

Learning and Memory

Monsoon 2024

1st August

Dr. Bhaktee Dongaonkar

NO NEGOTIATION OF GRADES AT THE END OF THE SEMESTER.

No Quiz1 or Quiz2 – only surprise class quizzes.

Type of Evaluation	Weightage (in %)
Surprise In-class quizzes	35%
Mid Sem-Exam	25%
End Sem Presentations in Class (group of 4 students design novel experiments to test behaviour) Contributions made by every student in the group will be assessed	30%
Participation in-class discussions (those who think and make interesting observations and ask relevant/critical questions in class)	5%
Participation in experiments	5%

Grade	%
A	≥ 88
A-	81-87.5
B	74-80.5
B-	66 -73.5
C	59-65.5
C-	52-58.5
D	40 – 51.5
F	Below 40

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What does 'learning' mean?

How do sensations become linked in the mind?

Aristotle and Associationism

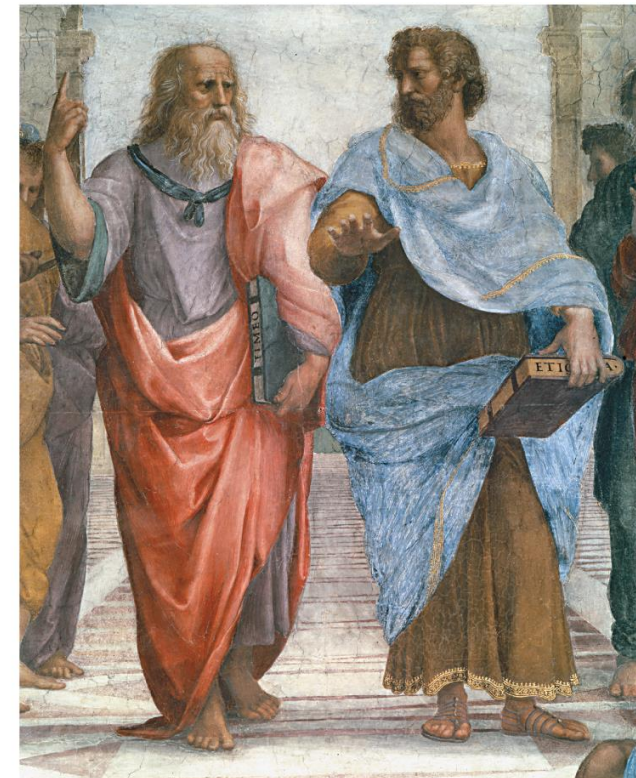
(384–322 BC)

