UNDERSTANDING AND OVERCOMING WORKING MEMORY PROBLEMS IN THE CLASSROOM

PRESENTED BY
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OVERVIEW

- Definition of Working Memory
- Review of Memory Systems Different Types of Memory
- Theoretical Basis of Working Memory
- Identifying Students with Working Memory Problems
- Classroom Observation List
- Assessments
- Teaching Memory Strategies
- Compensation Strategies
- Development of Phonological Skills
- Useful Ideas to Support Students (Parents)
DEFINITION OF WORKING MEMORY INDEX FROM THE WISC 1V

- The WMI assesses the ability to hold new information in short-term memory, concentrate, and manipulate that information to produce some result or reasoning processes.

- It is important in higher-order thinking, learning, and achievement. It can tap concentration, planning ability, cognitive flexibility, and sequencing skill, but is sensitive to anxiety too. It is an important component of learning and achievement, and ability to self-monitor.
DIFFERENT TYPES OF MEMORY

• LONG-TERM MEMORY SYSTEMS
  • PROCEDURAL MEMORY
    • LEARNED SKILLS
    • LASTS FOR A LIFE TIME ONCE ESTABLISHED
    • EXAMPLES: HANDWRITING, RIDING A BIKE, CAR DRIVING
  • PROCEDURAL MEMORY SKILLS CAN BE DIFFICULT TO ESTABLISH AND REQUIRES PRACTICE TO LEARN TO AUTOMATICITY LEVELS
  • SEMANTIC MEMORY
    • VOCABULARY, FACTS AND KNOWLEDGE
    • LASTS A LIFE TIME IF USED FREQUENTLY
    • STORED IN LONG TERM MEMORY
  • AUTOBIOGRAPHICAL MEMORY
    • STORED FACTS AND SIGNIFICANT EVENTS FROM YOUR LIFE
    • WE DEFINE OURSELVES BY THESE MEMORIES AS THEY ARE UNIQUE
DIFFERENT TYPES OF MEMORY

• EPISODIC MEMORY-TEMPORARY MEMORY
  • RECORDS DETAILS OF PARTICULAR EXPERIENCES
  • LAST FOR SEVERAL DAYS
  • EXAMPLE: WHERE YOU PARKED YOUR CAR OR WHAT YOU EAT FOR LUNCH

• SHORT TERM MEMORY SYSTEMS

• SHORT TERM MEMORY
  • CAPACITY TO HOLD ONTO INFORMATION FOR A VERY BRIEF TIME FROM ENVIRONMENT
  • PASSIVE SYSTEM RELATES TO VERBAL AND VISUAL INFORMATION
  • CAN AUTOMATICALLY ACCESSES LONG TERM MEMORY WITHOUT DIRECTION (AUTOMATICITY)

• WORKING MEMORY
  • MENTAL WORKSPACE ACTIVE SYSTEM CONSCIOUSLY RETRIEVES LONG TERM MEMORY AND ENGAGES EXECUTIVE FUNCTIONS TO DIRECT THINKING
  • LAST FOR SECONDS ONLY
  • EXAMPLES: MENTAL ARITHMETIC TASKS AND FOLLOWING VERBAL INSTRUCTIONS
COMPONENTS OF WORKING MEMORY


Central executive

CONTROL OF ATTENTION

VERBAL STORAGE

NON VERBAL STORAGE

Verbal STM

Visuo-spatial STM

BADDELEY & HITCH (1974) and BADDELEY (2000) proposed the components of working memory:

1. Central executive
2. Verbal short-term memory (STM)
3. Visuo-spatial STM

The central executive is responsible for the control of attention, which regulates the flow between the different components of working memory.
INFORMATION PROCESSING

- Environmental stimuli
- Hearing store
- Vision store
- Touch store

Sensory memory

Short-term memory

Long-term memory

Rehearsal

Information either passed on to long-term memory or lost.

Information you do not attend to is lost.
THE DEVELOPMENT OF WORKING MEMORY.

ALL ASPECTS OF WORKING MEMORY INCREASE BETWEEN 4 AND 14 YEARS WITH THE STEEPEST INCREASE DURING THE PRIMARY SCHOOL YEARS.

THERE IS A LARGE INDIVIDUAL VARIATION IN ABILITY IN CHILDREN THE SAME AGE ACROSS ALL AGES.

