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Introduction to Working Memory

- Have you ever been in a hurry, placed your keys somewhere and then completely forgotten where that was just moments later?
- Have you ever been introduced to someone new and then immediately forgotten his or her name?
- Have you ever been given an area code and phone number (10 digits) that you can't remember?

If you have experienced situations like these (and we all have), you were likely having difficulties with **working memory**. Working memory is a term from the field of cognitive psychology that refers to the brain structures and processes involved in **temporary storage and manipulation of information**. It was first used in the 1960's as an alternative for "short-term memory, primary memory, immediate memory, operant memory, or provisional memory."

Working Memory refers to the brain's limited capacity to hold on to and manipulate information *immediately* after presentation.

We now consider working memory and short-term memory to be different. Working memory refers to the ability to hold on to and manipulate information *immediately* after visual or auditory presentation. Short-term memory refers to the ability to remember information over a brief period of time – *less than 24 hours*. Long-term memory is the ability to remember and recall information over a longer period of time – *more than 24 hours*.

An interesting metaphor to understand the stages of memory is a person going to the library. If the person wants to gain knowledge from the library, he or she first has to enter through the outer door and vestibule (working memory). Once through the inner door, the person can then access the "new" information (short-term memory) and "old" information (long-term memory) stored in books and magazines filed on the shelves. If necessary, he or she can search the dusty archive stacks for older, less frequently used information (ancient memory).

Theories of Working Memory

Over the years, there have been multiple models attempting to explain working memory. On the next page are brief descriptions of three models with wide acceptance in the field.

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Working Memory Theories continued...

In 1974, **Baddeley and Hitch** introduced a multi-system model of working memory. One system, the "phonological loop," stores the sounds of language and provides a rehearsal loop for retention. Another system, the "visuo-spatial sketch pad," constructs visual images and mental maps for whole and part storage. A central system, the "central executive," directs attention to relevant information, suppresses irrelevant information, and coordinates multiple cognitive tasks.

In 1995, **Ericsson and Kintsch** related working memory to digit span, or the ability of most adults to recall and repeat up to seven digits. In their model, working memory is the process of packing small chunks of information and then unpacking and linking them through retrieval. Since only a small number of chunks (about 7) can be packed in working memory, we are constantly moving chunks into short and long-term memory and then associating them through retrieval structures.

In 2005, **Cowan** theorized that working memory is not a separate system, but rather part of long-term memory. In his model, representations (visual, auditory, spatial) in working memory are a subset of representations in long-term memory. Working memory occurs on two levels: (1) unlimited long-term memories that are activated and (2) a limited focus of attention holding up to 4 activations at a time.

Working Memory Capacity

Although the models vary in their explanations, it is agreed that **working memory has limited capacity**. We can temporarily store only a certain number of chunks of information (digits, letters, words, or other units), depending on our age and the length of the chunks. According to research, a typical adult's memory span (or working memory capacity) is about seven for digits, about six for letters, and about five for words. We have enhanced memory span for chunks of information related to content we already know. Young adults have a working memory capacity of about four and it is even less for children and older adults.

Working Memory and Learning

Working memory has been called the "door to learning" (think the library) and is strongly related to performance in reading comprehension and problem-solving. Persons with strong working memory have a wide open door for acquiring all types of new information. They are able to hang on to new information, work with it, integrate it with lots of known information, and then move it into storage.

In contrast, persons with weak working memory have a narrow opening for letting in new information. They may grasp only part of newly presented information, struggle to hold on to it, and then have difficulty with integration and storage because their known information is already sketchy. They may struggle with following verbal or written directions, processing visual or auditory information, organizing thoughts for speaking or writing, and learning multi-step procedures. Parents, teachers, peers, or coworkers may view them as lazy or unmotivated; they may feel inadequate and/or incompetent as they struggle to "keep up," remember, and complete assigned tasks in school, at home, or in the workplace.

Determining Working Memory Problems

Working memory problems are diagnosed with special tests of immediate memory administered by licensed psychologists, psychiatrists, or neuropsychologists. For example, an examinee is read a series of digits and then asked to repeat the series forwards and backwards. Or the examinee is read a number of sentences (between 2 and 6) and then asked to state the last word of each sentence in correct order. For both measures, the number of correct responses is derived into a standard score and percentile that is determined to be average, below average, or above average when compared to same-age peers.

Strategies for Improving Working Memory

When working with persons who have suspected or diagnosed working memory problems, keep in mind they can learn, but the demands on their limited working memory capacity need to be minimized.

