# Learning and Memory

Lecture 1

28th July 2022

Thursday

| Type of Evaluation | Weightage (in %) |
| --- | --- |
| In class quizzes | 40% (8 quizzes x 5%) |
| Mid Sem-Exam | 15% |
| End Sem Exam | 30% |
| In-class discussions & presentations | 15% |

- **Learning**: the process by which changes in behavior arise as a result of an organism's experience interacting with the world

- **Memory:** the organism's internal record of past experiences, acquired through learning

# Aristotle and Associationism

(384–322 BC)

Aristotle described the linkages between ideas in the mind as reflecting three fundamental principles, or universal laws, of association

- Contiguity
- Frequency
- Similarity

Aristotle's theory of **associationism**

Argued that memory depends on the formation of linkages ("associations") between pairs of events, sensations, or ideas, so that recalling or experiencing one member of the pair elicits a memory or anticipation of the other

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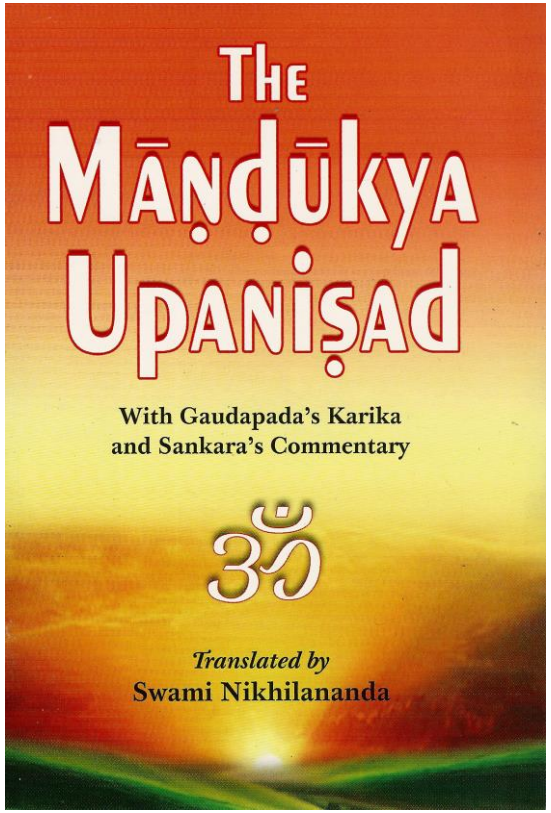
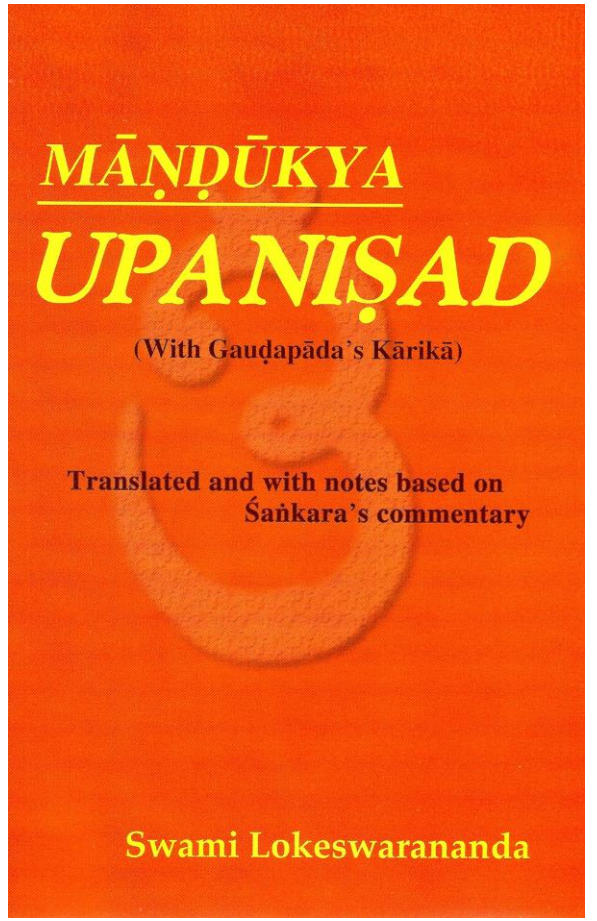
# Śaṅkara (788-820)



