cognitive science

the cog sci moment & movement

concepts of information

April 26 2010

food for thought

What puts the *i* in iSchool?

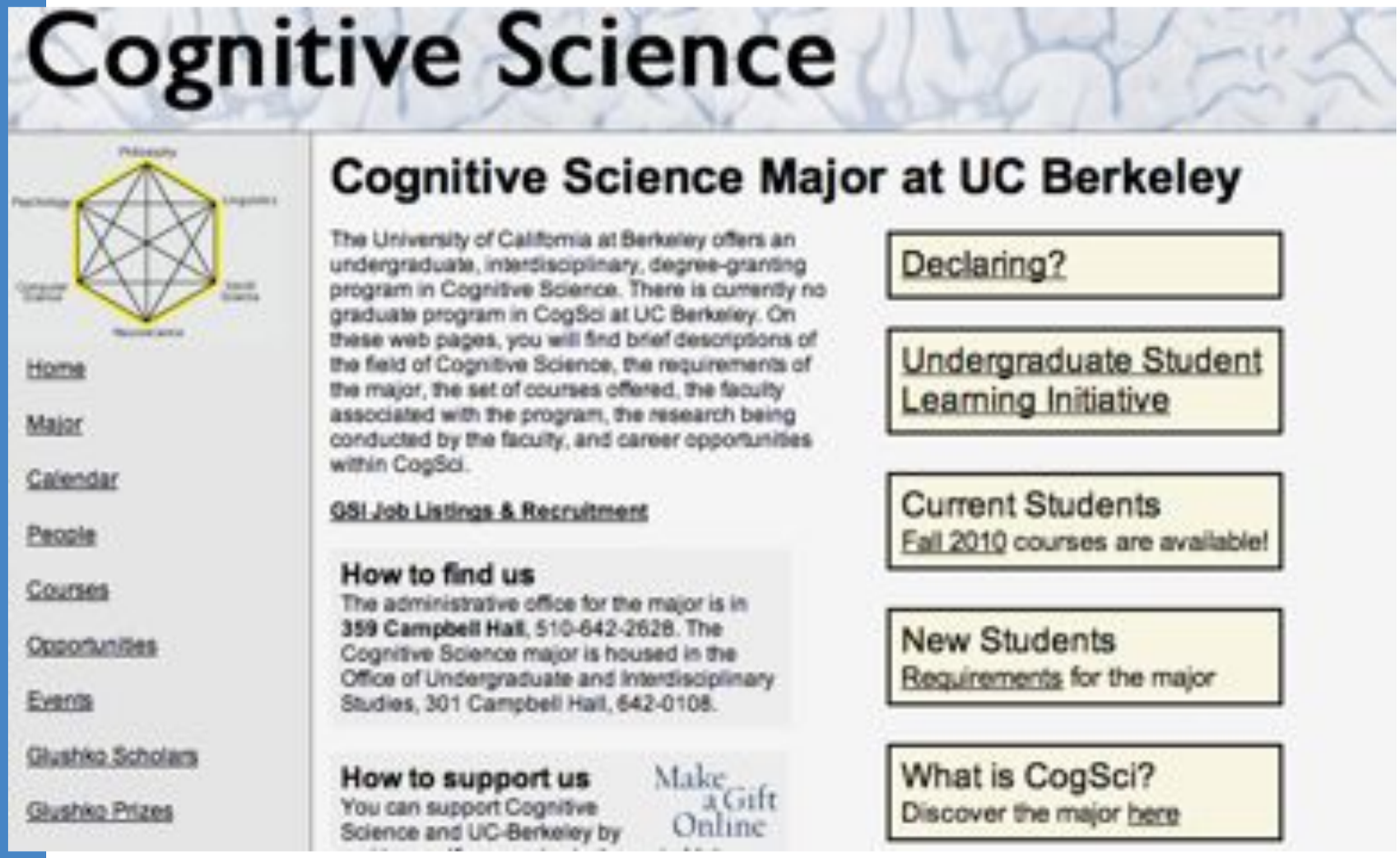
What does it mean to be a "school of information"? Is it computer science or library science? Is it social science, law, or business? Is it information architecture or multimedia design? Are we pioneering the next big navigation tool? Or are we concerned with "the human element" of information: how it connects, separates, affects people?

