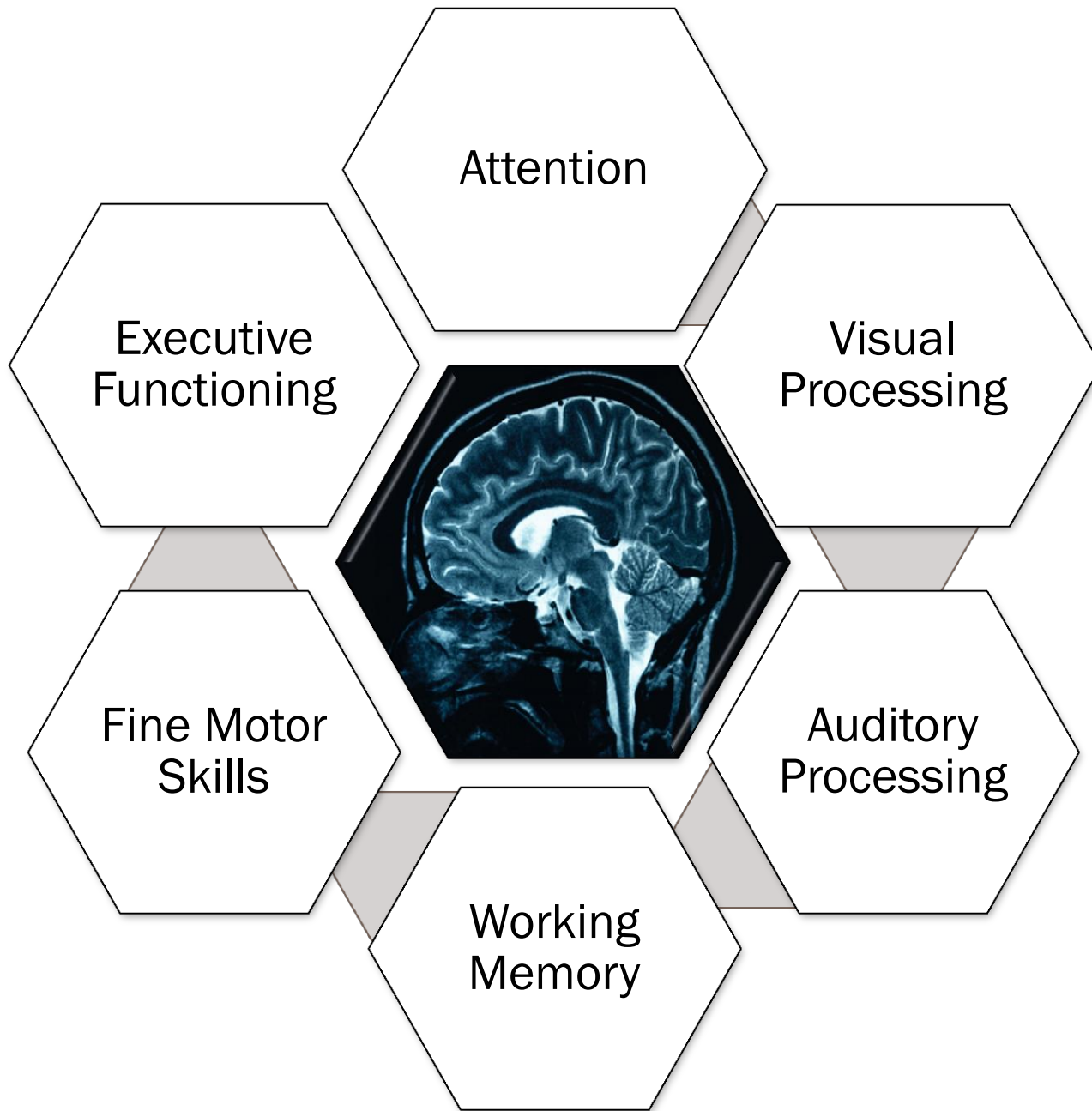


Reading, Writing & Arithmetic

The Role of Attention and Working
Memory & Executive Functioning



“...the human mental processes are complex functional systems that are not ‘localized’ in narrow, circumscribed areas of the brain, but take place through the **participation of groups** of concertedly working brain structures, each of which makes its own particular contribution..” (Luria 1973, p. 43)



What is Attention?

“...different [capacities](#) or [processes](#) that are related to aspects of how the organism becomes receptive to [sensory stimuli](#) and how it may begin processing incoming or ‘attended to’ excitation.” (Lezak, 2004, p. 34)

“...involves the selection of specific information by the organism...it is logical to expect it to be associated with selective facilitatory processing in the brain.” Gaddes & Edgell, 1994, p. 256

It **IS** the brain’s ability to efficiently and effectively process sensory information.