1. Be sure the person is attending to the task at hand.
2. Make connections with the person between new information and prior knowledge, experiences, emotions, or passions.
3. Provide verbal directions one or two at a time.
4. Order multiple directions from simple to more complex.
5. Ask the person to repeat or put directions into his or her own words.
6. Be willing to repeat verbal directions more than once.
7. Use shorter sentences with the person – but be careful that you are not talking down.
8. Present new information both verbally and visually. Support verbal directions with a written list, notes, or pictures. Talk through a written list of directions.
9. Provide hands-on experience as much as possible.
10. Provide frequent feedback about performance.
11. Provide review of previously-taught information by using different methods of practice: rereading, choral reading, copying, spelling, tracing, writing from memory, using in text or in example.
12. Expect (and accept) that persons with severe working memory deficits will need 3-5 times as much repetition and/or practice.

References:
Baddeley, A.D. & Hitch, G.J. (1974). *The psychology of learning and motivation: advances in research and theory*. Working Memory. Volume 8, 47-89. New York: Academic Press.

Cowan, N. (2005). *Working memory capacity*. New York: Psychology Press.

Ericsson, K.A. & Kintsch, W. (1995). *Long-term working memory*. Psychological Review, 102, 211-245.

http://en.wikipedia.org/wiki/Working_memory

Strategies for Improving Memorization

Memorizing requires not only working memory, but enough repeated practice so that the information moves into short and long-term memory. Here are four strategies to assist with memorization.

ACROSTICS
Make sentences in which the first letter of each word represents an order to be memorized. For example, music students can remember the order of notes with:
Every **G**ood **B**oy **D**oes **F**ine

ACRONYMS
Use words in which a single letter is made from the first letter of each bit of information to be memorizied. For example, social studies students can remember the Great Lakes with **HOMES: H**uron, **O**ntario, **M**ichigan, **E**rie, **S**uperior

KEYWORDS
Associate familiar words with the key word to be memorized. For example, science students can remember the term biome by remembering: “A biome is a ‘home’ for animals.”

RHYMES
Create jingles or rhymes that emphasize similar sounds. For example, reading students can memorize sound/letter rules with rhymes such as:
“I before e - except after c.”
“When two vowels go walking, the first one does the talking.”

Introducing New Assessment Staff

Due to the National Guard deployment of Mike Anderson to Iraq and the changing focus of Marn Frank to reading assessment/instruction and staff/resource development, several new people have joined the LDA Assessment Team.

Miriam Kragness, PhD, LP, is the new Youth and Adult Services Program Director. She is responsible for promoting and managing adolescent and adult services and Diagnostic Assessments.

Wendy Sweeney, LPP, is the new Assessment Coordinator. She is responsible for coordinating Learning Disability Assessments. If you have any questions or need the *ABE Application for Assessment*, contact Wendy at 952-922-8374, Ext. 3716 or ws@ldaminnesota.org.

Assessment Services for Minnesota ABE

The following assessments are available to Minnesota ABE students at no cost; however, the referral must be initiated by an ABE manager or teacher.

Learning Disability Assessment (LD) - to determine the presence of LD resulting in self-understanding, instructional recommendations, and required documentation for requesting GED accommodations.

Diagnostic Assessment (DA) - to determine the presence of other cognitive problems - including ADHD - resulting in self-understanding, instructional recommendations, and required documentation for requesting GED accommodations.

Adult Reading Profile (ARP) - to determine strengths and weaknesses in alphabetics (phonemic awareness and decoding), fluency, vocabulary, and comprehension resulting in self-understanding and recommendations for improving reading instruction.

ABE Staff and Resource Development

There are several exciting resources and staff development activities available to Minnesota ABE also at no cost! Contact Marn Frank at 952-922-8373, Ext. 3715 or mf@ldaminnesota.org for more information or to request copies of print resources.

Story by Story, a contextual phonics model and curriculum for adults "learning to read"

This print resource for Beginning Literacy teachers and tutors includes a model for teaching phonics within context, an informal word analysis assessment, and two levels of adult-authentic stories and word study activities at approximately K-2.5 grade equivalent. Level I is available now; Level II will be available in late January of 2008.

The Adult Reading Toolkit (ART) - Edition 5

This print resource includes a spiral-bound book for ABE/ESL teachers or tutors who seek to improve their reading research knowledge and reading instruction across all levels. Also included are four Appendices: (1) sequential sound lists, (2) sight word lists, (3) decodable word lists, and (4) phrase/sentence lists for beginning reading instruction.

Reading Assessment for Adult Basic Education
Available at http://online.themlc.org

This interactive online course resulting in Continuing Education Units (CEUs) for teacher licensure provides background in assessment terminology, the purpose of CASAS and TABE, links to informal reading assessments, and case studies that describe ABE success stories when research-based assessment and instruction has been provided. **Documentation for 5 state-approved CEUs will be received after completing and submitting a brief case study.**

A second interactive online course, ***Beginning Adult Reading Instruction,*** will be accessible in 2008. It will also be available at http://online.themlc.org