CSE 485:
History of Cognitive Science

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Outline

- The beginnings
- Important Theories and Personalities
- Demos

Historical Background

- Cognitive Science has a very long past but a relatively short history! (Gardner, 1985)

- Rooted in the history of philosophy

  - Rationalism (Plato, Descartes, Leibniz,...)
    vs.
    Empiricism (Aristotle, Locke, Hume, Mill, ...)

  - Arithmetic and logic (Aristotle, Kant, Leibniz, Peano, Frege, Russell, Gödel...)

Mid-Twentieth Century to Today:

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1950 **Jean Piaget** publishes "Introduction to Genetic Epistemology"
Alan Turing publishes "Computing Machinery and Intelligence"

1956 **Jerome Bruner** publishes "A Study of Thinking"
George Miller publishes "The Magical Number Seven…"

1957 **Skinner** publishes "Verbal Behavior"
Noam Chomsky publishes "Syntactic Structures"

1958 **Newell, Shaw, and Simon** cross over from computer science and report general theory of problem solving in *Psychological Review*

1959 **Chomsky** publishes critical review of "Verbal Behavior"

1961 **The Brelands** publish "The Misbehavior of Organisms"

1967 **Ulric Neisser** publishes textbook "Cognitive Psychology"

1975 **Journal of Experimental Psych** divided and info proc dominates

1977 ***Cognitive Science*** launched as multi-disciplinary journal
David Marr and Tomaso Poggio propose three levels of analysis

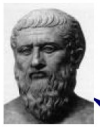
1986 **David Rumelhart** and group publish "Parallel Distributed Processing"

1988 **Paul Smolensky** distinguishes conscious and intuitive processors

1991 **Daniel Dennett** publishes "Consciousness Explained"

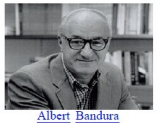
1997 **Steven Pinker** publishes and popularizes "How the Mind Works"

History of Cognitive Science



George Miller
Short term memory holds 7 + or -2 of "chunks" informatio. 1956

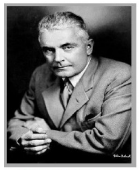
Bruner
Learning is dependent on structuring information and organiizingit for retrieval "storage system".



Albert Bandura
Social Cognitive Theory, studied aggression in adolescents. Though behavior cause the environment rather than environment causing behavior. Self-efficacy. 1977 Developed cognitive theory.

Edward Thorndike - behaviorist"Animal Intelligence: An Experimental Study of the Associative Processes in Animals" Developed the Cogat test.

Wolfgang Kohler
Gestalt Psychologist 1925 "Mentality of Apes" suggested "aha!" solutions to problems. Moved from being a behaviorist to a cognitive theorist.



John B. Watson- behaviorist wrote that the purpose of psychology is to predict the reaction to a given stimulus. (1930, p. 11).

Miller Bruner- Founded Harvard Center for Cognitive Studies (1960) Information processing, coding retrieval.

David Ausubel 1960 Developed a concept of an advanced organizer that utilizes prior knowledge.

Cognitive psychology history is traced back to the ancient Greeks Plato and Aristotle.

Descartes - Epistomologist
Wrote about doubt and certainty and reflected upon the question of how we really know something.

Locke- Thinking has two operations, sensation (objects are perceived by the senses) and reflection (thoughts are based on perceptions).

Kant- Our minds make representations of concepts.

Wilhelm Wundt and his students initiated laboratory methods for studying mental operations more systematically.

Within a few decades, however, experimental psychology became dominated by behaviorism.

As early as the 1920's, people started to find limitations in the behaviorist approach to understanding learning.

The cognitive revolution became evident in the mid 1950's when researchers in several fields began to develop theories of the mind based on representations and procedures.

Moving from Behavior to Cognitive Perspective

Origins of Cognitive Science

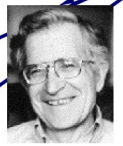
Cognitive Science Defined... Thinking can best be understood in terms of how the mind structures information and how it operates with those structures.

Influential Theorists on Cognitive Revolution

Piaget
Believed children progressed through 4 stages of cognitive development. People construct knowledge by storing information in schemas. 1963 Piaget's theories receive widespread attention in America due to Alan Flavell's work.

Vygotsky
Created the Zone of Proximal Development theory 1925 "Human intelligence originates in our society or culture, and individual cognitive gain occurs first through interpersonal 'interaction with social environment,' than interpersonal 'internalization'.

Modern Cognitive Theorists



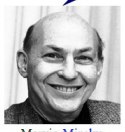
Chomsky
1959-Said ideas are turned into language as a cognitive process.

Herbert Simon
Simon was a pioneer in the field of Artificial Intelligence, creating with Allen Newell the Logic Theory Machine (1956) and the General Problem Solver (GPS) (1957) programs. GPS was possibly the first method of separating problem solving strategy from information about particular problems. Both programs were developed using the Information Processing Language (1956) developed by Newell, Cliff Shaw and Simon.

Newell Created a basis for continued research on knowledge acquisition systems, a unified theory of human cognition, human-computer interaction, and the efficiency of production systems

E.C. Tolman – behavioral psychologist Learning develops from bits of knowledge.

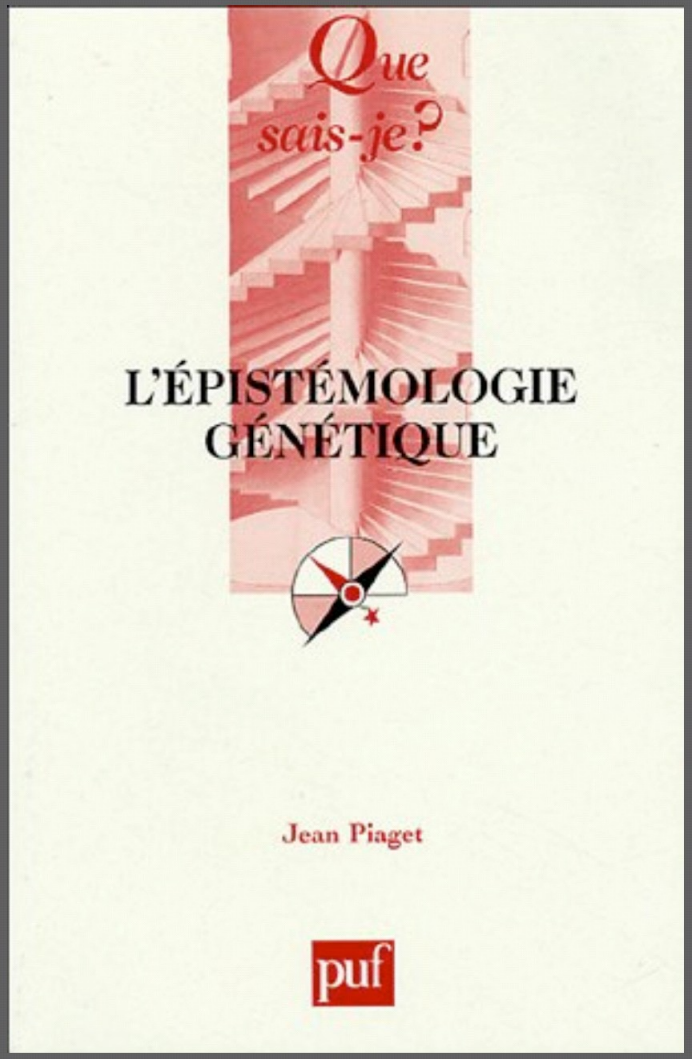
John McCarthy
Computer science professer and one of the founders of artificial intellegence. AI models cognitive development.

