

Brief History of Work in the area of Learning and Memory

- Basic Questions
- how does memory work
- are there different kinds of memory
- what is their logic
- where in the brain do we learn
- where do we store what is learned as memory
- can memory storage be resolved at the level of individual nerve cells

Prior to the 19 century

The early philosophical approaches used methods of introspection, logic, and argument to:

- define broad constraints on knowledge and what was knowable
- determine what was innate or acquired

The late 19th century brought quantitative study of mental processes

- The 1885, Hermann **Ebbinghaus** monograph On Memory described systematic measurement of memory in terms of accuracy, retention, and capacity. This work also revealed some basic properties of memory such as differences in duration and the impact of repetition on retention.
- In 1887 , Sergei **Korsakoff** published his work on a syndrome that established the use of memory disorders as a means of studying mnemonic processes.

- In 1890, William **James** wrote *Principles of Psychology* that outlined sharp distinctions between short (primary) and long (secondary) term memory.
- 1898, Edward **Thorndike** working under James published his work using animal subjects to study memory.

The 20th century brought the behaviorists demonstrating systematic ways of modifying behavior.

- Around 1904 **Pavlov** published his work on classical conditioning, or the conditioned reflex establishing the basis for systematic control of behavior through learning.
- In 1911, **Thorndike** demonstrated the principles of trial-and-error learning or instrumental/operant conditioning.
- The work of John **Watson**, B.F. **Skinner**, and Clark **Hull** in the 1930's and 40's introduced highly systematic singular black-box rules of learning for explaining complex behavior.

A more cognitive approach evolved from the limitations apparent in the behaviorists paradigm

- **Tolman** (1949) argued for a more cognitive mechanism of learning in which different types of learning used different rules. He studied more complex tasks that required behavioral selection related to problem solving.
- In the 1950's Frederic **Bartlett** examined memory of naturalistic scenes and stories in an effort to examine the cognitive complexities of memory.

“Remembering is not the re-excitation of innumerable fixed, lifeless and fragmentary traces. It is an imaginative reconstruction, or construction, built out of the relation of our attitude towards a whole active mass of organized past reactions or experience, and to a little outstanding detail which commonly appears in image or in language form.”

In addition to this work examining the principles of learning at the behavioral level there was an effort to identify the mechanisms responsible for learning and memory at the neural level.

- In the 1890's following his pioneering work in brain anatomy Ramon **Cajal** suggested that structural changes in the brain might underlie learning and memory.
- In 1897 Charles **Sherrington** named the "synapse" and suggested that it was a likely candidate for a structure related to learning and memory.

- Beginning in the 1920's Karl **Lashley** began studying the effect of removal of different amounts of cerebral cortex on maze learning. From this work the idea of "mass action" was formulated in which brain function was non-localized.
- In 1938, the neurosurgeon Wilder **Penfield** demonstrated that electrical stimulation of the brain, in particular the temporal lobe, could elicit reports of memories, perceptions, and hallucinations including voices, images, and music.

- In 1949, Donald **Hebb** published his work the Organization of Behavior in which he argued that memory was held in cell assemblies distributed throughout the brain which was in part, a response to the earlier work of Lashley.
- In 1957, **Scoville** and **Milner** published their work examining the patient H.M. in which removal of regions of the medial temporal cortex led to profound loss in memory capabilities without loss in intellectual or cognitive abilities demonstrating clear functional heterogeneity within the brain in contrast to the earlier notions of Lashley.

- Subsequent work in the 1960's by Brenda Milner demonstrated that procedural memory in H.M. was unaffected further demonstrating that different types of memory could be maintained by different brain regions.
- In 1967, Seymour **Benzer** working in the fruit fly *Drosophila* using chemical mutagenesis to alter the function of individual genes implicated specific proteins in behavior and introduced the use of molecular genetic approaches in the study of memory.