What gets your attention?

The **smell** of smoke coming from your neighbor's house.

The **sound** of the ambulance's siren.

The **sight** of a person' walking down the street wearing a mask.

The **feel** of heat against our skin.

Attention is related to sensory processing.

The Neural Structures of Attention

5. Thalamus plays a role in regulating higher-level brain activity: memory, executive functioning

4. Various parts of the thalamus control the shift of attention from the internal to external world

3. Upper part of the brainstem: mediates arousal and sleep regulation via chemical information

2. Reticular activating system: arousal and selective attention

1. Main branch of the brainstem: perceptual information is processed; arousal system is activated-registration

The Characteristics of Attention

Finite/limited capacity

Information processing capability

Ability to disengage and shift our attention

Responsivity to sensory and/or semantic stimuli

The Taxonomy of Attention

Selective / Focused Attention: the ability to highlight one or two important stimuli (external/internal)

Sustain Attention: the ability to stay on task in a vigilant manner for a prolonged period of time

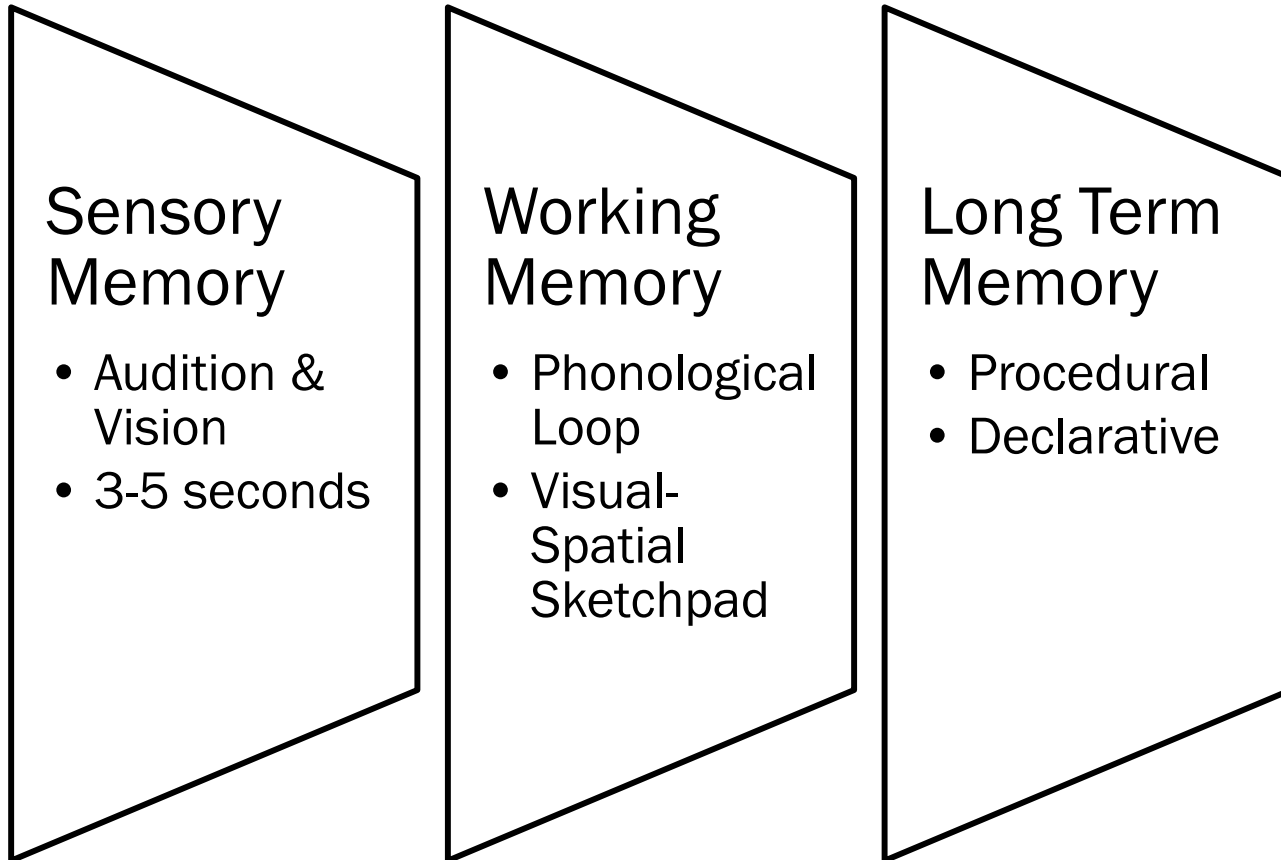
Shift Attention: the ability to reallocate attentional resources in a complex task

