences of numbers, it can also be used to remember other sequences such as the order of a deck of playing cards. This works by establishing some method of systematically converting the objects into numbers. If the nine of clubs is associated with 39 (CN), for instance, then Chuck Norris or a roundhouse kick could be used in a story describing where the nine of clubs is in the deck.

Method of loci

The method of loci (plural of Latin locus for place or location), also called the memory palace, is a mnemonic device introduced in ancient Roman rhetorical treatises (in the anonymous Rhetorica ad Herennium, Cicero's De Oratore, and Quintilian's Institutio oratoria). It relies on memorised spatial relationships to establish, order and recollect memorial content. The term is most often found in specialised works on psychology, neurobiology and memory, though it was used in the same general way at least as early as the first half of the nineteenth century in works on rhetoric, logic and philosophy.

The method of loci is also commonly called the mental walk. In basic terms, it is a method of memory enhancement which uses visualization to organize and recall information. Many memory contest champions claim to use this technique in order to recall faces, digits, and lists of words. These champions' successes have little to do with brain structure or intelligence, but more to do with their technique of using regions of their brain that have to do with spatial learning. Those parts of the brain that contribute most significantly to this technique include the medial parietal cortex, retrosplenial cortex, and the right posterior hippocampus.

O'Keefe and Nadel refer to

'the method of loci', an imaginal technique known to the ancient Greeks and Romans and described by Yates (1966) in her book The Art of Memory as well as by Luria (1969). In this technique the subject memorizes the layout of some building, or the arrangement of shops on a street, or any geographical entity which is composed of a number of discrete loci. When desiring to remember a set of items the subject literally 'walks' through these loci and commits an item to each one by forming an image between the item and any distinguishing feature of that locus. Retrieval of items is achieved by 'walking' through the loci, allowing the latter to activate the desired items. The efficacy of this technique has been well established (Ross and Lawrence 1968, Crovitz 1969, 1971, Briggs, Hawkins and Crovitz 1970, Lea 1975), as is the minimal interference seen with its use.

Applicability of the term

The designation is not used with strict consistency. In some cases it refers broadly to what is otherwise known as the art of memory, the origins of which are related, according to tradition, in the story of Simonides of Ceos and the collapsing banquet hall. For example, after relating the story of how Simonides relied on remembered seating arrangements to call to mind the faces of recently deceased guests, Steven M. Kosslyn remarks "his insight led to the development of a technique the Greeks called the method of loci, which is a systematic way of improving one's memory by using imagery." Skoyles and Sagan indicate that "an ancient technique of memorization called Method of Loci, by which memories are referenced directly onto spatial maps" originated with the story of Simonides. Referring to mnemonic methods, Verlee Williams mentions, "One such strategy is the 'loci' method, which was developed by Simonides, a Greek poet of the fifth and sixth centuries BC" Loftus cites the foundation story of Simonides (more or less taken from Frances Yates) and describes some of the most basic aspects of the use of space in the art of memory. She states, "This particular mnemonic technique has come to be called the "method of loci". While place or position certainly figured prominently in ancient mnemonic techniques, no designation equivalent to "method of loci" was used exclusively to refer to mnemonic schemes relying upon space for organization.

In other cases the designation is generally consistent, but more specific: "The Method of Loci is a Mnemonic Device involving the creation of a Visual Map of one's house."

This term can be misleading: the ancient principles and techniques of the art of memory, hastily glossed in some of the works cited above, depended equally upon images and places. The designator "method of loci" does not convey the equal weight placed on both elements. Training in the art or arts of memory as a whole, as attested in classical antiquity, was far more inclusive and comprehensive in the treatment of this subject.

Spatial mnemonics and the hippocampus

In a classic study in cognitive neuroscience O'Keefe and Nadel proposed "that the hippocampus is the core of a neural memory system providing an objective spatial framework within which the items and events of an organism's experience are located and interrelated." This theory has generated considerable debate and further experiment. It has been noted that "he hippocampus underpins our ability to navigate, to form and recollect memories, and to imagine future experiences. How activity across millions of hippocampal neurons supports these functions is a fundamental question in neuroscience, wherein the size, sparseness, and organization of the hippocampal neural code are debated."

