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Introduction to Cognitive Neuroscience  
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# Intro to Cognitive Neuroscience

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Working memory

# What is working memory?

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- Brief, immediate memory for information we are currently processing.
- Closely related to attention: attending to something is often equivalent to having it in working memory

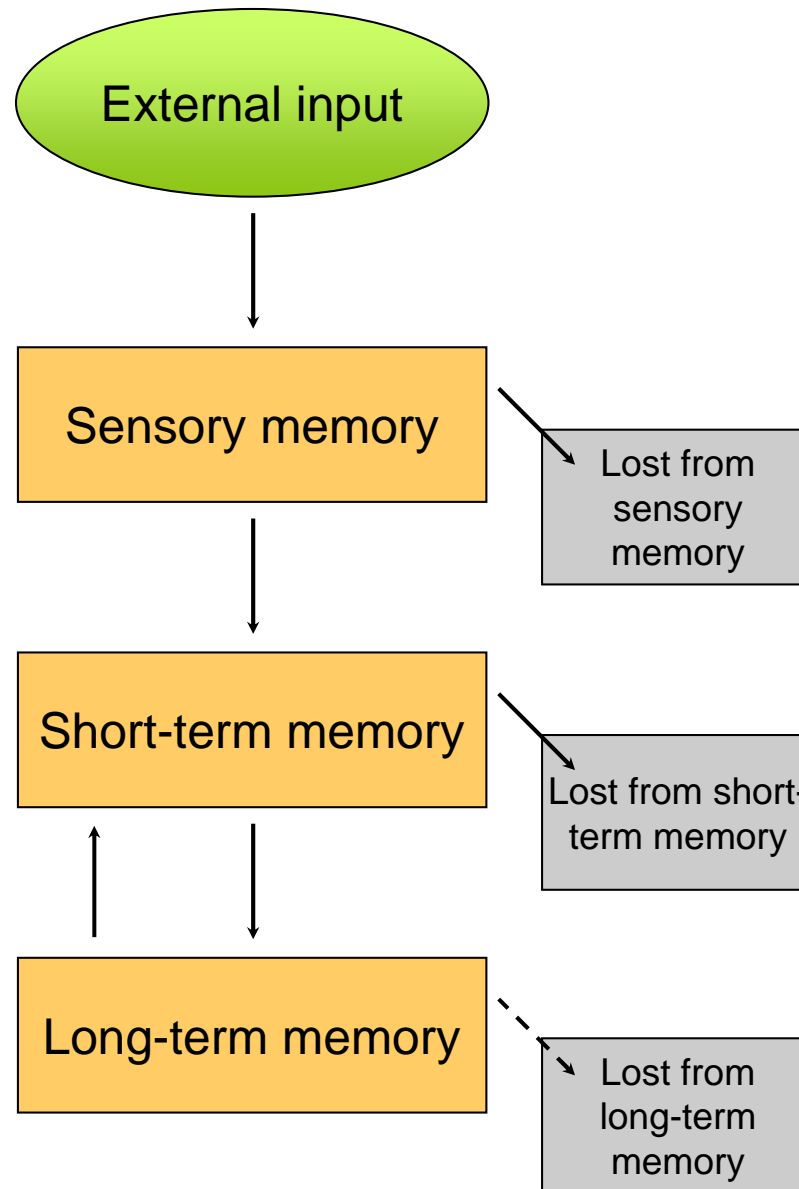
# Atkinson and Shiffrin

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- 1968 “modal model” for memory

# Atkinson's and Shiffrin's model

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# “The Magical Number Seven”

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- George Miller, 1956.
- Short-term memory is limited.
- People can remember between five and nine “chunks” of information.

# Chunking is your friend

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- Chunk - a well-learned cognitive unit made up of a small number of components representing a frequently occurring and consistent perceptual pattern.

# Chunking Demo

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# Chunking Demo

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- 1
- 4
- 9
- 2
- 1
- 7
- 7
- 6
- 1
- 8
- 1
- 2
- 1
- 9
- 4
- 5

# Chunking Demo

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- Count backwards by threes, as fast as possible, from 433.

# Chunking Demo

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- Remember the digits? Write down as many as you can remember.

# Chunking Demo

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- Here they are again

# Chunking Demo

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- 1492

- 1776

- 1812

- 1945

# Chunking Demo

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- Count backwards by threes, as fast as possible, from 687.

# Chunking Demo

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- Remember any?

# Chunking Demo

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- The point: Information can be “chunked” and thus more of it held in working memory.



# Factors that affect working memory capacity

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- Chunking (as just seen)
- Pronunciation rate:
  - People tend to be able to recall about 1.5 seconds worth of stimuli names
  - Holds for color, number, shapes, nouns, nonsense words
  - Numbers compared across English, Spanish, Hebrew and Arabic speakers

