Working Memory and Language Development

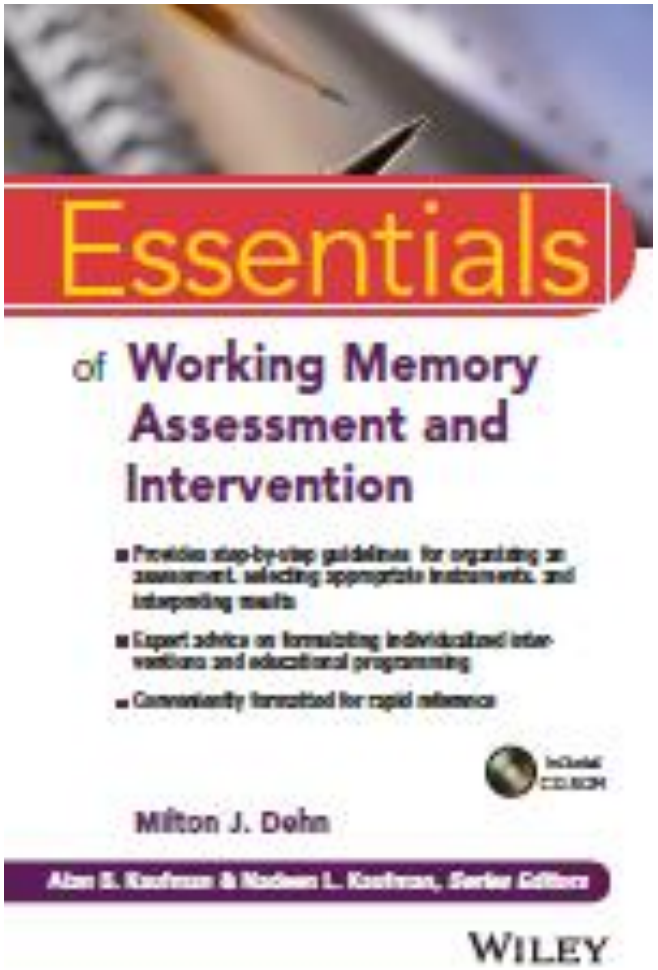
Milton J. Dehn, Ed.D.
Schoolhouse Educational Services
October 2018

Notice of Copyright 2018

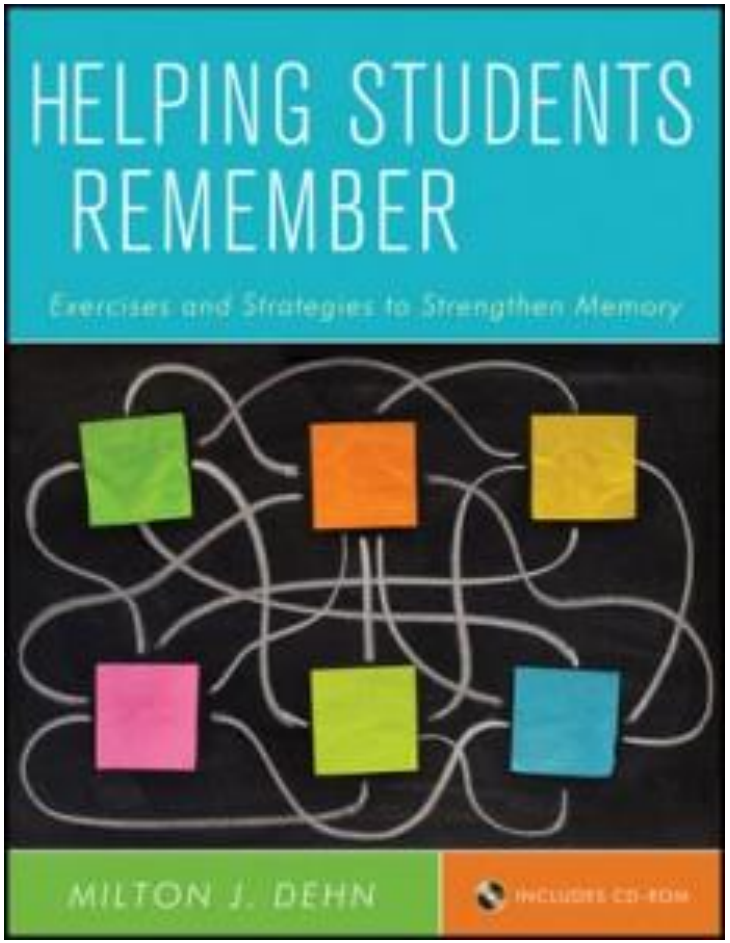
Workshop Information Sources

1. *Essentials of Working Memory Assessment*
2. *Helping Students Remember (HSR)*
3. *Working Memory in the Classroom*
4. www.SchoolhouseEducationalServices.com
5. Presenter Contact: milt@psychprocesses.com

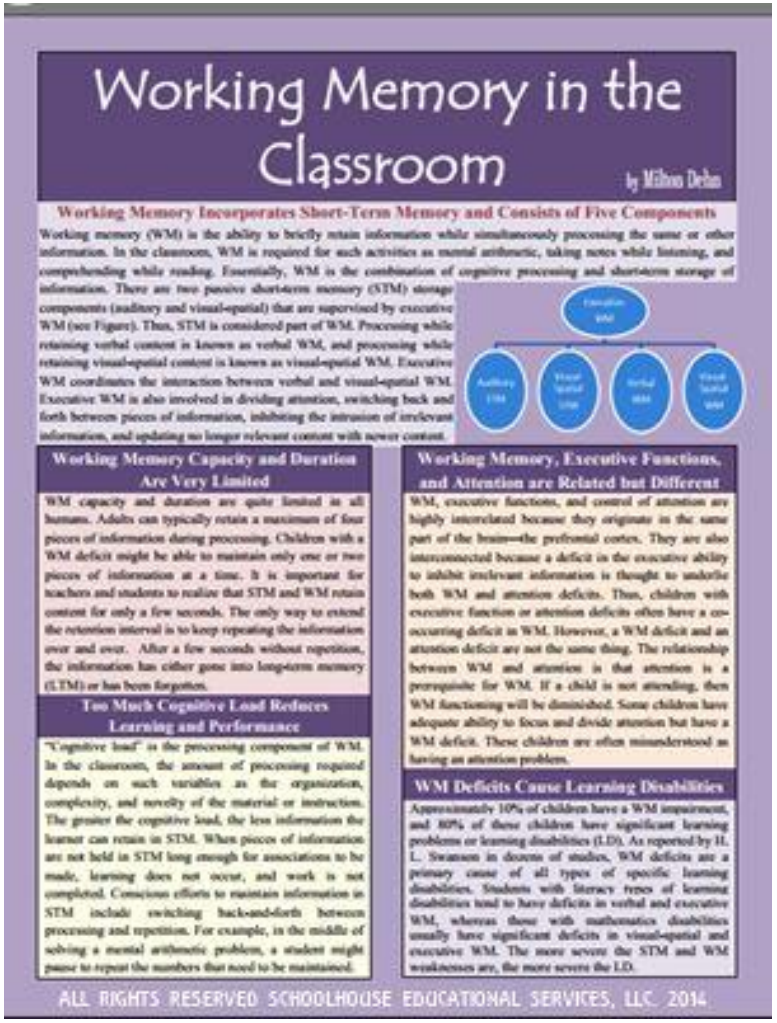
Essentials of Working Memory Assessment and Intervention