The answer to all these questions is "yes," because the study of information — how it is created, shared, and transformed into actionable knowledge — touches a wide range of issues and disciplines, just as it addresses the vast diversity of human needs, activities, and relationships.

AnnaLee Saxenian, Dean's statement

a model to think with?

"well on its way to becoming a major academic discipline"



what is it?

Cognitive Science

Home

Major

- About
- Declaring
- Student Learning Initative
- Requirements
- Honors
- Peer Advisors

Calendar

What is Cognitive Science?

Cognitive Science is an interdisciplinary field that has arisen during the past decade at the intersection of a number of existing disciplines, including psychology, linguistics, computer science, philosophy, and physiology. The shared interest that has produced this coalition is understanding the nature of the mind. This quest is an old one, dating back to antiquity in the case of philosophy, but new ideas are emerging from the fresh approach of Cognitive Science. Previously, each discipline sought to understand the mind from its own perspective, benefiting little from progress in other fields because of different methods employed. With the advent of Cognitive Science, however, common interests and theoretical ideas have overcome methodological differences, and interdisciplinary interaction has become the hallmark of this field.

The intellectual developments that paved the way for Cognitive Science began in the 1940s and 1950s. The most significant events were outgrowths of the conceptual invention (via mathematical description) of computer machines by the British mathematician, Alan Turing, in 1950. The first digital computers -- also known as "universal Turing machines" -- were built shortly thereafter. Turing and others soon realized that these computers could be programmed to perform complex "intellectual" tasks previously performed only by humans, tasks such as playing chess, proving mathematical theorems, and understanding language.

Pioneers in this new field of computer science began to make progress toward these goals by programming computers to simulate mental processes. For example, Allen Newell and Herbert Simon's famous program, the General Problem Solver (GPS), was able to play chess and to prove theorems remarkably well for a program written in the early 1950s. Understanding natural

What is Cognitive Science?

key ideas

computers
Turing machines

modelling mental processes
Simon & Newell & the GPS

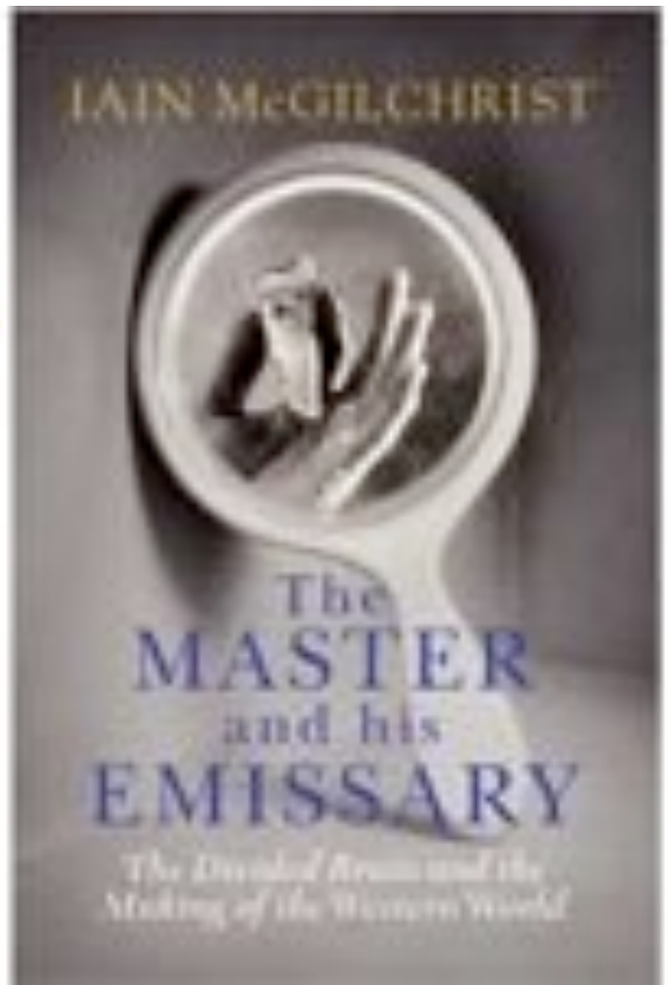
understanding mental activity
information processing
artificial intelligence

