Capacity of long-term memory

ASSIGN BUSTER

The long-term memory store is a place in which information can be kept for hours, days, weeks, or years. The long-term store, unlike short-term or sensory memory stores has no known capacity limits. Most people can recall up to 15, 000 words in their native language, tens of thousands of facts and a countless number of personal experiences. People are able to recall items for the long-term memory store even if they haven't recalled them for years, for example Bahrick (2000) found that even 50 years after graduation, participants could accurately recognize about 90% of their high school classmates from yearbook photographs.

Atkinson & Shiffrin (1968) proposed the Multi-store model of memory. In this model they suggest that human memory involves a sequence of three stages; sensory memory, short-term memory and long-term memory. This model has been criticized for being too linear as it doesn't accommodate for subdivisions of Long-term memory and as I shall discuss, there is significant evidence which suggests that long-term memory is supported by a number of functionally distinct memory systems.

The study of patients with neurological disorders lends support to the idea that there are distinct systems in long-term memory. Scoville & Milner (1957) studied the case of a 27 year old man, known by HM who suffered from intractable epilepsy following brain damage, caused by a cycling accident at the age of 7. To prevent further spread of epileptic tissue, HM had parts of his temporal lobes removed, including the hippocampus and some surrounding regions.

After the operation, HM was able to converse easily, perform well on intelligence tests and use and understand language. The only thing HM could not do was remember things that that happened after the operation. He would often forget that he had just eaten breakfast or fail to recognize the nurses who help him on a daily basis. Corkin (1984, 2002) found that HM could repeat a telephone number with no difficulty, suggesting that his short-term memory store was functioning, however after the information had left his short-term memory, it was gone forever.

The study of HM and other patients with similar disorders have shown that the hippocampal region of the brain is critical for moving new information into the long-term store. When the hippocampal region is damaged, patients suffer from anterograde amnesia; the inability to transfer new information from the short-term store into the long-term store. Some amnesic patients also suffer from retrograde amnesia, which is the inability to retrieve information that was acquired before a particular date, usually the date of an injury or operation. HM has much more anterograde amnesia than retrograde amnesia, which suggests that the hippocampal region is not the site of long-term memory.

Research has shown that different aspects of a single memory are stored in different places in the cortex. For example our memories of a music concert would require the visual cortex to memorize the bands appearance, and the auditory cortex to remember the tunes.…

Although it has been suggested that there are many separate memory stores in the brain, there needs to be something which gathers these stores together in order for us to have a single, integrated memory. It is believed (Insert reference from the red highlight above) that this is the job of the hippocampal region. It acts as a kind of “ index” that links together all of these otherwise separate bits and pieces so that we remember them as one.

- Performance tasks of mirror drawings

It has been suggested that the best place to look for memories is in the spaces between neurons. The idea that the connections between neurons are strengthened by their communication thus making communication easier the next time provides the neurological basis for long-term memory.

Researchers has been attracted to the relatively uncomplicated neurology of the tiny sea slug Aplysia which have a simple nervous system of 20, 000 neurons compared to roughly 100 billion in the human brain. When an experimenter stimulates Aplysia’s tail with a mild electric shock, the slug immediately withdraws its gill, and if the experimenter does it again a moment later, Aplysia withdraws its gill even more quickly.

Abel et al. (1995) came back an hour later and shocked Aplysia but the withdrawal of the gill happened as slowly as it did the first time, as if it couldn’t remember what happened over an hour earlier. In other trial, Abel et al. shocked the Aplysia over and over again and found that it developed an enduring memory which lasted up to 14 days. This suggests that long-term storage involves the growth of new synaptic connections between neurons.

So learning is based on changes involving the synapses for both short-term storage (enhanced neurotransmitter release) and long-term storage (growth of new synapses). Any experience that results in memory produces physical changes in the nervous system…. slug

For more complex mammals a similar process of synaptic strengthening happens in the hippocampus which is an area crucial for storing new long-term memories. Bliss & Lomo (1973) applied a brief electrical stimulus to a neural pathway in a rat's hippocampus. They found that the electrical current produced a stronger connection between synapses that lay along the pathway and that the strengthening lasted for hours or even weeks. They called this long term potentiation, more commonly known as LTP (Enchanced neural processing that results from the strengthening of synaptic connections). LTP has a number of properties that indicate to researchers that it plays an important role in long term memory storage. It occurs in several pathways within the hippocampus; it can be induced rapidly; and it can last for a long time.

Bliss (1999) found that drugs that block LTP can turn rats into rodent versions of the patient HM. The rats had great difficulty remembering where they've been recently and become easily lost in a maze.

References

- Atkinson, R. C.; Shiffrin, R. M. (1968). " Chapter: Human memory: A proposed system and its control processes". in Spence, K. W.; Spence, J. T.. The psychology of learning and motivation (Volume 2). New York: Academic Press. pp. 89-195.

- Bahrick, H. P. (2000). Long-term maintenance of knowledge. In E. Tuilving & F. I. M. Craik (Eds.) The Oxford handbook of memory (pp. 347-362). New York: Oxford University Press.
- Bliss, T. V. P. (1999) Young receptors make smart mice. Nature, 401, 25-27
- Bliss, T. V. P., & Lomo, W. T. (1973) Long lasting potentiation of synaptic transmission in the dentate area of the anesthetized rabbit following stimulation of the perforant path. Journal of Physiology, 232, 331-356
- Scoville, W. B., & Milner, B. (1957). Loss of recent memory after bilateral hippocampal lesions. Journal of Neurology, Neurosurgery, and Psychiatry, 20, 11-21.
- Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control

processes. In Spence, K. W., & Spence, J. T. (Eds.), The psychology of learning and

motivation: Advances in research and theory. Academic Press.

- Butters N. & Cermak, L. S. (1986) A case study of the forgetting of autobiographical

knowledge: implications for the study of retrograde amnesia. In Autobiographical

Memory, ed. D Rubin, pp. 253-72. New York: Cambridge Univ. Press

- Butters, N. Delis, D. C., & Lucas, J. A. (1995) Clinical assessment of memory disorders in amnesia and dementia. Annual Review of Psychology, 46, 493-523.

- Graf, P., Squire, L. R., & Mandler, G. (1984) The information that amnesic patients do not

forget. Journal of Experimental Psychology: Learning, Memory & Cognition, 10, 164-78.

- Jacoby, L. L. & Dallas, M. (1981) On the relation between autobiographical memory and

perceptual learning. Journal of Experimental Psychology: General, 110, 306-340.

- James, L. E. & MacKay, D. G. (2001) H. M., word knowledge, and aging: Support for a new

theory and long-term retrograde amnesia. Psychological Science, 12, 485-492.

- Milner, B. (1970) Memory and the temporal regions of the brain. In K. H. Pribram & D. E.

Broadbent (eds) Biology of memory. New York: Academic Press.

- Squire, L. R., Stark, C. E., & & Clark, R. E. (2004) The medial temporal lobe. Annual Review

of Neuroscience, 27, 279-306.

- Warrington, E. & Weiskrantz, L. (1974) The effect of prior learning on subsequent retention

in amnesic patients. Neuropsychologia, 12, 419-428.