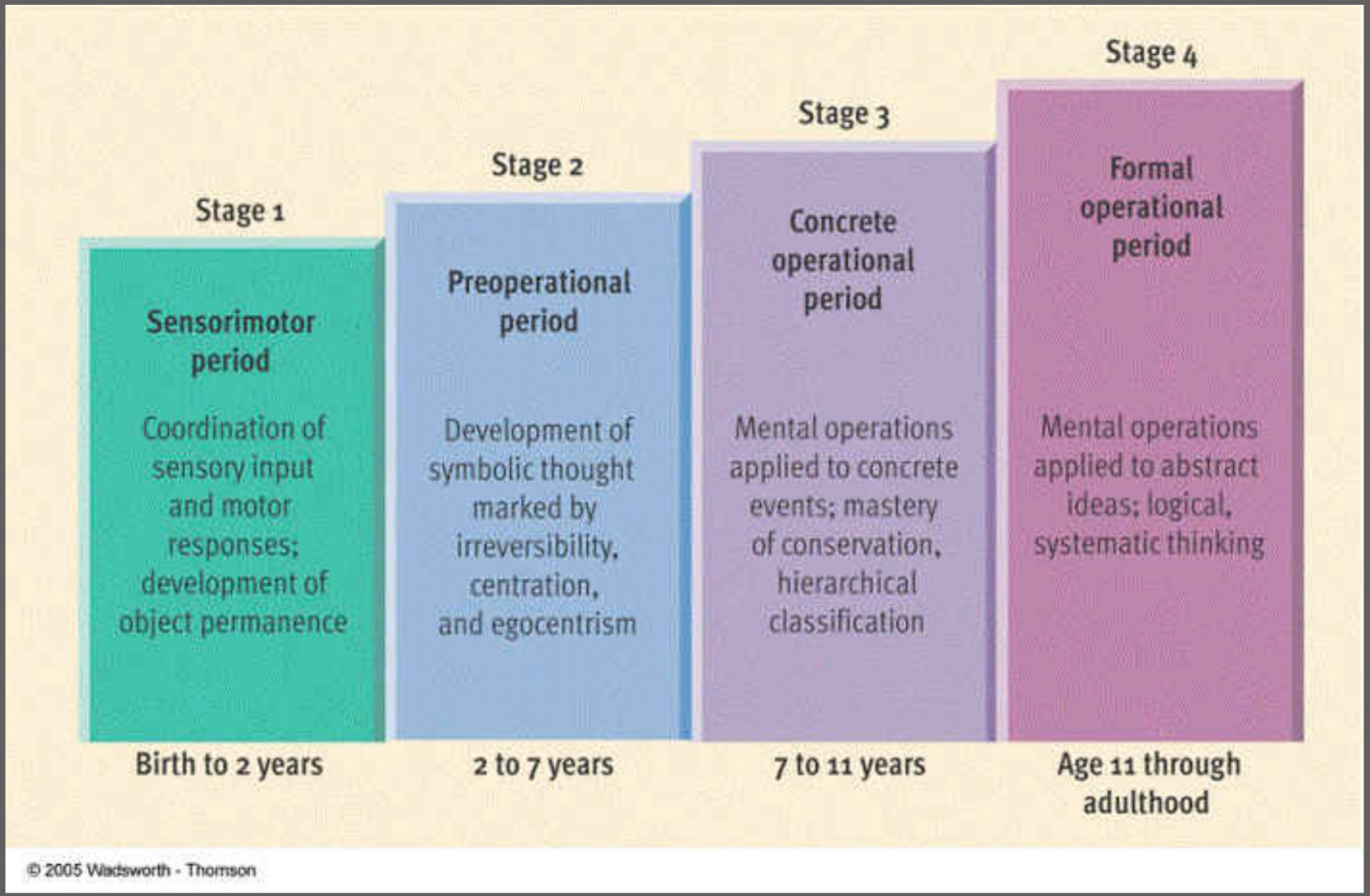


Marvin Minsky
Sometimes called the "father" of artificial intellegence. Has applied computational mechanics to human psychological processes and invented machines with "human" qualities

Piaget:

One of the founders of the "New Structuralism"


Que
sais-je?
L'ÉPISTÉMOLOGIE
GÉNÉTIQUE
Jean Piaget
puf



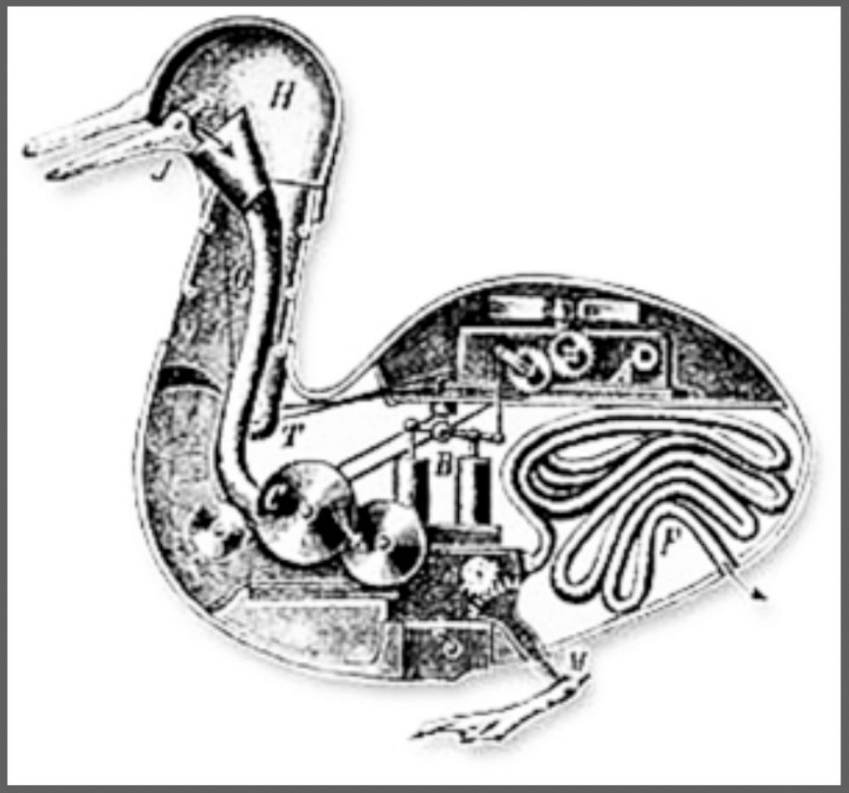
Social psychology provided an alternative to behaviorism
Dissonance theory provided *cognitive* alternative.

