Tutorial: Memory and Memory Problems

WHAT IS MEMORY?

Memory is one of the central components of human cognition, including the ability to take in information, process it, store it, and subsequently retrieve it when necessary. Thus the core processes of memory are encoding, storage, and retrieval:

Encoding: Processing information, organizing it, and marking it for storage
Storage: Holding information over time in what is ideally an organized storage system
Retrieval: Calling stored information to consciousness

Following TBI, both encoding and retrieval can be significantly impaired. However, storage (i.e., keeping information in storage after it has been effectively processed) is often relatively spared. Therefore, if information can be effectively processed and encoded, it is more likely to be retained, even though it may be difficult to retrieve. **Video Illustration of Types of Retrieval**

Memory Processes and Systems

Authorities on memory typically explain human memory by drawing a variety of distinctions among different types or aspects of memory. Understanding many of these distinctions is important for staff and family members working with students with memory and learning impairments.

Voluntary and involuntary memory: Encoding: Encoding of information for storage in long-term memory can be either involuntary (incidental, implicit) or voluntary (effortful, deliberate, strategic).

- **Involuntary encoding** occurs when the goal of the activity is something other than memory or learning, and memory occurs as a bi-product. For example, a young student may remember the names of geometric figures not by trying to memorize them, but rather because he was involved in an art project in which it was important to process the names of the geometric figures in order to complete the project. Young children tend to be good at involuntary or implicit encoding and weak at voluntary or effortful encoding.
- **Voluntary or effortful encoding** occurs when the goal of the task is to learn or remember (i.e., trying to learn or remember). The procedures used to achieve success in effortful encoding tasks are memory strategies (e.g., mentally rehearsing, organizing, or elaborating). Young children as well as individuals with frontal lobe injury tend to be weak at effortful or strategic memory/learning tasks. In fact, their ability to learn and remember may be reduced when they are told to "try to remember". Learning may be less effective under these circumstances because the child does not have or does not know how to use the strategies that would need to be used when "trying to learn or remember".
- **Voluntary and involuntary memory: Retrieval:** Retrieval can also be involuntary (often referred to as implicit retrieval) or voluntary (effortful, deliberate, strategic).
- **Involuntary or implicit retrieval** occurs when stored information is brought to consciousness with no effort to retrieve the information and often with no awareness that the information was stored. The information may be retrieved automatically when a cue triggers it.
- **Voluntary, effortful, or strategic retrieval** occurs when there is an attempt to retrieve the information, that is trying to remember. Young children (e.g., preschoolers) rarely benefit from the instruction to "try to remember" because they do not use memory strategies for this purpose. The same is true of developmentally young children and many children with frontal lobe injury. Voluntary retrieval is impaired by damage to the frontal lobes, common after TBI. Involuntary or implicit retrieval may be relatively intact even in the presence of damage to the frontal lobes and to the hippocampus (one of the primary brain structures for human memory and part of the limbic system located in the medial temporal lobes of the brain). **See Tutorial on Retrieval and Retrieval Problems**.

Retrospective and prospective memory: Retrospective memory is memory for past events. Prospective memory is memory for events in the future (e.g., remembering appointments; remembering to do an assignment). Both types of memory can be impaired by TBI, with prospective memory negatively affected by frontal lobe injury.

Verbal and nonverbal memory: Verbal memory is memory for language events or events encoded in language. Nonverbal memory is memory for events not encoded in language. Verbal memory tends to be impaired by damage to language centers of the brain, typically in the left hemisphere. Nonverbal memory may be relatively impaired by damage to the right hemisphere.

Sensory modality-specific memory: Memory can also be related to each of the senses (vision, hearing, touch, smell, and taste), with specific memory stores affected by damage to that sensory system.

In addition to these memory processes, memory can be understood by distinguishing a variety of memory systems in the brain:

Sensory, short-term, and long-term storage systems: In the past, it was common to distinguish three types of memory based on length of time the memory was stored.

- **Sensory store** refers to the very brief time that a sensation remains available to sensory consciousness.
- **Short-term store** refers to the period of time, from seconds to a few minutes, that information remains in consciousness, depending on efforts (e.g., mental rehearsal) to keep it in consciousness. Short-term storage is said to be limited in capacity (e.g., 7 plus or minus 2 units of information at one time in normal older children and adults).
- **Long term store** refers to the extended – possibly indefinite – storage of information in the knowledge base. Capacity of long-term storage is unlimited. Authorities often maintain that short-term storage is physiologically an electrochemical process whereas long-term storage requires protein synthesis for maintenance of information over extended periods of time.

