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Concentration Centres  
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## What is spatial memory?

Spatial memory is the part of memory responsible for recording information about one's environment and its spatial orientation. For example, a person's spatial memory is required in order to navigate around a familiar city. Spatial memories can be summarized as a Cognitive Map. Spatial memory has representations within working, short term memory and long term memory.

## Short-term spatial memory

Short term memory is described as a system allowing one to temporarily store and manage information that is necessary to complete complex cognitive tasks.

Tasks which employ short-term memory include learning, reasoning and comprehension. Spatial memory is a cognitive process that enables a person to remember different locations as well as spatial relations between objects. This allows one to remember where an object is in relation to another object, for instance, allowing someone to navigate through a familiar city. Spatial memories are said to form after a person has already gathered and processed sensory information about her or his environment.

## Spatial working memory

Working memory (WM) can be described as a limited capacity system that allows one to temporarily store and process information. This temporary store enables one to complete or work on complex tasks while being able to keep information in mind. For instance, the ability to work on a complicated mathematical problem utilizes one's working memory.

## Long-term spatial memory

Spatial memory recall is built upon a hierarchical structure. That is to say that people remember the general layout of a particular space and then "cue target locations" located within that spatial set. Recollection of spatial details is a top-down procedure that requires an individual to recall the superordinate features of a cognitive map, followed by the ordinate and subordinate features. Thus, two spatial features are prominent in navigating a path: general layout and landmark orienting.

People are not only capable of learning about the spatial layout of their surroundings, but they can also piece together novel routes and new spatial relations through inference. A cognitive map is "a mental model of objects' spatial configuration that permits navigation along optimal path between arbitrary pairs of points. This mental map is built upon two fundamental bedrocks: layout, also known as route knowledge, and landmark orientation. Layout is potentially the first method of navigation that people learn to utilize; its workings reflect our most basic understandings of the world.

Clustering also demonstrates another important property of our relation to spatial conceptions. This is that spatial recall is a hierarchical process. When someone recalls an environment or navigates terrain, that person implicitly recalls the overall layout at first. Then, due to the concept's "rich correlational structure," a series of associations become activated. Eventually the resulting cascade of activations will awaken the particular details that correspond with the region being recalled. For example such as the location of a stapler; in a desk which is in the office.

People perceive objects in their environment relative to other objects in that same environment. In other words, landmarks and layout are complimentary systems for spatial recall.

## Visual Memory

Visual memory is responsible for retaining visual shapes and colours (what?), whereas spatial memory is responsible for information about locations and movement (where). This distinction is not always straightforward since part of visual memory involves spatial information and vice versa. For example, memory for object shapes usually involves maintaining information about the spatial arrangement of the features which define the object in question.

## Physiology

Hippocampus



Hippocampus shown in red

Blocking plasticity in this region results in problems in goal-directed navigation and impairs the ability to remember precise locations. Amnesic patients with damage to the hippocampus cannot learn or remember spatial layouts and patients having undergone hippocampal removal are severely impaired in spatial navigation.

The left prefrontal cortex preferentially processes categorical spatial memory including source memory (reference to spatial relationships between a place or event), while the right prefrontal cortex preferentially processes coordinate spatial memory including item memory (reference to spatial relationships between features of an item).

## Neuroplasticity

Spatial memories are formed after information are gathered, and processes sensory information about its surroundings (especially vision and proprioception). In general, mammals require a functioning hippocampus (particularly area CA1) in order to form and process memories about space. There is some evidence that human spatial memory is strongly tied to the right hemisphere of the brain. Spatial learning requires both NMDA and AMPA receptors, consolidation requires NMDA receptors, and the retrieval of spatial memories requires AMPA receptors.

## Learning difficulties and spatial memory

Nonverbal learning disability is characterized by normal verbal abilities but impaired visual spatial abilities. Problem areas for children with nonverbal learning disability are arithmetic, geometry, and science.

Arithmetic word problems involve written text containing a set of data followed by one or more questions and require the use of the four basic arithmetic operations (addition, subtraction, multiplication, or division). Researchers suggest that successful completion of arithmetic word problems involves spatial working memory (involved in building schematic representations) which facilitates the creation of spatial relationships between objects. Creating spatial relationships between objects is an important part of solving word problems because mental operations and transformations are required.

For example, consider the following question: "A child builds three towers using red and white coloured blocks of the same size. The lowest tower has 14 blocks; the highest has 7 more blocks. The intermediate tower has three blocks less than the highest one. How many blocks are in each of the three towers?" To solve the question, it is necessary to maintain incoming information (i.e., the text) and integrate it with previous information (such as knowledge for arithmetic operations). The individual must also select relevant (i.e., the spatial relationship between the blocks) and inhibit irrelevant information (i.e., the colours and textures of the blocks) and simultaneously build a mental representation of the problem.

## Spatial memory and sleep

Sleep deprivation and sleep has also been a researched association. Sleep deprivation actually hinders memory performance improvement due to an active disruption of spatial memory consolidation. Therefore, spatial memory is enhanced by a period of sleep.

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