Helping Students Remember



Working Memory in the Classroom



Workshop Content

1. The different types of memory
2. Brief neuroanatomy of memory
3. Reducing cognitive load
4. WM and academic accommodations
5. Metamemory
6. WM exercises
7. WM strategies

Working Memory Definition

1. Short-term retention + processing = WM
2. “WM: the limited capacity to retain information while simultaneously manipulating the same or other information for a short period of time”
3. Keeping information in mind from moment to moment
4. STM is part of WM; WM “manages” STM as needed

Why WM is Very Important

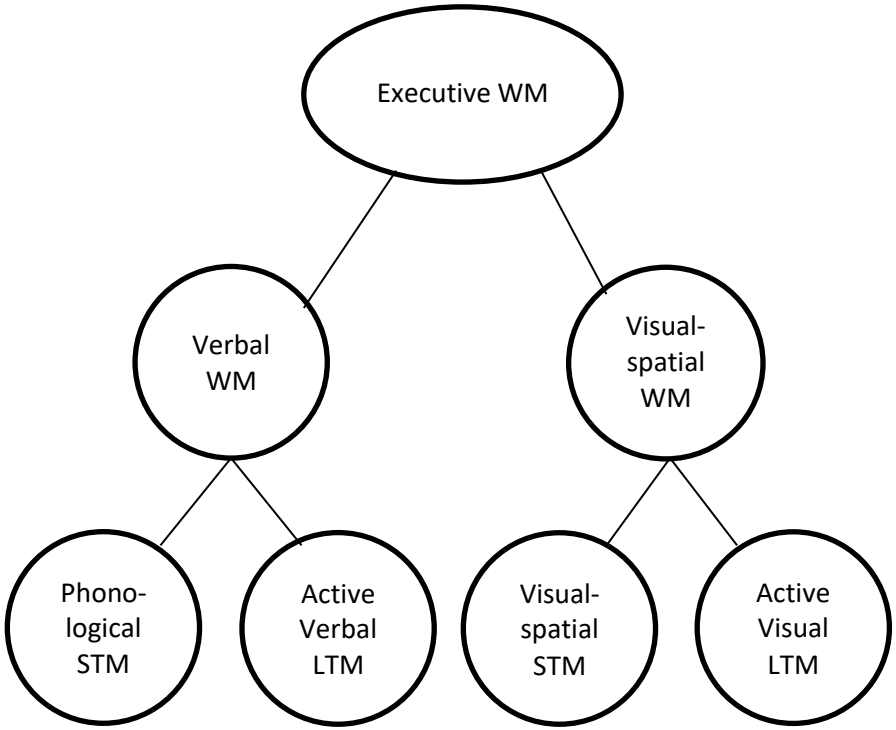
1. WM is a core cognitive process
2. Also, an important executive process
3. It's the interface between STM and LTM
4. WM predicts academic learning
5. Deficit predicts need for special ed.
6. WM deficits seen in several disabilities
7. Important in daily functioning

Signs of WM Overload in Daily Life

1. “What was I going to say?”
2. “What did I walk in here to get?”
3. Not noticing you made a mistake
4. Reaching for the calculator
5. Having to switch back and forth from one computer screen to another to remember
6. Having difficulty focusing or dividing attention
7. Unrelated thoughts getting in the way

Dehn's Integrated Model of WM

Integrated Model of Working Memory



Activated LTM

1. Recently activated LTM representations
2. Same as Cowan's concept; similar to Baddeley's episodic buffer
3. WM works with these, going back and forth
4. Effectively expands capacity of WM because these are not stored in STM/WM (up to 20)
5. WM may draw from these more than STM
6. Problem: No way to easily assess these

WM Capacity

1. Is very limited in all humans
2. Storage and processing use same capacity
3. Adults have a STM span of 7
4. Adult WM capacity is 4 “chunks”
5. As little as 1 chunk in a disabled child
6. Without rehearsal or processing that keeps it active, information is gone within a few seconds
7. Human limitations

WM Components

1. Executive Working Memory
2. Verbal Working Memory
3. Visual-Spatial Working Memory
4. Phonological Short-Term Memory
5. Visual-Spatial Short-Term Memory

Phonological STM (Auditory)

1. Holds & manipulates speech-based info.
2. The coding is phonological
3. A loop of about 2 seconds
4. Span equals amount articulated in 2 sec.
    1. Span increases with speech rate increases
5. Includes a subvocal rehearsal process
6. Similarity/rhyming reduces span (interference)
7. Related to phonological processing & language development & basic reading skills

Visuospatial STM

1. Visual (object) and spatial (location); these are separate neurologically, e.g. dorsal (spatial) and ventral (visual) stream and thus should be considered separately
2. Is automatically updating
3. Concrete, nameable images are consciously recoded verbally after age 8; tendency to "abandon" visual-spatial

Verbal Working Memory

1. Processing plus storage
2. Effortful processing, manipulating, transforming, while maintaining verbal info.
3. Can draw information from either STM or activated LTM
4. Meaningful processing, semantic information
5. Examples: Taking notes, reading comprehension, mental arithmetic

Visuospatial Working Memory

1. Both mental imagery and visual stimuli
2. Maintaining visual images during processing
3. Draws from either STM or activated LTM
4. Manipulating, restructuring images
5. Necessary for dealing with rotation
6. Example: On-going awareness of location of automobiles in motion on a freeway
7. Related with math

Executive WM

1. The essence of working memory
2. Combines storage and processing
3. Integrates visual and verbal
4. Controls and coordinates other components
5. Allocates/focuses attention
6. Inhibiting, shifting, updating
7. Involves strategy use
8. Often where the deficiency lies
9. Close relationship with executive functions
10. This is the part of WM operating from the PFC