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

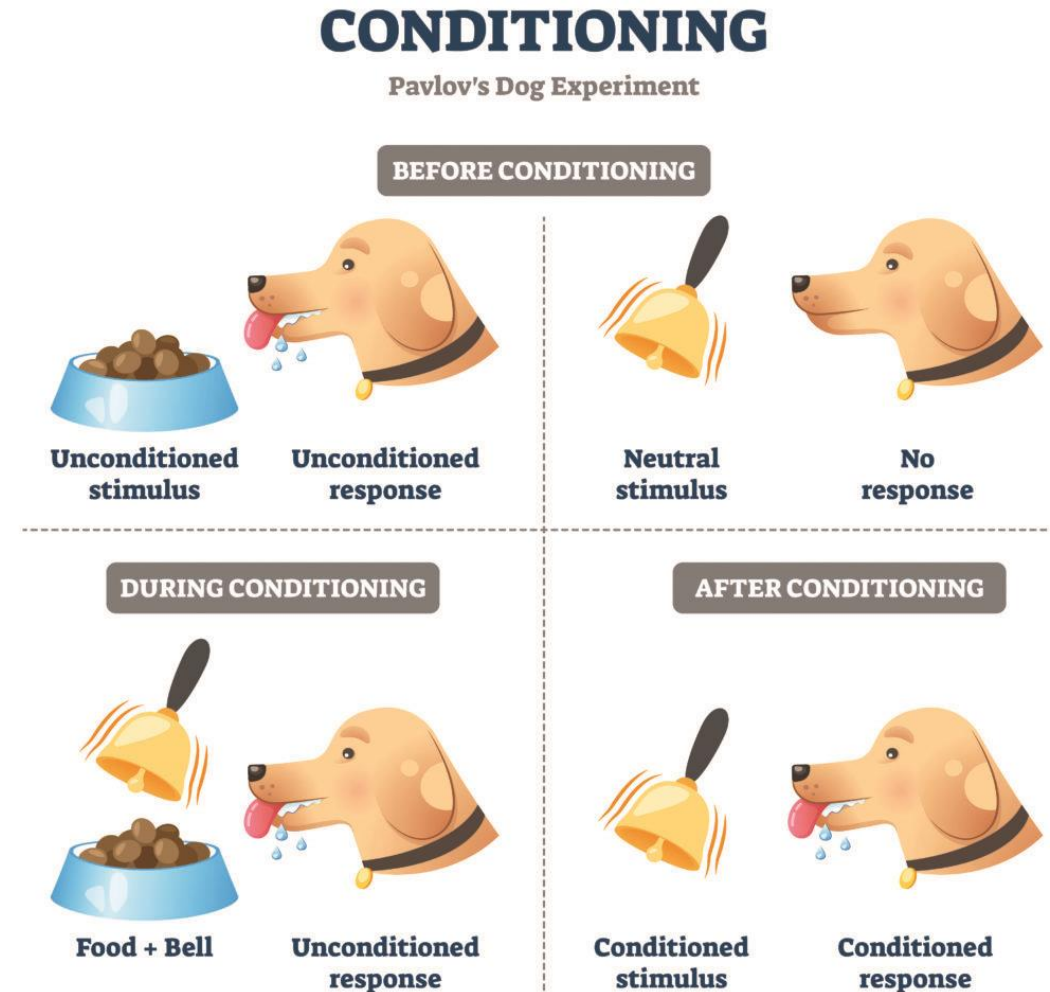


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Ivan Pavlov's Conditioning Studies

(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

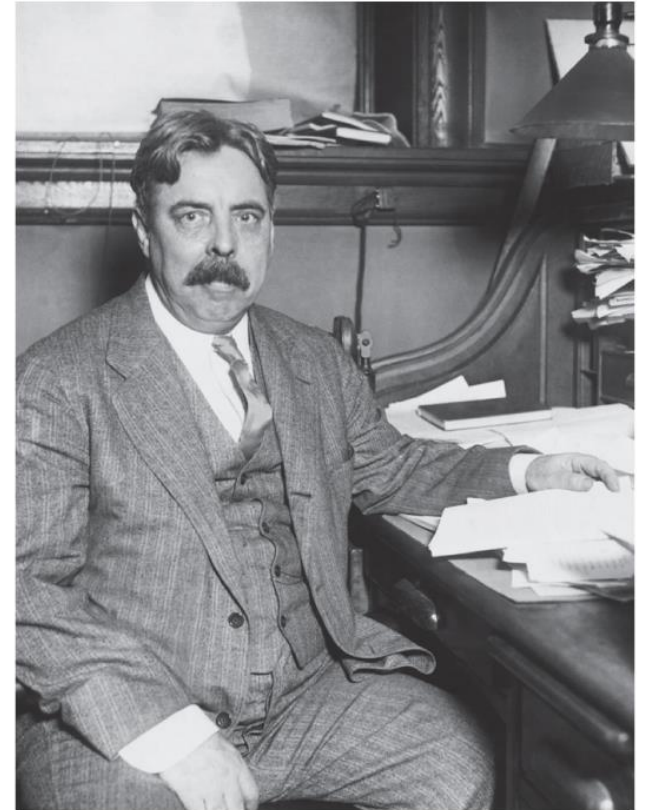
(1874–1949)

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

Reward/Punishment

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**

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



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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

Serendipity and Variable Reinforcement (reward based behaviour)

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

radical behaviorism - free-will is an illusion

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 driven by the need to fulfil an intrinsic drive (Drive Reduction theory).

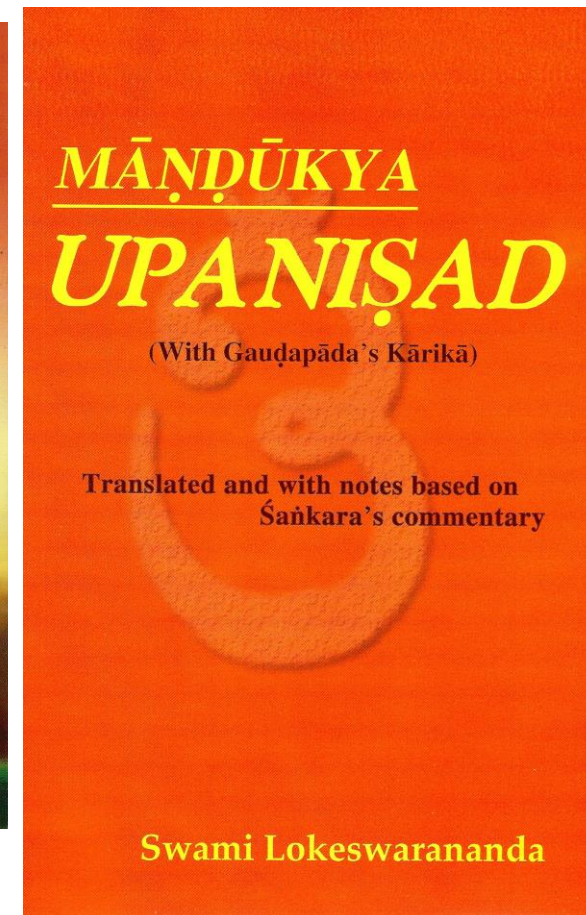
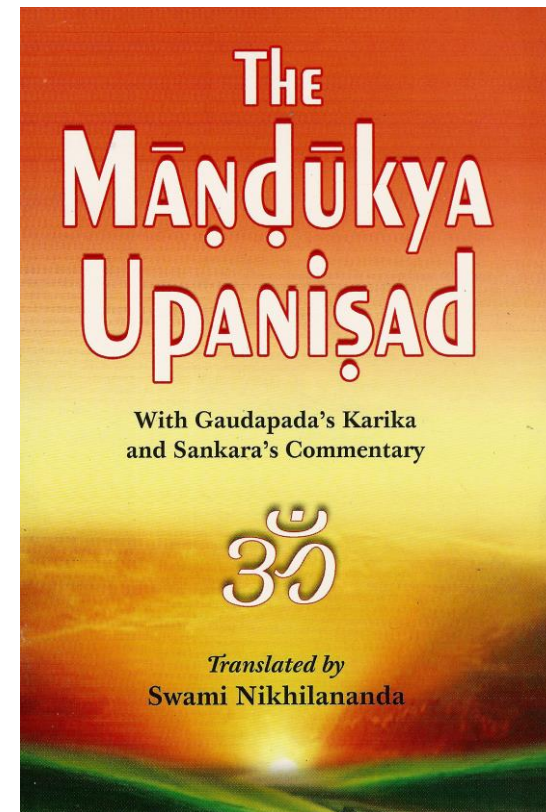