Working memory and the knowledge base: In recent years, the concept of short-term memory has largely been replaced by that of working memory. Working memory refers not just to a holding space (like short-term memory), but rather to the processes used to hold information in consciousness and actively attend to it, filter out that which is irrelevant, and create associations that ultimately assist in transferring information from consciousness to the knowledge base. Therefore, there is conceptual overlap between definitions of working memory, attention, and organization. Working memory enables people to keep one or more thoughts active and possibly to relate the thoughts or create associations. Thus there is a large amount of cognitive activity included within the definition of working memory. Similarly, there is a large amount of brain tissue devoted to working memory tasks, notably dorsolateral prefrontal cortex, both left and right hemispheres. The left hemisphere is associated with manipulation of verbal information and the right hemisphere with visual-spatial information.

The term "knowledge base" refers to what was once called *long-term storage*. Widespread areas of cortex (more posterior than anterior) may be connected in neural networks to support stored memories of people, things, events, or series of events.

Declarative and procedural memory: Declarative memory (i.e., remembering or knowing that such and such is the case) is memory for facts of greater or lesser generality (e.g., I remember that George Washington was the first president of the USA; I remember that e=mc2). In contrast, procedural memory (i.e., remembering or knowing how to do something) is memory for procedures that can either be physical acts (like getting dressed or riding a bike) or habits/routines (like preparing toast and eggs for breakfast). After brain injury, declarative memory can be significantly impaired, while procedural memory remains relatively intact. Procedural memory may be relatively intact both in the sense of preserved procedures/routines from before the injury, but also the learning of new procedures, motor acts, or habits. Procedural memory, especially the motor aspects, is said to rely heavily on the basal ganglia and cerebellum. Declarative and

explicit memory systems appear to rely heavily on the hippocampus which is vulnerable in TBI because of hypoxic brain injury (reduction of the supply of oxygen to brain tissue).

Explicit and implicit memory: With respect to storage of information, explicit memory refers to memories that are stored along with some awareness that the memory is stored. Implicit memories are stored without an associated awareness that there is such a memory. The explicit/implicit distinction can also be used to refer to encoding rather than storage (explicit = deliberate, voluntary encoding; implicit = involuntary encoding). Finally, the distinction can also be used to refer to retrieval (explicit = deliberate, effortful retrieval; implicit = retrieval with no deliberate attempt to retrieve).

After TBI, explicit memory is often impaired while implicit memory may be relatively spared. This is one of the important reasons for using errorless teaching/learning procedures (see below; **see Tutorial on Errorless Learning**). Implicit memory may be relatively spared because it appears not to be as dependent as explicit memory on the vulnerable hippocampus and prefrontal structures. Emotionally charged implicit memories may rely on the activity of the amygdala, while implicit procedural memories rely on the basal ganglia and cerebellum.

Episodic and semantic memory: The knowledge base can be divided into episodic and semantic memories (a subdivision of declarative memory). Episodic memories are those that have a time and place reference in the individual's life (e.g., I remember that I lost my wallet at a hotel in Stockholm several years ago). Semantic memories include knowledge of things, events, and concepts that are not tied to my autobiography (e.g., I know that the North won the Civil War).

Remote and recent memory: In the context of brain injury, the term remote memory usually refers to memories from before the injury. Recent memory refers to memories acquired recently and after the injury. Retrograde amnesia is an impairment of remote memory, that is, difficulty remembering events from before the injury. Anterograde amnesia is an impairment of recent memory, that is, difficulty remembering day-to-day events that have occurred since the injury. After TBI, it is possible to have excellent memory for events from before the injury, but relatively impaired ability to lay down new memories (anterograde amnesia). This is because existing knowledge is largely stored in posterior regions of the brain, relatively safe in TBI. New learning relies on the hippocampus and frontal lobe structures, which are vulnerable in TBI.