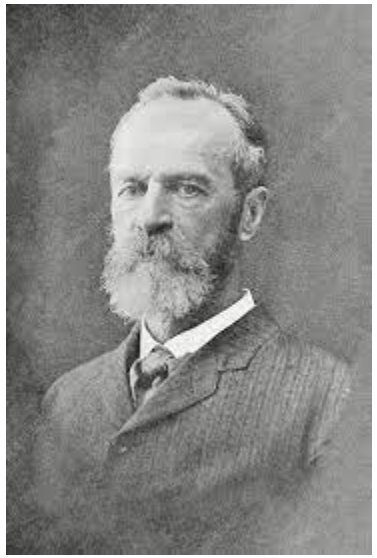



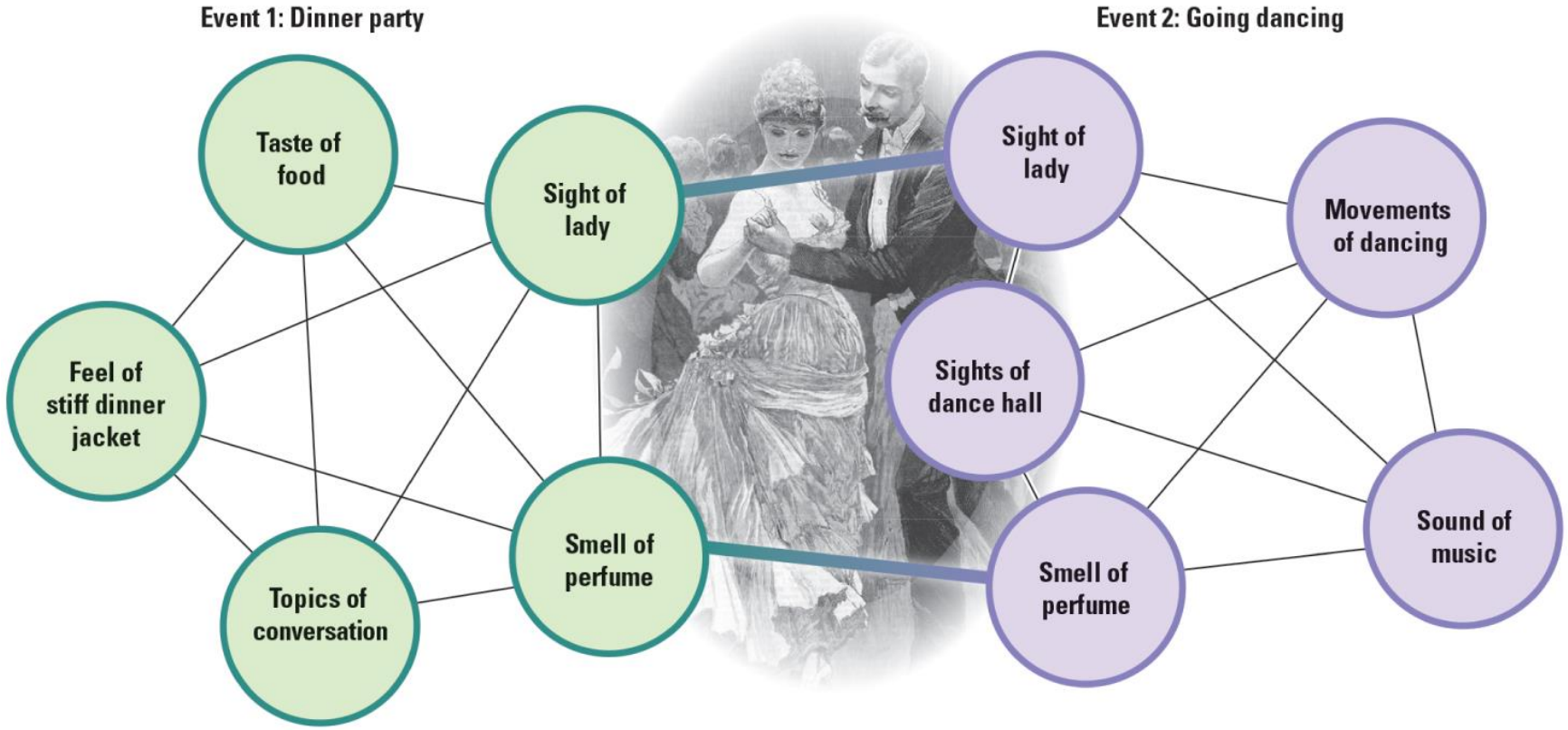

- Adi Shakara
- Sage/scholar
- Notable Indian thinker
- Interpretations vary across translators
- Memory is an extension of our consciousness
- Memory has a purpose – our past experiences help us to navigate or interpret the present

# William James and Memory Networks

(1842–1910)