"Using neuropsychological, structural, and functional brain imaging measures, we found that

superior memory is not driven by exceptional intellectual ability or structural brain differences. Rather, we found that superior memorizers used a spatial learning strategy (the method of loci; Yates, 1966) while preferentially engaging brain regions critical for memory and for spatial memory in particular, including the hippocampus."

The "method of loci," as first described by Simonides (cf. Yates, 1966), is explicitly spatial. In this technique, subjects improve memory by putting to-be-remembered items into some place or spatial context. Retrieval is effected simply by "going" to that place in thought Events occurring within separate contexts are efficiently recalled in those contexts and minimally confused between contexts, though the events themselves might be highly similar. The mental maps we have of our home town, our neighborhood, and our house are all examples of the kinds of spatial contexts within which events occur, can be coded internally, and can subsequently be effectively retrieved or recalled: Studies by Smith, Glenberg, and Bjork (1978) and Bellezza and Reddy (1978) indicate that the power of the method of loci might lie in its ability to take advantage of this natural state of affairs.

Parietal cortex and retrosplenial cortex contributions to spatial mnemonics

The medial parietal cortex is most associated with encoding and retrieving of information. Patients who suffered from medial parietal cortex damage had troubles linking landmarks with certain locations. Many of these patients were unable to give or follow directions and often got lost.

The retrosplenial cortex is also greatly linked to memory and navigation. In Pothuzien HH's study on the effects of selective granular retrosplenial cortex lesions in rats, the researcher found that damage to the retrosplenial cortex lead to impaired spatial learning abilities. Rats with damage to this area failed to recall which areas of the maze they had already visited, rarely explored different arms of the maze, almost never recalled the maze in future trials, and took longer to reach the end of the maze, as compared to rats with a fully working retrosplenial cortex.

The mental walk originated from the idea that you can best remember things that you are familiar with. Therefore, by associating a certain object with a familiar landmark, you increase your chances of remembering that object. Since the mental walk revolves around the idea of visualizing a familiar place and associating certain ideas or items with landmarks within that familiar place, the medial parietal cortex plays a huge role in this technique. Without the ability to mentally "walk" through a familiar route, this method cannot work.

Contemporary usage

All top memorisers today use the 'method of loci' to a greater or lesser degree. Contemporary memory competition was initiated in 1991 and introduced to the USA in 1997. Part of the

competition requires committing to memory and recalling a sequence of digits, 2-digit numbers, alphabetic letters, or playing cards. In a simple method of doing this, contestants, using various strategies well before competing, commit to long-term memory a unique vivid image associated with each item. They have also committed to long-term memory a familiar route with firmly established stop-points or loci. Then in the competition they need only deposit the image that they have associated with each item at the loci. To recall, they retrace the route, 'stop' at each locus and 'observe' the image. They then translate this back to the associated item. Memory champions elaborate on this by combining images. Eight-time World Memory Champion Dominic O'Brien advocates this technique. His name for it is The Journey Method. The 2006 World Memory Champion, Clemens Mayer from Germany, used a 300-point-long journey through his house for his world record in "number half marathon", memorising 1040 random digits in a half hour. One individual has used the method of loci to memorise pi to 65,536 digits.

Using this technique a person with ordinary memorization capabilities, after establishing the route stop-points and committing the associated images to long-term memory, with less than an hour of practice can remember the sequence of a shuffled deck of cards. The world record for this is held by Simon Reinhard at 21.90 seconds.

The technique is taught as a metacognitive technique in learning to learn courses. It is generally applied to encoding the key ideas of a subject. Two approaches are: 1. Link the key ideas of a subject and then deep-learn those key ideas in relation to each other, and; 2. Think through the key ideas of a subject in depth, re-arrange the ideas in relation to an argument, then link the ideas to loci in good order. It has been found that teaching such techniques as pure memorization methods often leads students towards surface learning only. Therefore, it has been recommended that the method of loci should be integrated thoroughly with deeper learning approaches.

Something that is likely a reference to the 'method of loci' techniques survives to this day in the common English phrases "in the first place", "in the second place", and so forth.

In popular culture, the technique is employed by serial killer Dr Hannibal Lecter in Hannibal (1999) the third of a series of novels by American author Thomas Harris. In several passages in the book Dr Lecter is described as mentally walking through an elaborate memory palace to remember facts.