neurophysiology
from modelling to extrospection

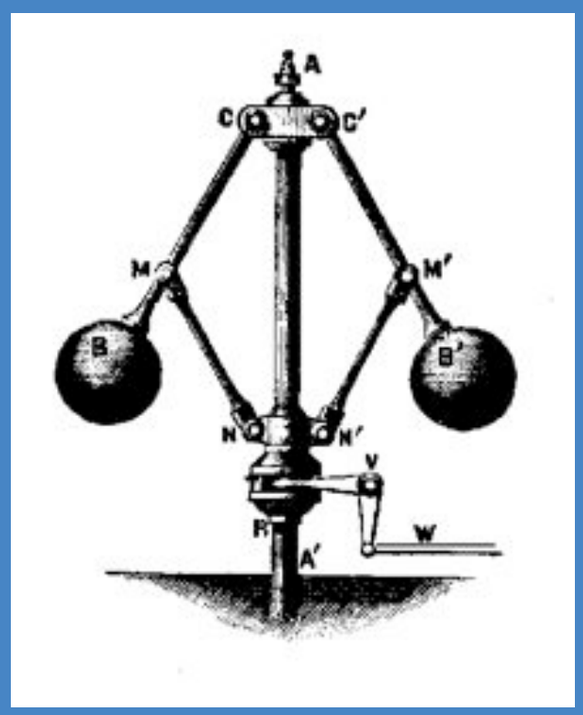
an aside

neurophysiology & cyclical history

linear or cyclical?