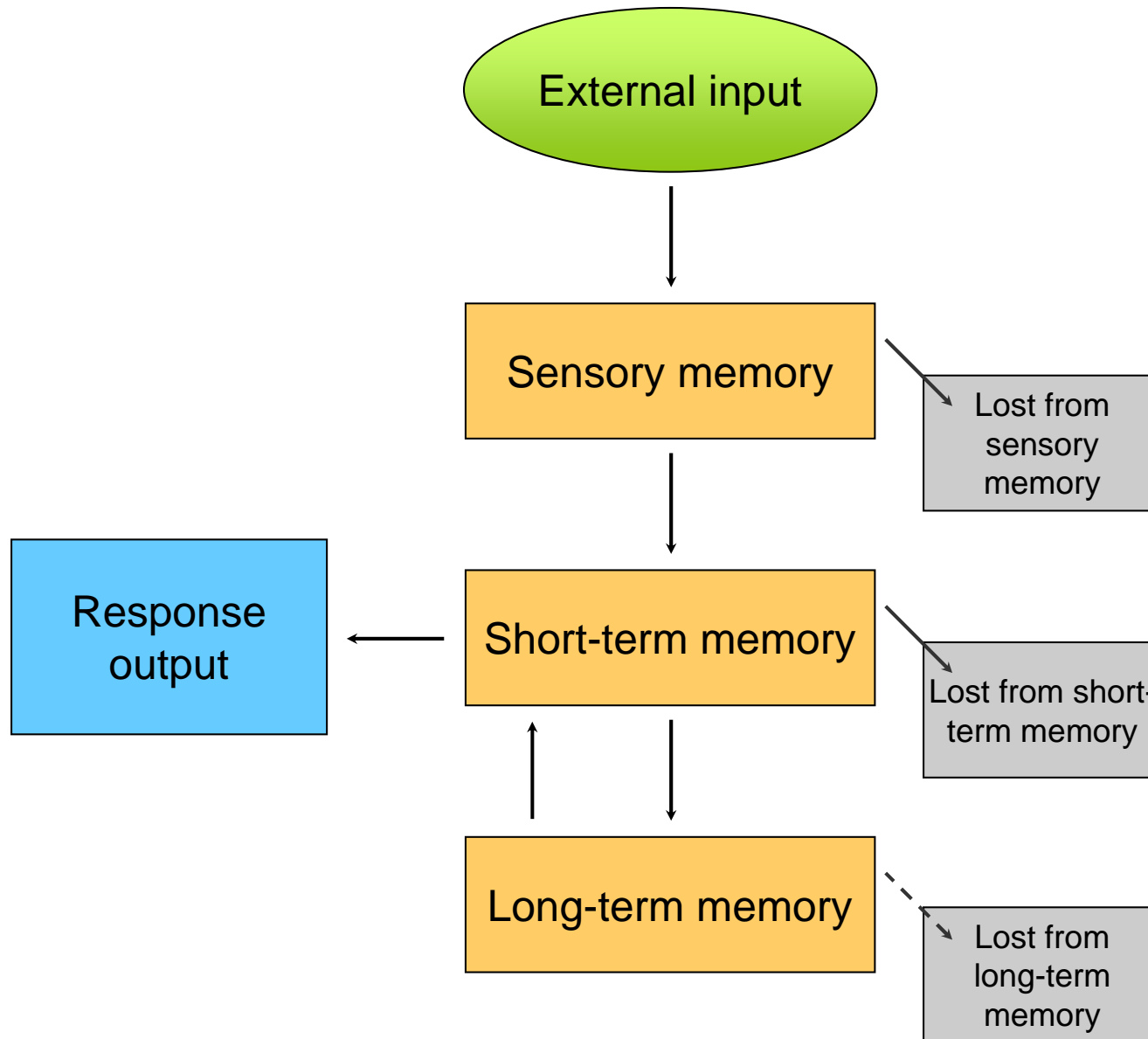
# Factors that affect working memory capacity

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- Chunking
- Pronunciation time
- Semantic similarity

# Atkinson's and Shiffrin's model

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# Atkinson and Shiffrin's model

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- How is information lost from short-term memory?
- Two possibilities: decay over time, interference from other information.
- Demo: I'm going to read several strings of numbers and letters, your task is to, after each string, write them down.

# Atkinson and Shiffrin's model

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- A & S were focused on the role of short-term memory in learning and passing information to long-term storage.
- More recently, researchers have been interested in how working memory is involved in accomplishing other tasks.

# Baddeley and Hitch

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- What does short-term memory do? Holds several interrelated bits of info in mind so that they can be worked with and processed.
- This is necessary for a wide range of tasks: reading, arithmetic, reasoning, etc.

# Baddeley's model

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- Three main parts
  - Phonological loop
  - Visuospatial sketch pad
  - Central executive

# Why three parts?

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- Baddeley and Hitch (1974) presented subjects with a string of digits, instructed to rehearse them.
- At the same time, performed spatial reasoning task.



# Why three parts?

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- Baddeley and Hitch (1974) presented subjects with a string of digits, instructed to rehearse them.
- At the same time, performed spatial reasoning task.
- People in short and long conditions all got 95% accuracy on spatial task.
- Long condition were only about 500 ms slower on spatial task.
- Implies that working memory has multiple independent components.

# Phonological Loop

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- Stores a limited number of sounds for a short period of time.
- Certain kinds of errors in recall can be traced to acoustical confusions in the phonological loop.

# Phonological Loop

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- Read the digits below, then immediately close your eyes and try to remember the digits, silently.

7 5 9 4 3 2  
1

# Phonological Loop

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- Two components:
  - Phonological store
  - Articulatory rehearsal process
- Phonological loop used heavily in tasks such as counting, reading

# Visuospatial sketch pad

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- Stores a limited amount of visual and spatial info.
- Mental imagery module - lets you hold, inspect, and modify a mental image.
- “Imagine the letter D. Rotate it 90 degrees to the right. Put the number four above it. Now remove the horizontal segment of the four to the right of the vertical line.” What object do you “see”?

# Visuo-spatial sketch pad

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- Visual encoding seems to be less preferred for many types of information.
- Subjects were asked to memorize a list of pictures of objects.
- Then asked to visualize one, subtract a specific part, and name the remaining portion.
- Performance was better when phonological loop was suppressed during memorization than when not.

# Central Executive

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- Determines when information is deposited in the storage buffers, and into which one.
- Integrates information from visuo-spatial sketch pad, phonological loop, sensory input, and long-term memory.
- Involved in attention, planning strategies, coordinating behavior.
- Suppresses irrelevant information.