The Big Three Executive WM Processes

1. Inhibiting: Suppressing distractors and interference
2. Shifting: Alternating between different processing tasks or between processing and storage (rehearsal)
3. Updating: Continual replacement of no longer relevant information with current information

Metamemory

1. Understanding memory functions
2. Self-awareness of strengths/weaknesses
3. Regulating/controlling memory
4. Strategy knowledge and monitoring
5. Conditional knowledge (why a strategy works)
6. Metamemory development is an essential intervention piece
7. Assess informally

Signs of Poor Metamemory Development

1. Not aware of existing memory problems
2. No understanding of how memory works
3. Poor estimates of how much will be remembered (usually over estimates)
4. Has no realistic idea of how to make a memory stronger
5. Has no memorization strategies
6. Not aware of different types of memories

Examples of WM in the Classroom

1. Taking notes
2. Mental arithmetic
3. Reading comprehension
4. Retaining multi-step directions
5. Getting ideas onto paper
6. Completing work efficiently

WM is Necessary for All Learning

1. All academic skills: reading, math, language
    1. Correlations from .3 to .5
    2. WM correlations higher than STM correlations
2. Listening comprehension
3. Following directions
4. Learning vocabulary
5. Note taking
6. Reasoning

WM, Learning, and LTM

1. If WM is limited or overloaded, information is lost before it can be encoded into long-term memory (LTM)
2. Associating new information with prior knowledge requires working memory
3. WM can be normal, but LTM encoding weak
4. WM also involved in conscious, effortful retrieval from LTM

WM and Learning Disabilities

1. 10% of children have a WM deficit
2. Of these 10%, 80% have significant learning problems
3. 6% of normal children have a long-term memory deficit
4. About half of LD children have some kind of memory deficit

WM Deficit and Academic Performance

1. Slow to complete quality work because
    1. Can’t remember directions
    2. Loses place and must start over
    3. Does not have a consistent strategy
    4. Can’t hold and process all the information necessary to complete items
    5. Loses focus; can’t divide attention
    6. Switching is difficult
    7. Skipping steps creates problems
    8. Can’t monitor work quality at same time

What WM and Attention Have in Common

1. Controls are both in dPFC
2. Both part of general executive functions
3. Both involve controlled attention
4. **Inhibition deficit underlies both ADHD and WM**
5. Both respond to Ritalin
6. Problems manifest in similar ways
7. When a student has a WM deficit, the number one thing reported by teachers is that the student has an attention problem

WM and Attention

1. The control of attention is part of WM
2. Paying attention is a necessary but insufficient condition for processing and retention in STM and WM
3. If child is paying attention and still can't remember in the moment, it's probably WM
4. Attention problems diminish WM performance in a normal WM

WM vs ADHD

1. The majority with ADHD have a WM problem
2. ADHD behavior issues have little to do with WM, except for poor decision-making
3. Attention involves arousal & motor inhibition
4. WM deficit closely related to Inattentive ADHD, not Hyperactive/Impulsive type
5. ADHD: mainly visuospatial WM weakness
6. Divided attention closest to WM
7. As WM load increases, hyperactivity increases

Assessment: WM vs Attention

1. WM implicated when described as Inattentive but not hyperactive
2. ADHD may be WM misdiagnosed
3. Standardized measures will help differentiate
4. Be sure to have examinee's attention as each WM item is presented
5. Behavior rating scales often mix WM and Attention specific items

WM vs Executive Functions (EF)

1. WM is one of the executive functions
2. General executive processing cues, controls, and coordinates all cognitive functions
3. WM has it's own executive control; can differ
4. It's mainly the WM components; STM is cognitive
5. Inhibition is an overlapping function
    1. General executive---resisting distraction
    2. Working memory---inhibiting old information
6. Strategy selection is also overlapping

WM & Processing Speed

1. Processing speed accounts for most of the variance in STM span (up to 90%)
2. Slow: Information lost before processing and task completed
3. Slow: Poorer encoding into LTM
4. Faster rehearsal maintains more info.
5. Less of a relationship in adults
6. Case study example

WM & Phonological Processing

1. Correlation of .85 with phonological STM
2. As reading develops, more differentiation
3. Phonological awareness and processing places demands on STM and WM
4. Phonological processing deficit is primary cause of reading disabilities
5. Sounding out phonemes depends on STM; blending requires some verbal WM

WM and LTM

1. WM capacity is a general limiting factor for academic learning; specifically, it is necessary for the generation and modification of knowledge stored in LTM
2. Direct access and maintenance of several separate elements (some recently retreived) is necessary to construct new relations in episodic WM and LTM
3. Need to hold information in STM/WM long enough to make the associations that are to be encoded
4. WM involved in conscious LTM retrieval

WM and Oral Language

1. L1 and L2 development depend on Phonological STM and Verbal WM
2. Communication (thoughts into words with appropriate structure) depend on WM
3. Language development facilitates WM processing of information (they're reciprocal)
4. Vocabulary development depends on phonological STM and verbal WM

WM and Oral Language

1. Learning new words depends on retaining the phonological sequence of the word
2. Nonword repetition is a good test

Listening Comprehension

1. Correlations between language comprehension and WM are .70 - .90
2. Must hold all of the words in a sentence or previous sentence
3. Most comprehension automatic without WM
4. WM comes into play when it is not
5. If interference, comprehension suffers

Oral Expression

1. WM needed during conceptualization and formulating sentences
2. Correct syntax requires WM

Oral Language Disabilities

1. Do poorly on phonological STM & verbal WM tests like digit span and nonword repetition
2. WM may be lower than lang. development
3. Weak phonemic awareness contributes to lower phonological STM performance
4. Slow speech rate and processing speed also reduce STM/WM
5. Slow word retrieval also increases load on WM

WM and Bilingualism

1. WM plays a crucial role in 2L learning
2. Poor phonological STM, such as repeating pseudowords related to difficulty acquiring L2, just like monolingual vocabulary
    1. Normal: 6 exposures to acquire new word
    2. Normal: 10 new words per day
3. Bilinguals have higher WM but no clear evidence that bilingualism increases WM capacity

WM Development

1. Early development is mostly STM
2. Measured onset at 5-6 months---1 object
3. One year: 10 seconds and 3 visual objects
4. Visual needed for object permanence and imitation
5. Phonological STM necessary for language development, both 1L and 2L
6. Individual WM differences in early childhood are primarily genetic
7. Linked to myelinization in parietal and frontal lobes
8. Speech fluency relationship