Divided Attention: the ability to respond to more than one task or event simultaneously

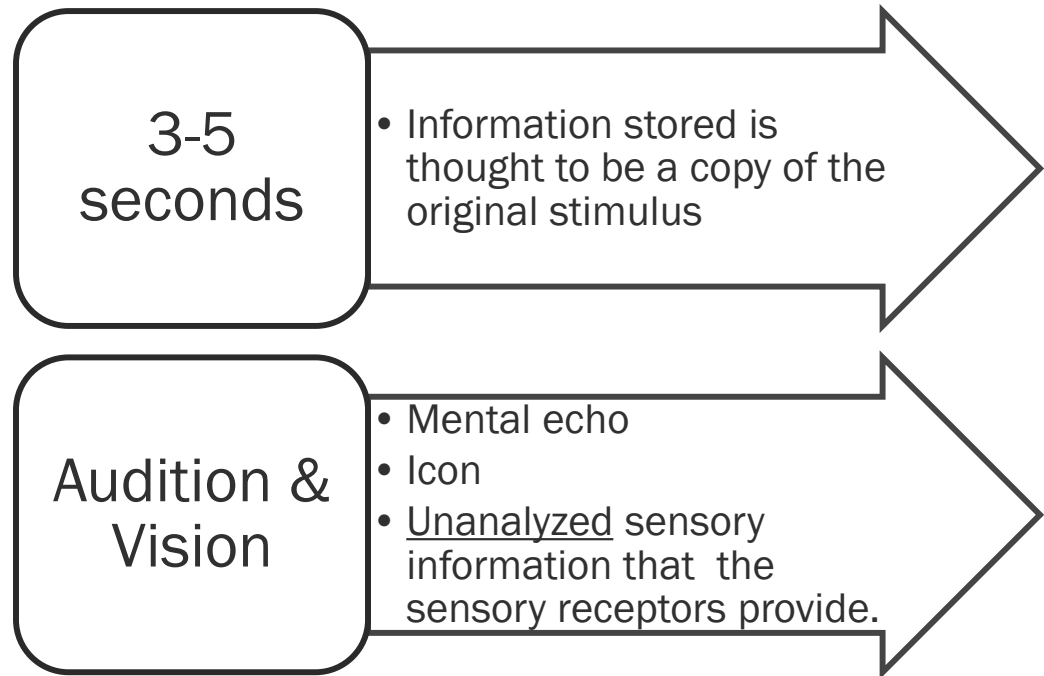
Memory Processing

- Perceive Stimuli
- Encode
- Consolidate
- Store
- Retrieve/Recall

The Structural Components of Memory



Sensory Memory



Working Memory

Phonological Loop

- How we store auditory information
- Limited capacity— 7 ± 2 numbers
- Grouping information: efficient storage
- Meaningful information is more easily stored than non-meaningful

Central Executive

- Monitors and coordinates the PL and VSSP
- Decides the order in which the processes will be performed
- How much attention goes to each task

Visual-Spatial Sketchpad

- How we rehearse and store visual information
- Mental blackboard
- Subvocal speech i.e., requires language
- Requires efficient visual scanning abilities

