

**Executive Function:  
The Brain's Air Traffic Control System**

**Part 2: Working Memory**

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**Part 2: Working Memory Webinar**

**Darla Stack**

Darla is a former AEA school psychologist who worked with Pre-K to 21 students with academic and behavior needs. She also served on behavior teams, autism teams, Early Access and Child Find. She used her training and experience in understanding data to serve as a school improvement consultant.

**Shirley Sinnott**

Shirley is a former special education teacher and AEA special education consultant. She worked with students aged 5-21 with mild to severe disabilities. She was an adjunct instructor for Upper Iowa University teaching undergraduate and graduate courses in the area of special education.

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**Celebrating LD Awareness Month with a Series of Four Webinars on Executive Function**

- About Executive Function:
  - Executive Functioning Defined
  - Executive Function and Co-Existing Conditions
  - Signs of Executive Functioning Difficulties
  - Implications for Educators

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**Executive Function:  
Part 2: Working Memory**

- What is Working Memory?
- Why is it Important?
- What are the Signs of Working Memory Difficulties?
- How Can Educators Support Working Memory?

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**What is Working Memory?**

- The Brain's Temporary Work-Space/Processor
- Limited Capacity / Temporary Duration
- Central Cognitive Control Process
  - Focuses the Mind
  - Directs Mental Efforts
  - Accomplishes Tasks
  - Ignores Distractions
  - Inhibits impulses
  - Shifts Attention
- Strong Predictor of Academic Success

<https://idaamerica.org/whats-the-big-deal-about-executive-functions/>



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**Working Memory Limitations**

- Capacity Demands/ Cognitive Load
- Duration/Time
- Distractions
- Limited Prior Knowledge and Experiences
- Slow Processing Speed
- "Gone for Good!"



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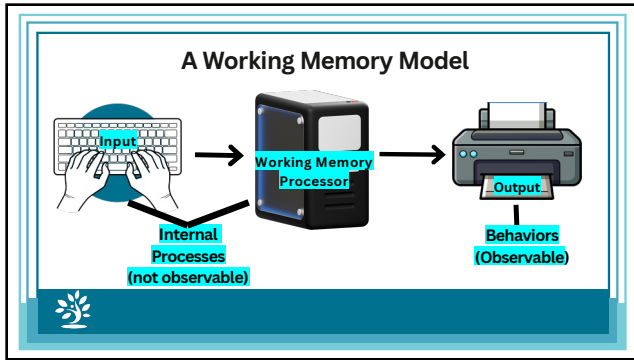
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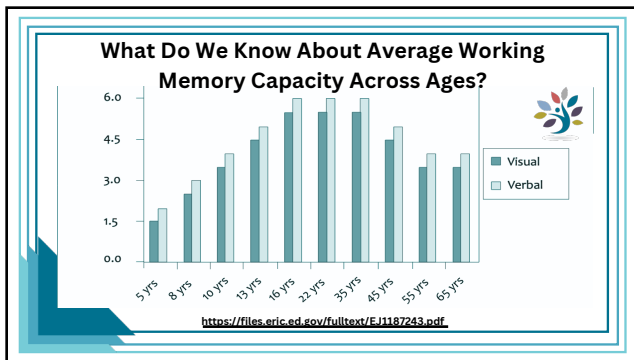
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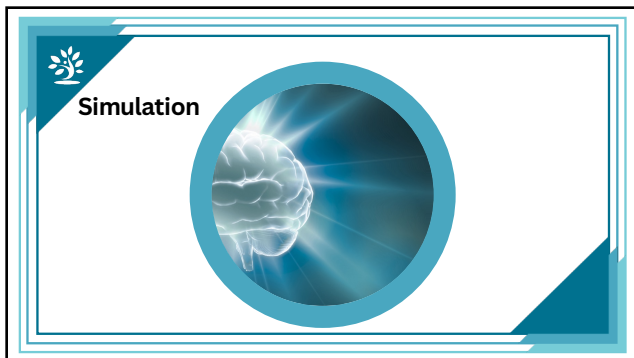
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**How Many Students in Your Classroom Have Working Memory Deficits?**