Leon Festinger (1919 -1989)

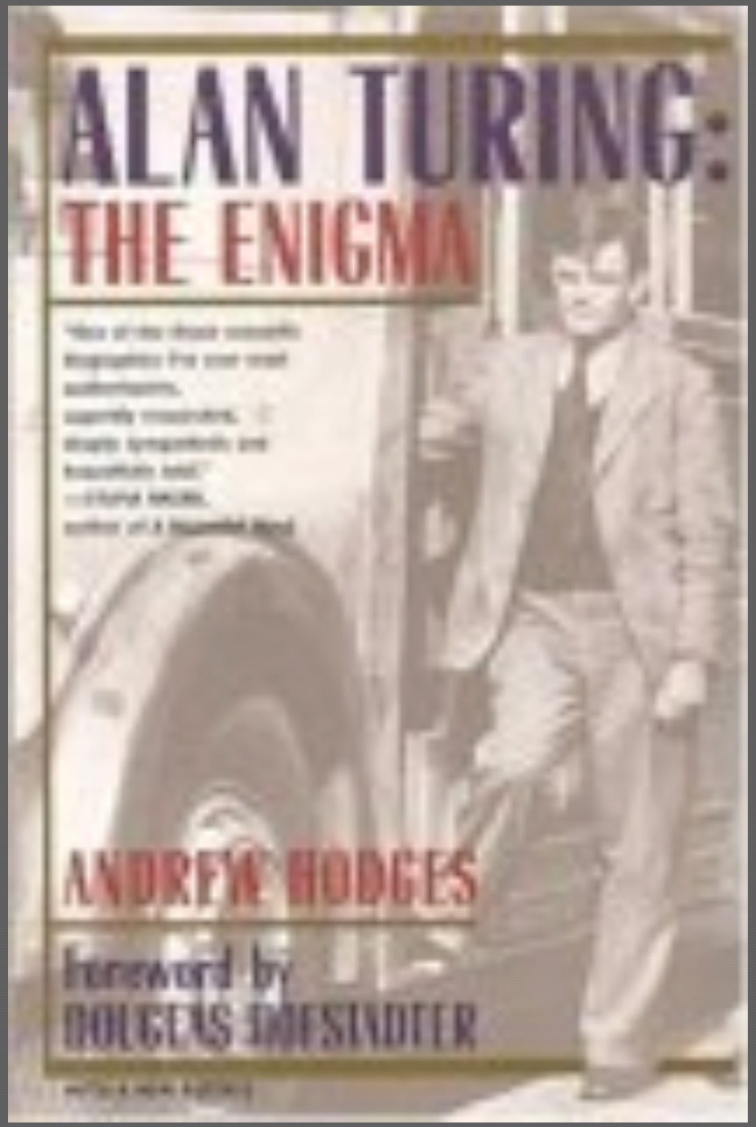
Jerome Bruner
(1915-)

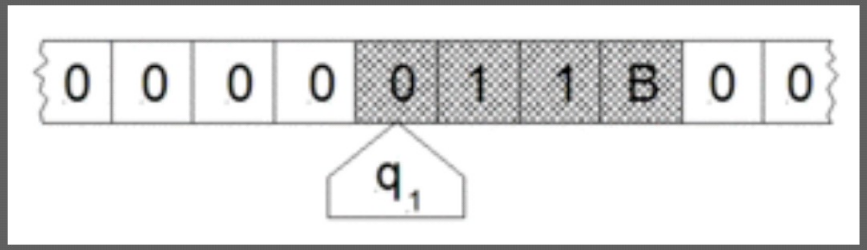
Bruner's studies in the "new look" in perceptio made the subject an active participant rathe than merely a passive receiver of external sti

His later studies of thin and the process of categorization helped lay the groundwork for cognitive science.



With the birth of artificial intelligence and robotics, ancient dream of mechanizing mind became more possible.
It has turned out that much can be learned by identifying and solving the engineering problems involved.



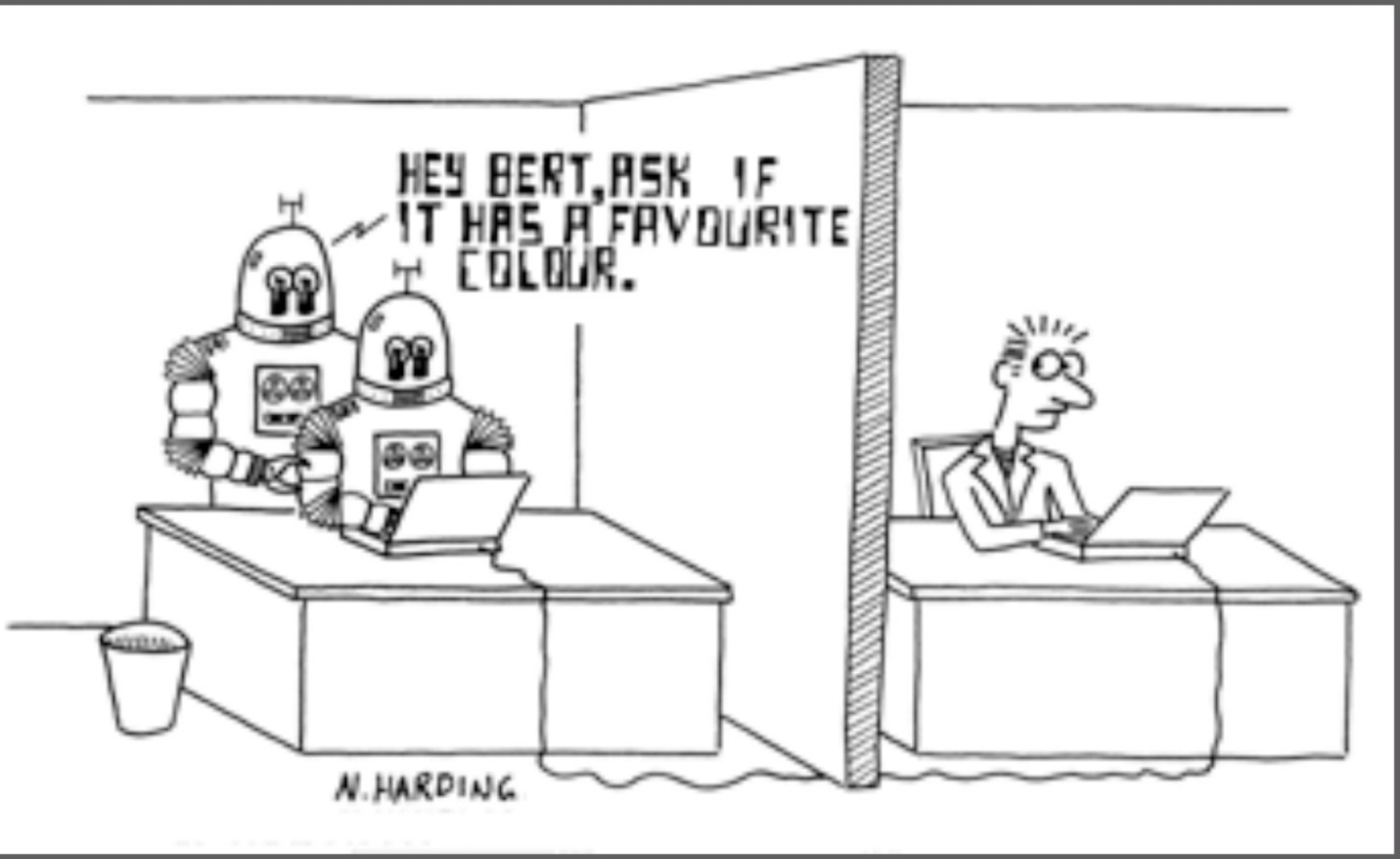


Alan Turing was a British mathematician who made important contributions t computability theory befo turning his attention to biology and artificial intelligence.