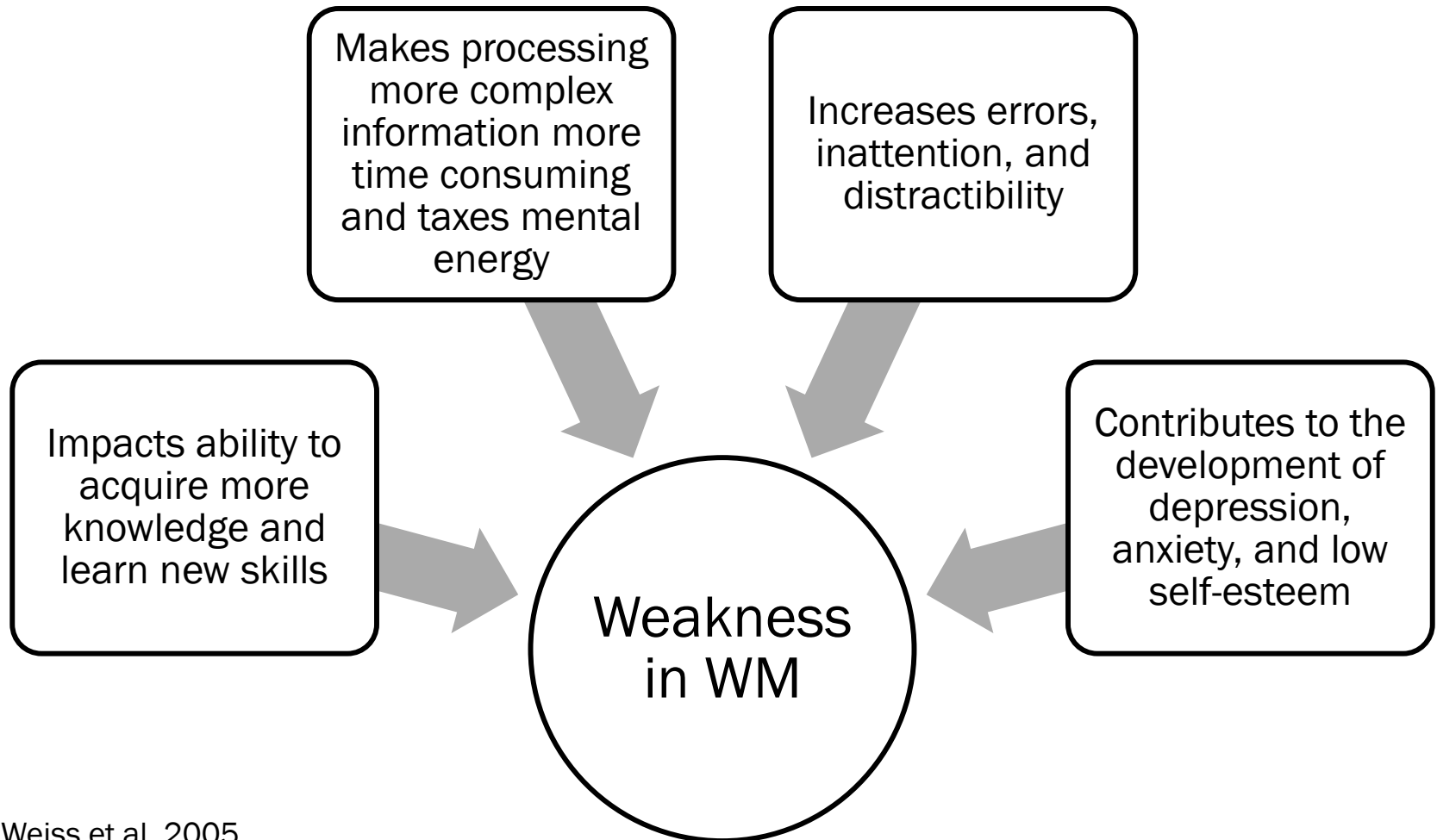
Examples of Working Memory

Attend a lecture while taking notes

Remember 3 parts of homework while recording the first two parts

Keeping in mind the point you want to make in a conversation while explaining the first point

Problems with Working Memory



Weiss et al, 2005

Long Term Memory

Procedural: Skills & Habits

Semantic: General Memory

Episodic: Personal
Knowledge

} Declarative

Rehearsal:

consciously repeating the information; visual scanning

Organization Strategies:

chunking, categorizing, mnemonics, imagery

Mediation:

making associations between the old and the new

Processing Speed

- The ability to fluently and automatically perform a cognitive task
- 'Attentive Speediness'
- The rapidity with which a student can produce simple/routine information without making errors (Weiss et al, 2005, pg. 26)

Visual scanning
Visual discrimination
Sequential tracking
Visual-motor coordination

Executive Functioning

1. Organizing, prioritizing and activating for tasks
2. Focusing, sustaining and shifting attention to task
3. Regulating alertness, sustaining effort and processing speed
4. Managing frustration and modulating emotions
5. Utilizing working memory and accessing recall
6. Monitoring and self-regulating action

Tom Brown, 2001

Executive Functioning: It's a Family Affair

It's like he can't connect the dots!

Set Shifting
Hypothesis Generation
Problem Solving
Concept Formation
Abstract Reasoning
Planning
Organizing
Inhibition
Self-Monitoring
Self-Control
Estimation
Behavior Regulation
Common Sense

Why do you keep making the same choices over and over again?

I just don't think he gets it.

How many times do I have to explain it to you?!