**10%** of Non-Disabled Students

**20%–50%** of Students with LD or ADHD

<https://dyslexiaida.org/working-memory-the-engine-for-learning/>

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**Why Should Educators Learn More About Working Memory ?**

- Strong Predictor of Academic Success
- Mental Workspace for Learning and Problem-Solving
- Keeps Track of Information, Aids in Following Instructions, and Connects New Information With Prior Knowledge
- Incidence of Students with Working Memory Difficulties
- Wide Variability Among and Inconsistencies Within Students
- Need to Increase Awareness (Signs, Strategies, Supports)

<https://calm.mrc-cbu.cam.ac.uk/wp-content/uploads/calm/sites/5/2014/06/Holmes-Gathercole-Dunning-book-chapter-2010.pdf>

<https://caer.org.uk/wp-content/uploads/CAER-Working-Memory-Guidance.pdf>

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**Let's Help Kids Work Smarter, Not Harder**

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**Output-Observable Behavior**

Sally Student has been waving her hand in the air to be called on. When teacher calls on Sally, Sally says she forgot what she was going to say.

The diagram illustrates the information processing model with three main components: **Input** (represented by a keyboard icon), **Working Memory Processor** (represented by a computer monitor icon), and **Output** (represented by a printer icon). Arrows indicate the flow from Input to the Working Memory Processor, and then to Output. Below the Input and Working Memory Processor boxes, the text reads "Internal Processes (not observable)". Below the Output box, the text reads "Behaviors (Observable)". To the right of the diagram is a photograph of a young woman with long blonde hair, wearing a light blue shirt, looking thoughtful with her hand on her forehead.

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**Output-Observable Behavior**

When you ask me what you are supposed to do after I just finished giving directions!

The diagram illustrates the information processing model with three main components: **Input** (represented by a keyboard icon), **Working Memory Processor** (represented by a computer monitor icon), and **Output** (represented by a printer icon). Arrows indicate the flow from Input to the Working Memory Processor, and then to Output. Below the Input and Working Memory Processor boxes, the text reads "Internal Processes (not observable)". Below the Output box, the text reads "Behaviors (Observable)". To the left of the diagram is a photograph of a man with glasses and a beard, wearing a grey cardigan over a plaid shirt, looking slightly confused.

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**Output-Observable Behavior**

This student turned in the test without finishing it!

The diagram illustrates the information processing model with three main components: **Input** (represented by a keyboard icon), **Working Memory Processor** (represented by a computer monitor icon), and **Output** (represented by a printer icon). Arrows indicate the flow from Input to the Working Memory Processor, and then to Output. Below the Input and Working Memory Processor boxes, the text reads "Internal Processes (not observable)". Below the Output box, the text reads "Behaviors (Observable)". To the right of the diagram is a photograph of a young woman with glasses, wearing a green blazer, holding two sheets of paper.

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### What Do We Know About Supporting Working Memory in the Classroom?

*"The best way to support working memory in the classroom is to structure the environment and to adapt teaching practices. We need to be mindful of tasks that create heavy demands on working memory, try to reduce those demands where possible, and provide appropriate support structures and strategies for children with reduced working memory ability to enable them to compensate for working memory difficulties."*



<https://caer.org.uk/wp-content/uploads/CAER-Working-Memory-Guidance.pdf>

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### How Do Students Use Working Memory in the Classroom?



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**7 Step Process For Supporting Working Memory in the Classroom**

Let's Help Kids Work Smarter, Not Harder

[https://chadd.org/wp-content/uploads/2018/06/ATTN\\_02\\_11\\_ImprovingMemory.pdf](https://chadd.org/wp-content/uploads/2018/06/ATTN_02_11_ImprovingMemory.pdf)

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**Step 1: Recognize Students Who Are Having Working Memory Difficulties**

- Difficulty Following Multi-Step Directions
- Trouble with Place-Keeping
- Challenges with Organization and Planning
- Academic Difficulties
- Inconsistent Performance
- Inattentiveness and Distractibility
- Difficulty with Problem-Solving
- Forgetting What They Were Doing
- Feeling Frustrated and Overwhelmed

<https://calm.mrc-cbu.cam.ac.uk/wp-content/uploads/calm/sites/5/2014/06/Holmes-Gathercole-Dunnings-book-chapter-2010.pdf>

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**Step 2: Monitor /Interview the Student**

Where is the break-down?