(MS Am 1092.) Houghton Library, Harvard University



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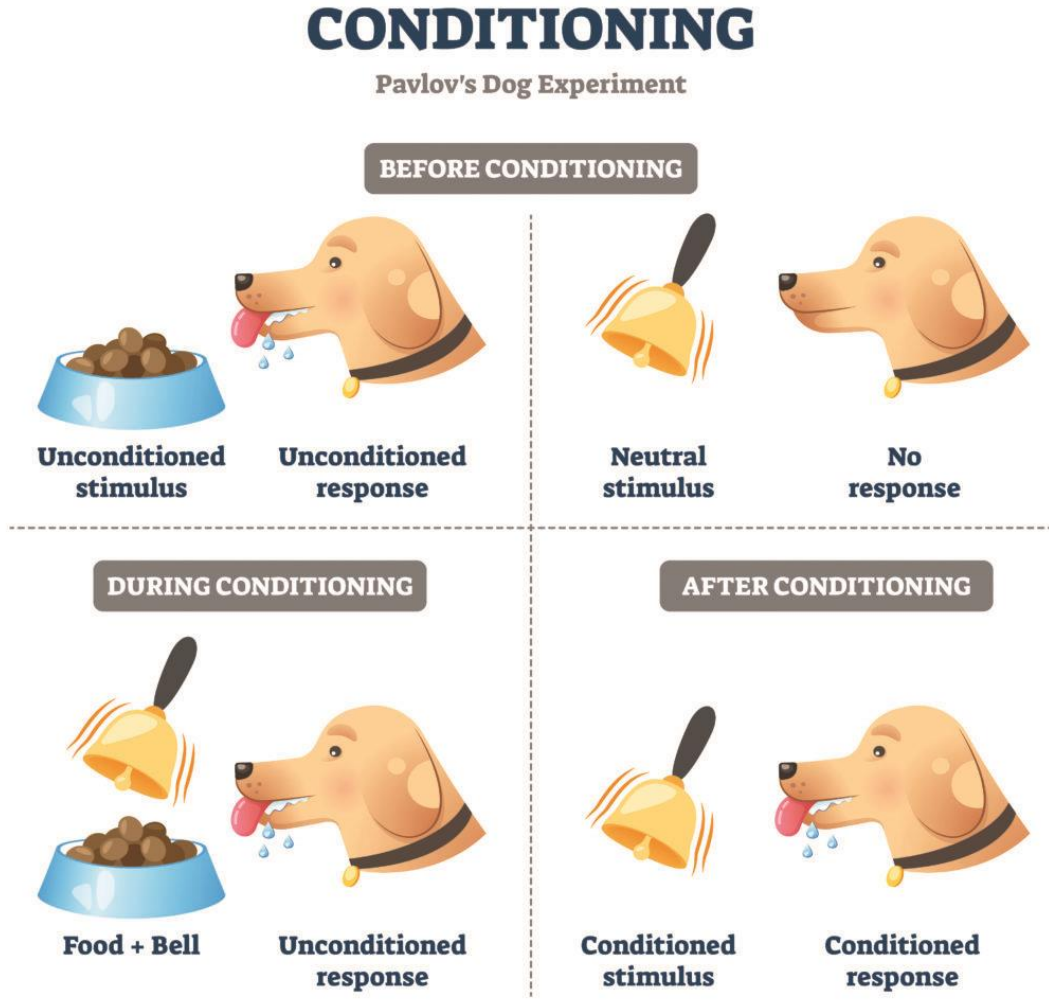
especially interested in how we learn new habits and acquire new memories

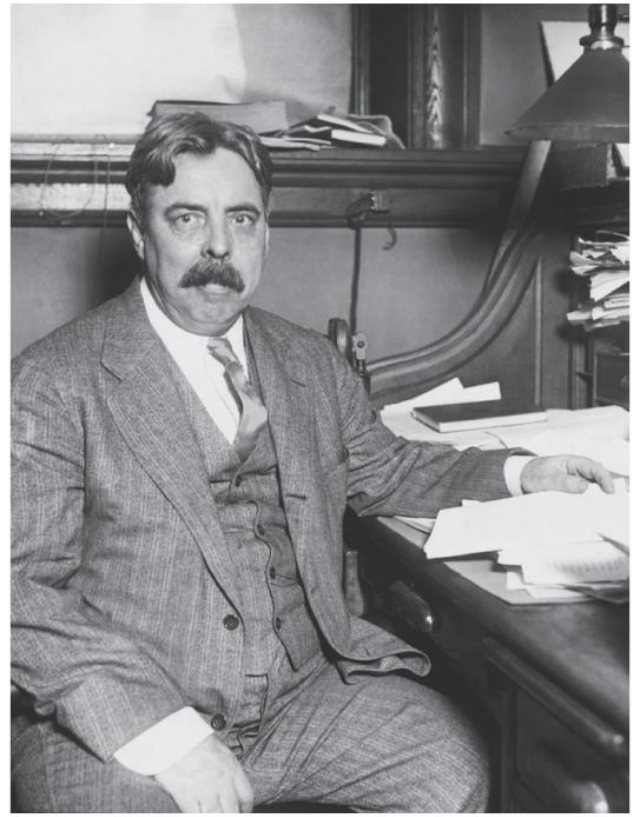
# Ivan Pavlov's Conditioning Studies
(1849–1936)

- Ivan Pavlov is known for developing methods for studying animal learning that are still in widespread use today



# Edward Thorndike and the Law of Effect

(1874–1949)



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**Instrumental (Operant) conditioning**: organisms learn to make responses in order to obtain or avoid important consequences

Thorndike observed that the probability of a particular behavioral response increased or decreased depending on the consequences that followed; he called this the **law of effect**

Reward/Punishment

Some of Thorndike's most influential studies involved observing how cats learn to escape from puzzle boxes

# Nature Versus Nurture

- Which has the greater influence on our learning and memory abilities?
  - Nature: genetics
  - Nurture: environment and upbringing