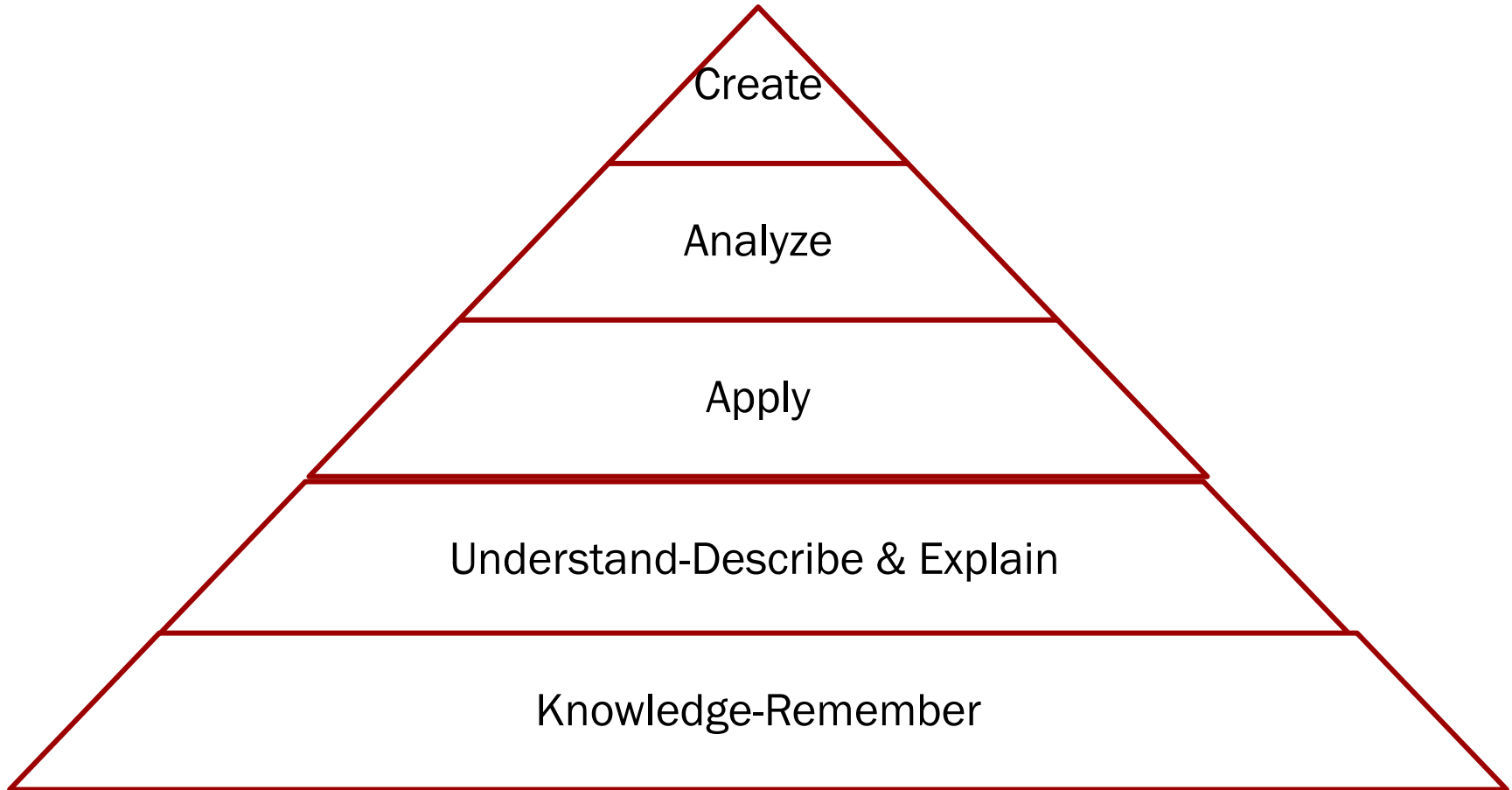
Higher Order Thinking

Set Shifting
Hypothesis Generation
Problem Solving
Concept Formation
Abstract Reasoning
Planning
Organizing
Inhibition
Self-Monitoring
Self-Control
Estimation
Behavior Regulation
Common Sense

Executive Functioning Verbs

Evaluate
Determine
Reason
Plan
Assess
Hypothesize
Compare
Contrast
Summarize
Judge

How do we learn?



ALL Learning is founded on sensory motor integration

Gaddes & Edgell (1994)

“... behavior includes well-balanced sensory integration-
a smooth blending of visual, auditory, tactile, and kinesthetic
input, and that this collective pattern of neural energy must be
integrated with the simple pattern of outgoing motor impulses.”