A 10 YEAR OLD HAS TWICE THE WM CAPACITY AS A 5 YEAR OLD. THERE CAN BE A THREE YEAR DIFFERENCE IN ABILITY IN ONE CLASS LEVEL. WORKING MEMORY CAPACITY IS INHERITABLE AND NOT RELATED TO ENVIRONMENT OR SOCIAL STATUS.
TYPICAL POPULATION: WM AT SCHOOL ENTRY PREDICTS ACHIEVEMENTS 2.5 YEARS LATER
GATHERCOLE ET AL (2003)

• ASSESSED WITHIN 6 WEEKS OF SCHOOL ENTRY AT 4 YEARS
• WORKING MEMORY SKILLS WERE STRONGLY ASSOCIATED BASELINE ASSESSMENT OF READING, WRITING AND MATHEMATICS
• EXCELLENT PREDICTOR OF KEY SKILLS IN MATHS AND ENGLISH AT BOTH 7 AND 11 YEARS
• WORKING MEMORY PROBLEMS ARE COMMON IN STUDENTS WITH SPECIFIC LEARNING DIFFICULTIES
• STUDENTS WITH COGNITIVE IMPAIRMENTS CAN BE CATEGORIZED INTO GROUPS USING WORKING MEMORY TESTING
IDENTIFYING CHILDREN WITH WORKING MEMORY PROBLEMS

• 10% OF STUDENTS FIT INTO THIS CATEGORY
• 80% OF THESE STUDENTS SHOW POOR ACADEMIC ACHIEVEMENT IN EITHER READING OR MATHS OR BOTH. (Gathercole & Alloway, 2008)
• CHARACTERISTICS: RESERVED IN GROUPS, NOT CONTRIBUTING TO CLASS DISCUSSIONS, DIFFICULTIES IN FOLLOWING INSTRUCTIONS
• LOSES TRACK IN COMPLEX TASKS PARTICULARLY IN WRITING AND MATHS
• PROBLEMS COMBINING BOTH PROCESSING AND STORAGE
• TEACHER SAYS: SHORT ATTENTION SPAN AND HIGHLY DISTRACTIBLE
CLASSROOM OBSERVATION LIST (FROM M.J. DEHN 2008)

• **GENERAL WORKING MEMORY ISSUES**
  
  • CLASSROOM PERFORMANCE IS POORER THAN EXPECTED FROM INFORMAL TESTS
  
  • HAS DIFFICULTIES IN COGNITIVELY DEMANDING TASK BUT FINE OTHERWISE
  
  • PREFERENCES TO SIMPLIFY TASKS REDUCING WORKING MEMORY LOAD
  
  • FAILS TO COMPLETE COMPLEX TASKS
  
  • LOSES TRACK OF WORKINGS IN MORE COMPLEX TASKS
  
  • UNABLE TO RETRIEVE LEARNED INFORMATION TO COMPLETE TASKS
  
  • UNABLE TO CONNECT NEW LEARNING TO OLD (POOR ACCESS TO LONG TERM MEMORY)
  
  • RARELY CONTRIBUTES TO CLASS DISCUSSIONS (LOOSING TRACK OF IDEAS)
  
  • SAYS "I FORGET EVERYTHING"
  
  • STRUGGLES TO ORGANISE IDEAS FOR WRITING
  
  • LOSES WORKINGS IN MENTAL MATHS
  
  • HAS DIFFICULTIES MEMORISING AND RETAINING FACTS
  
  • CONFUSES KNOWN FACTS
CLASSROOM OBSERVATION LIST

• PHONOLOGICAL SHORT TERM MEMORY
  • DIFFICULTIES REMEMBERING MULTISTEP ORAL INSTRUCTIONS
  • DIFFICULTIES REPEATING INSTRUCTIONS
  • HAS MORE PROBLEMS RECALLING DIGITS THAN WORDS
  • COUNTING ERRORS
  • PROBLEMS BLENDING PHONEMES WHILE READING
  • PROBLEMS WITH PHONETIC DECODING (READING) AND ENCODING (SPELLING)
  • STRUGGLES WHEN LEARNING NEW VOCABULARY