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Why do we have memories?

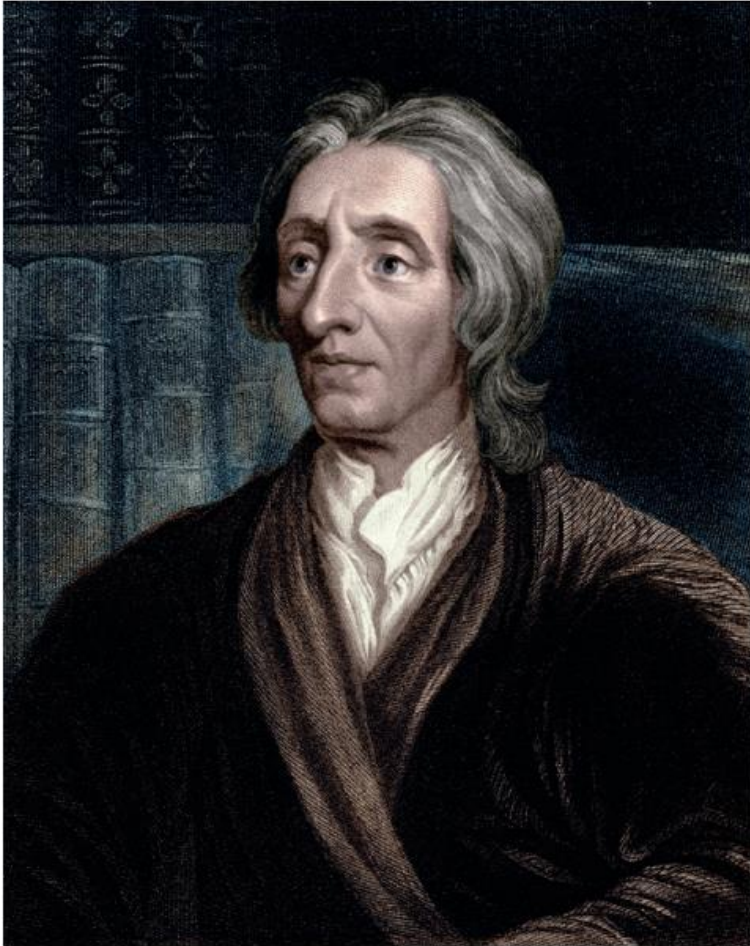
Śaṅkara (788-820)

- Adi Shankara
- 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



John Locke the Blank Slate

(1632–1704)



INTERFOTO/Alamy Stock Photo

Isaac Newton's Light and Robert Boyle's chemicals

- Associationism (Green, Bitter/Sour vs. Limes)