Gaddes & Edgell, 1994, p. 180

Level 4: Academic Readiness

Executive Functions

Academic skills

- Complex motor skills
- Regulation of attention
- Organized behavior
- Self-esteem & self-control

Level 3: Perceptual Motor Skills

- Auditory discrimination
- Speech and language
- Visual discrimination
- Eye-hand coordination
- Purposeful activity

Level 2: Sensory Motor Skills

- Body Awareness
- Use of both sides of the body
- Hand preference
- Motor planning

Level 1: Primary Sensory Systems

- Touch
- Balance & Movement
- Body Position

Sensory Processing & Reading

- ∞ Visual letter and word recognition
- ∞ Visual searching and scanning
- ∞ Figure-ground perception
- ∞ Visual sequential perception

- o Repetitive speech
- o Word Fluency

- ∞ Phonetic auditory discrimination
- ∞ Auditory memory
- ∞ Auditory-verbal understanding
- ∞ Auditory sequential skills

- o Tactile sensitivity
- o Finger localization

AUTOMATICITY

Neurocognitive Processes Involved in Fluent and Successful in Reading

1. Visual processes
 2. Phonological processes
 3. Short-term memory
 4. Word Retrieval from memory
 5. Comprehension common to reading and listening
 6. The ability to use contextual information to facilitate word recognition
- Gaddes & Edgell, 1994, p. 332

Dyslexia:

Affects the accuracy and rate of word decoding, word reading, and spelling...it is the result of impaired orthographic, phonological, and working memory processes

Weiss et al (2005, p. 73)

Poor Working Memory & Reading

- weak phonemic representations
- difficult with comprehension
- problems with word retrieval
- 'chugging' reading style
- slow reading, lacks inflection and intonation

Level 1

**Auditory & Visual Attention, Memory
Working Memory
Executive Functioning**

Word Level Reading
Receptive & Expressive Vocabulary

**Word
Reading**

**Pseudoword
Decoding**

Spelling

Phonology: speech sounds

Syntax: phrase and sentence meaning

Semantics: word, phrase and sentence meaning

Discourse structure: organization of connected sentences

Pragmatics: use of language for communication acts

Level 2: Comprehension

Reading is a tool for **deriving** stated **meaning** from text and **constructing meaning** that can be **inferred** from text based on background knowledge of the world (Batts & Underwood)

Literal

- search strategy
- contextual clues

Inferential

- higher order thinking
- prior knowledge

Level 3: Expression

Oral Expression:

Organize thoughts

Retrieve vocabulary

Create the language in an understandable form

Verbal Production Requires:

coordinate breathing, tongue, lips, facial muscles

vocabulary acquisition

word finding abilities

syntax abilities

grammar abilities

Written Expression:

3 Separate Processes:

Handwriting
Spelling
Composition

The Neurological Determinants of Writing

“The neuromuscular patterns in normal writing originate in visual, auditory, tactile, kinesthetic, and linguistic images in the human cortex that stimulate the motor are where manual-motor images are aroused.”

Gaddes & Edgell, 1994, p. 391

Neurocognitive Processes Involved in Writing

- Automatic letter writing from memory
- Hand writing speed
- Motor-related issues
 - motor programming for planning and executing motor output,
 - visual-spatial arrangement on paper, and letter formation parameter setting that affects letter sizing
- Generating ideas
- Planning what to write and how to write it
- Translating ideas and plans into written text
- Review and revise work
- Make corrections and improvements

Weiss et al 2005, p. 76

Neurocognitive Processes Involved with Spelling

1. Connecting letters and sounds (visual & auditory)
2. Separating words into phonemes (memory)
3. Spacing, sequencing (fine motor)
4. Grapheme-Phoneme association (GPA)
5. Recognition of GPA patterns and increased memory capacity for these
6. Patterns is at the heart of spelling abilities (Owens, 2008, p.370)

Dysgraphia: affects handwriting and spelling and is the result of impaired orthographic, **fine motor planning** and **working memory** processes.