Alan Turing (1912 – 1954)

A father of computer science and an early theorist in AI

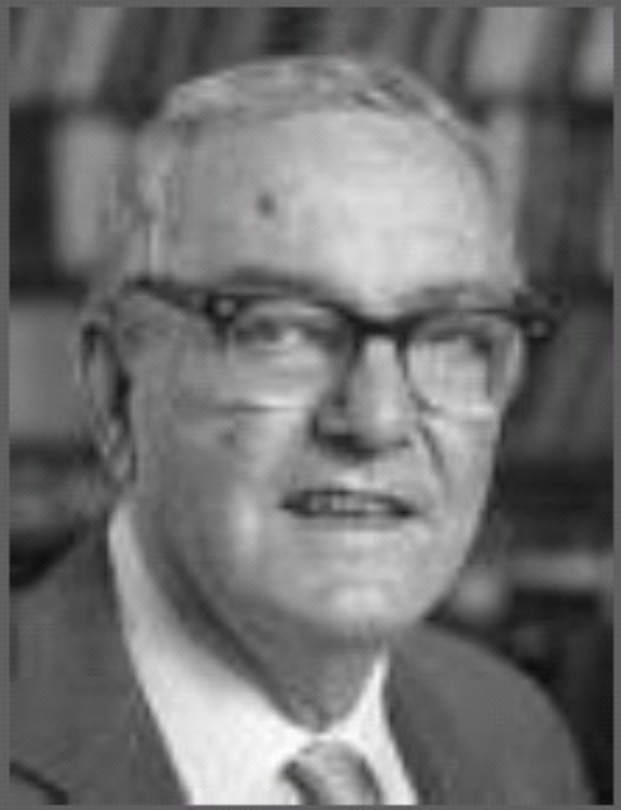
The Enigma was a cryptographic device used by the Nazis to encode their communications. It was secretly broken by the Allies using the Bombe, an electromechanic al device that found the encryption code for the Enigma each day. It helped pave the way for general Purpose computer


HEY BERT, ASK IF IT HAS A FAVOURITE COLOUR.
N. HARDING

The Turing Test inspired an early, satirical, attempt to create a computerized Rogerian therapist, "Eliza":

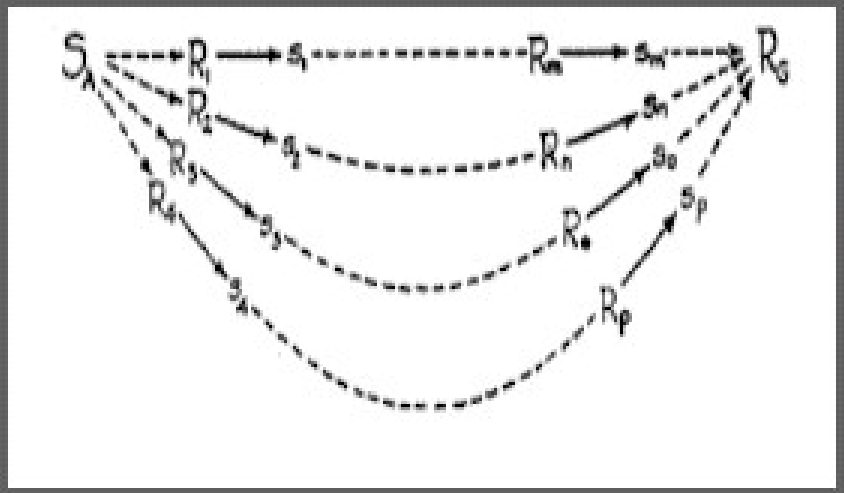
http://www.wedesoft.demon.co.uk/eliza

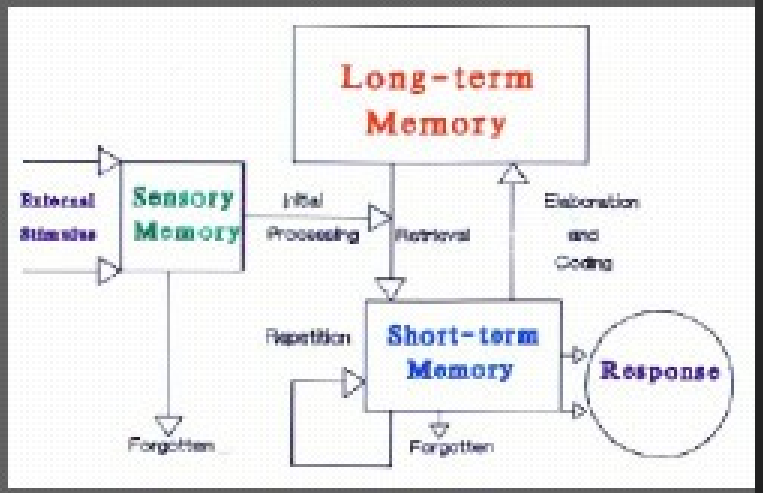
George A. Miller (1920-2012)
Magical Number 7±2 (Capacity of Short Term memory)



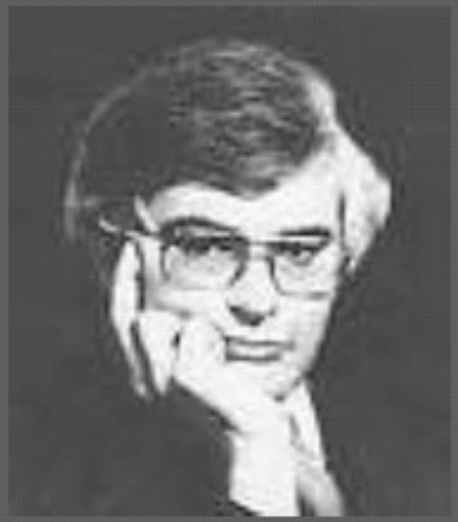
Allan Newell and Herbert Simon, in their work on the GPS—the General Problem Solver—helped define a new information processing approach to psychology.

