Working Memory Neuropsychology

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What is working memory?

Working Memory is a cognitive system that allows us to **temporarily hold and manipulate information** in order to perform a wide range of mental tasks. It is responsible for maintaining and updating information in our brain in real-time, as well as using that information to guide our thoughts and actions.

When do we use working memory?

We use working memory, for example, when we need to remember a phone number for a short period of time. Reciting the number over and over acts as an aid to working memory. If you need to remember the number more permanently (perhaps because it is your own), then, through reciting it mentally, it eventually moves to long-term memory stores.

Capacity of working memory

Working memory capacity is limited, meaning that we can only hold a certain amount of information in mind at any given time. However, working memory capacity can be increased through certain working memory tasks and working memory training. This is especially important for children with learning disorders given that research has shown they tend to have smaller working memory capacity.

Subsystems of working memory

Working memory is thought to be made up of several different subsystems, each of which plays a role in processing and manipulating information.

- The **Phonological Loop** is responsible for maintaining and manipulating verbal information (verbal working memory).

- The **Visuospatial Sketchpad** is responsible for visual and spatial information (visuo-spatial working memory).
- The **Central Executive** coordinates and controls the flow of information.

The Central Executive

At the core of the working memory system is the Central Executive, which is thought to be located in the **pre-frontal cortex**. This is the system that holds attention, directs and monitors cognitive processes, and helps to regulate behavior.

It is responsible for organizing, coordinating and controlling the different components of working memory and has been linked to higher-level executive functions such as problem-solving, decision-making and goal-directed behavior.

The Central Executive is associated with a specific neural network that includes the **dorsolateral pre-frontal cortex**, the **anterior cingulate cortex**, the **basal ganglia**, and the **dorsomedial prefrontal cortex**. This neural network is responsible for **recruiting other brain regions** when a particular task requires them, and for **inhibiting** those regions when they are not needed.

The Central Executive remains active throughout the course of a task, and its level of activity has been found to be **correlated with performance on cognitive tasks**.

For example, people with higher levels of activity in the Central Executive have been found to perform better on tasks requiring working memory. Thus, the Central Executive is key to the functioning of the working memory system and plays an important role in our ability to store and manipulate information.

Working memory is related to academic achievement

Working memory plays an important role in many cognitive tasks, such as attention, reasoning, problem solving, and learning. It is not surprising, therefore, that research has shown that working memory capacity is related to overall cognitive abilities and academic achievement, as well as reading capacity.

Working memory performance and working memory deficits in brain issues

Working memory performance can be impacted by certain neurological disorders such as Attention Deficit Hyperactivity Disorder (ADHD), Schizophrenia, and Dementia, as well as brain injuries, such as those caused by a traumatic accident or stroke.

These disorders result in working memory deficits because they can affect the ability to process and retain new information, making it difficult to complete tasks that require working memory, to remember instructions, and to plan and organise thoughts and actions.

Working memory deficits impact performance in other neuropsychological domains

Problems with working memory can also result in poor performance on tasks involving neuropsychological domains. For example, it may appear that a person has problems making decisions because they are unable to hold the information in mind long enough to weigh up all possibilities. A neuropsychologist is trained to be **careful in their interpretation of test performance to ensure the correct deficit is identified and rehabilitated**.

Commonly used neuropsychological tests of working memory

- Digit Span Test: This test measures a person's ability to repeat a sequence of numbers in the same order they were presented. The test typically starts with a short sequence of numbers, and the length of the sequence increases as the test progresses. The test measures both forward digit span (repeating the numbers in the same order as they were presented) and backward digit span (repeating the numbers in the reverse order).
- Letter-Number Sequencing Test: This test measures a person's ability to recall a sequence of numbers and letters in the correct order. The test typically starts with a short sequence of numbers and letters, and the length of the sequence increases as the test progresses.
- Spatial Span Test: This test measures a person's ability to recall the location of objects on a grid. The test typically starts with a small grid of objects, and the size of the grid increases as the test progresses. The test measures both forward spatial span (recalling the objects in the same order as they were presented) and backward spatial span (recalling the objects in the reverse order).

Alan Baddeley Video on the development of the Working Memory Model

Embedded media: https://www.youtube-nocookie.com/embed/mT0NLihOK30?controls=0

Working memory Podcast

Alan Baddeley talks about his model of working memory in this Neuropsychology Podcast from Navigating Neuropsychology.

Further reading

- Conway, A. R. A., Kane, M. J., Bunting, M. F., Hambrick, D. Z., Wilhelm, O., & Engle, R. W. (2005). Working memory span tasks: A methodological review and user's guide. Psychonomic Bulletin & Review, 12(5), 769-786
- Gathercole, S. E., Alloway, T. P., Willis, C., & Adams, A. M. (2006). Working memory in children with reading disabilities. Journal of Experimental Child Psychology, 93(3), 265-281.
- Redick, T. S., & Engle, R. W. (2020). The relationship between working memory capacity and academic achievement: A meta-analytic review. Educational Psychology Review, 32(3), 493-528.

Neuropsychological Assessment for Working Memory

If you feel you need a working memory neuropsychological assessment and assistance from a clinical neuropsychologist with rehabilitation of memory function, please contact us!