Meta-memory: Meta-memory refers to knowledge of one's memory functioning, knowledge of memory strategies, and possibly a disposition to use the strategies when trying to encode new information or retrieve information from storage. Thus there is a static aspect to meta-memory (e.g., I know that my declarative memory is weak and that I need to use strategies like elaboration if I hope to remember effectively) and also a dynamic aspect (e.g., I actually use the strategies in an effective manner). Meta-memory is impaired by frontal lobe injury. **(See Tutorials on Self-Awareness; Cognitive and Learning Strategies)**

Memory and other cognitive processes: (See Tutorial on Cognition.) It is clear that aspects of memory interact with other components of cognition. For example, if a student does not attend effectively to an assignment, it is unlikely that the information will be remembered. Similarly, if the student fails to make connections as new information is presented (i.e., organize, elaborate), then memory for that information will be weak. Furthermore, if a student is not aware of memory problems or is a poor problem solver, then strategic learning and memory will be negatively affected. Many more examples of inter-relationships among cognitive components could be added to this list.

WHAT MEMORY PROBLEMS ARE ASSOCIATED WITH TBI?

In the paragraphs above, several comments are made about the areas of the brain associated with specific types of memory. The vulnerable areas of the brain in TBI most closely associated with memory problems are the frontal lobes and the hippocampus. In addition, widespread microscopic damage throughout the brain can degrade storage systems and "retrieval routes", making retrieval of information more difficult. The frontal lobes are vulnerable because of their position in relation to bony prominences within the skull.

The hippocampus is vulnerable to secondary hypoxic injury (reduction in the supply of oxygen), common after severe injuries.

With these types of brain damage, the following memory challenges and profiles are commonly observed in children with TBI.

Impaired encoding and retrieval: Both encoding and retrieval are commonly impaired after TBI. Encoding for many types of memory is affected by damage to the hippocampus and surrounding structures in the medial temporal lobes. Voluntary or strategic encoding (i.e., trying to encode) is affected by damage to the vulnerable frontal lobes. Retrieval (including word retrieval) can be affected by damage to retrieval routes throughout the brain. Thus retrieval problems are associated with many kinds and locations of brain damage as well as normal aging. Voluntary or strategic retrieval (i.e., trying to retrieve) is affected by damage to the vulnerable frontal lobes.

Superior involuntary/incidental memory over voluntary/strategic memory: With damage to the frontal lobes, strategic thinking and behavior in general can be impaired. Therefore both voluntary/strategic encoding (e.g., trying to encode information effectively by rehearsing it, elaborating it, creating organizing systems, and the like) and voluntary/strategic retrieval (e.g., trying to retrieve information by using associations, mnemonic strategies, and the like) can be impaired. Despite these impairments, the student may be able to encode and retrieve information if teachers and parents provide effective organization/elaboration at the time of encoding and effective retrieval cues at the time of retrieval. That is, the student no longer has to rely on the parts of the brain involved in strategic effort. This is important for teachers and parents to remember. When students have impaired strategic processing, it can make memory problems worse by asking the student to try to remember information (encode or retrieve).

Superior implicit over explicit memory: Students with apparently severe memory impairments after TBI may nevertheless encode, store, and retrieve information and skills implicitly. These are students who may have extreme difficulty answering questions like, "What did you have for breakfast?" or "What did you learn yesterday in History class?" If the information was salient at the time of encoding and if effective retrieval cues are given by adults, the student may remember the information or skill even though he did not know he knew it and cannot remember learning it. When students have this memory profile, teachers should use errorless teaching/learning procedures (See below; **See Tutorial on Errorless Learning**).

Superior remote memory over new learning: The cognitive profiles of many students with TBI are confusing because they remember information and skills acquired before the injury despite great difficulty acquiring new information and skills after the injury. For this reason, they may score at reasonably high levels on academic tests despite significant learning difficulties. Decisions about services and supports for these students should not be made on the basis of their test scores, but rather on their ability to learn **after** the injury.

Superior procedural over declarative memory: It is common for students with TBI to have difficulty learning/remembering facts and other academic information despite relatively strong ability to acquire new motor skills and other procedures, routines, or habits.

Interference in memory/learning from other cognitive deficits: Deficits in other cognitive areas like attention, organization, problem solving, and reasoning have an inevitable negative effect on memory and learning. Similarly problems in executive functioning have a negative effect on strategic learning and memory.

Interference in memory/learning from emotional impairments: Anxiety has a negative effect on memory and learning. Students who are anxious tend not to use strategies at the time of encoding or retrieving information. Similarly students who are depressed tend not to pay attention effectively or use strategies for encoding or retrieving information.

WHAT ARE THE MAIN THEMES IN INTERVENTION AND SUPPORT?