- 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

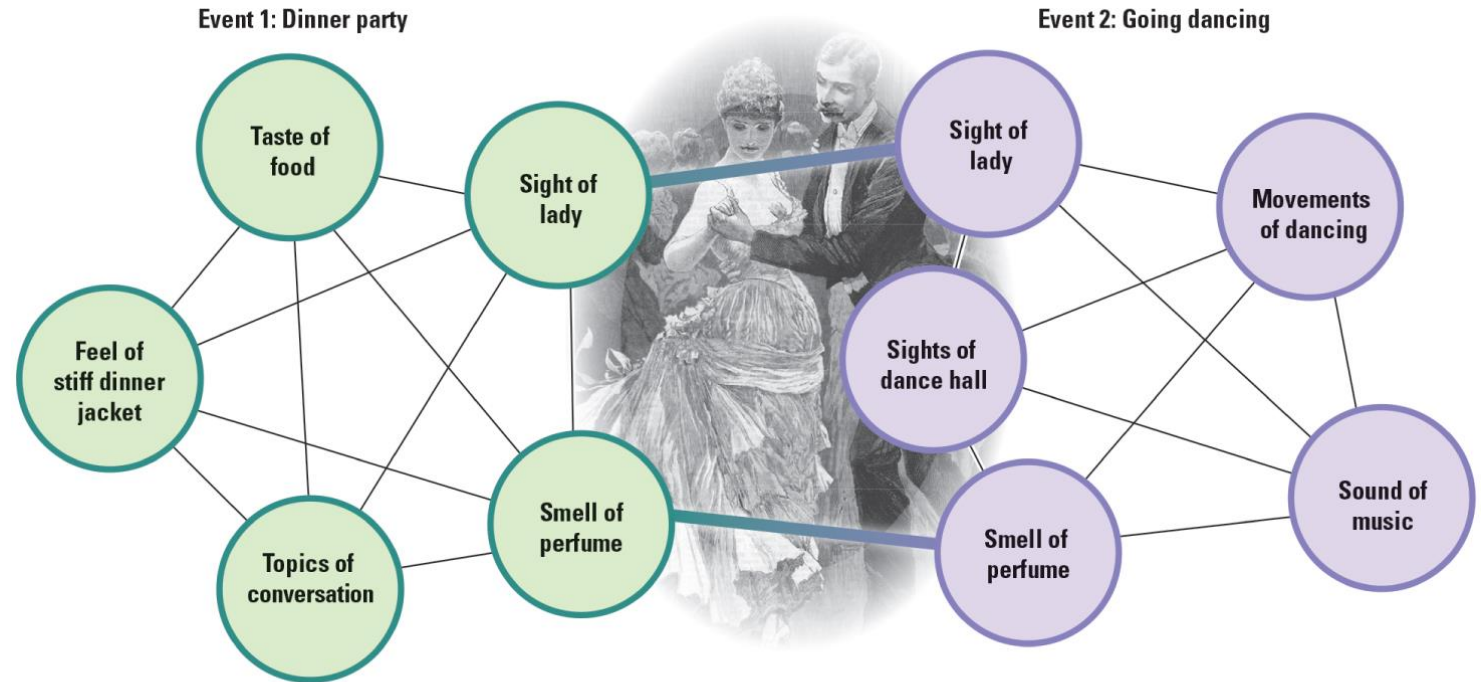


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William James and Memory Networks

(1842–1910)



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Memory depends on:

1. Strengthening of reflex pathways
2. Associational Links

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

W. K. Estes and Mathematical Psychology



- William K. Estes (1919–2011) and his colleagues established a new subdiscipline of psychology, **mathematical psychology**
- Stimulus Sampling Theory (SST). SST is a probabilistic model that provides a statistical explanation of how we learn a stimulus-response association in a single trial, but require more stimulus-response repetitions to build an evident unit of learning.

