NEUROpsychology

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READING: Principles of Neuropsychology Chapter 4, 5

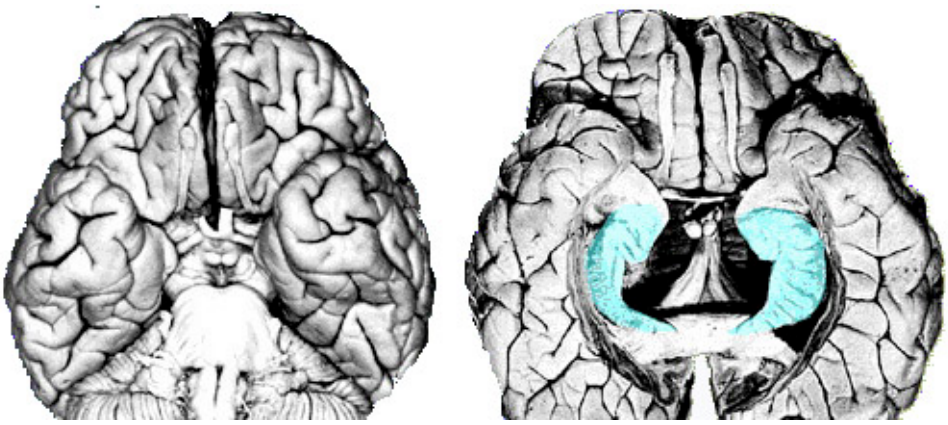

Figure Caption: This figure illustrates the normal bottom surface of the brain on the left. The right image depicts the dissection of the hippocampus (light blue). The cerebellum, brainstem and parts of the inferior temporal lobe were removed.

Amnesic Disorder: Partial or total loss of memory. New information is first perceived by sensory systems. It is then processed by cortical systems that derive meaning from this new information, make elaborate perceptual associations and engage in a variety of other processes that fall under the general heading of cognition. Part of this processing involves retaining new information for processing and problem solving in the future. Clearly, any organism that can retain information from past experiences has a great advantage and resources when similar experiences occur again. For this reason, virtually every organism has some form of memory ability.

The manner by which nervous systems store new information is largely undiscovered, although many of the brain structures and pathways involved in memory are known. In the human brain, the important structures are the hippocampus, mammillary bodies, dorso-medial thalamus and other parts of the limbic system.

The conventional theory of memory storage involves these processes presented in simplified form:

Disorders
Body Schema Disturbance
Cerebral Disconnection
Rehabilitation & Recovery
Glossary

- Information is perceived by the senses.
- Cortical systems process this information and it is retained for the relatively brief period required for processing (working memory).
- Pathways convey information from cortical sensory association areas to the hippocampus and some processing occurs there that presumably enhances permanent storage.
- Information is conveyed from the hippocampus to storage locations that are widely distributed throughout the cortex. Presumably these are areas that can use the information in the future.
- Information is retrieved using cortical systems only and the hippocampus is not part of the retrieval system.

Patients with lesions involving components of this model will have characteristic syndromes:

- Patients with cortical lesions will have difficulty with working memory and immediate recall of new information.
- Patients with lesions of the hippocampus will have intact immediate recall, intact retrieval of old memories and poor retention of new information. This is called anterograde amnesia.
- Presumably there is a syndrome of poor retrieval that results from cortical lesions. However, this syndrome is not clearly established. Patients with difficulty retrieving old information, also called retrograde amnesia, usually have injury of the hippocampus and other structures in the temporal lobes. They also have an anterograde amnesia. Diseases that produce anterograde and retrograde amnesia include traumatic brain injury, Korsakoff syndrome, and Huntington's disease.

Although patients with anterograde amnesia have severe inability to remember new information, some information has been shown to be retained at near-normal levels. This includes specialized procedural and implicit knowledge that is distinct from declarative information that is perceived at a conscious level. For example, if an amnesic subject practices a cognitive procedure, such as reading words presented in mirror form, the subject will later perform on the task consistent with the level of practice and similar to normal subjects. However, amnesic subjects may protest that they have never practiced

the task. Clearly some implicit, unconscious information about the task was retained. This suggests that alternative memory systems exist to retain and retrieve this information. Presumably these memory systems are part of the processing systems that utilize the information. These may include subcortical and cortical systems. For example, mirror reading may involve implicit memory systems that are part of the cortical language centers as well as eye-movement control centers in the cortex and subcortical areas.

Anterograde amnesia is the syndrome usually referred to as pure memory disorder. It includes these major features:

- Loss of ability to retain new information.
- Intact immediate recall of new information within the bounds of short-term memory (10-15 seconds).
- Intact ability to retrieve information that was stored before the onset of memory disorder (remote recall).
- Other cognitive abilites, such as language and visual spatial processing, are also intact. Intelligence is usually normal.
- Certain implicit and procedural memories are substantially intact.