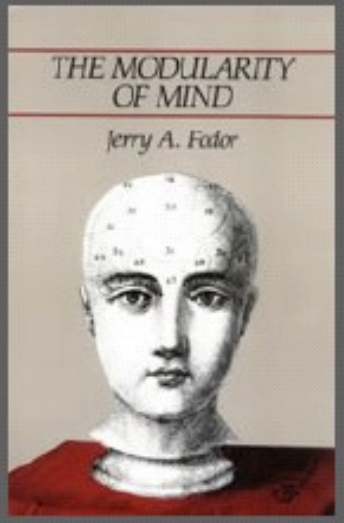
From this……to this.





Finally, the "reflex arc" and its more elaborate behaviorist version---"mediational psychology"--- are replaced by information processing models.

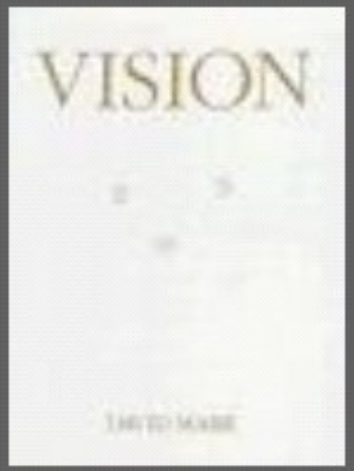




Jerry Fodor (1935 -)
has articulated a new form of
"functionalism" and has advocated
a "modularity" view of the mind, harkening back to

Marr and Poggios' (1977) Levels of Analysis in Cognitive Neurosceince

- The problem the system, such as vision, faces (the cognitive or computation level)
- The strategy that may be used (algorithm level)
- How it is actually done in the brain and nervous system (implementation level)



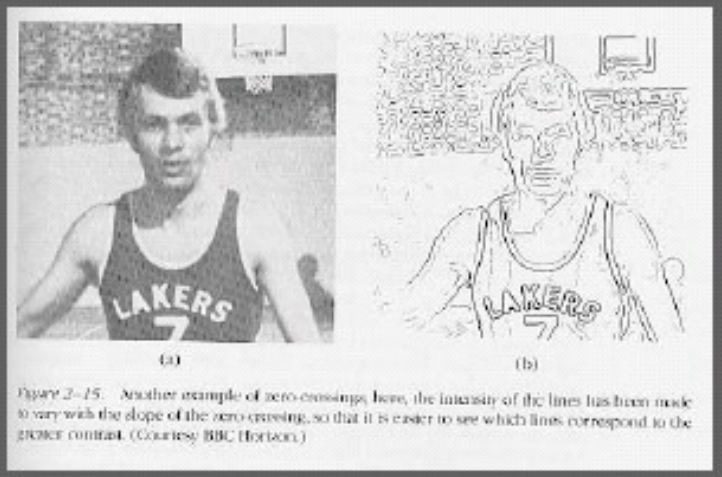
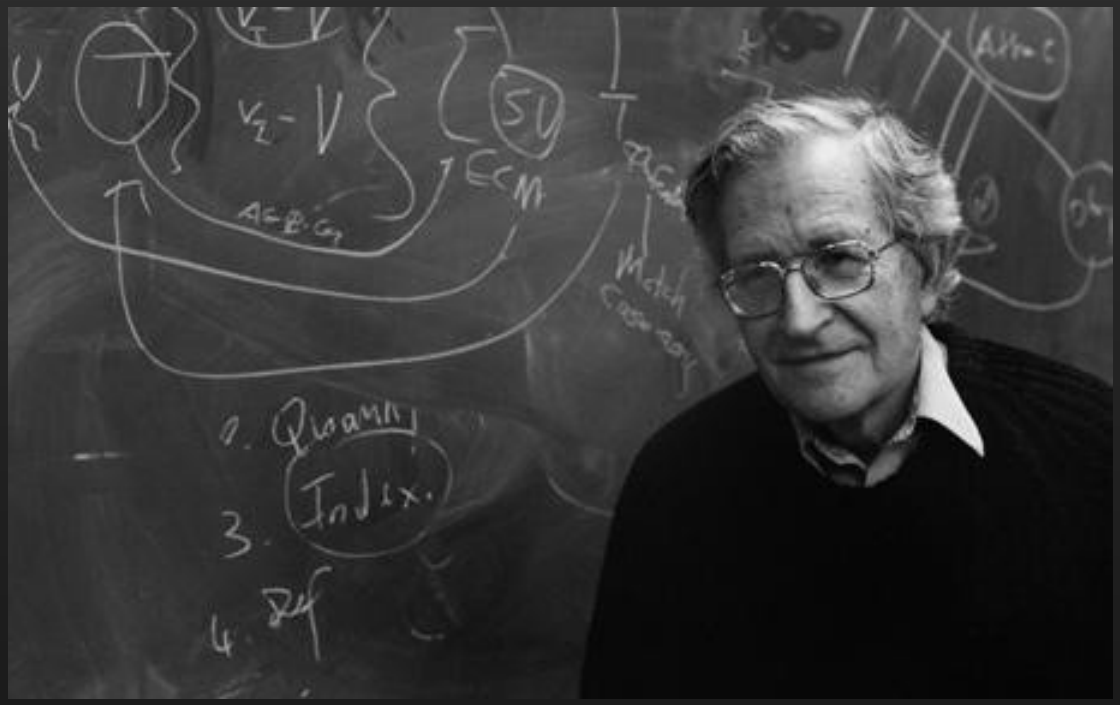
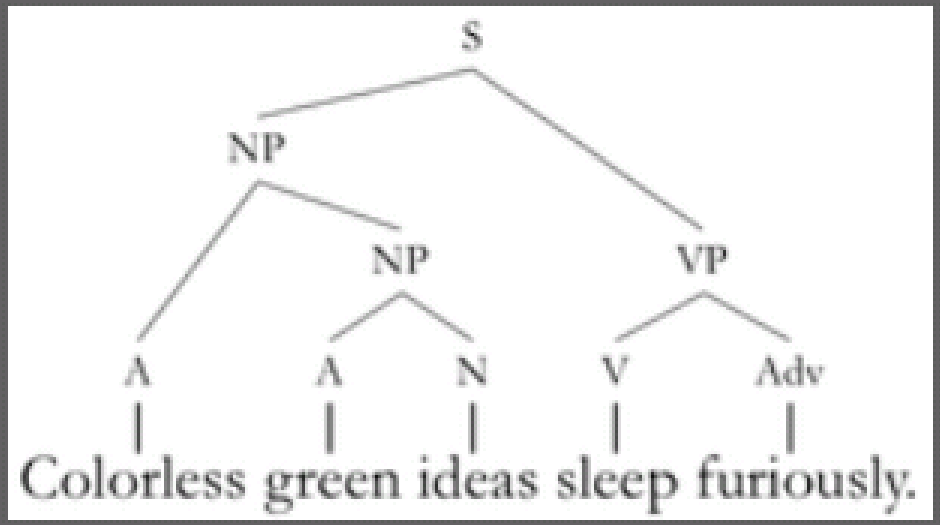


Figure 2–15. Another example of zero-crossings; here, the intensity of the lines has been made to vary with the slope of the zero-crossing, so that it is easier to see which lines correspond to the gross contrast. (Courtesy BBC Horizon.)