Stimulus-Response Models

HULL

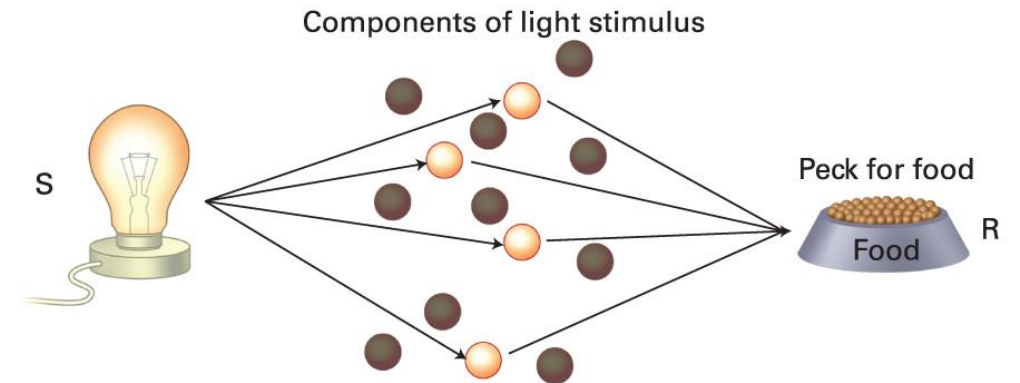


ESTES

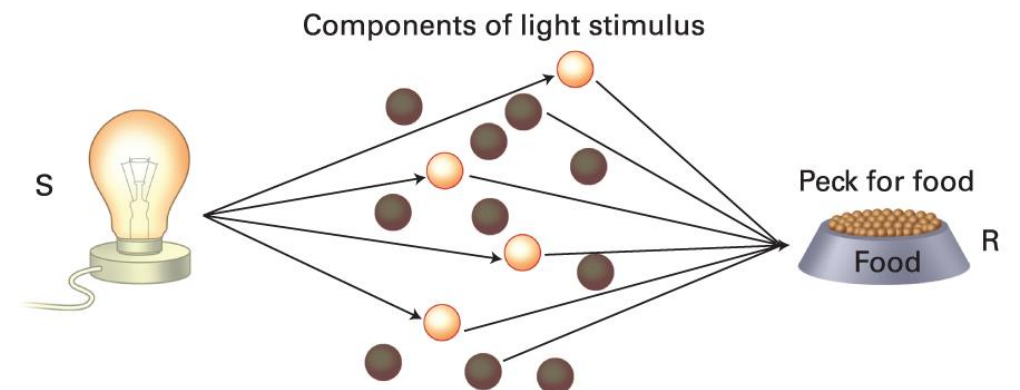
A Hull: Direct S-R associations



B Estes: Stimulus sampling theory, first trial



C Estes: Stimulus sampling theory, second trial



Connectionist Models - David Rumelhart

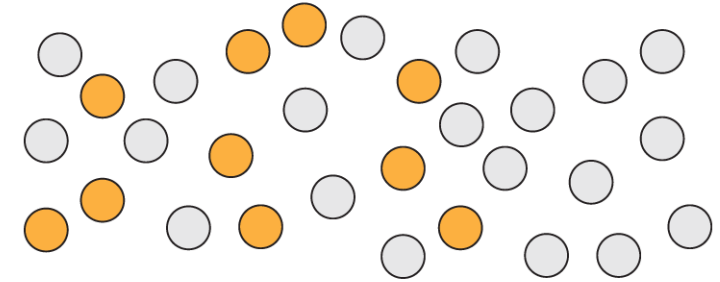


Linda A. Cicero/Stanford News Service

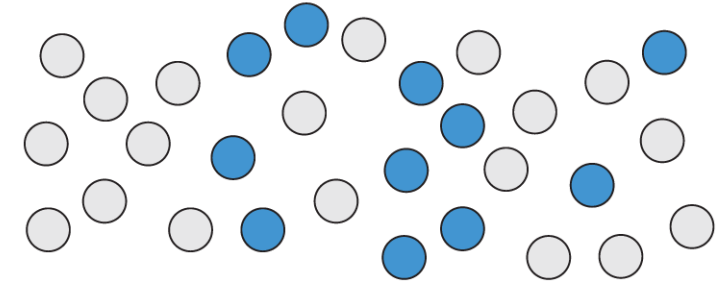
In **connectionist models**, ideas and concepts in the external world are not represented as distinct and discrete symbols but rather as distributed patterns of activity over populations of many nodes

(1942–2011)

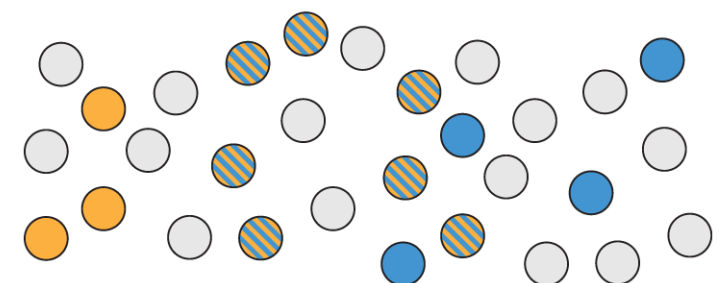
A "Golden retriever"



B "Cocker spaniel"