Understanding the Problem

As always, the first task for teachers and parents is to correctly understand the problem. The wide variety of types and aspects of memory listed above indicate that there are many kinds of memory problems. Different problems are typically associated with different interventions or supports. For example, both encoding problems (i.e., inefficiency in putting the information into storage) and retrieval problems (i.e., difficulty taking the information out of storage when needed) manifest themselves in retrieval problems. But approaches to intervention differ. Therefore, the problem-solving/hypothesis-testing assessment procedures offered on this web site are useful in identifying the underlying problem before proceeding with intervention and support plans. Alternatively, review of a neuropsychological evaluation will shed light on the type of memory problems experienced by the student.

Remediation of Memory Problems with Memory Exercises

Memory exercises to improve memory: Some educators and therapists have students with memory problems practice remembering with the goal of improving their underlying memory functioning. For example, they might have the student repeat back numbers in sequence or repeat lists of unrelated words. Or they might have the student hold instructions in mind for increasing periods of time and then act on the instruction. It has been shown that adults and children with memory problems can improve on such training tasks, but the improvement does not transfer to everyday functional memory tasks. Therefore there is no justification for using memory exercises of this sort in therapy or special education. Therefore, what remains are environmental compensations (including special teaching procedures) and memory strategies as the intervention procedures for students with memory problems.

Memory and Existing Knowledge

In the area of memory and learning, the rich get richer; that is, the more one knows within a domain of knowledge, the easier it is to process, comprehend, encode, store, and subsequently retrieve/use new information in that domain. For example, even very weak students may be passionate and knowledgeable about something, like football or a video game. In that case, attending to and taking in the details of a game may be easy for that person and learning new information or rules may occur with a single learning trial, despite failure to learn new information after scores of learning trials in school. The same holds true at higher levels. An expert in a profession may scan a journal article in her field, quickly filter important from unimportant details, comprehend the critical information, and readily retrieve it at a later date. A novice student in the same field may require hours to comprehend and learn what the specialist comprehends and learns in a few minutes.

Therefore, ongoing accumulation of new knowledge must be seen as an important component of "memory rehabilitation" or "cognitive rehabilitation".

Environmental Compensations or Task Modifications

What is most important for teachers and parents to know about memory?? The following principles of memory are true for most people, including students with TBI. These principles should be used in designing learning and memory tasks for these students.

Memory interacts with other cognitive functions: For example, the better one attends to incoming information, the better it will be encoded and later retrieved. The more effectively one organizes information, the better it will be encoded (elaborated), stored, and later retrieved. The more one engages in learning as a problem-solving activity, the more effectively one will encode, store, and retrieve information. Conversely, the better one remembers and the more one knows, the easier it will be to attend, organize,

and problem solve. Therefore, teachers and parents should try to ensure attention during learning tasks, offer the student ways to elaborate or organize the information, and make learning and memory a problem-solving activity (e.g., "What do you think you could do in your head to hold onto this information?").

Memory interacts with emotion: Information that is emotionally salient tends to be remembered better than information that is not emotionally salient. Conversely, the more one remembers/knows about a domain, the greater the likelihood that emotional salience may be triggered by new information. Therefore, teachers and parents should seek ways to make new information emotionally salient; they should connect new information with something that the student already knows and is important to her.

Meaningfulness enhances memory: If students find a piece of information or a procedure meaningful, interesting, and/or important, they are more likely to encode it in an elaborative manner (i.e., with meaningful connections), store it effectively, and retrieve it when relevant. Meaningfulness can be created artificially (e.g., "You better remember this because it will be on the test!") or naturally (e.g., "Let me try to explain why this is really important for you in relation to ...."). Teachers and parents should try to ensure that students understand that it is important to attend to, think about, and remember the new information.

However, with students who are anxious about their ability to learn, teachers should be cautious in their emphasis on the importance of learning. The additional anxiety that this emphasis creates is likely to interfere with learning. Furthermore, for students with significant strategic learning problems, it may not be helpful to highlight the importance of remembering.

Organization/elaboration enhances memory: The better elaborated/organized information is at the time of encoding, the more effectively it is stored (i.e., multiple neural connections) and the easier it will be to retrieve (i.e., many retrieval routes). Elaborative encoding facilitates all three stages of memory: encoding (making connections when first taking the information in), storage (storing information in more than one place with multiple neural connections), retrieval (increasing the number of retrieval routes in the brain to the stored information). Developmentally young people – or those with executive system impairment – may need this organization created by others in ways that make sense to the students (i.e., give the students meaningful connections among the pieces of information presented). Cognitively more mature students are capable of creating their own elaboration and organization – which may be more effective organization than that imposed by a teacher. Teachers and parents should encourage this elaboration/organization process. **(See Tutorial on Organization.)**

Repetition enhances memory: For most people, including students with brain injury, repetition enhances memory and is essential for learning. Repetition includes multiple learning trials when the information or skill is first presented. It also includes regular review and cumulative review of the information or skills. Repetition and review cannot be over-emphasized in teaching students with memory impairment after TBI.