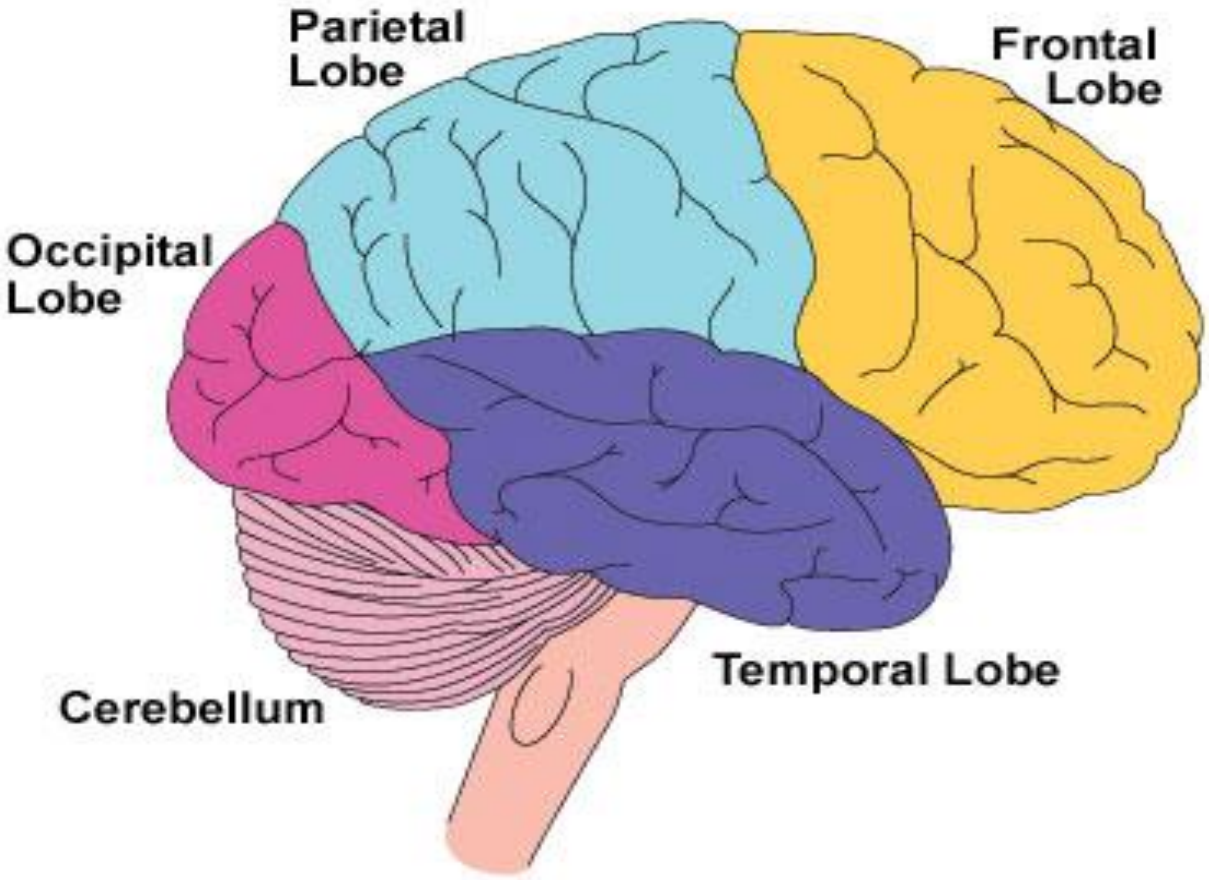
WM Development Cont'd

1. Span expands 2-3 times from ages 4-14
    1. 4-5 years of age ---- digit span of 3
    2. 14-15 years of age ---- digit span of 7-8
2. Slower development after age 8
3. Visuospatial verbally recoded---age 8
4. Related to other process increases (e.g., PS)
5. Increased use of strategies by age 7
6. Executive WM develops last

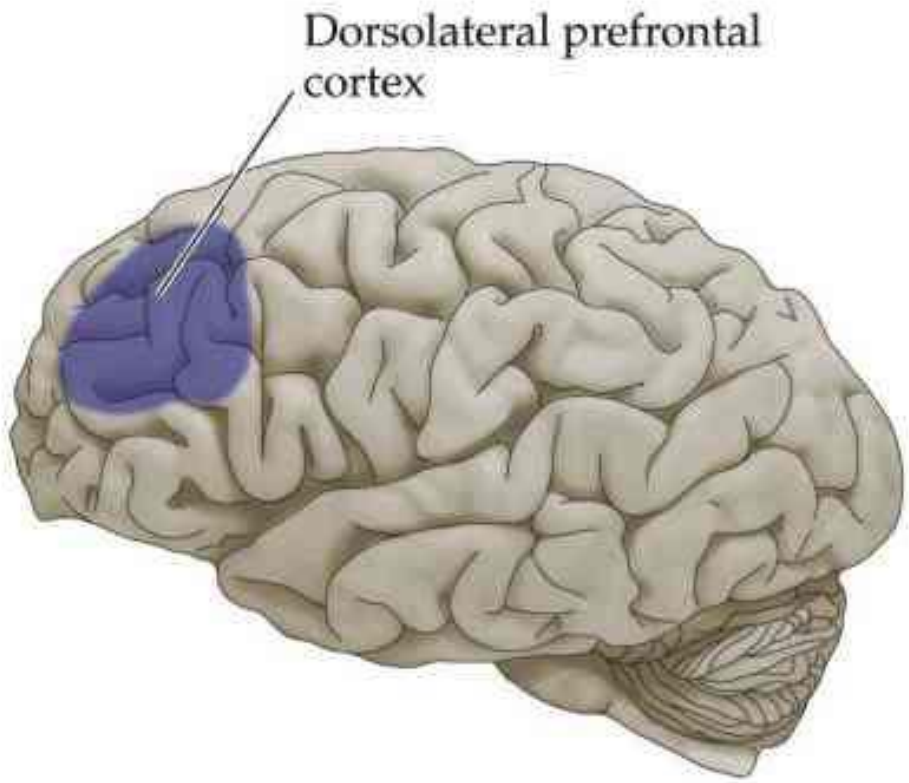
Development of Memory Strategies

1. From simple to complex to integrated
2. Simple strategy use at age 3 (rehearsal)
3. After age 6, strategies account for improvement
4. Strategy use and recall (r = .81)
5. Strategy use depends on metamemory (r = .41) and knowledge of efficacy
6. Development spurred by academic memorization requirements
7. Simple (rehearsal) not enough for advanced LTM