Example of usage of the method of loci/mental walk

During the mental walk, people remember lists of words by mentally walking a familiar route and associating these objects with specific landmarks on their route. An example of this would be to remember your grocery shopping list in a mental walk from your bedroom to kitchen in your house. Let's say the first item on your list was bread; then mentally you can place a loaf of bread on your

bed. As you continue mentally walking you can place the next item, assume it is eggs, on your dresser. The mental walk continues like this as you place consecutive items along a familiar route that you walk. So when you are at the grocery store, you can then think about this walk and "see" what you placed at each location. In your head you will remember bread being on your bed, and eggs being on the dresser. This can continue for as many items as you want to place on your path as long as the route continues. The more dramatic the images, the more vivid the memory. For instance: instead of "bread", try to visualize a giant loaf of bread; instead of "eggs", imagine broken eggs all over the place.

Cramming (Mnemonics and Memorization)

In education, cramming (also known as mugging or swotting) is the practice of working intensively to absorb large volumes of informational material in short amounts of time. It is often done by students in preparation for upcoming exams. Cramming is often discouraged by educators because the hurried coverage of material tends to result in poor long-term retention of material (see spacing effect).

Cramming usually occurs during the revision week, also known as swotvac or stuvac (student vacation) in some Commonwealth countries.

The pressure to excel academically has led to cramming behavior among students as young as five years old.

Cramming as a study technique

Best stated by H.E. Gorst in his book, The Curse of Education, "as long as education is synonymous with cramming on an organized plan, it will continue to produce mediocrity."

Generally considered as a negative study technique, cramming is becoming more and more common among students both at the secondary and post-secondary level. Pressure to perform well in the classroom and engage in extracurricular activities in addition to other responsibilities often results in the cramming method of studying. Cramming is a widely-used study skill performed in preparation of an examination or other performance-based assessment.

Most common among high school and college-aged students, cramming is often used as a means of memorizing large amounts of information in a short amount of time. Students are often forced to cram after improper time utilization or in efforts to understand information shortly before being tested. Improper time management is usually the cause for last-minute cramming sessions, and many study techniques have been developed to help students succeed instead of cramming.

Research

Criticism for this study mechanism has long been a difficult topic to address and overcome for administrators and teachers of all ages, and numerous studies have been conducted researching the effectiveness of cramming. In a 2007 study conducted by University of South Florida psychologist Doug Rohrer, it was determined that last minute studying reduces retention of material and may hinder the learning process in the long term. Additional studies in rote learning, or memorization, have shown that relying solely on memorization techniques reduces the overall retention of information.

Cramming and school performance

Teaching students to avoid last-minute cramming is a large area of concern for education professionals and profit for educational corporations and businesses. Learning and teaching study techniques that enhance retention as opposed to learning for a single examination is one of the core issues that plagues colleges and university academic advisors, and also adds to the stress of academic success for students. Ideally, proper study skills need to be introduced and practiced as early as possible in order for students to effectively learn positive study mechanisms.

According to W.G. Sommer, students in a university system often adapt to the time-constraints that are placed upon them in college, and often use cramming to perform well on tests. In his article, Procrastination and Cramming: How Adept Students Ace the System, he states "Many students outwardly adapt to this system, however, engage in an intense and private ritual that comprises five aspects: calculated procrastination, preparatory anxiety, climactic cramming, nick-of-time deadline-making, and a secret, if often uncelebrated, victory. These adept students often find it difficult to admit others into their efficient program of academic survival."

Active learning and critical thinking are two methods which emphasize the retention of material through the use of class discussions, study groups and individual thinking. Each has been cited as a more effective means of learning and retaining information as compared to cramming and memorization.

Linkword

Linkword is a mnemonic system promoted by Michael Gruneberg since at least the early 1980's for learning languages based on the similarity of the sounds of words. The process involves creating an easily visualized scene that will link the words together. One example is the Russian word for cow (??????, pronounced roughly karova): think and visualize "I ran my car over a cow."

It has a long history of software versions in its native United Kingdom being available for the

Sinclair, Acorn and BBC micro computers as well as a variety of audio and book editions over the years.