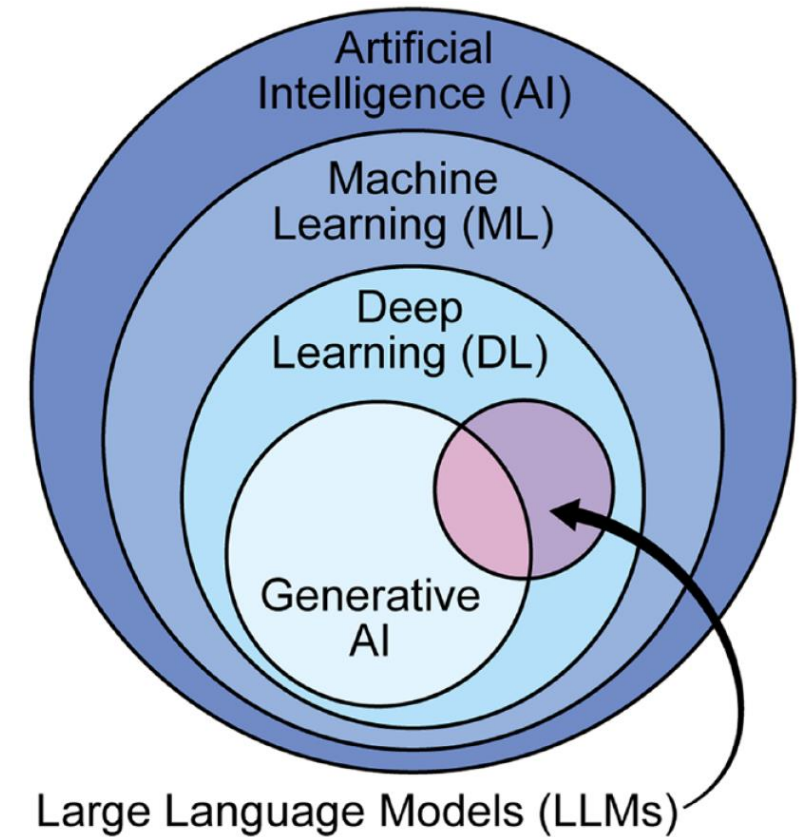
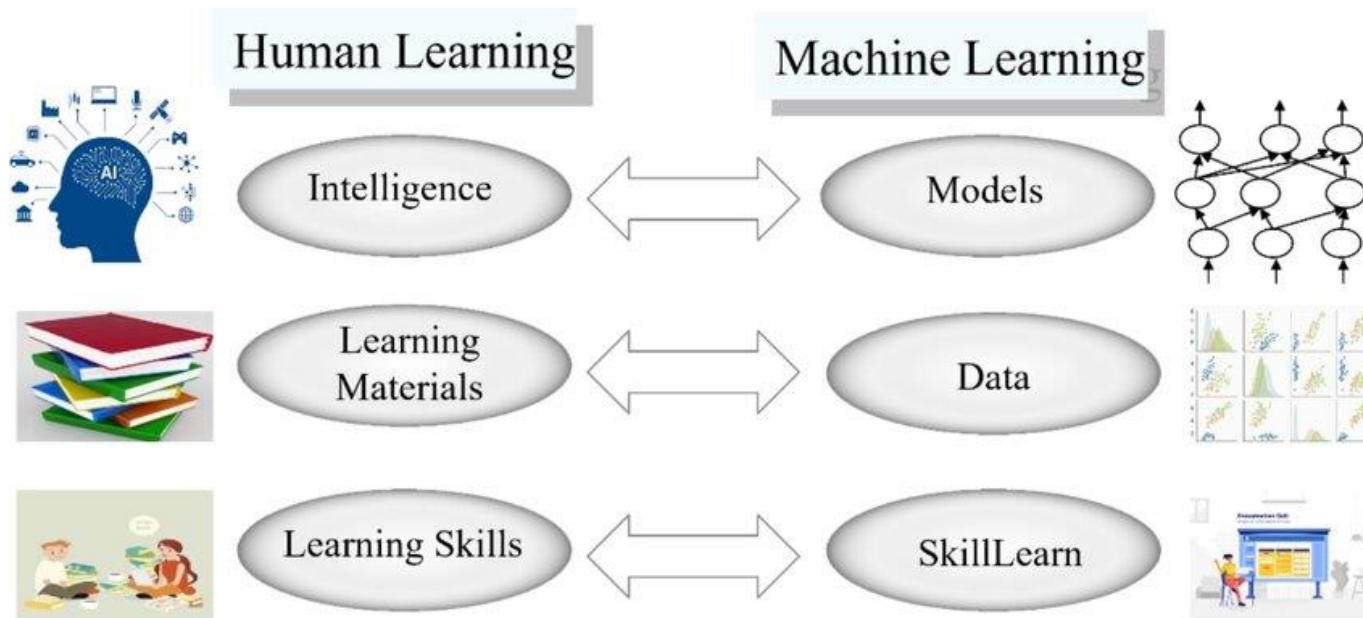


C "Dog"



Developed models of learning and thinking that he described as "connectionist network models"

How do machines learn?
LLMs?
ChatGPT?



Which has the greater influence on our learning and memory abilities?

Nature Versus Nurture

Plato

(427–347 BC)