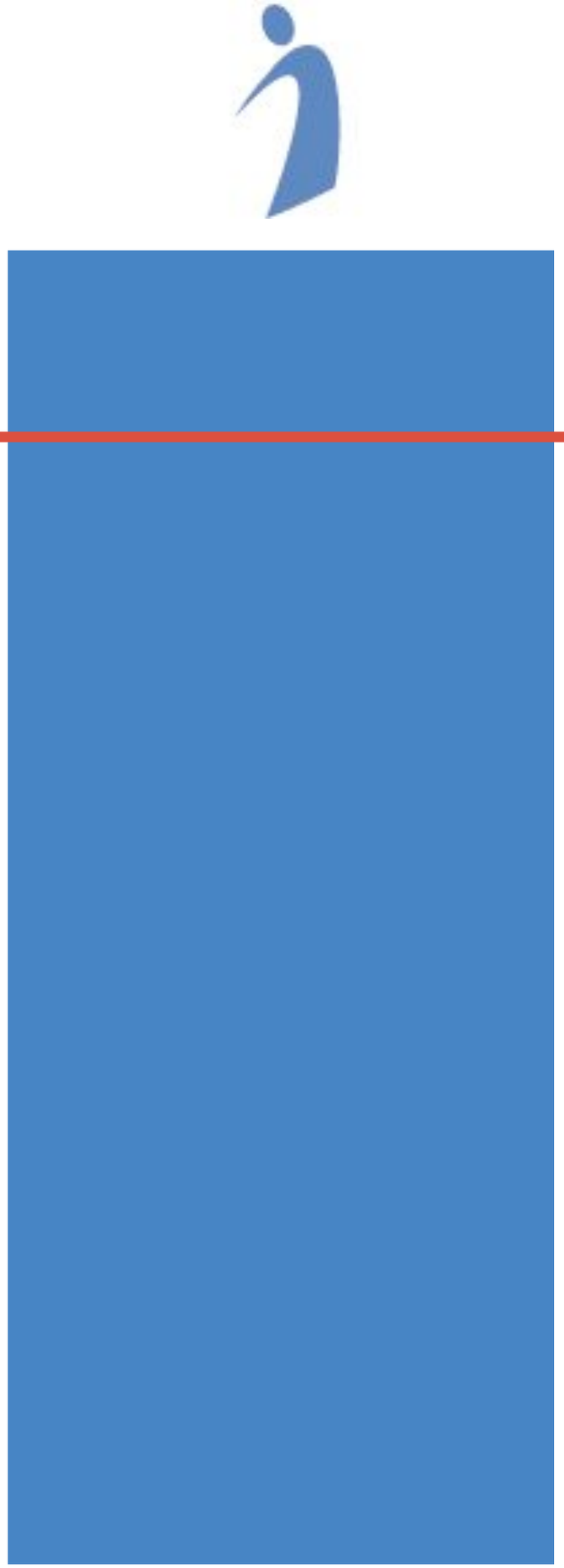


computers



von Neumann
store and process

Babbage to Weiner, Weaver, Bateson
feedback & cybernetics



inside the mind

1948 Hixon Conference
Warren McCullough & Walter Pitt
nerves & logical (binary) propositions

antecedents

"the nerves which carry the information of [pain] to the brain" --Malthus

"it receives information from the nerve centres ... sends back detailed and complex instructions to ... to the muscular nerves, and so co-ordinates their action as to bring about the required results"--Marshall

towards cog sci

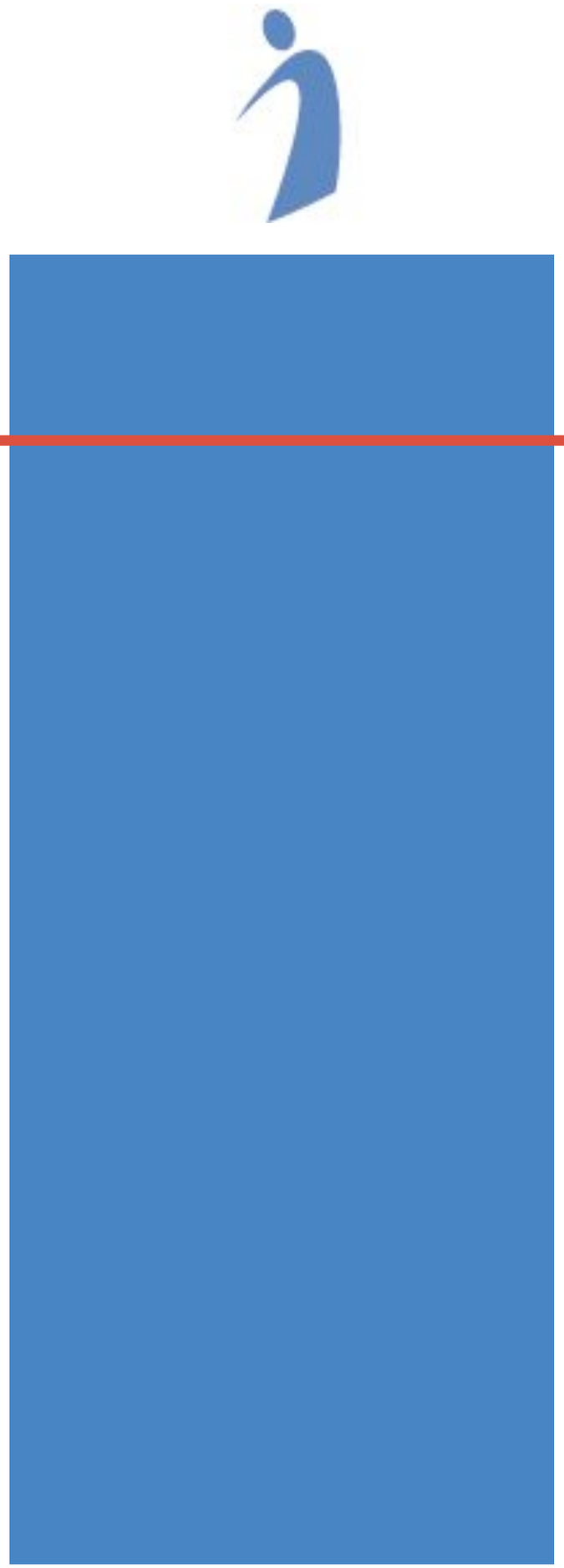
1950: Turing "Computer Machinery & Intelligence"