Discussion of the method

Many teachers and students of language have used the same technique, and many examples have been used independently by many people (e.g., to remember that in Thai, khao means rice, imagine a cow eating rice).

One of the drawbacks of such methods is that it takes a lot of effort to create a scene for every new word. Linkword has the advantage of offering ready made scenes for each word, so hundreds of words can be memorized in a few hours. However, it offers only a basic vocabulary (e.g. 200 words for a survival course and around 1400 words for a 4-level course).

Another criticism of mnemonic techniques such as this is that they tend to assume a one-to-one relationship between the learner's first language and the target language. In reality, words often have a different range of meanings, and so the student must learn the complexity or nuance of the new words. For this reason, such techniques may be seen as a useful and powerful way to progress in the language, especially in the early stages, rather than giving a complete understanding.

Critics also say that because the method relies on the coincidental similarities in the sounds of words, it cannot be used to teach all, or even most, words of another language as there may be no corresponding phonetically similar words or visualizations that could be used. In practice, however, there is usually a visualization that can be used, but for some words it is a less direct connection and not as effective. In these cases, there is more need for other learning methods to support the visualization, such as repetition and flashcards.

The system is similar to a well-known trick of some stage mnemonists employed for memorizing huge lists of words suggested by spectators to repeat them in any given order, forwards, backwards, even ones, etc, known as mnemonic peg system. A mnemonist has his own "counting list" of words. Each counting word is bound to the next spectator's word by means of a sentence, as described above. Some mnemonists claim the sillier the binding sentence, the easier it is to remember.

While this method could be used to teach from any language to any language, it is currently used almost exclusively to teach English speaking people other languages. Many different companies offer systems based on this method, but the list of languages offered is almost identical. Learning courses have been developed to teach students Dutch, French, German, Greek, Hebrew, Italian, Japanese, Portuguese (both Brazilian and European), Russian, Spanish (both European and South American) and Welsh.

Mnemonic peg system

A peg system is a technique for memorizing lists. It works by pre-memorizing a list of words that are easy to associate with the numbers they represent (1 to 10, 1-100, 1-1000, etc). Those objects form the "pegs" of the system. Then in the future, to rapidly memorize a list of arbitrary objects, each one is associated with the appropriate peg. Generally, a peglist only has to be memorized one time, and can then be used over and over every time a list of items needs to be memorized.

The peglists are generated from words that are easy to associate with the numbers (or letters). Peg lists created from letters of the alphabet or from rhymes are very simple to learn, but are limited in the number of pegs they can produce. The Major System is often used to create pegs. While it is more complicated to learn than simple rhymes or alphabetic pegs, it is limitless in the number of pegs it can produce.

Peg Lists

A rhyming example

1-gun Visualize the first item being fired from a gun
2-zoo Visualize an association between the second thing and a zoo
3-tree Visualize the third item growing from a tree
4-door Visualize the 4th item associated with a door
5-hive Visualize the fifth item associated with a hive or with bees
6-bricks Visualize the sixth item associated with bricks
7-heaven Visualize the seventh item associated with heaven
8-plate Visualize the 8th item on a plate as if it is food
9-wine Visualize a glass containing the 9th item
10-hen Visualize the 10th item associated with a chicken.

For example to remember the following grocery list of 10 items:

Apple: Picture an apple being fired from a gun
Butter: picture a gorilla stomping up and down on a stick of butter
Razor Blades: Picture a tree with razor blades for leaves
Soap: Picture a door made from soap
Bread: Picture bees flying from a loaf of bread as if it is a hive
Milk: Picture a brick house with milk jugs where the bricks should be
Cat food: Picture an open can of cat food with angel wings and a halo
Bacon: Picture bacon on a plate
Batteries: Picture a wine glass filled with batteries
Orange juice: Picture a hen being squeezed, and orange juice coming out

Rhyme may also help with memorising a peglist. Here is another example that includes an element of rhyme:

one ate a bun
two in shoes
Three for free
four on the floor
five is alive
six on sticks
seven in heaven
eight comes late
nine down a mine
ten in a pen

Shape example

Based on the shape of the digits.

1-candle
2-swan
3-camel
4-chair
5-hook
6-cherry
7-cliff
8-hourglass
9-balloon
10-baseball and bat