The value of repetition assumes that the student is actually paying attention during the repetition, which may not be the case if "drill" is boring. Therefore, teachers should seek ways to make repetition or practice interesting. For some students, taping of class materials for repeat review at a later point in time may enhance repetition of novel information. For many students, well designed computer programs offer adequate practice while also making the practice interesting. Therefore, interesting educational software should be explored.

The repetition principle has led many to advocate "covert rehearsal" (i.e., repeating to oneself) as a useful memory strategy. This may be true for simple memorization tasks. However, simple rehearsal may actually interfere with functional memory if it detracts from the processes that go into understanding the information. However important repetition is it should be combined with organization/elaboration and meaningfulness in designing learning/memory tasks. **(See Tutorial on Instructional Routines.)** Furthermore, in more advanced learning environments (for example, listening to lectures in high school), mental rehearsal of the teacher's words may block the processing of what the teacher is continuing to say, thereby interfering with learning. In such situations, taping of class content and replaying it at a later date may be most beneficial

External memory aids can compensate for memory problems: External aids (e.g., posted reminders, written lists, memory books, electronic storage systems, buddy systems for reminders) are the most commonly used and most effective intervention for adults and adolescents with memory impairment. External aids are also important for younger children, with the type of aid varying with the developmental level of the student. Young students might use posted reminders (words, symbols, or pictures) or buddy systems as components of their compensation for memory problems. In addition, parents and teachers should make sure that there is a tight association between types of objects and the places where they should be kept and can be found.

Older and more mature students may develop a habit of making lists when necessary and using a memory book (or at least an assignment book) or hand-held electronic organizer in which to record information that would otherwise be forgotten. When these systems are developed, maintained, and cued by somebody other than the student, they can be considered a component of environmental compensations.

In general, the simpler the external aid, the more likely it is to be used. For example, electronic storage systems may be extremely powerful, but despite their potential power, they may not be used because they are too complex. In addition, aesthetics matter to students, especially adolescents. For example, an adolescent male may tolerate a small reminder and schedule book that can fit in his pocket, but not a large notebook that he may consider stigmatizing. Furthermore, memory/schedule/assignment books need to be well organized or they may prove too frustrating to use. The student with TBI may need to rely on an adult to keep the book organized and current.

Errorless learning is important for students with severe memory impairment: As discussed above in the section on explicit and implicit memory, many students with TBI have severe explicit memory impairments; when asked to retrieve information from their recent life or recent lessons, they may say that they remember nothing, not even the fact that they had a lesson. Nevertheless these same students may encode, store, and potentially retrieve information implicitly. That is, an experience they have may leave memory traces that they are not aware of, but that may yet come to consciousness in the future when properly cued. Furthermore, these students may learn routines effectively if properly taught, including academic routines like arithmetic operations and reading decoding.

The key to teaching for these students is to ensure that their learning is errorless, that is they do not make errors as they learn new information or skills. Teachers and parents must ensure that sufficient supports are in place so that the student's responses are correct. At the outset, this may mean that the student simply listens to the teacher give the response; subsequently the student can respond along with the teacher; then respond with ample cues. The teacher should systematically pull back the cues only when confident that the student can respond correctly.

The opposite of errorless learning is "trial and error" learning, which might be most efficient for students who are generally accurate in their responses and who remember their mistakes and try to avoid making the same mistake twice. In fact, for students with reasonably good memory, trial and error learning may be preferable, particularly when understanding of complex material is the goal. However, when students with severe memory impairment make a mistake, the emotionality that is often associated with mistakes can easily make the mistake memorable, that is "drive it into the memory bank". Later the student will have forgotten the teaching episode, but the mistake still remains in memory and may easily be elicited by future cues. Unfortunately, the student does not remember that it is a mistake. Thus errors for students with severe memory impairment can be very insidious in their effects on future performance; for this reason, teaching should be as errorless as possible.