• VISUOSPATIAL WORKING MEMORY
  • DOES NOT NOTICE THE SIGNS IN MATHS (+, X)
  • CAN’T RECALL RECENT EVENTS
  • LOSES PLACE WHILE READING

• VERBAL WORKING MEMORY
  • REQUIRES FREQUENT REMINDERS, FORGETS WHAT HE NEEDS TO SAY AND VERBAL INSTRUCTIONS, HAS DIFFICULTIES SUMMARISING. STRUGGLES WITH UNDERSTANDING COMPLEX LANGUAGE STRUCTURES
VERBAL WORKING MEMORY

- Has difficulties taking notes (paraphrasing)
- Continues to use finger counting beyond grade 3
- Needs to reread text even when there is no reading problem
- Can’t recall the content of a reading passage or paragraph
- Produces short sentences in writing
- Often struggles with subject-verb agreement in writing
- Omits part of the sentence while writing or repeats words

EXECUTIVE WORKING MEMORY

- Answers are off topic in oral discussions
- Difficulties changing operations (i.e. addition to subtraction)
- Difficulties listening and taking notes
- Has difficulties using strategies preferring simple to complex methods
- Not using basic strategies such as sub vocal rehearsal
- Uses ineffective strategies during problem solving
CHOOSING ASSESSMENTS

• CHOOSE THE ASSESSMENTS TO MATCH YOUR NEEDS

• SOME GENERAL INDICATIONS OF LIKELY WM PROBLEMS TO WARRANT WATCHFULNESS /GENERAL SUPPORT
  • ATTENTION TO WARNING SIGNS OF MEMORY FAILURE
  • USE BEHAVIOURAL CHECKLISTS

• MORE DETAILED UNDERSTANDING NEEDED OF THE PARTICULAR PROBLEMS AND HOW THEY CAN BE MANAGED IN DETAILS (STRATEGIES, AIDS, ETC)
  • BACKWARD/FORWARD DIGIT SPAN
  • WISC V OR OTHER
  • AUTOMATED WORKING MEMORY ASSESSMENT (AWMA)
ASSESSING VERBAL SHORT TERM MEMORY

• DIGIT SPAN
  E.G 7…..4….2…8
  SIMPLE AND RELIABLE

• NON WORD REPETITION
  BALLOP, WOOGALAMIC,
  (CHILDREN’S TEST OF NON WORD REPETITION, PEARSON)
  SIMPLE AND RELIABLE UNLESS PROBLEMS WITH ARTICULATION OR HEARING.

• RESULTS ARE CLOSELY LINKED WITH VOCABULARY KNOWLEDGE AND
  ABILITIES TO LEARN SOUND PATTERNS IN NEW WORDS

• OFTEN MARKED VERBAL STM IMPAIRMENTS IN CHILDREN WITH
  LANGUAGE IMPAIRMENTS AND READING DIFFICULTIES
ASSESSING WORKING MEMORY

• WISC-4 WORKING MEMORY INDEX
  • FORWARD AND BACKWARD DIGIT SPAN
  • LETTER-NUMBER SEQUENCING

• AUTOMATED WORKING MEMORY ASSESSMENT (AWMA)
  • MORE ROBUST TEST THAN THE WISC 4 INDEX TESTS AS IT TESTS BOTH VISUAL AND VERBAL STM AND WORKING MEMORY SYSTEMS

• WORKING MEMORY RATING SCALE (PEARSON) IS A USEFUL SCREENER THAT USES 20 ITEMS TO RATE TYPICAL BEHAVIOURS. NOT DIAGNOSTIC

• OTHER CONSIDERATIONS IN INTERPRETING POOR WM SCORES
  • SENSORY PROBLEMS HEARING AND VISION
  • PROCESSING PROBLEMS APD, PHONOLOGICAL AND LANGUAGE DELAYS
  • MOTOR DYSPRAXIA ARTICULATION
  • ATTENTION MOTIVATION TO LEARN
  • COMPREHENSION 5-7 YEAR OLDS CAN BE DIFFICULT TO TEST
  • BROADER COGNITIVE FUNCTIONING
TEACHING MEMORY STRATEGIES