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



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



George Rinhart/Corbis Historical/Getty Images

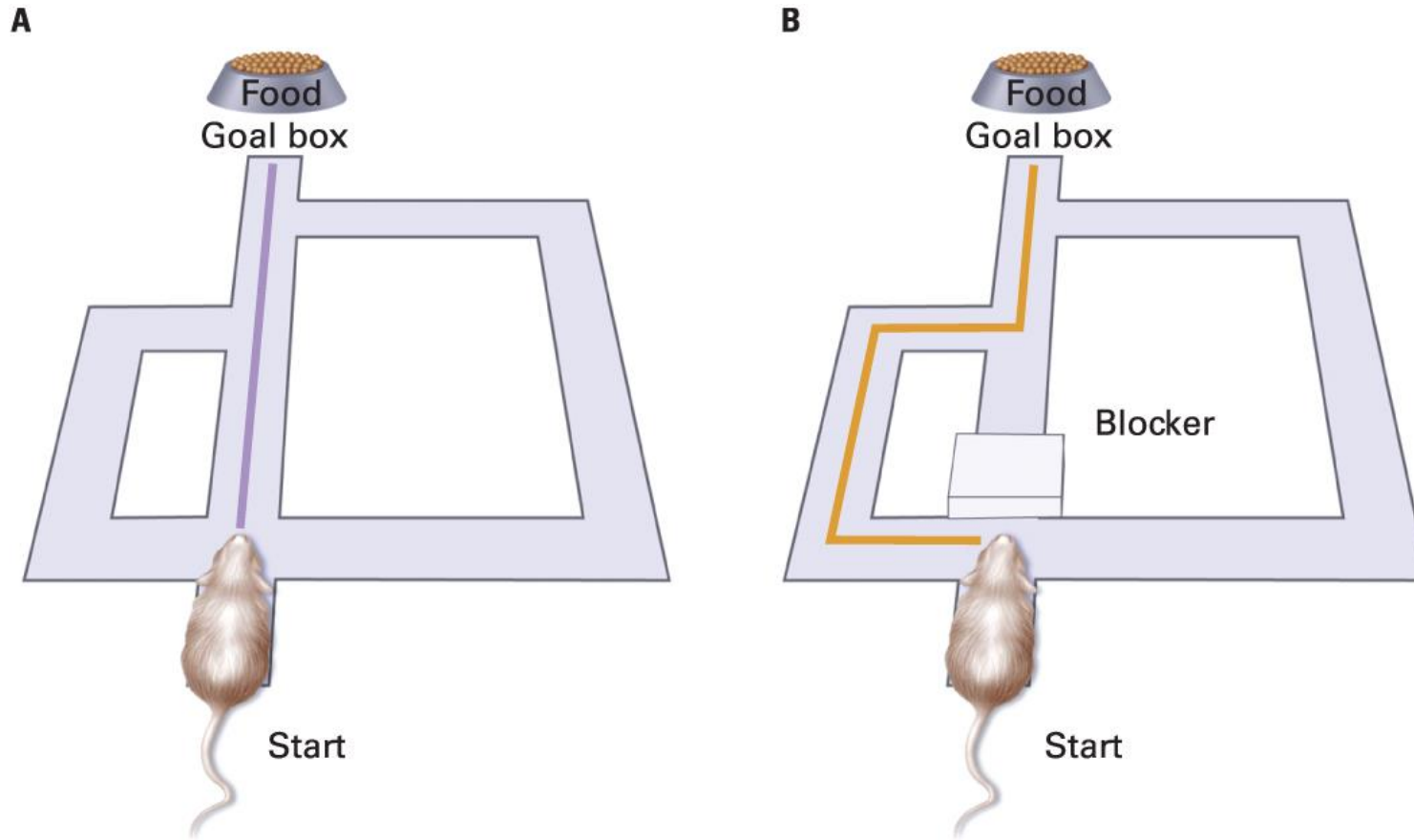
The Neo-Behaviorism of Edward Tolman (1886–1959)

- 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

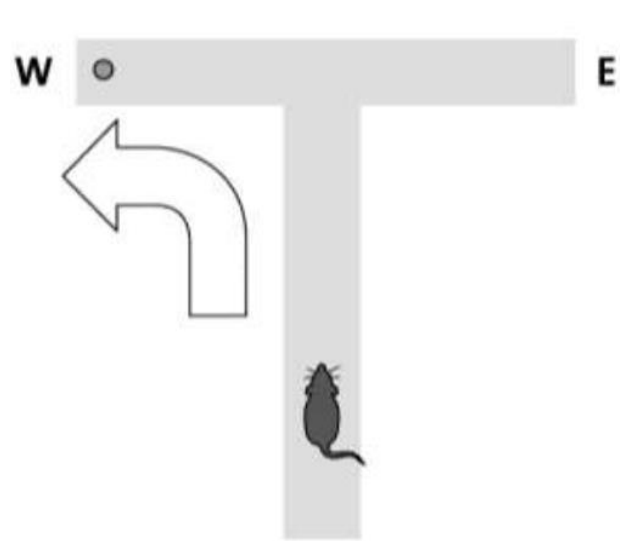


Gluck et al., *Learning and Memory*, 4e, © 2020 Worth Publishers

- 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

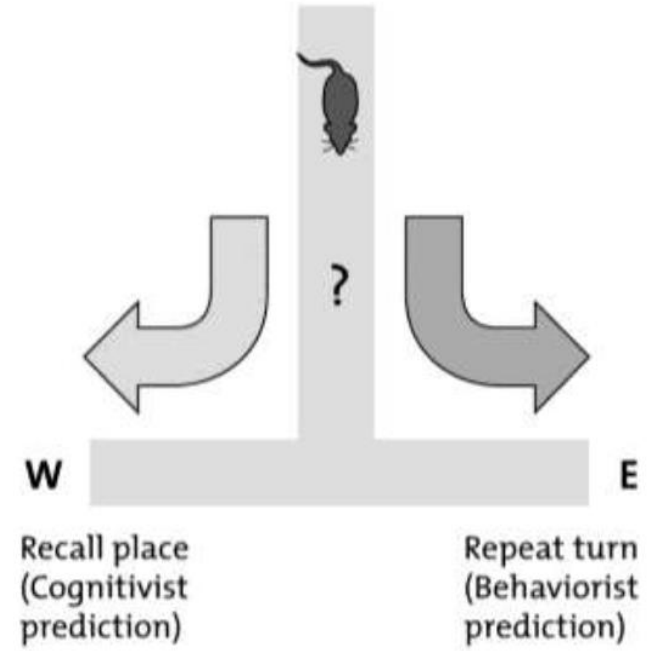
(A)

Train one or two weeks



(B)

Test at the end of each week



Can the psychological study of the mind be rigorously scientific?

Can we uncover universal principles of learning and memory that can be described by mathematical equations and fundamental laws?

–Ebbinghaus, Watson, Hull, Skinner, Estes, and nearly everyone who followed.