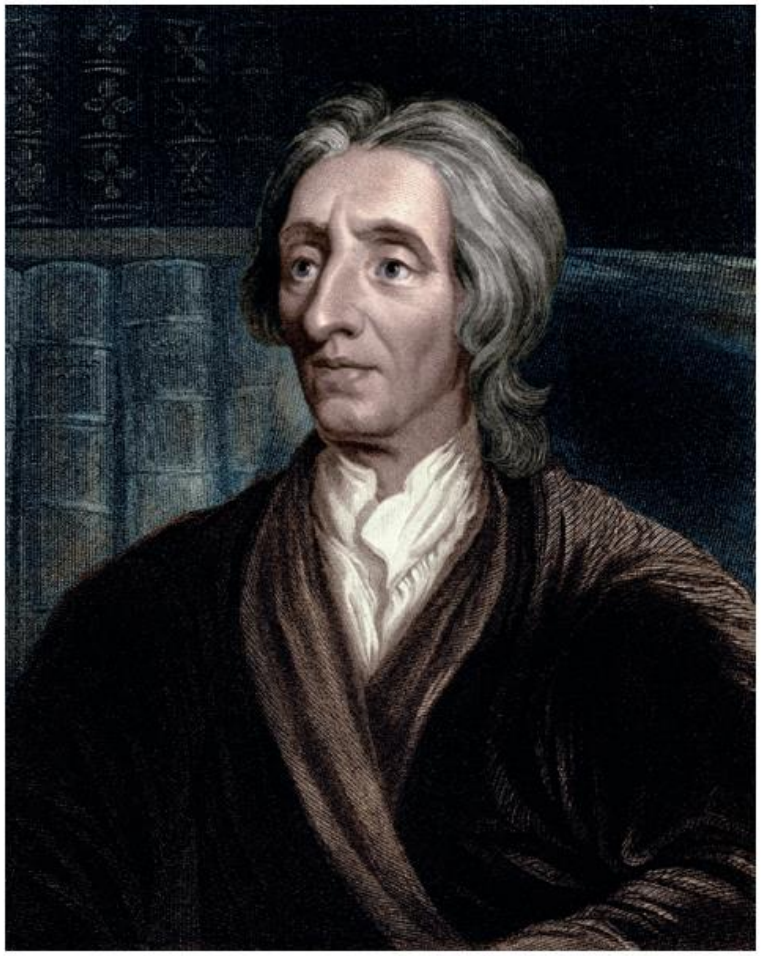
# Plato

(427–347 BC)

**Nativism -** that the bulk of our knowledge is inborn or innate (or native)

# John Locke and the Blank Slate

(1632–1704)



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- John Locke argued that all knowledge is derived from experience
- Suggested that children arrive in the world as a blank slate (tabula rasa), ready to be influenced by experience and learning

Locke argued that access to a good education should be available to all children, regardless of their class or family wealth, because common people, through striving and learning, could transcend the limits and barriers of class

# John Watson's Behaviorism

(1878–1958)

**Behaviorism:** a school of thought that says psychology should restrict itself to the study of observable behaviors (such as lever presses, salivation, and other measurable actions) and not seek to infer unobservable mental processes

From his studies with rats, Watson came to believe that all behavior is learned and a product of our environments