The optimistic message is that students with severe memory impairment can nevertheless learn new information, skills, and routines, if properly taught. However, the learning that these students acquire tends to be superficial, lacking in depth of understanding, and dependent on specific cues for retrieval.

Errorless learning procedures should also be considered for students with significant anxiety associated with learning. For reasonably confident students, a little anxiety can heighten attention and retentiveness; therefore it may facilitate learning. However, serious anxiety can substantially interfere with acquisition and

retention of information. Some students with TBI are anxious because they are perplexed about what they can do and what they can't do after the injury. Others are anxious because of large amounts of unexpected failure after the injury. Still others are anxious because of changes in brain function. In any of these cases, teaching/learning routines designed to minimize errors are important to reducing anxiety and enhancing overall performance.

Finally, errorless learning procedures are also important for students who are discouraged or frankly depressed about their overall abilities after the injury. Because of all the losses they may have experienced (e.g., loss of abilities, loss of activities, loss of friends), many students with TBI experience depression at some stage of their recovery in reaction to the changes in their lives. In these cases, teachers should work hard to ensure as much success as possible. Errorless learning procedures are one tool to achieve this goal.

Memory/Learning Strategies That Can Be Used by the Student as Compensation for Memory Impairments

Context sensitivity in teaching the use of memory strategies: If memory strategies are to be taught to the student, whether external memory aids or internal strategies, they should be taught within the context of everyday home and academic routines to avoid the likelihood that strategies taught in isolated settings will not transfer to functional settings and activities. Transfer of new skills or procedures from a training context to a real-world context should never be assumed and rarely occurs without considerable effort.

External memory aids: External aids were discussed above as part of environmental compensation. In some cases, the student can be taught to take responsibility for managing and using the external aids. For students with ongoing memory impairment, it is critical to develop a habit of using external aids. This is often a life-long need.

Internal (mental) memory strategies for encoding: Students who are aware of their memory impairment and sufficiently mature to actively compensate for their memory problems may be taught to use the following strategies to encode information more effectively. Internal memory strategies have not been shown to be particularly effective in memory rehabilitation. One reason is that people with memory impairment often forget to use the strategies that they have been taught. They also might have limited "space" in working memory; therefore it is hard to think about strategies and the task at hand at the same time. Furthermore, most of the studies have been conducted with adults who rarely have to learn or memorize large amounts of new information. However, in an academic setting, it is worth encouraging students to do at least some of the following at the time of encoding to enhance their memory:

- Tell myself, "pay attention; focus";
- Highlight the information that seems most important;
- Organize the information into natural groups;
- Create association links to information that I already know;
- Generate my own examples;
- Think about how I might apply this information;
- Repeat the information;
- Summarize and review;
- Take notes;
- Speak the information out loud; tell or explain it to some other person;
- Create visual images of the new information;
- Create diagrams or flow charts of the information;
- Test myself on the information;
- Take in reasonably small amounts of information at a time

Internal (mental) memory strategies for *retrieval*: Books on how to improve memory often advocate the use of mnemonic strategies to increase the likelihood of retrieving information. Mnemonics have limited usefulness in memorizing discrete information for tests, but should never replace understanding the

information as the ultimate goal of learning. Because mnemonic strategies are often associated with superficial understanding of the material, they may even interfere with deeper understanding. For example, students can memorize the colors in the color spectrum with the first-letter mnemonic "Roy G Biv" (i.e., red, orange, yellow, green, blue, indigo, violet) without understanding any of the physical properties of the colors. If students overuse mnemonics, they can spend too much time on generating and learning the mnemonics and too little time on real understanding of the material.

With these important qualifications as background, what follows are mnemonic strategies sometimes used to facilitate memorization:

Rhymes: Example, "Id is the kid!" for part of Freud's personality theory

Acronyms: Example: Roy G Biv for the colors in the spectrum

Visual Images: Associating information with striking visual images sometimes facilitates retrieval.

Method of Loci: Items to be remembered are placed in a series of location that can then be mentally reviewed at the time of retrieval.

Catch phrases: Each word in the catch phrase begins with the first letter of a different key word.

In addition, retrieval practice (for example, practicing taking an exam) helps many students. Mentally retracing the steps taken at the time of encoding or imaginatively placing oneself where the event/learning took place might jog memories. For many people, simply relaxing and turning off the effort to remember may assist retrieval.

Written by Mark Ylvisaker, Ph.D. with the assistance of Mary Hibbard, Ph.D. and Timothy Feeney, Ph.D.