David Marr (1945 – 1980) developed a computational model of human vision that involved five stages using different representations at each stage. Stage two– the raw primal sketch–uses variation in light intensity to identify boundaries, which is used by the next stage to identify objects in the visual field



Noam Chomsky (1928-)

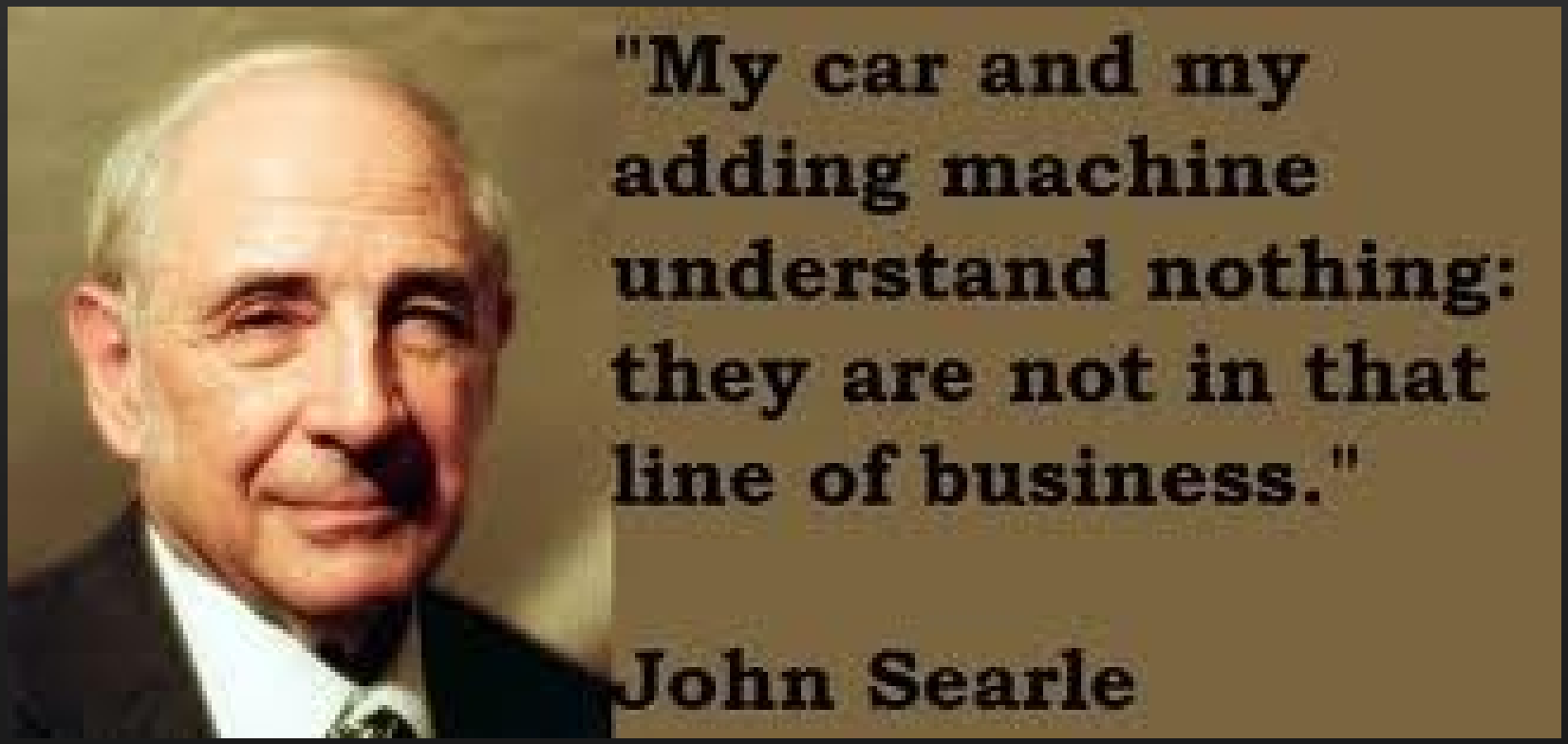


The syntax is fine, but the semantics are meaningless

Can a computer learn, or be programmed, to recognize this?

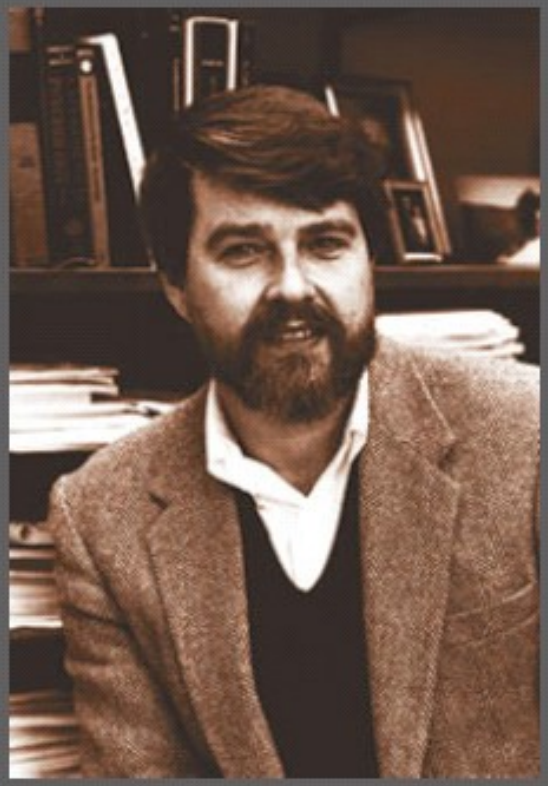
Syntax is the study of the logical rules that govern the way words combine to form phrases and phrases combine to form sentences.
Semantics refers to the meaning that is expressed in a
language, code, or other form of representation.

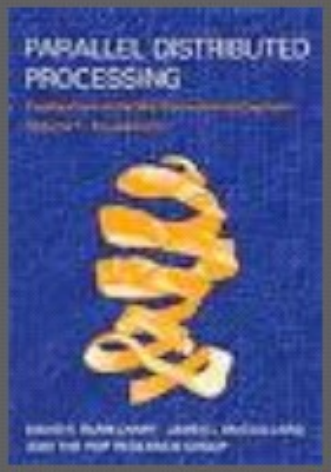
A persistent question in AI and cognitive science is whether computers, which are electronic rule-followers, are capable of modeling and explaining semantics and meaning



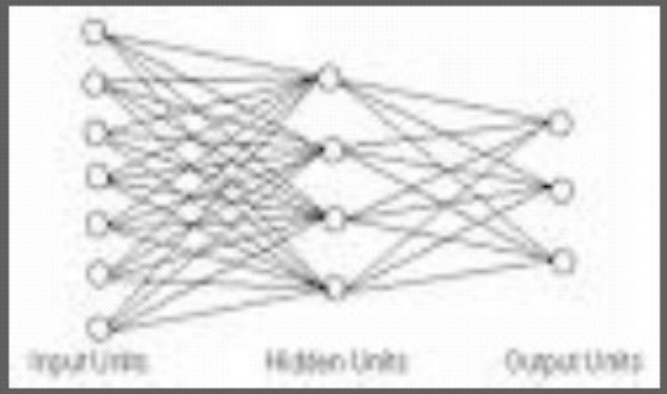
John Searle (1932-)