1956: MIT Symposium on Information Theory
(Miller, Chomsky, Simon, Newell)

1957: Miller, "Magical Number 7"

1958: von Neumann, *Computers & Brain*
Simon & March, *Organizations*
Broadbent, *Perceptions & Communication*

1959: Chomsky on Skinner's *Verbal Behavior*



towards AI & respectability

1960: Miller et al, *Plans & the Structure of Behavior*

1972: Simon & Newell, *Human Problem Solving*

1977: *Cognitive Science* (Don Norman, UCSD)

1979: Cognitive Science Society

towards cog sci

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The Turing Test

I propose to consider the question, "Can machines think?" This should begin with definitions of the meaning of the terms "machine" and "think." The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous… Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

I believe that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted.

Turing's Predecessors

…none of our external actions can show anyone who examines them that our body is not just a self-moving machine but contains a soul with thoughts, with the exception of words, or other signs that are relevant to particular topics without expressing any passion. … I add also that these words or signs must not express any passion, to rule out not only cries of joy or sadness and the like, but also whatever can be taught by training to animals. If you teach a magpie to say good-day to its mistress, when it sees her approach, this can only be by making the utterance of this word the expression of one of its passions. For instance it will be an expression of the hope of eating, if it has always been given a tidbit when it says it. …Now it seems to me very striking that the use of words, so defined, is something peculiar to human beings. Descartes' letter to the Marquess of Newcastle

Responses to Turing

Test is too hard (what if machine lacks cultural knowledge?)

Could a Martian pass the test? A seven-year old? A Uighar?

How could you skunk out the machine?

Responses to Turing

What Computers can't do...

Robert French: computers can't duplicate subcognition

flugblog as name of a breakfast cereal, a computer company, etc.
"Rate dry leaves as a hiding place"/"Rate these jokes for funniness…"

?= Turing's "argument from informality of behaviour"?

Responses to Turing

What Computers can't do...

Emotions/consciousness:

G. Jefferson, Lister Oration.: "No machine could feel (and not merely artificially signal, an easy contrivance) pleasure at its successes, grief when its valves fuse, be warmed by flattery, be made miserable by its mistakes…. be angry or depressed when it cannot get what it wants." But if the machine can seem to have emotions…: "an easy contrivance"?

But how does one tell?