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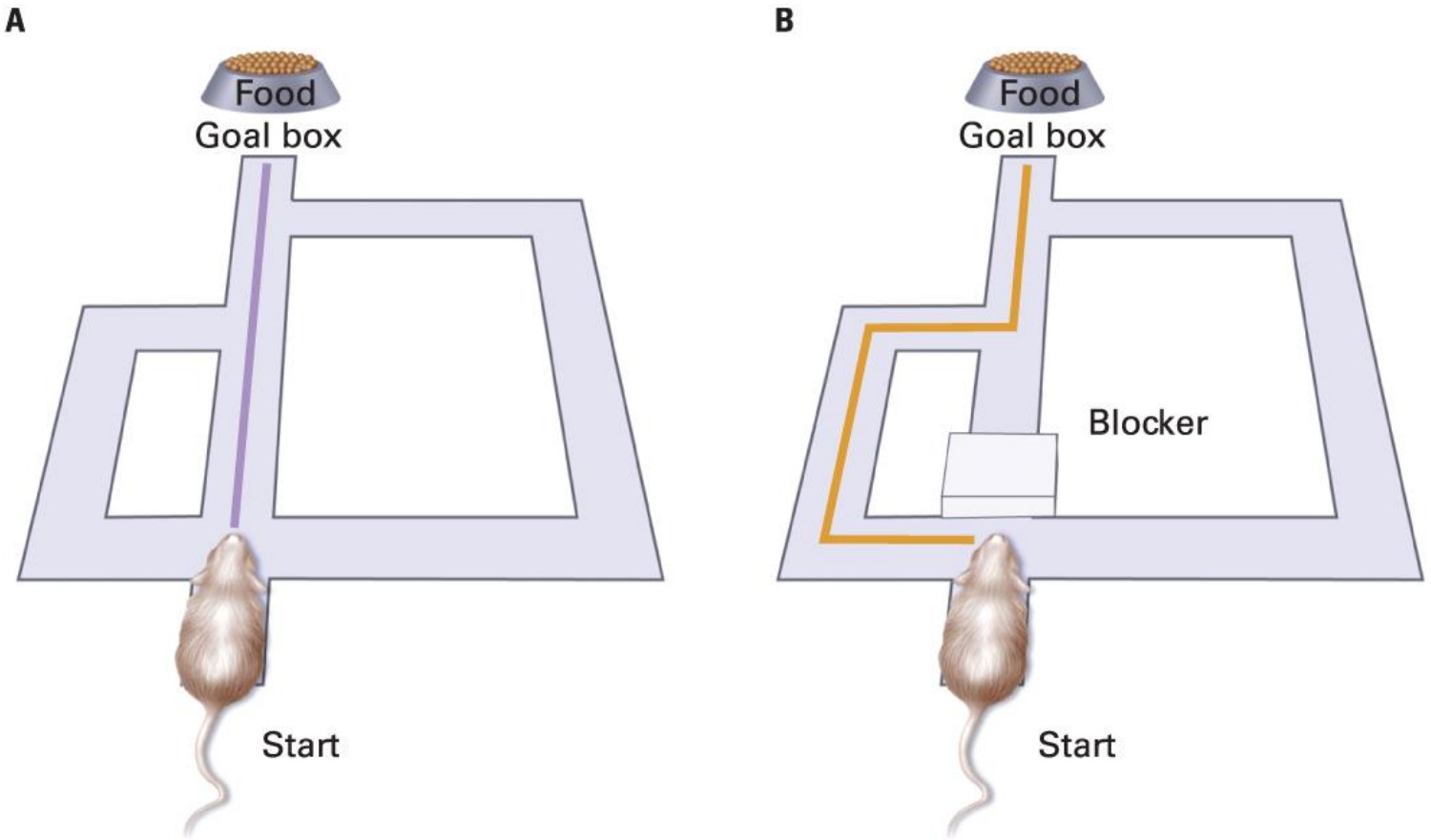
# The Neo-Behaviorism of Edward Tolman (1886–1959)

- Edward Tolman Argued that rats are like humans in that they are intrinsically motivated to learn the general layout of mazes by forming what he called a **cognitive map**, an internal psychological representation of the spatial layout of the external world
- “Behavior reeks of purpose”

The Drs. Nicholas and Dorothy Cummings Center for the History of Psychology, The University of Akron

# Cognitive Maps in Rats

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- Tolman showed the value of cognitive maps for understanding how rats can apply what they have learned in novel situations; rats, he showed, are able to find food in mazes by using alternative routes if their preferred route is blocked
- Tolman argued that during their free exploration, the rats were learning a cognitive map that they could exploit later (**latent learning**)
  - **Latent learning:** learning that is unconnected to a positive or negative consequence and that remains undetected (latent) until explicitly demonstrated at a later stage

# B. F. Skinner's Radical Behaviorism
(1904–1990)

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- Burrhus Frederic Skinner
  - Believed psychologists should limit themselves to the study of observable behaviors that can be learned through experience, and not try to speculate about what is going on in the mind of an animal while it learns

**radical behaviorism -** he asserted that consciousness and free will are illusions

Skinner argued that humans, like all other animals, function by blindly producing learned responses to environmental stimuli

# Hermann Ebbinghaus and Human Memory Experiments

(1850–1909)