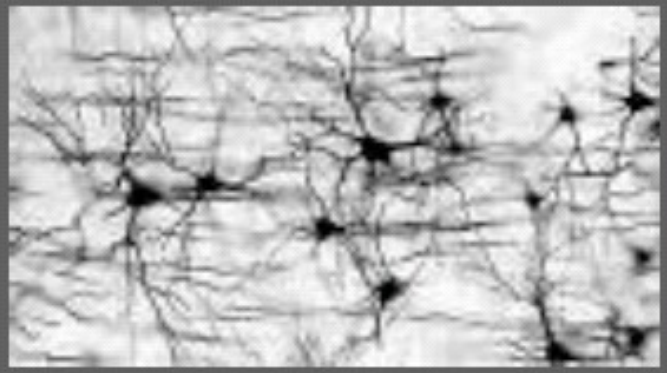

I'm just manipulating squiggles and squoggles to produce Chinese language behavior. But I don't understand Chinese. This rule book is in English.
Take a squiggle-squoggle sign from basket number 1 and put it next to a squoggle-squoggle sign from basket number 2.
1
2
3
在這屋裡的任何人或物，一定懂中文。
[Whoever or whatever is in that room is an intelligent Chinese speaker!]



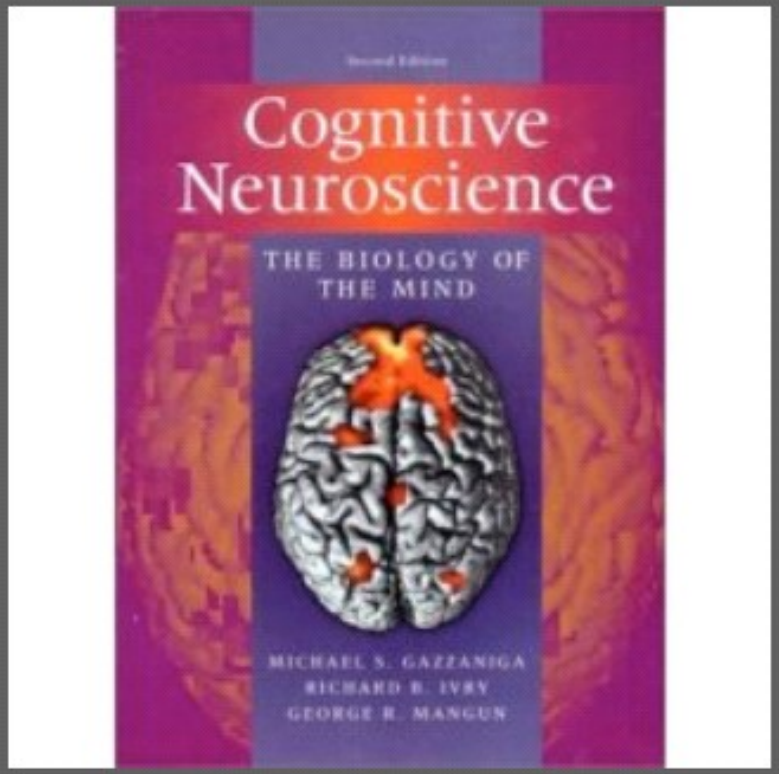


David Rumelhart's work on parallel distributed processing helped bring connectionism into the cognitive science

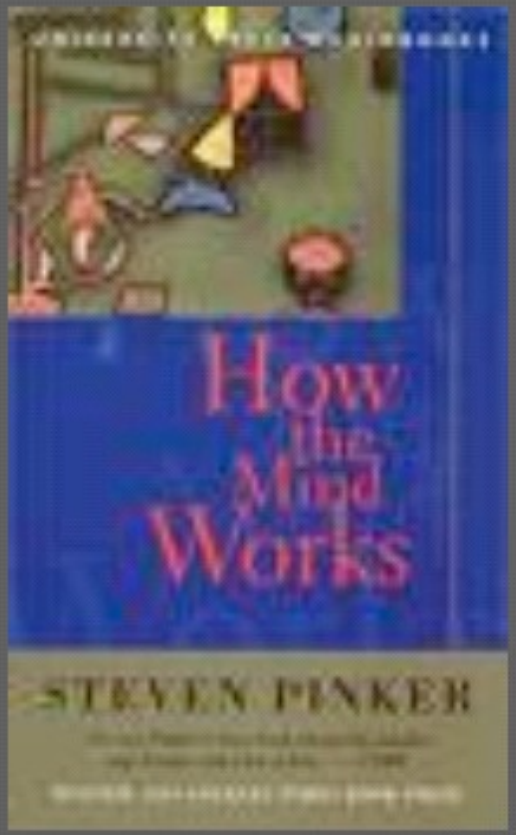




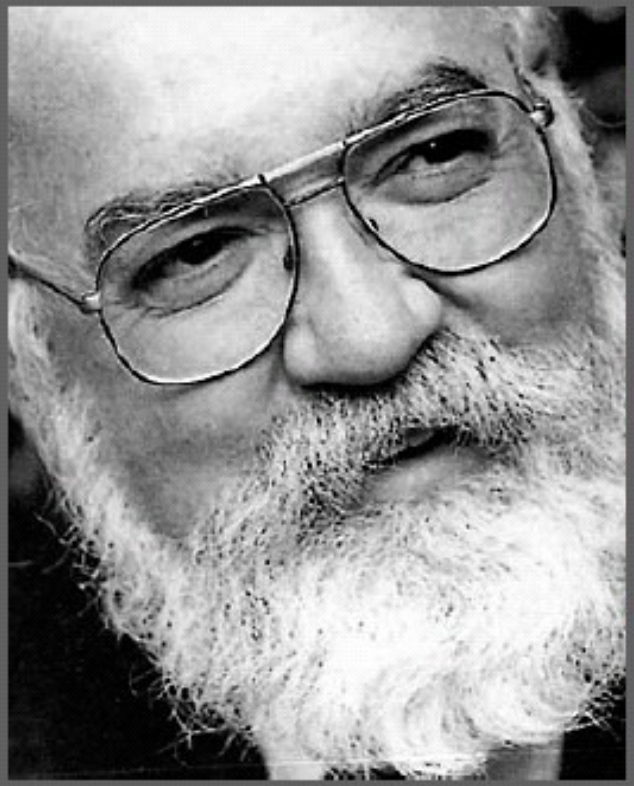
Neural nets seek to simulate the functions of neuro
They have proven especially useful f
modeling learning.
Neural nets are a sophisticated exploration of idea
dating back to the
associationism of t
19th century.