Output-Observable Behavior

Input (Internal Processes) → Working Memory Processor → Output (Behaviors)

Internal Processes (not observable)      Behaviors (Observable)

What do you know how to do and what you need help with?

[https://chadd.org/wp-content/uploads/2018/06/ATTN\\_02\\_11\\_ImprovingMemory.pdf](https://chadd.org/wp-content/uploads/2018/06/ATTN_02_11_ImprovingMemory.pdf)

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**Step 3: Evaluate the Working Memory Demands of the Classroom**

**Identify Tasks That Are Likely to Exceed a Student's Working Memory Capacity**

- Length of Task / Number of Steps
- Unfamiliar or Unmeaningful Content
- Demanding Mental Processing Activity

[https://chadd.org/wp-content/uploads/2018/06/ATTN\\_02\\_11\\_ImprovingMemory.pdf](https://chadd.org/wp-content/uploads/2018/06/ATTN_02_11_ImprovingMemory.pdf)



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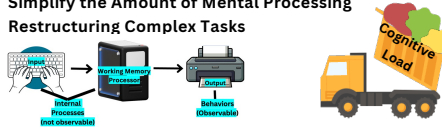
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**Step 4: Reduce Working Memory Load**

**Adapt the Task to Reduce Working Memory Load**

- Reduce the Amount of Material
- Increase the Meaningfulness of the Material (make connections-schema)
- Simplify the Amount of Mental Processing
- Restructuring Complex Tasks



[https://chadd.org/wp-content/uploads/2018/06/ATTN\\_02\\_11\\_ImprovingMemory.pdf](https://chadd.org/wp-content/uploads/2018/06/ATTN_02_11_ImprovingMemory.pdf)



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**Step 5: Be Prepared to Repeat**

**Students with Poor Working Memory Benefit From:**

1. Information Repeated
2. Visual Reminders of Steps
3. Peer Helper
4. Frequent Teacher Check-Ins

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### Step 6: Encourage the Use of Memory Aids



Visual Aids	Graphic Organizers, Timelines, Concept Maps, Mind Maps, Number Lines, Word Banks, Math Fact Charts, Templates
Organizational Tools	Calendars, Assignment Planners, To Do Lists, Checklists, Color-Coded Folders
Mnemonics	Acronyms, Rhymes, Songs, Other-Visualizing, Chunking and Storytelling
Technology Aids	Voice to Text, e-Books, Word Processors with Spell Check and Grammar Check, Scanners, Digital Timers, Calculators

<https://freeology.com/graphicorgs/>  
<https://www.edhelp.com/teachers/graphic-organizers.htm>  
<https://psychcentral.com/lib/memory-and-mnemonic-devices#examples>



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### Step 7: Develop the Student's Use of Strategies Supporting Working Memory



Effective Strategy Instruction Typically Includes the Following:

- Explicit Instruction
- Modeling
- Guided Practice
- Independent Practice
- Self-Regulation for Self-Monitoring and Goal Setting
- Maintenance and Generalization



<https://iris.peabody.vanderbilt.edu/module/ef1/cresource/a2/p03/>

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### General Strategies and Supports for Working Memory Difficulties



- Reduce the Memory Load
- Repeat and Review
- Use Advance Organizers
- Teach Step-by-Step Strategies
- Encourage the Use of Memory Aids
- Pause, Paraphrase, Summarize and Allow Time
- Get Physical
- Color Code
- Make Overt Links or Connections
- Use Key Words



<https://www.ysatartelelearningtrust.net/Portals/0/Supporting%20Working%20Memory.pdf>

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### Strategies and Supports: Reduce Working Memory Load

- Chunking: One Task at a Time
- Provide Information in Multiple Ways
- Hands-On Activities/ Use of Manipulatives
- Reduce Length or Amount of Work
- Provide Verbal Cues, Key Words
- Develop Routines and Procedures and Use Them Repeatedly
- New Information: Brief/ Concise/ to the Point
- Pair Verbal Directions with Written Copy

<https://www.vnsaterelearningtrust.net/Portals/0/Supporting%20Working%20Memory.pdf>