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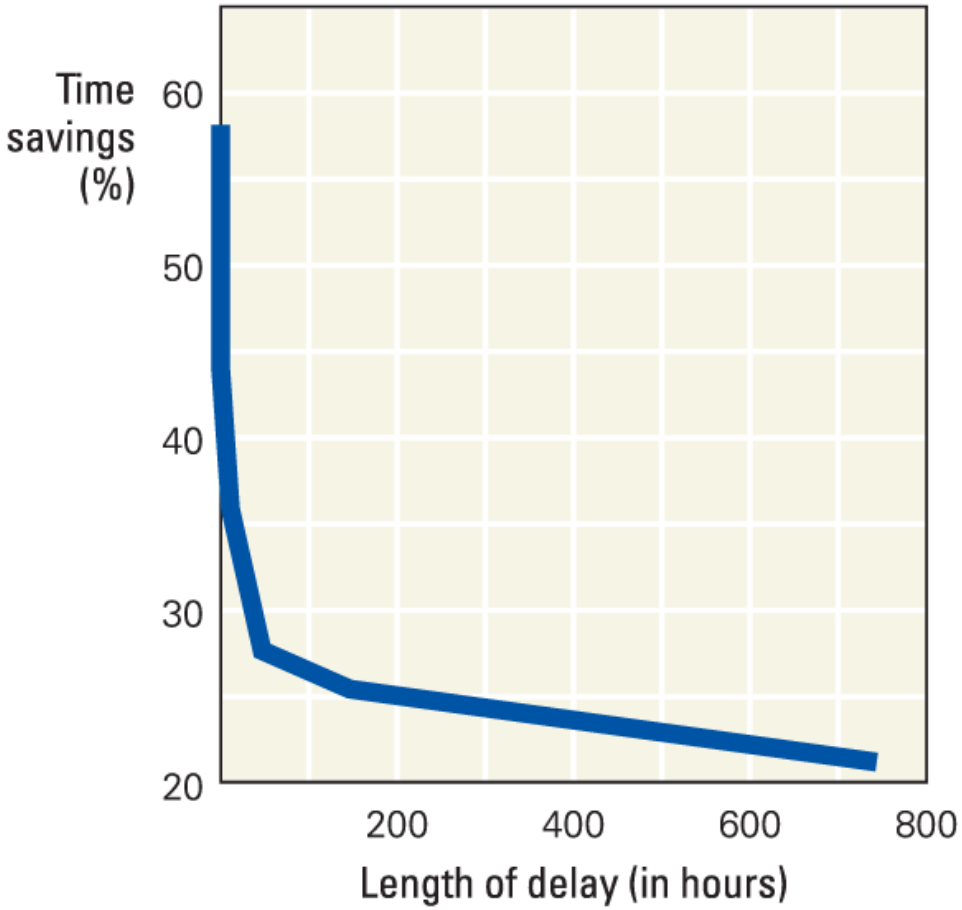
- Hermann Ebbinghaus conducted the first rigorous experimental studies of human memory
- Proposed that the psychology of memory could also become a rigorous natural science, defined by precise mathematical laws
- So he measured memory over time

# Ebbinghaus's Retention Curve

- Ebbinghaus was especially interested in **forgetting**—that is, in how memory deteriorates over time
  - Measured forgetting by examining how long it took to relearn a previously learned list

- Ebbinghaus was able to plot a **retention curve**, which measures how much information is retained at each point in time following learning

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# Clark Hull and Mathematical Models of Learning (1884–1952)

- Hull's goal was to develop a comprehensive mathematical model of animal learning that would predict exactly what an animal will learn in any given situation

- Most learning theorists of that era, including Hull, assumed that learning should be viewed as the development of associations between a stimulus and a response.

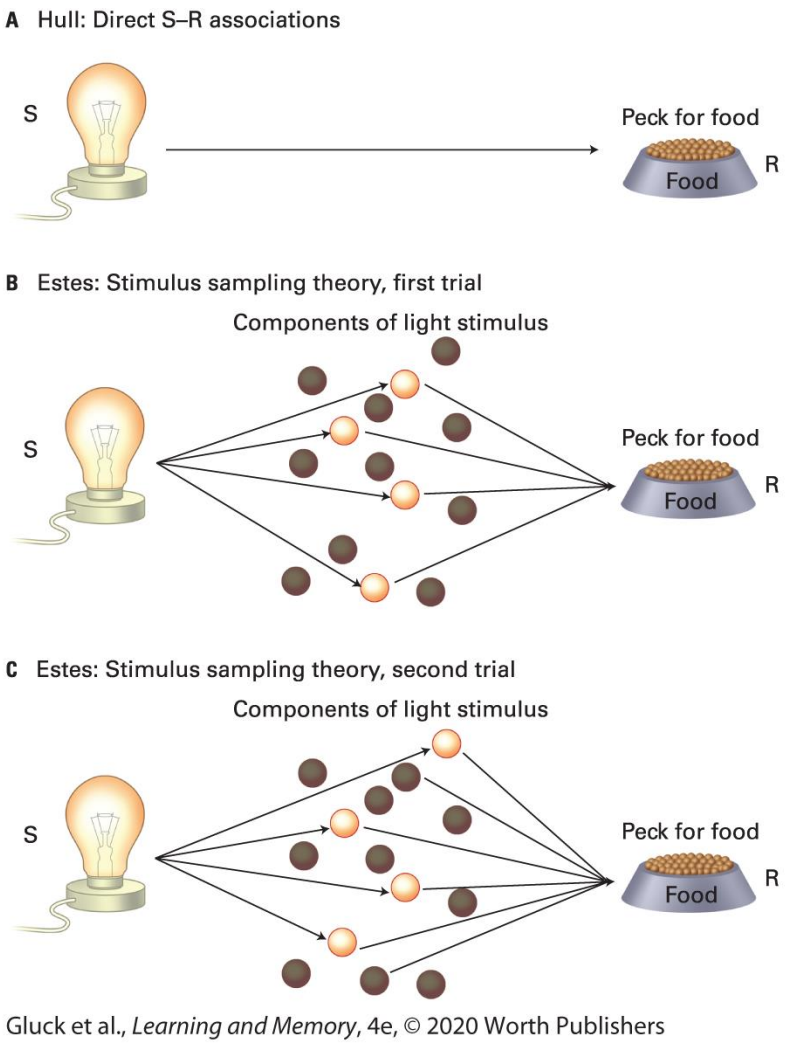
Office of Public Affairs, Yale University, Photographs of Individuals (RU686). Manuscripts and Archives, Yale University Library.