Weiss et al 2005, p. 73

Neurocognitive Processes Involved in Math

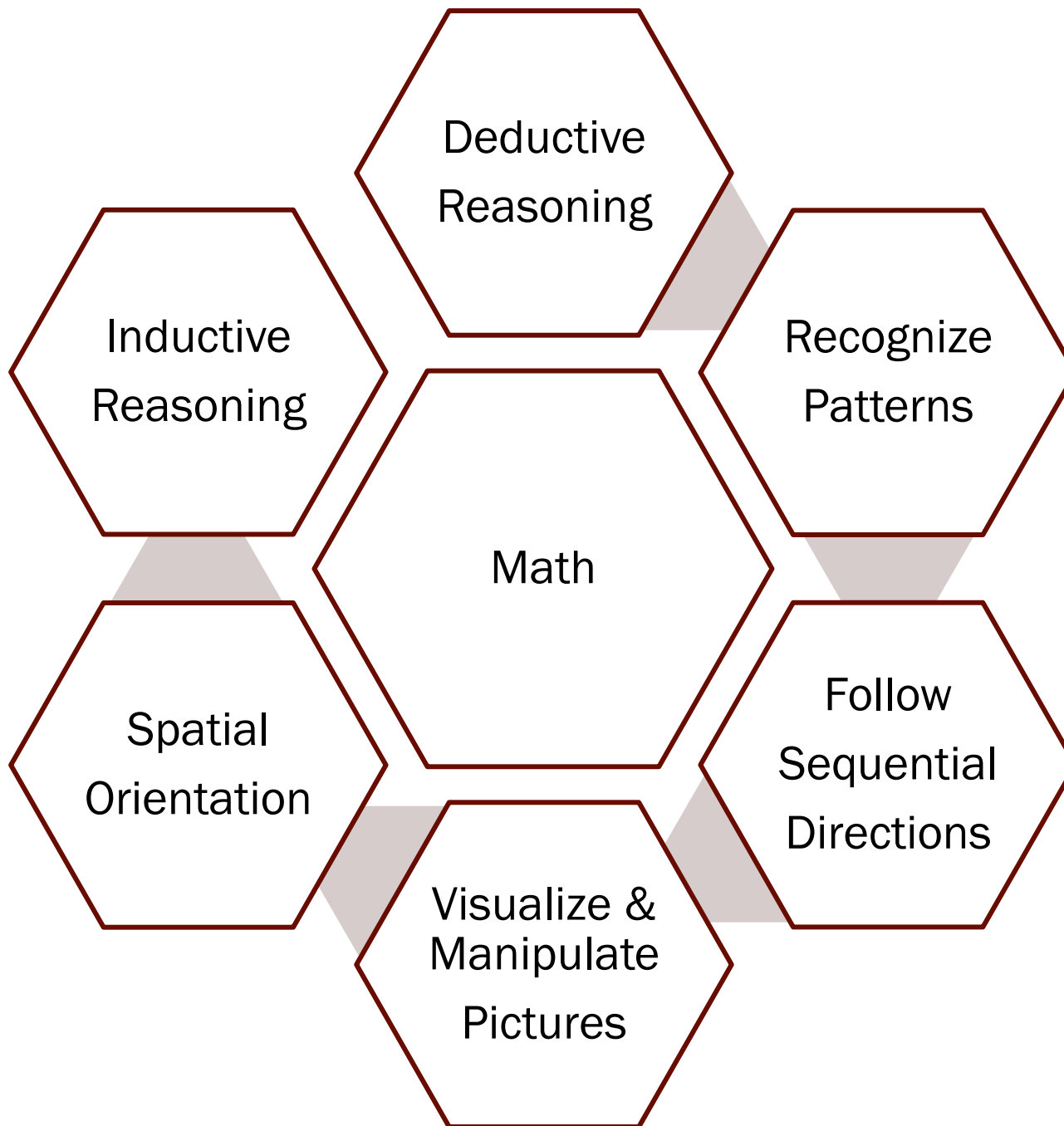
1. Number concepts
2. Relative value
3. Numeral imagery
4. Accurate reading and writing of numbers
5. Retrieval of numbers
6. Calculation
7. Visuo-motor/Fine motor planning and execution

Gaddes & Edgell, 1994, p. 416

2 components of Number Sense:

1. The ability to compare the sizes of two collections shown simultaneously
2. The ability to remember numbers of objects presented successively in time

Sousa, 2008, p. 11



Causes of Dyscalculia

1. Visual processing weaknesses
2. Difficulties with subitizing
3. Problems with sequencing (orders of mathematical operations)
4. Procedurals disorders
5. Memory disorders

Sousa, 2008, p. 180

Dyscalculia

Impairment in rapidly accessing and retrieving math facts from memory, applying algorithms or steps or calculation to solve math problems, and expressing answers orally or in written format (Weiss et al, p. 73)

Dyscalculia

May result from:

1. Lack of conceptual understanding of counting, place value, or part-whole synthesis
2. Difficulty with the visual notation system (e.g., automatic number writing coding, multi-place numerals in working memory, representing visual problems in two-dimensional space and time, or integrating somatosensory information with visual symbols)
3. Impaired quantitative or visual-spatial working memory (visual-spatial sketchpad)
4. Inefficient executive functions for switching attention, staying on task over time, or self-monitoring

Weiss et al, 2005

Reasoning Skills

“Require the active manipulation of stored information, and many reasoning tasks take us well into the domain of metacognition.”