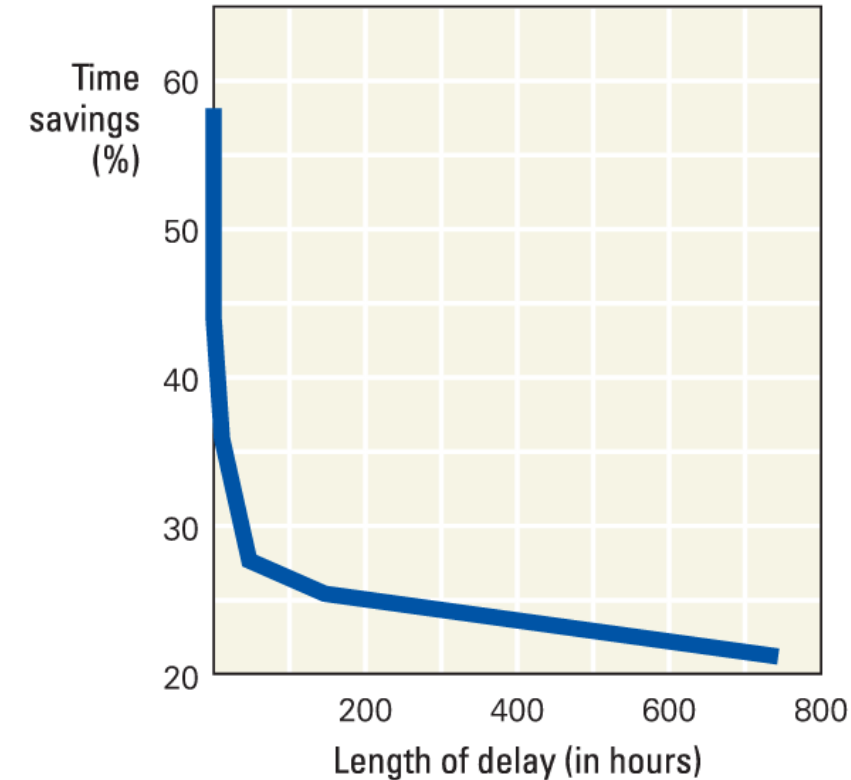
Hermann Ebbinghaus and Human Memory Experiments

(1850–1909)



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- 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

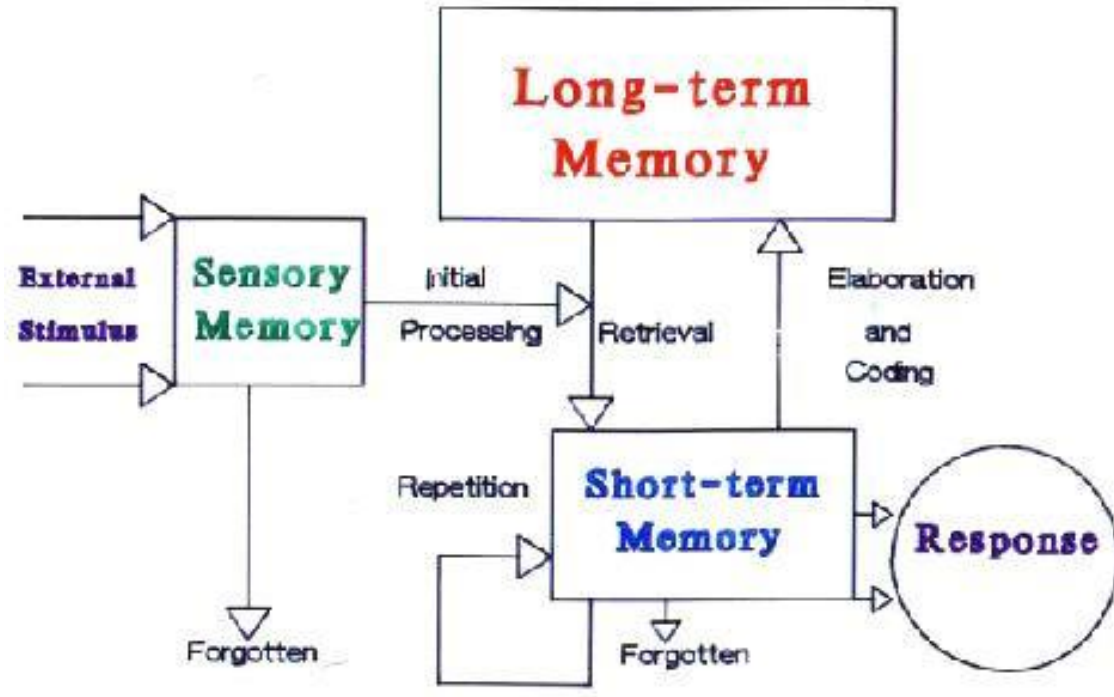


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Plot of a **retention curve**, which measures how much information is retained at each point in time following learning

George Miller -- Information Processing 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 understand the information holding capacity – Short Term Memory (chunking) and other memory processes

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

- 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?

What we learn and remember, does it stay with us forever?

Can you remember things from a long time ago exactly as they were?