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## WORKING MEMORY: LOOKING BACK AND LOOKING FORWARD

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### Preface

**The concept of working memory proposes that a dedicated system maintains and stores information in the short term, and that this system underlies human thought processes. Current views of working memory involve a central executive and two storage systems: the phonological loop and the visuospatial sketchpad. Although this basic model was first proposed 30 years ago, it has continued to develop and to stimulate research and debate. The model and the most recent results are reviewed in this article.**

### Summary

- The concept of working memory assumes that a limited capacity system temporarily stores information and thereby supports human thought processes. One prevalent model of working memory comprises three components: a central executive, a verbal storage system called the phonological loop, and a visual storage system called the visuospatial sketchpad.
- The phonological loop consists of a store that can hold memory traces for a few seconds, and an articulatory rehearsal process. Retrieval and re-articulation are used to refresh memory traces, and the span of working memory is limited by the amount of material that can be articulated before the first item fades from the store. Word length and similarity between items strongly influence performance on tests of verbal working memory.
- Various models have been proposed to account for how serial order is remembered. In chaining models, each item is a cue for the next item, but these models run into problems with sequences in which an item recurs and with similarity effects. Contextual models assume that successive items are associated with a contextual cue or that recall of order is based on positional associations between items.
- It has been proposed that the phonological loop evolved to facilitate the acquisition of language. In support of this, phonological loop capacity is a good predictor of second language learning. Future studies seem likely to link the phonological loop more closely to theories of language perception and production.

- The visuospatial sketchpad is less well understood than the phonological loop. Spatial and visual working memory also have limited capacity and the two can be dissociated. Visuospatial working memory predicts success in fields such as architecture and engineering.
- One model proposes that the sketchpad is divided into two components, a visual cache and a retrieval and rehearsal process called the 'inner scribe', analogous to the storage and articulatory components of the phonological loop.
- The central executive is the least understood component of working memory. In one model, control is divided between 'automatic' habits or schemas, and an attentional system called the supervisory activating system that intervenes to overrule habitual control.
- To move our concept of the supervisory activating system beyond a simple 'homunculus', we need to specify the processes attributed to it, and then to explain them. The processes needed are to focus, divide and switch attention, and to connect working memory with long-term memory. To account for the latter capacity, a fourth component of working memory has been proposed: the episodic buffer, a limited capacity store that binds information to form integrated episodes.
- Neuroimaging and neuropsychology have provided evidence for localization of the components of working memory. The phonological loop is associated with the left temporoparietal region, and visuospatial working memory with analogous areas in the right hemisphere. The central executive is probably associated with the frontal lobes.
- Work on the phonological loop, the visuospatial sketchpad and the central executive should be more closely linked to studies on language, visual processing and motor control, and executive control, respectively. In addition, more work is needed on what drives working memory.

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