Neuroanatomy of WM



WM Control Center (Executive WM) is in the Prefrontal Cortex

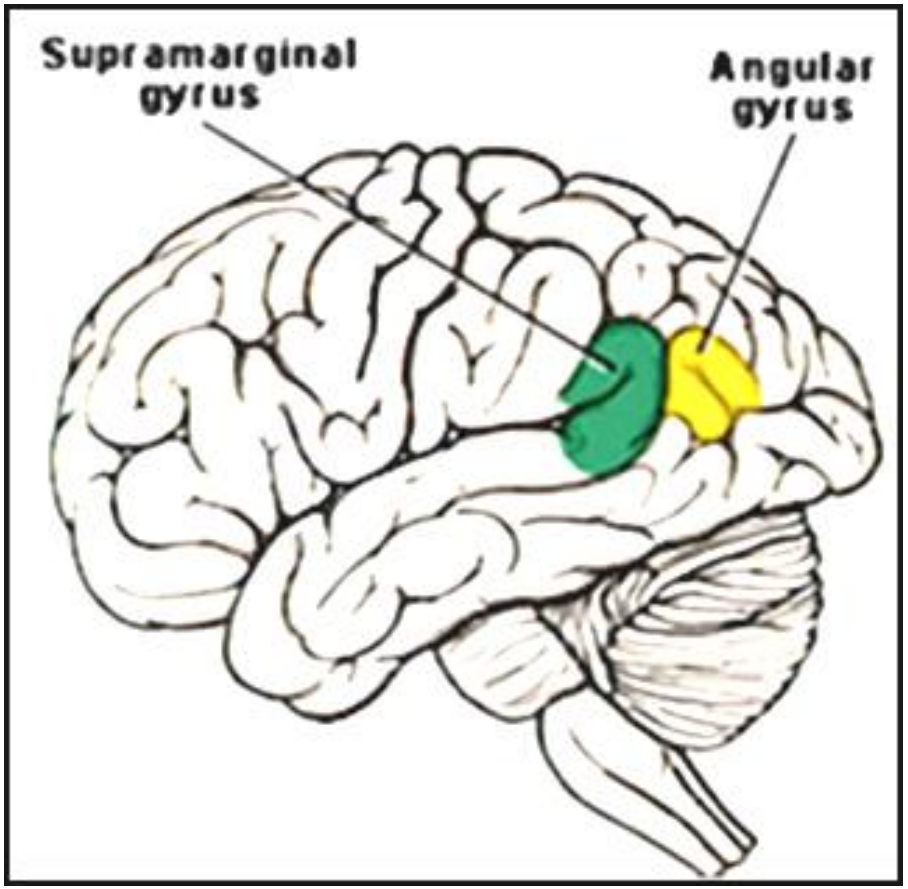


Phonological Short-Term Memory

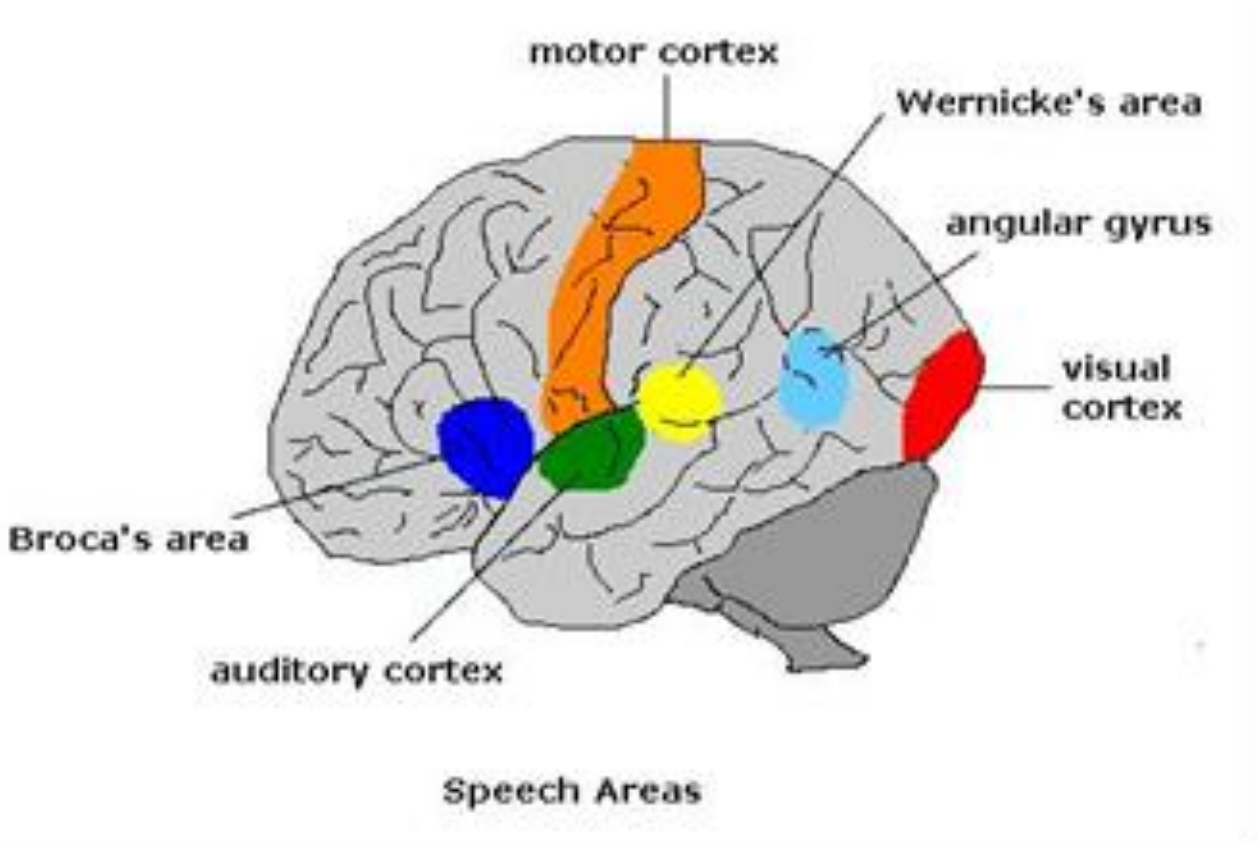
1. Left-hemisphere inferior parietal areas
2. Brodmann's area 40 in parietal lobe is the storage area; Brodmann's is involved in phonological processing; part of #3 below
3. Supramarginal gyrus in parietal lobe is also involved; supramarginal gyrus is involved in language processing
4. Broca's area (language function) in inferior left frontal lobe is subvocal rehearsal area

(epilepsy case)

Supramarginal Gyrus



Broca's Area


motor cortex
Wernicke's area
angular gyrus
visual cortex
Broca's area
auditory cortex
Speech Areas

Neuropsychology of WM

“working memory can be viewed as neither a unitary nor a dedicated system. Thus, working memory is not localized to a single brain region but probably is an emergent property of the functional interactions between the PFC and the rest of the brain” (D’Esposito, 2007)

Observations

1. During testing, observe retrieval (p. 152 of LTM book)
    1. Retrieval speed
    2. Better when cues provided
2. Classroom observations (p. 150 of LTM book)
    1. See list
    2. Which ones are new to you?

