Working Memory

Lesson IV: Memory
module 19

Baddeley’s model of working memory (Baddeley & Hitch, 1974; Baddeley, 2002)

- Working memory consists of multiple components
  - Visuo-spatial sketch pad
  - Phonological loop
  - Central executive
  - Episodic buffer (*new, 2000)
- Working memory is a set of structures which are connected to LTM but allow specialized processing (rehearsal, generation of images)
- Working memory emphasizes function over structure
- Baddeley’s model of Working Memory has become one of the most used frameworks in memory research
Differentiating specific WM components

- The basic idea of "dual tasks" and "selective interference"—When performing one task (e.g., remembering a set of words) a secondary task might selectively interfere with this task but not with others
- Evidence for the separation of
  - Visuo-spatial tasks
  - Phonological tasks
- Examples
  - Selective interference: the Brook’s task
  - Selective interference: articulatory suppression

The Brook’s task (1968)

- Two different mental tasks
  - Classify geometric properties of a figure
  - Classify words as nouns or not
- Two different response modes
  - Verbal response (say yes or no)
  - Pointing response (point to yes or no)

<table>
<thead>
<tr>
<th>yes</th>
<th>no</th>
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<tbody>
<tr>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>yes</td>
<td>no</td>
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Start at the bottom. If you were walking a path along the F, decide at each corner whether you are turning left or not. Determine for each word whether it is a noun or not.

A bird in the hand is not in the bush.
The Brook's task (1968): results

- If the mental task is visuo-spatial ...
  - Completion time is longer when pointing than when verbalizing
- If the mental task is verbal ...
  - Completion time is longer when verbalizing than when pointing
- Interference tasks like these indicate ...
  - That some mental processes interfere more with each other than others
  - This implies that different structures / resources are available for different types of information

The phonological loop

- Empirical evidence for a phonological sub-structure
  - Acoustical confusion of items in STM which is different from the semantic confusion found in LTM
  - Word-length effect on STM (disappears with articulatory suppression)
  - Irrelevant auditory material impairs immediate serial verbal recall

The phonological loop

- Speech and language related evidence
  - Speech deficits have impact on STM if they are related to construct speech programs
  - Children with specific language impairments and normal non-verbal intelligence have lower level of non-word repetition than other children
  - Patients with severely impaired STM (low digit span) can have normal LTM
Proposed evolutionary role of the phonological loop

- Human language acquisition
  - Temporary store for phonological information related to language
  - Allows maintaining the representation of a new word to optimize learning
- Foreign language acquisition
  - Patients with reduced verbal STM have a harder time learning foreign languages
  - Children’s capacity to hear and repeat back non-words predicts vocabulary development

The visuo-spatial sketchpad

- Empirical evidence for a visuo-spatial sub-structure
  - Performance in Corsi block-tapping task and pattern span is not highly correlated with verbal measures
  - Selective interference of this system by spatial movement patterns, visual imagery, or visual noise
- Neuropsychological evidence for separate structures for visual and spatial processing
  - Occipital/temporal: visual
  - Parietal: spatial
  - Frontal: integration

The central executive

- Allocates attentional resources to the other sub-structures
  - Limited resources in each sub-system can be partially compensated by tapping into the central executive
- Empirical evidence for the central executive
  - Some tasks interfere selectively with the central executive (e.g., random digit generation)
- Example from chess performance
  - Articulatory suppression doesn’t interfere much
  - Visuo-spatial tasks show some interference
  - Random digit generation shows most interference
Features of the episodic buffer
- Multimodal storage system
- Links directly to episodic LTM
- Access to this structure is via conscious awareness

It addresses the following questions...
- How are the contents of the phonological loop and the visuo-spatial sketchpad bound together?
- How is chunking accomplished?
  (chunking relies on LTM knowledge and processing)
- Better performance of people on sentence and prose memory than for individual words

Specific working memory tasks ...
- Phonological loop
  - Word span, digit span
  - Dual task interference: articulatory suppression
- Visuospatial sketchpad
  - Corsi block-tapping task, mental rotation,
    visual imagery tasks (vividness, construction)
  - Dual task interference: visuo-spatial tasks
- Central executive
  - Random digit generation
- Episodic buffer
  - Sentence and prose memory

General working memory tasks ...
- N-back task
  - Participant has to monitor a list of numbers and
    report if a number has been repeated “n-back”
  - E.g., 2-back task: 1 3 6 4 5 1 5 ...
    Subject reports "5" and continues on
- Working memory span
  - Participant reads number of sentences and verifies /
    categorizes each one
  - At the same time, participant has to remember the
    last word of each seen sentence
  - Correlates highly with general intelligence
- These tasks are often the basis for diagnostic
  and clinical tests