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### Strategies and Supports: Repeat and Review

- Be Prepared to Repeat Information
- Use Visual Reminders, Checklists, To Do Lists, Steps
- Provide Opportunities for Student to Rehearse and Repeat
- Spaced Practice is More Effective than Massed Practice

**DUE Today**

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### Strategies and Supports: Advance Organizers

Advance Organizers are Instructional Tools that are Used Before Presenting New Information to Help Students Connect it with Their Prior Knowledge and Better Understand the New Material

Examples:

- Before a lesson, talk about the goal or purpose of the lesson and link to previous learning
- Prior to lesson, tell a story that relates to important concepts in the lesson
- Look ahead at headings, captions; do a picture walk; KWL chart or other graphic organizer

<https://www.understood.org/en/articles/common-advance-organizers-and-why-they-work>

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**Strategies and Supports: Teach Step-By-Step Strategies**



**Include the following steps in teaching a 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, activities and groups.

**\*Teach One Strategy at a Time**  
**\*Teach Students When, Where, Why and How to Use the Strategy**

<https://www.yesataretelearningtrust.net/Portals/0/Supporting%20Working%20Memory.pdf>

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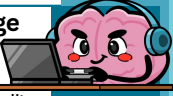
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**Strategies and Supports: Encourage the Use of Memory Aids**



- Posters and Charts, Word Walls
- Directions, Steps or Instructions Using Both Visual and Auditory Modalities-White Board, Handout, Sticky Note or Desk Copy
- Checklists for Multi-Step Tasks
- Graphic Organizers
- Pair Pictures or Hands-On Activities with Verbal Information
- Rhymes, Songs, Movements, and Patterns--especially when linked to fact information "30 Days Hath September..."
- Technology: Calculator, Word Processor, Spell-Check, Grammar-Check, Text Readers, and Voice to Text

<https://www.yesataretelearningtrust.net/Portals/0/Supporting%20Working%20Memory.pdf>

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
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**Strategies and Supports: Pause, Paraphrase, Summarize and Allow Time**



- Frequent Pauses-Paraphrase-Summarize (Write Notes on Board)
- Research:
  - 40% of Total Learning Time Needs to be Spent Reviewing New Material
  - Students are More Likely to "Hear" and "Remember" if they hear their own voice or a peer's voice
- Allow Extra Time:
  - For Rehearsal and Processing
  - To Retrieve Information (Give Advance Warning)
- Avoid Open-Ended Questions / Use Structured Response Questions Instead

<https://www.yesataretelearningtrust.net/Portals/0/Supporting%20Working%20Memory.pdf>

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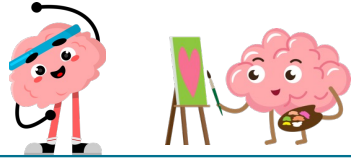
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### Strategies and Supports: Get Physical

- Active Participation
  - Multiple Modalities, Move Around, Manipulatives, Hands-On
- Games, Drama and Art to Reinforce Concepts



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### Strategies and Supports: Color Code

- Color Code Notebooks/Folders by Subject
- Code New Concepts: Nouns are Red and Verbs are Green
- Spelling: Highlight difficult parts of words or word patterns
- Vocabulary: Teach New Words and Color Code by Categories
- Encourage the Use of Colored Pens, Pencils or Highlighters



The **dog** can **run**.



h at  
c at  
r at  
b at



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### Strategies and Supports: Make Overt Links to Prior Knowledge and Use Key Words

- Encourage Drawing, Writing and Verbal Reflection
- Start Each Lesson with a Quick Review of the Previous Lesson-Write Down Key Words or "Trigger Words" as the Students Recall the Information
- Teach Students to Listen for Key Words. Post the Words and Use Them Frequently
- End Each Lesson with a Summary of What Was Learned



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
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**Memory Aids**

**Mnemonics**

- Effective Strategy for Improving Memory of Factual Information or Remembering Essential Steps
- Examples:
  - HOMES-acronym Great Lakes 
  - "Every Good Boy Does Fine"-acrostic for remembering lines on treble clef 
  - ROY G BIV-colors of the rainbow 
  - "30 days has Sept., June, Apr & Nov."-rhyming mnemonic
  - "Does McDonald's Serve Cheeseburgers"-long division 