WM Research-Based Observations

1. Abandons activities before completion
2. Does not follow instructions accurately
3. Reserved in group activities
4. Short attention span
5. Poor monitoring of work quality
6. Loses place in complicated tasks
7. Depends more on teacher or peers for support

Memory Processes Analyzer (MPA) 3.0

1. For use with selective, multi-battery testing of memory components and processes
2. Statistically analyzes strengths and weaknesses across 13 memory processes
3. Identifies statistically significant memory strengths, weaknesses, and deficits
4. Allows memory composites and subtests from more than 40 batteries
5. Unlisted composites/subtests can be entered
6. Includes report with narrative, graph, and

MPA 3 Memory Processes

1. Executive Working Memory
2. Verbal Working Memory
3. Visual-Spatial Working Memory
4. Phonological Short-Term Memory
5. Visual-Spatial Short-Term Memory
6. LTM Encoding
7. LTM Verbal Recall
8. LTM Visual-Spatial Recall
9. LTM Consolidation
10. LTM Recognition
11. LTM Retrieval Fluency
12. Rapid Automatic Naming
13. Orthographic Memory

Memory Interventions: General Approach

1. Strengthen weakness/deficit if possible
2. But also utilize the strong areas more
3. Use methods that involve other processes, more of the brain
4. Principle: make the brain work; it gets better
5. Training demands prompt strategy use
6. May still need accommodations that reduce the need to rely on the weak processes

Approaches to Improving WM

1. Reduce the “cognitive load”
2. Accommodations
3. Directly increase WM capacity through the use of training exercises
4. Teach strategies that allow more effective use of existing WM capabilities
5. Long-term memory strategies
6. Metamemory

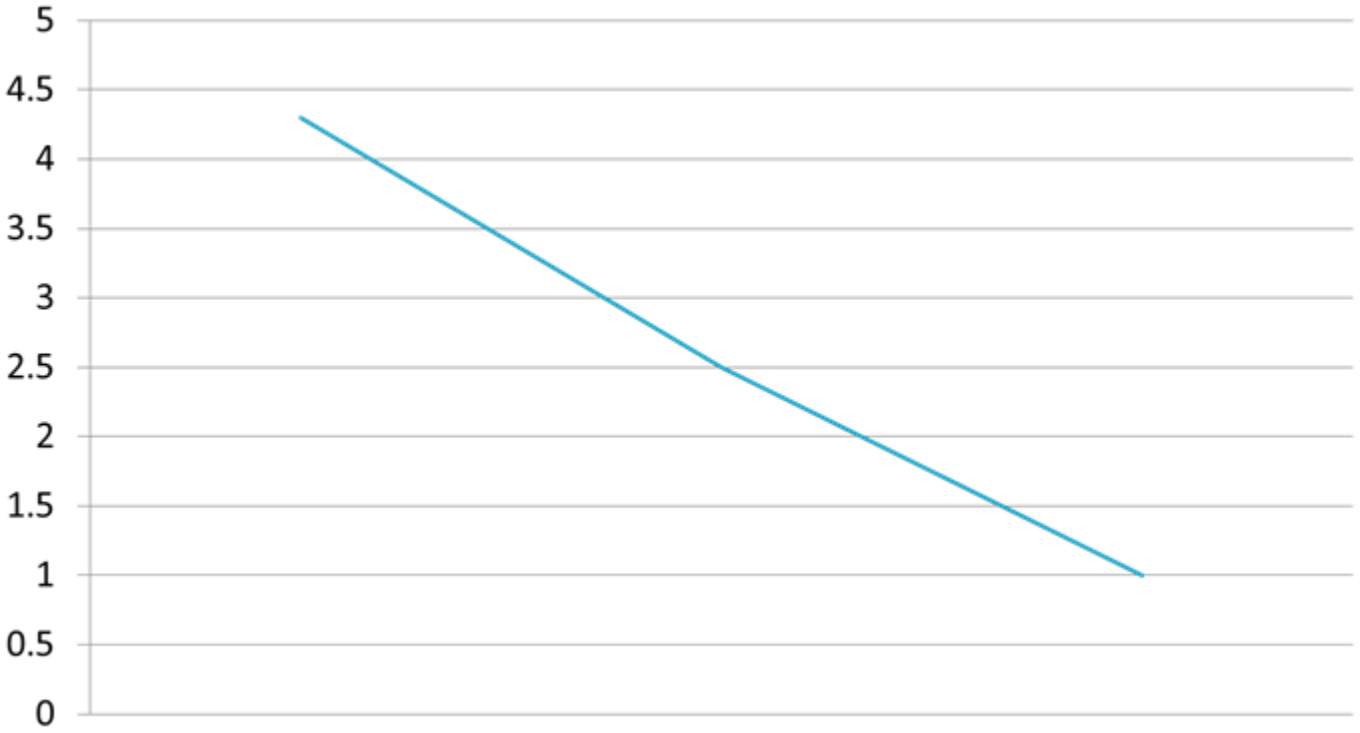
Exercises vs Strategies

1. Exercises try to make the brain stronger; grow working memory capacity
2. Strategies make more effective use of existing capacity
    1. 80 Digit Span Example
    2. Memory champions
3. WM is more exercise focused
4. LTM is all strategies

Cognitive Load

1. Processing & storage both use WM capacity
2. “Cognitive Load” is the processing portion
3. The greater the processing demands, the less that can be retained in WM/STM
4. Thus, too much cognitive load slows down cognitive performance and reduces learning (getting information into long-term memory)
5. Reducing cognitive load is an intervention

Cognitive Load and Span



Increasing cognitive load

Cognitive Load in the Classroom

1. Cognitive load is the main determinant of retention in WM (and STM) and highly influences how much gets encoded into LTM
2. Can also cause processing problems
3. Three sources of cognitive load
    1. The materials and their content
    2. Instructional methods and teacher behaviors
    3. The learner's internal processing