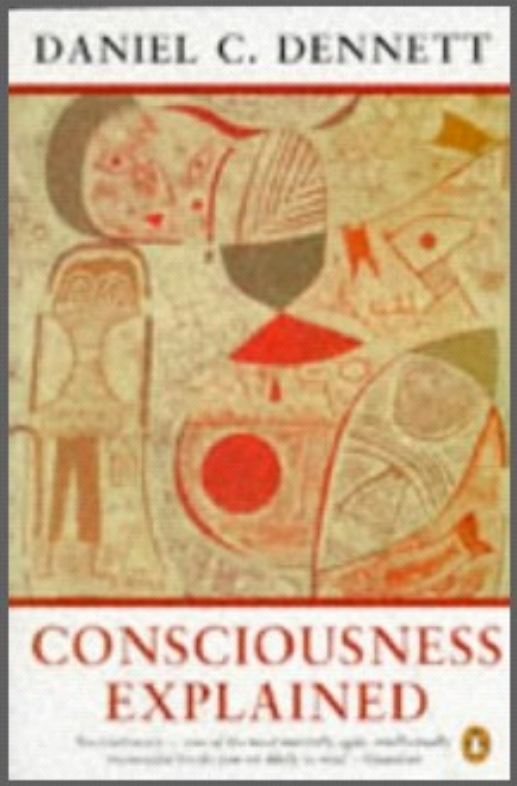


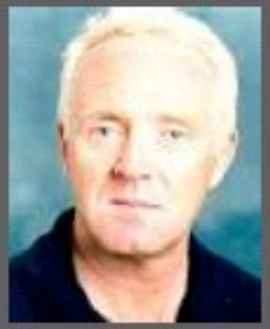
Gazzaniga, Ivry and Mangun coined the term "cognitive neuroscience" in the late 1970s to describe the study of "how the brain enables the mind."



Steven Pinker's books articulate a computati model of mind that als integrates insights fr evolutionary psycholo

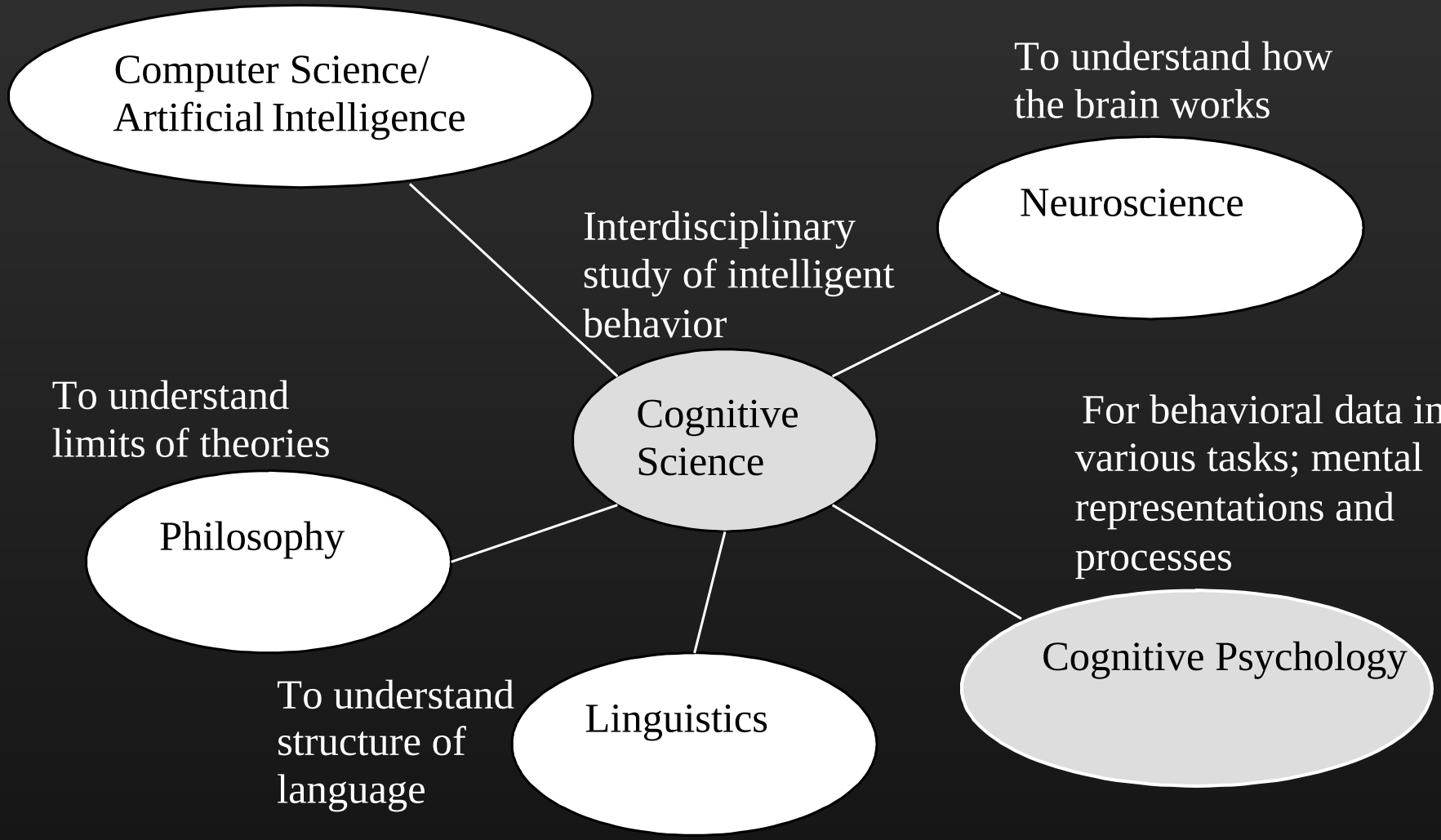



DANIEL C. DENNETT
CONSCIOUSNESS
EXPLAINED



"New Mysterians" like Colin McGinn find reasons to believe that we are cognitively unequipped to understand the relation between brain and consciousness.

Understanding Computation
Building computer models that learn from the environment



Integrating Research Traditions

- Formal analysis of tasks and systems
  - using techniques from philosophy & logic, mathematics & physics, and the foundations of computer science
- Empirical methods
  - from experimental psychology & neuroscience, and from anthropology, used for model testing
- Computational (Programming) techniques
  - developed in Artificial Intelligence, used for model construction

Situated Cognition

- Situated cognition is a theory that posits that knowing is inseparable from doing by arguing that all knowledge is situated in activity bound to social, cultural and physical contexts.
- Situated cognition encompasses a range of theoretical positions that are united by the assumption that *cognition is inherently tied to the social and cultural contexts in which it occurs.*

Embodied Cognition

- Embodied cognition is the theory that many features of cognition, whether human or otherwise, are shaped by aspects of the entire body of the organism.
- Embodied Cognition emphasizes the formative role the environment plays in the development of cognitive processes.
  - The general theory contends that cognitive processes develop when a tightly coupled system emerges from real-time, goal-directed interactions between organisms and their environment.

Summary

- History of CogSci linked to developments in
  - Philosophy
  - Cognitive Psychology
  - Linguistics
  - Neuroscience
  - Cognitive Modeling (Connectionism)
  - AI and Robotics

References

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