Promoting Executive Function in the Classroom, The Guilford Press  
<https://caer.org.uk/wp-content/uploads/CAER-Working-Memory-Guidance.pdf>

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**Graphic Organizers for Reading Comprehension**

- Story Maps
- Timelines
- Venn Diagrams
- Concept Maps
- Sequence Chains



**The IRRC is a GREAT resource for FREE graphic organizers!**

<https://irrc.education.uiowa.edu/resources/irrc-resources/reading-graphic-organizers>

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**What Have We Learned?**

- INPUT + WORKING MEMORY PROCESSING = OUTPUT
- Limited in Capacity and Duration: Variable and Inconsistent
- Often Unidentified or Misidentified as a Behavior Problem
- Predictor of Academic Success
- Signs Observed Across All Subject Areas
- Determine the Breakdown First, then Strategies and Supports
- Help Students Work Smarter Not Harder with Classroom Structure, Adaptations, Strategies and Supports

 *Thank you, Teachers, for making a difference!*

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**Learning Disabilities Association of Iowa**

Website: <https://lda-iowa.org>  
 Facebook: <https://www.facebook.com/LDA.Iowa/>  
 Instagram: <https://www.instagram.com/ldaofiowa/>  
 Twitter/X: <https://twitter.com/ldaofiowa>  
 Email: [info@lda-iowa.org](mailto:info@lda-iowa.org)  
 YouTube: <https://www.youtube.com/@learningdisabilitiesassoc7948>

For Membership Information or to Join LDA:  
<https://ldaamerica.org/membership/>



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**Working Memory Sources**

- Kincaid, Donna M. and Nancy Trautman. "Ch. 5 Remembering: Teaching Students How to Retain and Mentally Manipulate Information." Promoting Executive Function in the Classroom, The Guilford Press, New York, New York, 2010, pp 110-139.
- <https://ldaamerica.org/whats-the-big-deal-about-executive-functions/> "What's the Big Deal About Executive Functions?" Chris A. Zelgler Dendy and Dr. Ruth Hughes
- <https://files.eric.ed.gov/fulltext/EJ1187243.pdf> "The Role of Working Memory in Childhood Education: Five Questions and Answers" Kate Cockcroft
- <https://pdnet.org.uk/media/WM-classroom-guide.pdf> "Understanding Working Memory: A Classroom Guide" Susan Gathercole and Tracy Packiam Alloway
- <https://caer.org.uk/wp-content/uploads/CAER-Working-Memory-Guidance.pdf> "CAER: Working Memory: A Practical Guide for Teachers"
- <https://dyslexiaida.org/working-memory-the-engine-for-learning/> The International Dyslexia Association "Working Memory: The Engine for Learning"

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**Working Memory Sources**

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- <https://iris.peabody.vanderbilt.edu/module/ef1/cresource/a2/p03/#content> "Models for Teaching Strategies"
- <https://calm.mrc-cbu.cam.ac.uk/wp-content/uploads/calm/sites/5/2014/06/Holmes-Gathercole-Dunning-book-chapter-2010.pdf> "Advances in Child Development and Behavior"
- [https://irrc.education.iowa.edu/resources/irrc-resources/reading-graphic-organizers\\_iowa](https://irrc.education.iowa.edu/resources/irrc-resources/reading-graphic-organizers_iowa) Reading Research Center
- <https://www.vesatartetelearningtrust.net/Portals/0/Supporting%20Working%20Memory.pdf> "Supporting Students with Working Memory Difficulties," Can Learn Society
- <https://www.understood.org/en/articles/common-advance-organizers-and-why-they-work> "Common Advance Organizers and Why they Work"

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**Working Memory Sources**

- <https://freology.com/graphicorgs/> (Freeology-Free Graphic Organizers)
- [https://www.edhejner.com/teachers/graphic\\_organizers.htm](https://www.edhejner.com/teachers/graphic_organizers.htm) (Free Graphic Organizers)
- <https://psychcentral.com/lib/memory-and-mnemonic-devices#examples> (mnemonic examples)

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