# W. K. Estes and Mathematical Psychology

George Estes

- William K. Estes (1919–2011) and his colleagues established a new subdiscipline of psychology, **mathematical psychology**
  - Used mathematical equations to describe the laws of learning and memory and demonstrated how quantitative approaches can be applied to observable behaviors in order to understand, and formally model, mental functions

# Stimulus-Response Models

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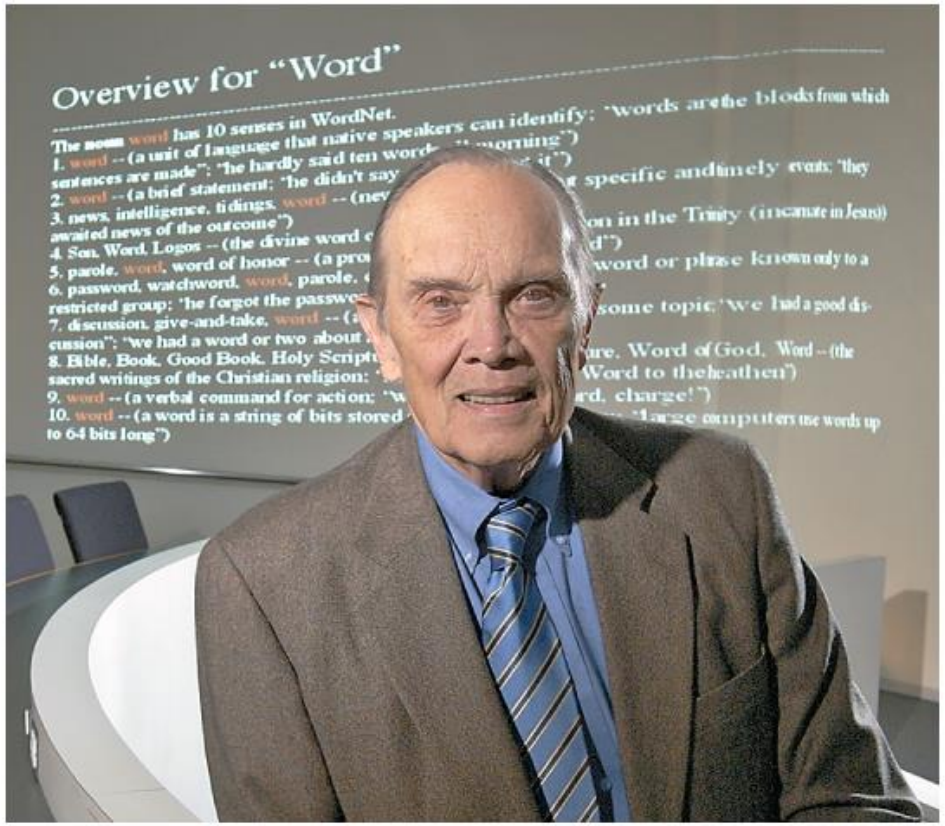
# George Miller and Information Theory

- George Miller (1920–2012) adapted formal models of information theory to psychology to help us understand memory capacity

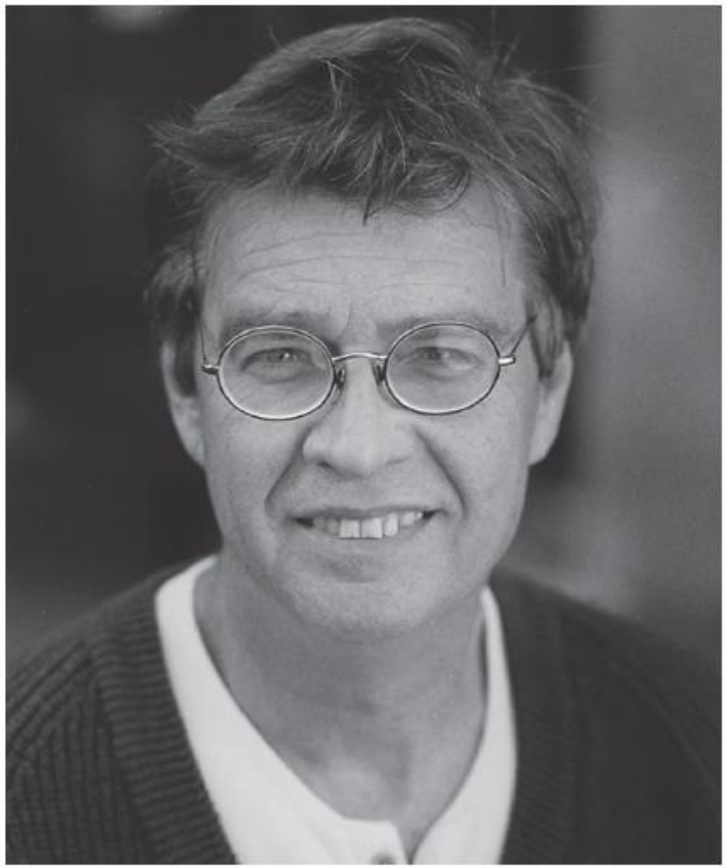
Miller's specific goal was to answer the question of whether information theory can help us understand how people make judgments about the magnitude of any stimulus