• TEACH STUDENTS STRATEGIES AND MNEMONICS: PLANNING, EXECUTION AND EVALUATION OF PRODUCT

• LD STUDENTS ARE LESS LIKELY TO DEVELOP THESE STRATEGIES AND NEED TO BE EXPLICITLY TAUGHT TECHNIQUES

• EARLY INTERVENTION WORKS BEST: LITERACY INTERVENTIONS IMPROVE WORKING MEMORY

• REMEDIAL VERSUS COMPENSATION (DIRECT TEACHING OR USING STRENGTHS)

• EXPLICIT AND INTENSIVE TEACHING OVER EXTENDED TIME, TRAIN TO AUTOMATICITY (WHY, WHEN AND HOW TO USE STRATEGIES)

• FAILURE CAN BE DUE TO POOR METACOGNITION (POOR USE OF SELF TALK AND CONTROL OF EXECUTIVE FUNCTIONS)

• SELF AWARENESS AND SELF CONTROL TRAINING USING AUDIBLE OR SILENT VERBALISATIONS

• EDUCATE THE STUDENT ABOUT HOW MEMORY WORKS AND WHEN TO USE STRATEGIES

• TRANSFER OF STRATEGIES IS NOT AUTOMATIC BUT STUDENTS CAN BE PROMPTED TO USE APPROACHES WHEN THEY ARE AWARE OF THE BENEFITS
MEMORY STRATEGIES

- **ROTE LEARNING**: Simple repetition holds information in phonological short term memory, easy to learn and place minimal load on working memory, less efficient and effective. Useful strategy for early learning. Watch lips and ask how they memorise.

- **RELATIONAL STRATEGIES**: Engage meaning to learning. Mnemonics using imagery work well.

- **SUB VOCAL REHEARSAL**: Can be used by 5 or 6 year olds but is not universally used till 10.

- **EXPlicit REHEARSAL TRAINING**: Improves both short term memory and working memory but the benefits are **HIGHLY TASK SPECIFIC**.

- **NAMING LETTERS AND OBJECTS**: Is a useful training method (auditory to visual), repeating sentences and listening to stories and nursery rhymes (helps identify phonological structures of words).

- **CHUNKING**: Pairing, clustering or grouping units of information assists processing and remembering the whole. I.e. 8 and 6 combined to 86 is easier to recall. Chunking reduces the load in working memory and is most helpful in decoding tasks.

- **PARAPHRASING**: Flows from both rehearsal and chunking.

- **VISUOSPATIAL WM INTERVENTIONS**: Use verbalisation to describe what is viewed.
COMPENSATE FOR WORKING MEMORY DIFFICULTIES.

CURRENTLY, WE DO NOT HAVE EASY APPROACHES TO BUILD WORKING MEMORY SKILLS. SKILL BUILDING DOES NOT GENERALIZE WELL TO CLASSROOM PERFORMANCE. HOWEVER, THERE ARE WAYS TO SUPPORT STUDENTS THAT WILL HELP THEM

• **MONITOR THE STUDENT**

Ask the student to **verbalize** their steps in completing tasks they often struggle to complete. This can provide important information about where the breakdown is occurring and what supports are likely to work best.

• **EVALUATE THE WORKING MEMORY DEMANDS OF LEARNING ACTIVITIES.**

A student with working memory difficulties will need more support as tasks get longer, become more complex, have unfamiliar content or demand more mental processing.

• **REDUCE THE MEMORY LOAD**

Break tasks into smaller chunks. One task at a time is best, if possible.

• **REDUCE THE AMOUNT OF MATERIAL THE STUDENT IS EXPECTED TO COMPLETE.**

Keep new information or instructions brief and to the point, and repeat in concise fashion for the student, as needed.

• **USE ADVANCE ORGANIZERS.** Use advance organizers and teach students how to use them. Connect what they learn to what they already know.
COMPENSATE FOR WORKING MEMORY DIFFICULTIES.

