Working Memory: The Engine for Learning

Approximately 10% of us have weak working memory; however, the estimates of the percentage of weak working memory in students with specific learning disorders, including dyslexia, ranges from 20 to 50 percent. Weak working memory is a core difficulty for students with ADHD, Inattentive Type.

Individuals with traumatic brain injury, deafness, oral language deficits or genetic disorders such as Down Syndrome are also more likely to have weak working memory. The purpose of this fact sheet is to describe the function of working memory, discuss the impact that weak working memory has on learning, and offer suggestions and resources for improving working memory and learning.

Types of Memory

Parents often report that their child has a "poor memory" and that poor memory is contributing to difficulties with learning; however, we don't have just one global memory system. We have several different memory systems that hold different types of information. For example, episodic memory is the store for events in the relatively recent past, such as the birthday party we attended last weekend. Procedural memory is memory for skills and habits. We use procedural memory for riding a bike or driving a car. Semantic memory is the store of knowledge gained over our lifetime and includes information about word meanings, spellings, and pronunciations. We may have great variation in the capacity of these different memory systems. For example, it's possible to have a very strong episodic memory but a weak semantic memory.

Working Memory

"Working memory" is crucial for learning and refers to the ability to hold and manipulate information mentally over short periods of time. Working memory is a process and is different than rote memory, which involves passively memorizing static information. Working memory is what is needed when we must go beyond straight memorization and do something with the information. Examples of everyday tasks that require working memory include:

- Listening to, remembering, and following directions that contain multiple steps

- Remembering a question long enough to think about it and formulate an answer

- Carrying out the steps to a recipe when no longer looking at the recipe

- Engaging in mental arithmetic

> WORKING MEMORY IS A COGNITIVE PROCESS AND NOT A PASSIVE
>
> STORE OF INFORMATION

Working memory is limited both in capacity and duration. The average adult cannot hold more than six or seven bits of information in working memory. The duration of working memory is

usually limited to a matter of seconds. Once information is lost from working memory, it cannot e retrieved. The student who "loses" some of the steps for directions delivered orally will not be able to retrieve the steps without repetition or some other form of assistance.

Components of Working Memory

Working memory is a system of interlinked components. The working memory system includes verbal and visual-spatial short-term memory stores. Verbal short-term memory holds information that can be expressed in numbers, words, and sentences. Visual-spatial short-term memory holds images, pictures, and information about location in space. Working memory also has a component that helps us resist distractions and remain focused when engaged in a task that requires working memory.

One of the key responsibilities of working memory is to manage, manipulate, and transform information from short-term and long-term memory. Working memory is the "go-between" for short and long-term memory. For example, solving a math word problem involves holding on to the details of the word problem in verbal short-term memory while retrieving from long-term memory the basic math facts needed to carry out the calculations involved in solving the problem.

Characteristics of a Weak Working Memory

Individuals with poor working memory tend to have trouble planning, organizing, and carrying out daily chores such as running errands, because it requires mentally formulating a "to do" list organized by time and location. Study skills may also suffer. Working memory allows us to keep track of priorities and helps us block the external or internal distractors that can derail us from the task at hand. Working memory helps us persist with tasks that require focused attention over time. Any of us, even those with strong working memories, can experience working memory problems when overly tired, anxious, or stressed.

Weak Working Memory in the Classroom

A weak working memory can also have an impact on learning. Students with working memory constraints may:

- perform below average in some or all areas of learning

- have difficulty with complex reasoning

- have trouble with tasks that have more than one step

- stop working because they have lost track of what they are supposed to do

- frequently engage in daydreaming

- lack skills in planning and organization

- have difficulty applying what they learned in a previous experience to a new situation

- have trouble remembering all the steps in oral directions

- have trouble thinking and doing at the same time

- appear highly distractible and inattentive but not impulsive or hyperactive

- demonstrate low self-esteem

- have relationships with peers but have difficulty following conversations in a group

Impact of Weak Working Memory on Reading and Written Language

A weak working memory can impede phonological learning and production at all levels. Consider a frequent rhyming exercise for young children. "Tell me which word rhymes with *fox*: *truck*, *dog*, *box*."

To identify the two rhyming words, the child must hold and then compare all of the words in working memory (*fox/truck*, *fox/dog*, *fox/box*). When older children attempt to sound out new words, they must use their working memory to hold the entire sequence of sounds long enough to blend those sounds together.

Working memory is also key to

- linking to information held in long-term semantic memory stores to provide the meaning and pronunciation of words.

- holding and sequencing sounds for spelling and also for composing, holding, and connecting ideas in written text.

- reading comprehension and reading fluency. When reading a long sentence, paragraph or passage, working memory is what allows us to hold on to and integrate information we read early on with information that comes later. Students with strong decoding skills but weak working memories often comment that they "can't remember anything!" from a page that they just read.

Impact of Weak Working Memory on Math

Children with math learning disorders have pervasive weaknesses across all working memory components. Young students with weak working memory make more errors when translating numbers from verbal to written form than do students with strong working memory. The most persistent weakness in children with math learning difficulties is the ability to store and retrieve number combinations and facts from long-term memory. As a result, working memory resources are not available for more complex aspects of mathematical processing. Math fluency is disrupted because a slow and unpredictable response time is the outcome of lack of automaticity in retrieval of basic math facts.

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Helpful Approaches

Gaps in reading and spelling skills should be addressed directly. Weak working memory contributes to poor word decoding and encoding. Systematic synthetic multisensory phonic approaches are recommended for students with weak working memory.

For students with adequate decoding but low reading comprehension, direct training in strategies such as comprehension monitoring, knowledge and use of text structures, and use of linguistic context should be addressed. Students can also learn that it may be difficult to hold on to information when sentences are too long. Recognizing when sentences are too long is a cue to slow down, check for comprehension, and, if necessary, re-read.

Slow reading interferes with sentence/phrase comprehension. One strategy to address fluency is to model good fluency for the student by using proper intonation and chunking sentences into meaningful chunks. "Chunking" helps reduce the number of parts to be stored in working memory for immediate processing.

Students who struggle with math due to difficulty retrieving math facts should be allowed easy access to basic math facts. This approach allows the student to focus on higher level math reasoning without bogging down while trying to pull up information that is not automatic. In more advanced math, students may have trouble carrying out math processes that involve multiple steps. Such students may understand long division but make errors due to omitting some essential step. A ring with index cards that provide examples of worked problems that involved multiple steps can support memory and learning.

Classroom-based Support

Classroom-based supports are easy to use and can benefit all students, not just students with weak working memory! Such supports include the following:

- Monitoring the students for signs of poor working memory

- Reducing the amount of information to be stored (for example, providing information on a white board so students don't have to hold the information in memory)

- Simplifying information to make it easier to process

- Teaching students how/when to apply memory aids

- Repeating information as often as needed

- Keeping directions simple and brief

- Providing worked examples

Working memory is essential for learning. While we do not yet have a way to change working memory per se, there are many things that parents and teachers can do to

support learning and achievement in students who have weak working memories. Helpful resources and websites are listed below:

- Www.understood.org provides information regarding how children use working memory to learn. This information can be found under the section "Learning & Attention Issues."

- "Working Memory Tips: Helping Kids Reach Their Full Potential" available at https://wwwparentingscience.com/working-memory-tips.html

- "Math: Memory Challenges" available at www.dyslexia.yale.edu

- "Understanding Working Memory: A Classroom Guide" by S. Gathercole & T Alloway available at mrc-cbu.com.ac.uk

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