What Causes Cognitive Overload

1. Long, complex, inconsistent verbalization
2. Requiring two processes simultaneously
3. No time for processing or rehearsal
4. No external memory aids
5. Noisy learning environment
6. No or limited scaffolding (learning supports)
7. Disorganized presentations
8. Too many concurrent demands

More Overload Examples

1. Excessive length
2. Unfamiliar and not meaningful content
3. Demanding mental activities
4. Need to integrate information
5. Keeping track of steps while doing task
6. Tasks that require a lot of switching of attention

Reducing Cognitive Load

1. Only one step, process at a time
2. Allow time for processing and rehearsal
3. Allow self-paced processing
4. Provide external memory aids
5. Quite learning environment
6. Organized materials and presentations
7. Worked, partially-completed examples

Reducing Cognitive Load

1. Sequence material from simple to complex
2. Present material in an integrated way
3. Include visual presentation
4. Side by side information (being able to see as all the information in an integrated fashion) better than stacked information
5. Avoid load that is not related or necessary to the learning (extraneous load)

Reducing Cognitive Load

1. Well designed instruction reduces load (direct instruction)
2. Processing without need to remember; e.g. facts in writing are available
3. Processing steps/reminders are available
4. Teach students to switch between processing and rehearsing
5. Students learn under low load conditions

Cognitive Load Handout

- Link

Accommodations and Strategies for Working Memory Deficits

Basic Reading Skills Strategies

1. Support student during decoding and blending
2. Prompt by saying the first phoneme in a syllable if student forgets before blending
3. Say the segmented phonemes/syllables slowly after student has sounded them out
4. Have student say blended word smoothly again after correct pronunciation

Reading Comprehension Strategies

1. Student previews and skims the passage to activate relevant prior knowledge so that long-term memory supports WM
2. If partially read previously, review what was read before
3. Have student pause after each sentence or paragraph to visualize/imagine
4. Allow silent reading when comprehension is the priority over oral reading fluency

Reading with Personal Visualization HSR Lesson 25

1. Works because it personalizes the memory
2. Content: History, literature, science, etc.
3. Imagine yourself in the scene, viewing things as if you were actually there
    1. Be an impartial observer, like a reporter
    2. Imagine details and the conversation
    3. Your feelings and reactions
    4. Pause periodically to do this as you read

Written Language Strategies

1. Have the student express it orally first
2. Teacher “stores” it and says what student said as student writes
3. Or, teacher writes part of sentence so that student just needs to use closure to finish
4. Editing/revising should be broken down into discreet steps

Written Language Accommodations

1. Shorten writing assignment
2. Allow shorter sentences
3. Allow opportunity to revise after feedback provided
4. Allow abbreviations and symbols in first draft
5. Provide notes, note-taker, or partially completed class notes in classes where note-taking is required

Mathematics Accommodations

1. Allow calculator use with young children
2. Allow list of steps/procedures
3. Support during story problems
    1. Explain their problem solving strategy orally before doing calculations
    2. Reduce need to solve problem in divergent ways
4. Completed examples and partially completed problems

WM General Accommodations

1. Extended testing time
2. Repeating information
3. Repeating information in a simplified manner
4. Providing written checklists and reminders of step-by-step procedures
5. One task at a time
6. Slow down presentation
7. Preferential seating to reduce distraction
8. Provide prompts and cues

Rehearsal Strategy
HSR Lessons 11-13

1. Is the subvocal repetition of information
2. Most use this strategy by age 10
3. Should be taught to all 1st graders and students with learning disabilities
4. Academic benefits example
5. Students with severe memory problems can not maintain sequence during verbal rehearsal

WM Rehearsal Strategies

1. Goal: Maintain until processing is complete or information encoded
2. Serial and cumulative repetitive process
3. First aloud, then subvocal
4. Increase length of list as student improves
5. Good maintenance if overlearned

Material for Rehearsal Exercises

1. Use a variety of stimuli
2. Letters phonemes, numbers, words
3. Non-words are ideal
4. Require aloud rehearsal when child can not maintain sequence

Rehearsal (Strategy) Training Steps

1. Serial: present all items at once
2. Cumulative: Repeat first word until next delivered then keep adding words
3. First aloud, then whisper, then subvocal, then check to see if student using
4. Student needs to learn when to use this
5. Remind students when to use this
6. Practice cumulative rehearsal

Using Rehearsal with Switching

1. Switching back and forth between the processing and rehearsal
2. Switching with rehearsal helps maintain the information in STM while processing the same or other information
3. Require trainee to use rehearsal with switching for most WM exercises
4. Switching is embedded in all WM exercises

Why is Metamemory Education Essential?

1. Without it, there is:
    1. Less improvement from intervention
    2. Less motivation and cooperation
    3. Continued misconceptions and frustration
    4. Less maintenance and generalization

Video

Teaching Metamemory

1. Could begin with a class or group, but later needs to be conducted individually
2. *Helping Students Remember* has metamemory lessons
3. Metamemory should be addressed during each private session
4. Per session, focus on:
    1. Why it works from a memory perspective
    2. Why this student needs this method/strategy
    3. When and how to use it

More on Metamemory

1. This is ongoing through sessions
2. Always help child understand why, when, where it works or will benefit (conditional knowledge)
3. Always show the child the data
4. Reinforce progress
5. Child should become expert on memory
6. The older the child, the more metamemory

Why Face-to-Face, WM Exercises

1. Compliance with online training is a concern
2. Oral responding not allowed online
3. Online training does not combine exercises and strategies
4. A trainer, parent, or peer administers these
5. Can be done with a student partner who knows the rules; take turns
6. Adapt with a longer span as progress is made

Guidelines for Hands-On, WM Exercises

1. 20-30 minutes a day, every other day
2. About 5 minutes with each type of exercise
3. When span of a given length is mastered, increase the span
4. Lower the span when it is too difficult
5. Require child to use rehearsal and switching strategies
6. Weight training analogy

Counting Span

1. Ideal for young children, preschool
2. Make cards with a variety of dots
3. Have dots of a different color as distractors
4. Count the number of dots on each card
5. Remember the total on each card in correct sequence
6. Not in HSR

Span Recall Practice

1. Ideal for young children
2. Practice remembering sequences of words, digits, nonwords
3. Nonwords are more challenging
4. Or sentences; can recall more words in a sentence than in unrelated list

Listening Span/Last Word

1. Not in HSR
2. The task: remember the last words in sequence.
3. Short sentences presented orally.
4. Processing part is answering the question
5. Example: “Do cats bark?” “Do cars have different shapes?” Then, trainee says, “Bark, shapes.” Practice Link