(thinking about thinking)

3 Broad Classes or Domain-General Forms of Reasoning

1. Inductive Reasoning: moving from specific to general

*taking data from individual observations and experiences and using those data for form more global, generalized rules about the world
subtypes:

- a. Categorical
- b. Analogical Reasoning

Hollister-Sandberg, McCullough (2009). *A Clinician's Guide to Normal Cognitive Development In Childhood: The Development of Reasoning Skills*

2. Deductive Reasoning: moving from the specific to the general

taking established general premises and applying rules of logic to draw valid conclusions that would apply to new specific instances; making Inferences

3. Scientific Reasoning: most complex and explicit forms of reasoning

*is a method, not a content area,--systemic reasoning that involves **formulating and testing hypotheses**, gathering and **evaluating** evidence , and **drawing conclusions** that represent links between hypotheses and evidence

Inductive & Deductive Reasoning are essential components of scientific reasoning

Poor Working Memory and Math

Phonological Loop

Younger children: pattern recognition, rote memory of basic math facts

Older children: pattern recognition, rote memory combined with number knowledge, strategies, deductive and inductive reasoning, poor computational skills, impaired recall of words and numbers

Visual-Spatial Sketchpad

1. mental blackboard: supports number representation
e.g., place value, number, alignment, counting
2. Poor VSSP: less room on the blackboard for multi-digit operations, nonverbal problem solving Weiss et al 2005, p. 23-24

Neuropsychological Testing

Where is the break down?

Indicators for Slow Processing Speed

- Being slow to perform basic arithmetic operations, not learning the times tables, and not attaining automaticity in calculations and so uses fingers or counters.
- Taking longer to complete assignments in class.
- Not finishing tests and exams within the time allotted.
- Reading slowly.
- Taking even more time to complete tasks under pressure.
- Coming to the right answer, but taking longer to do it.

Weiss et al, 2005, p. 57-58

Treatment Recommendations Slow Processing Speed

- Emphasize accuracy rather than speed in evaluation the student in all subject areas.
- Do not use timed tests for evaluation. Instead, use assessment procedures that do not rely on speed.
- Allow a specified amount of extra time for tests and exams (usually time and a half).
- Provide supervised breaks during tests and exams.
- Break long tests into more sittings of shorter duration across a few days.
- Provide a reader or text-to-voice software to read test and exam questions to a student to accommodate for low reading fluency.
- Provide a scribe or voice-to-text software to record the student's answers on test to accommodate for slow writing fluency.
- Use test and exam formats with reduced written output formats to accommodate for slow writing fluency. Examples include:
 - multiple choice & true/false test formats
 - short answer formats where a student fills in the blanks

Indicators for Problems with Attention and Slow Working Memory

- following directions beyond the first steps
- forgetting what they have to do next
- sentence writing
- losing his or her place in complex activities
- writing sentences or paragraphs
- mathematics computations that involve more than one step, such as long division
- attending to and immediately recalling information they have just seen or heard

Weiss et al, 2005

Treatment Recommendations for Poor Attention and Working Memory

- Reduce opportunities for distraction and reduce the number of distractions in the vicinity.
- Provide visual reminder and other memory supports for multi-step tasks.
- Attach the student's daily schedule or timetable to the notebook cover that the child takes home every day.
- Post the student's daily schedule or timetable on the student's desk or classroom wall. Send a copy of the schedule or timetable home for posting in the student's room or on the fridge.
- Minimize distractions
- Reduce the amount of sensory information needed to be processed.

Weiss et al, 2005

Treatment Recommendations for Poor Attention and Working Memory

- Remove distractions while learning. For example, turn off background noise; study in a distraction free room; remove clutter from study area.
- Use mnemonic devices and visual imagery to build working memory (repetition facilitates memory storage).
- Use appointment books, filing systems, calendars, schedules, PDA etc.
- Use an assignment notebook with columns to indicate due dates, completion of assignments, grades, amounts, etc.
- Use memory aids such as lists, post-it notes, alarms, and timers.
- Keep a notebook and pen available to write down important or distracting thoughts.
- Divide large projects into smaller more manageable parts spread out across a period of time (e.g., collect 3 research articles every other day)
- Learn to ask review questions such as “What do I need to do next?”; “Is this working?;” and “How fast/slow am I working?”

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