- TEACH **STEP-BY-STEP** STRATEGIES (10 MINUTES DAILY OVER SIX WEEKS)
- **TEACH ONE STRATEGY AT A TIME** IN BRIEF, FOCUSED SESSIONS.
- TEACH STUDENTS **WHEN, WHERE, WHY AND HOW TO USE THE STRATEGY.**
- REVIEW AND **ACTIVATE PRIOR KNOWLEDGE.**
- **BE OVERT AND EXPLICIT.**
- **MODEL AND THINK ALOUD.**
- HAVE **SKILLED STUDENTS** MODEL STEPS.
- **ENCOURAGE USE AND PRACTICE.**
- EVALUATE AND **RECOGNIZE EFFORT AND SUCCESS.**
- **ENCOURAGE SELF-MONITORING.**
- PROMOTE TRANSFER TO OTHER SITUATIONS, TIMES,
- **PROVIDE INFORMATION IN MULTIPLE WAYS:** **SPEAK IT, SHOW IT, AND CREATE OPPORTUNITIES TO PHYSICALLY WORK WITH IT OR MODEL IT. PROVIDE WRITTEN DIRECTIONS FOR REFERENCE.**
- **SIMPLIFY** THE AMOUNT OF MENTAL PROCESSING REQUIRED BY PROVIDING SEVERAL ORAL “CLUES” FOR A PROBLEM AND **WRITING KEY WORDS ON THE BOARD**
COMPENSATE FOR WORKING MEMORY DIFFICULTIES.

• INCREASE THE MEANINGFULNESS OF THE MATERIAL BY PROVIDING EXAMPLES STUDENTS CAN RELATE TO.

• DEVELOP ROUTINES SUCH AS SPECIFIC PROCEDURES FOR TURNING IN COMPLETED ASSIGNMENTS. ONCE A ROUTINE IS PRACTICED REPEATEDLY, IT BECOMES AUTOMATIC AND REDUCES THE WORKING MEMORY DEMAND.

• REPEAT AND REVIEW. BE PREPARED TO REPEAT INFORMATION AND INSTRUCTIONS.

• USE VISUAL REMINDERS OF THE STEPS NEEDED TO COMPLETE A TASK. (PICTURES)

• PROVIDE OPPORTUNITIES TO REPEAT THE TASK. REGULAR REVIEW IS ESSENTIAL

• ENCOURAGE PRACTICE TO INCREASE THE AMOUNT OF INFORMATION ENCODED INTO MEMORY.

• TEACH STUDENTS TO PRACTICE IN SHORT SESSIONS, REPEATEDLY THROUGHOUT THE DAY. SPACED PRACTICE IS MORE EFFECTIVE THAN MASSED PRACTICE. HAVE STUDENTS PRACTICE NEW SKILLS OR INFORMATION IN SHORT SESSIONS OVER THE COURSE OF THE DAY RATHER THAN IN ONE LONG SESSION. FOR EXAMPLE, GIVE THE STUDENT A SET OF KEY FACTS TO REVIEW FOR A FEW MINUTES TWO OR THREE TIMES DURING THE SCHOOL DAY, AND ENCOURAGE THEM TO

• REVIEW AGAIN AT HOME BOTH AT NIGHT AND IN THE MORNING.
USEFUL IDEAS TO DEVELOP WORKING MEMORY

1. Teach visualization skills.
Encourage your child to create a picture of what he’s just read or heard. For example, if you’ve told him to set the table for five people, ask him to come up with a picture in his head of what the table should look like. Then have him draw that picture. As he gets better at visualizing, he can start describing the image to you instead of drawing it.

2. Have your child teach you.
Being able to explain how to do something involves making sense of information and mentally filing it. If he’s learning a skill, like how to dribble a basketball, ask him to teach it to you after his coach explains it to him.

3. Suggest games that use visual memory.
Give your child a magazine page and ask him to circle all instances of the word “the” or the letter “a” in one minute. Alternatively, play games in the car in which one of you recites the letters and numbers on a license plate you see and then has to say it backwards, too.

4. Play cards.
Simple card games like Crazy Eights, Uno, Go Fish and War improve working memory in two ways. Your child has to keep the rules of the game in mind, but also has to remember what cards he has and which ones other people have played.
USEFUL IDEAS TO DEVELOP WORKING MEMORY

-CONTINUED

5. Make up category games.
When words and ideas are put into categories, they’re easier to remember. Playing games in which you name as many animals as you can think of can eventually lead to playing games with more complicated concepts. For example, you may ask your child to name as many clue words for addition as she can (such as “all together,” “in all,” “total” and “plus”).

6. Number your directions.
Beginning a sentence with words like “I need you to do three things…” can help your child keep all of the different points in his head. You can do the same thing with other information, too, like shopping lists (“We need to buy these five items…”).