Using Math to Build WM
HSR Lesson 19

- Complete calculations
- Remember the answers in sequence

  4 + 3 = 7

  9 – 3 = 6

  8 + 2 = 10

  Response: 7, 6, 10

- With groups, call on one student randomly for response

Using Math Flashcard to Build WM

1. See rules/procedures
2. Best to use more than one operation in same deck
3. Teach trainee to switch and use cumulative rehearsal
4. How should calculation errors be handled?
5. Practice

N-Back Exercise
HSR Lesson 20

1. Found to have corresponding growth in brain
2. Challenging task but easily administered
3. Remember stimulus n-items back
4. Do it repetitively
5. Deck of cards ideal; prevents practice effects
6. *n*-back task
7. What is the strategy?
8. Improvement will be slow at this task
9. See rules/procedures
10. Practice

N-Back Procedures Summary

1. Display items one at a time for 1-2 seconds
2. Start over after 1st error
3. Should get 10 consecutive correct 3 times before going to next *N*
4. 5+ minutes, 4 times per week
5. More challenging: A double *n*-back
6. Establish baseline
7. Encourage strategy use
8. What other materials can be used?

Computerized and Internet-Based Working Memory Training

1. These are exercises, not strategies
    1. But they prompt the use of a strategy
2. They work because of brain plasticity
3. Evidence that
    1. Untrained WM performance (near transfer) almost always improves
    2. Far transfer to academics: evidence is inconsistent and limited

What is Required to Make a Computerized Exercise Work

1. Must be adaptive
    1. Difficulty level constantly adjusted
    2. Confirmed by research
2. Processing and storage required during the task
3. Consistent high cognitive workloads
    1. Has to be challenging enough
4. Extensive practice over a sustained period of time
    1. 30 minutes a day for 25 days over 5 weeks minimum

Lumosity

1. Numerous exercises; more than memory
2. Has N-Back exercises (that's why it's recommended)
3. Exercises based on research
4. Are adaptive and appropriate
5. Affordable plans, such as yearly
6. Can monitor learner's progress
7. Best to select appropriate games rather than allow Lumosity to control individual's

Brain HQ

1. Affordable plans, such as yearly
2. Variety of WM exercises
3. Well designed, challenging, cover a wide range of ability and age
4. Has verbal WM exercises, e.g., listening to a conversation

WM Training Impact on Brain

1. Takeuchi et al. (2010)
2. Adaptive training with 2 *N*-Back visual tasks
3. Increase in white matter correlated with amount of training & improved performance
4. Mainly adjacent to the corpus callosum and in white matter parietal region
5. Increased transfer of info, at the dorsolateral prefrontal cortex, location of executive WM

Problems with Online Training

1. Do not encourage strategies
2. May not be challenging enough
3. Don’t match well with learner’s WM needs
4. Motivation and guessing
5. Not all are research based
6. Timed responding; too quick
7. No oral to oral exercises

Memory Interventionist Training

- For psychologists and related professionals
- Background in psychoeducational assessment required
- Taught by Dr. Dehn
- Taught once per year, beginning in fall
- CEU's from Kids, Inc.
- 36-hour course
- Includes neuropsych assessment of memory
- Case study with supervision

Cogmed Training Details

1. Adaptive, game-like, internet-based training, records everything
2. Has preschool, school age, and adult levels
3. 25 sessions, 30 minutes each with 8 exercises out of 12, over 5 weeks
4. Child can do without assistance
5. Does not encourage use of strategies
6. https://youtu.be/j-Pojkqekq0
7. See Video

Cogmed Research Review

1. Improved WM, especially visual-spatial
2. Fluid reasoning sometimes improves
3. Math and reading sometimes improve
4. ADHD kids improved in WM; less hyperactivity
5. Holmes et al. found substantial and sustained gains in WM and math

Cogmed Research Controversy

1. Two recent studies have concluded that the claims are “largely unsubstantiated”
2. No control group
3. Younger kids respond better
4. Not everyone improves
5. Is it just practice effects?
6. Recent study with proper design: WM improved, but still poor far transfer

Dehn's Views on Cogmed

1. Majority of kids will benefit
2. Cost is an issue; timely feedback is an issue
3. Maintaining practice schedule is concern
4. Parents not trained to supervise practice
5. In general, may be too superficial; does not target actual WM deficits well
6. Cogmed discourages strategies; Dehn introduces when subject hits wall
7. Probably best for ADHD/WM co-morbid

Why LTM Strategies for WM Weakness?

- Weak WM is holding back encoding/learning
- Many learners have normal LTM. If they can get information encoded they retain it.
- If WM does not respond to interventions or is extremely limited, use LTM strategies to circumvent it

Dehn's Big Four LTM Intervention Principles/Strategies

1. Organization; e.g., semantic clustering
2. Visualization; e.g. dual encoding
3. Associations, e.g., mnemonics
4. Review and retrieve; e.g., testing effect
5. All of these have a deep and consistent evidence-base

Loci (The Palace Technique)

1. Romans matched items with a route
2. Evolved into the Palace method
3. How the competitors use this approach
4. https://youtu.be/PIg73ppoVZw
5. See video (Andi Bell on youtube)
6. Locations can be used again with different items
7. Create your palace; can have more than one

Loci with Children

1. With children, use items in their bedroom
2. Or rooms in their house
3. Use items/rooms in sequence so nothing is forgotten
4. Have them follow visualization rules
5. Suggest associations as needed
6. See Training Manual p. 70; HSR Lesson 26
7. *Practice*: African export list from Lesson 26
8. Practice explaining to a child

Keyword

1. Highly effective; largest effect size, about 1.6
2. Combines auditory and visual
3. First, the acoustical link (keyword)
4. Then, image of linked items interacting
5. To retrieve, think of keyword first
6. LD do better when keyword & image provided
7. Two kinds: Single and double keywords
8. See Training Manual p. 71; HSR Upper Level Lesson 40

Keyword Practice

1. Video illustrates a “double” keyword
2. Use keywords for Denver, Colorado
3. Single Keyword practice with Spanish vocab:
    1. Vaca = cow
    2. Carta = letter
    3. Escalera = ladder
4. Make the images unique, interactive, but focused on the keyword and meaning

The Retrieval Principle

1. Retrieve from LTM, not STM
2. More effective than just reviewing
3. More effective when info is partially forgotten and it takes effort to retrieve
4. Also strengthens recall for related info.
5. Supports consolidation and reconsolidation
6. See Training Manual p. 78
7. Why does it work?
8. Explain to an adolescent how to apply this principle