The following are neurological illnesses that commonly result in amnesic disorder:

- Alcoholic Korsakoff syndrome
- Traumatic Brain Injury
- Cerebral Anoxia
- Tumors within or near the hippocampus
- Dementia-related illnesses, such as Alzheimer's Disease

Material Specific Memory Systems

Concepts of memory subtypes emerged from the study of the intact memory function present among amnesics and the study of memory function in cognitive psychology. Theories of multiple systems have been used to explain the dissociation of certain memory content in amnesia. For example, if immediate recall of information is possible within the context of impaired delayed recall, then immediate recall must be mediated by a processing system that is distinct from the storage of information over an extended period of time.

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Verbal and Visual-Spatial Memory Systems

It has long been postulated that verbal and visual-spatial information is stored independently in the brain. Certainly this information is processed by relatively independent systems within the left (verbal) and right (visual spatial) hemispheres. The question remains whether information is actually consolidated and stored within each hemisphere. Unfortunately the studies of unilateral temporal lobe lesions are equivocal; some studies have found lateralized differences and others have not. This research area is hampered by the occurrence of a small number of cases that have the necessary lesions. In reference to clinical assessment, it is certainly valid that patients with left hemisphere lesions and aphasia do poorly on verbal memory and better on visual-spatial memory. Patients with right hemisphere lesions and visual-spatial processing deficits also do worse on visual-spatial memory tasks and better on verbal tasks. It is clear that the initial processing of verbal or visual-spatial information affects its consolidation and storage. What remains unclear is whether storage systems and sites are lateralized.

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Immediate verses Delayed Recall

Amnesia patients have normal immediate recall of information. If information is presented and the patient is asked to recall it immediately there is no deficit of performance. The intact immediate recall period is approximately 10 seconds. If the interval between presentation and recall is longer than this period then there is deterioration of performance. The amnesia patient can remember information for brief periods and this is accomplished using a memory system distinct from the long-term consolidation system. This system is presumed to reside within the cortical processing systems that uniquely process information before it is consolidated and stored for the extended future. For example, verbal information such as strings of numbers, is probably stored temporarily while it is processed by the language centers. The subject may then report the content of this memory storage within the short time it resides in the cortex.

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Semantic verses Autobiographical Memories

Semantic memories are composed of the general fund of information and the semantic knowledge of words. A clear example is the word knowledge stored as vocabulary. This information is highly organized into subordinate and superordinate categories and by other logical relationships. For example, "kinds of fruit" represents a superordinate category for a number of semantic elements, such as apple, pear, lemon etc. Autobiographical knowledge represents the store of personal experience, usually organized by time. It is poorly organized in comparison to semantic knowledge. It has been proposed that separate brain systems mediate each kind of memory and that amnesics may be classified by the relative ability to store and retrieve these separate types of information.

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Implicit verses Explicit Memories

The subject's report of an experience includes the explicit aspects of the experience and the subject is aware of storing and retrieving this information. Subjects commonly identify this as the material they have remembered from the experience. However, some information may have been retained of which the subject has no awareness. These are implicit aspects of memory for the experience. They are only observable using specialized testing. For example, amnesic subjects were requested to engage in a certain perceptual motor skill called the pursuit rotor task. They practiced over many training sessions. After a delay interval in which they did not practice, they were asked to engage in the task again. Although they had no explicit memory for the previous practice sessions, they performed as if they had indeed practiced. Some information about the task was retained but the subject did not have an explicit memory of it. This retained knowledge is an implicit aspect of the task. Since amnesic subjects have numerous intact implicit memory processes, it has been proposed that these are mediated by separate memory systems.

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Declarative verses Procedural Memories

A distinction similar to the Implicit/Explicit dichotomy is the one separating declarative memories from procedural ones. Declarative memories consist of semantic and episodic memories of which the subject is aware and reports at the time of retrieval. Procedural memories are essentially implicit aspects of procedures, such as motor skills and cognitive procedures.

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Assessment

Memory function is assessed by asking the patient to remember information over a delay. The material may be lists of words, short stories, geometric designs and pictures of common objects. The material is explicitly divided by verbal and visual-spatial content. The delay intervals range from a few minutes to one hour. The patients are also examined using recall and recognition formats. For example, recall of a word list involves 1) presenting the words; 2) waiting a delay interval; 3) asking the subject to report the words presented before. Recognition of this list would be assessed by presenting a list of words to the subject after delay that contained the words on the list presented earlier plus distraction words that were not on the list. The subject is requested to indicate the words that appeared on the list. Both verbal and visual-spatial information is tested using recall and recognition procedures.

Immediate recall is assessed by reciting strings of numbers to the patient that increase in length over trials. Failure to immediately repeat two strings of the same length represents the stopping point of the trials. The greatest length repeated is the measure of immediate recall, or "Digit Span". Normal subjects can immediately recall approximately seven digits.