7. Connect emotion to information.
Processing information in as many ways as possible can help your child remember it. Help him connect feelings to what he’s trying to remember. For instance, if he’s learning about how the pyramids in ancient Egypt were built, ask him to think about what it felt like to have to climb to the top of one of them pulling a heavy stone in the hot sun.

8. Help make connections.
Connections are the relationship between things. Finding ways to connect what your child is trying to remember with things he already knows can help him learn the new material. For instance, show him that the twos times table is the same as his doubles facts, such as $4 \times 2 = 8$ and $4 + 4 = 8$.

(Amanda Morin-Understood 2015)
**DEVELOPMENT OF PHONOLOGICAL SKILLS** *(MOATS AND TOLMAN 2003)*

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<th>Age</th>
<th>Skill Domain</th>
<th>Sample Tasks</th>
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| 4   | Rote imitation and enjoyment of rhyme and alliteration | **pool, drool, tool**  
"Seven silly snakes sang songs seriously." |
| 5   | Rhyme recognition, odd word out | "Which two words rhyme: **stair, steel, chair?**" |
|     | Recognition of phonemic changes in words | "**Hickory Dickory Clock. That's not right!**" |
| 5.5 | Clapping, counting syllables | **truck** (1 syllable)  
**airplane** (2 syllables)  
**boat** (1 syllable)  
**automobile** (4 syllables) |
|     | Blending onset and rime | "What word?"  
th-umb  qu-een  h-ope |
|     | Compound word deletion | "Say **cowboy**. Say it again, but don't say **cow**." |
|     | Syllable deletion | "Say **parsnip**. Say it again, but don't say **par**." |
## DEVELOPMENT OF PHONOLOGICAL SKILLS

| 6 | Blending of two and three phonemes | /z/ /ū/ (zoo) /sh/ /ō/ /p/ (shop) /h/ /ou/ /s/ (house) |
| 6 1/2 | Phoneme segmentation of words that have up to three or four phonemes (include blends) | "Say the word slowly while you tap the sounds." b-a-ck ch-ee-se c-l-ou-d |
| 6 1/2 | Phoneme substitution to build new words that have simple syllables (no blends) | "Change the /g/ in cage to /n/. Change the /ā/ in cane to /ō/." |
| 7 | Sound deletion (initial and final positions) | "Say meat. Say, without the /m/.

"Say safe. Say it again, without the /f/." |
| 8 | Sound deletion (initial position, include blends) | "Say prank. Say it again, without the /p/.

"Say snail. Say it again, without the /n/.

"Say fork. Say it again, without the /k/." |
TAKE HOME MESSAGES

• TRAIN TO AUTOMATICITY IN PHONICS AND MATHS FACTS TO REDUCE LOAD IN WORKING MEMORY

• GIVE TIME FOR STUDENTS TO PROCESS VERBAL INFORMATION WHEN GIVING INSTRUCTIONS (3 SECOND RULE), ENCOURAGE VISUALISATION AND SUPPORT WITH POSITIVE COMMENTS RELATING TO NEXT STEP, DOING WELL SO FAR ETC.

• ENCOURAGE SUB VOCAL REHEARSAL AND CHUNKING USING WHISPERING STRATEGIES TO ENGAGE INNER LANGUAGE SUPPORTS

• GIVE ONE VERBAL INSTRUCTION AT A TIME USING SIMPLE SENTENCE STRUCTURES. ENCOURAGE REPEATING INSTRUCTIONS IF ASSISTANCE IS REQUIRED

• ENCOURAGE VISUALISATION FROM LANGUAGE AND PROVIDE VISUAL SUPPORTS

• GIVE HOMEWORK ON PAPER OR THROUGH PORTALS (NO COPYING FROM THE BOARD)
ADDITIONAL RESOURCES


TRACY PACKIAM ALLOWAY (2011), IMPROVING WORKING MEMORY: SUPPORTING STUDENT’S LEARNING PUBLISHED BY SAGE PUBLISHING

TRACY PACKIAM ALLOWAY AND SUSAN E. GATHERCOLE EDITORS (2008), WORKING MEMORY AND NEURODEVELOPMENTAL DISORDERS PUBLISHED BY PSYCHOLGY PRESS


Google search on Working Memory also provides a wide range of resources for further reading

YouTube search on Working Memory has a good collection of video presentation