Jon Roemer

# The Connectionist Models of David Rumelhart

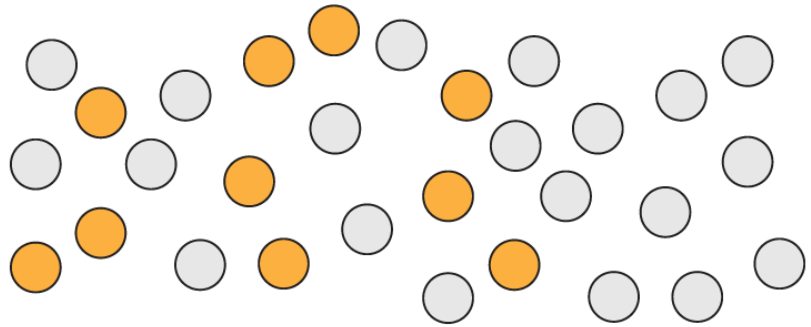
(1942–2011)



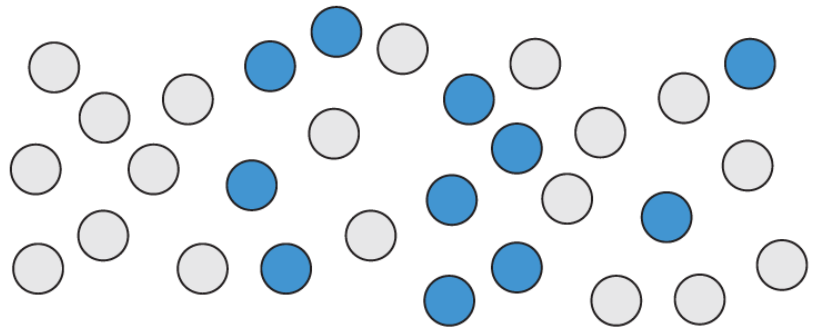
Linda A. Cicero/Stanford News Service

- Developed models of learning and thinking that he described as "connectionist network models"
- In **connectionist models**, ideas and concepts in the external world are not represented as distinct and discrete symbols but rather as patterns of activity over populations of many nodes
  - **Distributed representation:** a representation in which information is coded as a pattern of activation distributed across many different nodes

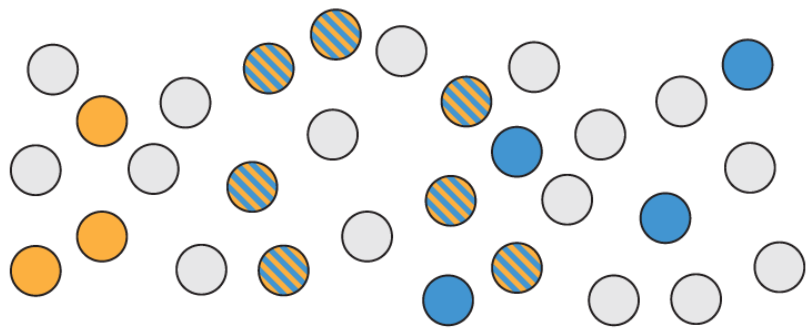
**A** "Golden retriever"



**B** "Cocker spaniel"



**C** "Dog"



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Many of the scientists who made important contributions did so by liberally borrowing from the methods and concepts of the physical and natural sciences.

| Who… | Borrowed from… | To explain or do what? |
|---|---|---|
| 1. René Descartes | Hydraulic engineering | How the body could function like a machine with input and output control pathways |
| 2. John Locke | Physics (Newton), chemistry (Boyle) | How complex ideas could be formed from combinations of simpler and more elementary components |
| 3. Hermann Ebbinghaus | Laws of perception (Fechner) | How psychology of memory could be a rigorous natural science, defined by precise mathematical laws |
| 4. Ivan Pavlov | Telephone exchanges | The distinction between a direct fixed connection and a modifiable indirect connection, as when a switchboard operator makes the call |
| 5. Edward Thorndike | Evolution by natural selection (Darwin) | That of all possible behavioral responses, the ones that are more successful and adaptive are more likely to be retained (i.e., learned) |
| 6. Clark Hull | Theory of relativity (Einstein) | The search for simple, powerful equations that unify many disparate observations |
| 7. George Miller | Information theory (Shannon) | How to measure the amount of information in a message or stored memory, independent of the content |

- What are the rules for learning?
- Does everyone follow the same learning rules?

- Several studies have shown what seems to be a genetic influence on some kinds of memory ability: parents with high memory ability are likely to have children who also have high memory ability. How would an empiricist account for such findings?