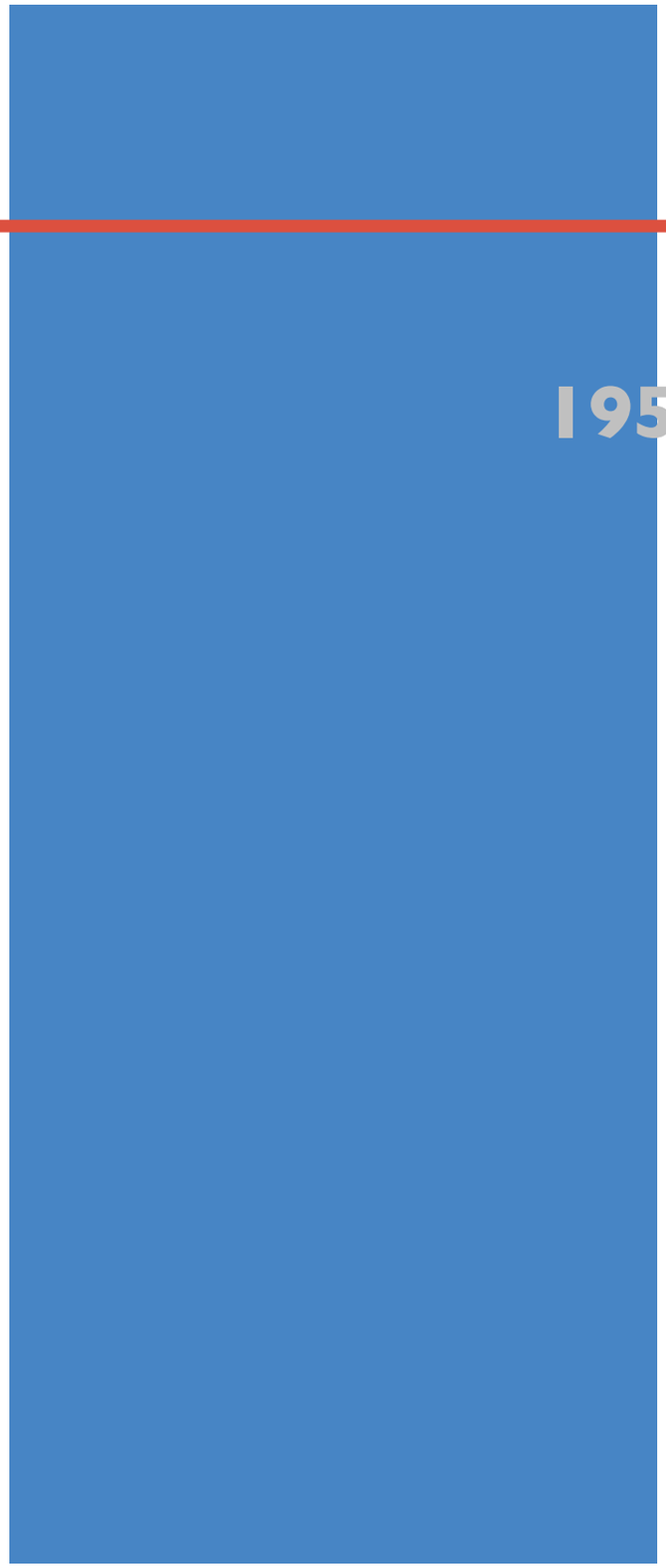
Turing: "This argument appears to be a denial of the validity of our test. According to the most extreme form of this view the only way by which one could be sure that machine thinks is to be the machine and to feel oneself thinking."

Responses to Turing

Creativity:

Does the Turing test tell us how human machines can be, or how mechanical humans can be?: the case of Eliza

http://www.chayden.net/eliza/Eliza.html



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On "Formal Symbol Manipulation"

George Miller, 'The magic number seven, plus or minus two'.

My problem is that I have been persecuted by an integer. For seven years this number has followed me around, has intruded in my most private data, and has assaulted me from the pages of our most public journals.

The persistence with which this number plagues me is far more than a random accident. There is, to quote a famous senator, a design behind it, some pattern governing its appearances… I shall begin my case history by telling you about some experiments that tested how accurately people can assign numbers to the magnitudes of various aspects of a stimulus. In the traditional language of psychology these would be called experiments in absolute judgment. Historical accident, however, has decreed that they should have another name. We now call them experiments on the capacity of people to transmit information.

towards cog sci

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Admiral Troubridge
1758-1807

[H]uman behavior disrupts the best laid organizational plans, and thwarts the cleanness of the logical relationships founded in the structure'.

-- Scott, "Organization Theory," 1961

ideas of organization

Simon & March

administrative man vs economic man

3 assumptions

workers as passive instruments
members as goal driven
members as decision makers

towards satisficing

"choosing, decision-making, problem solving organism that can do only one or a few things at a time"

towards cog sci

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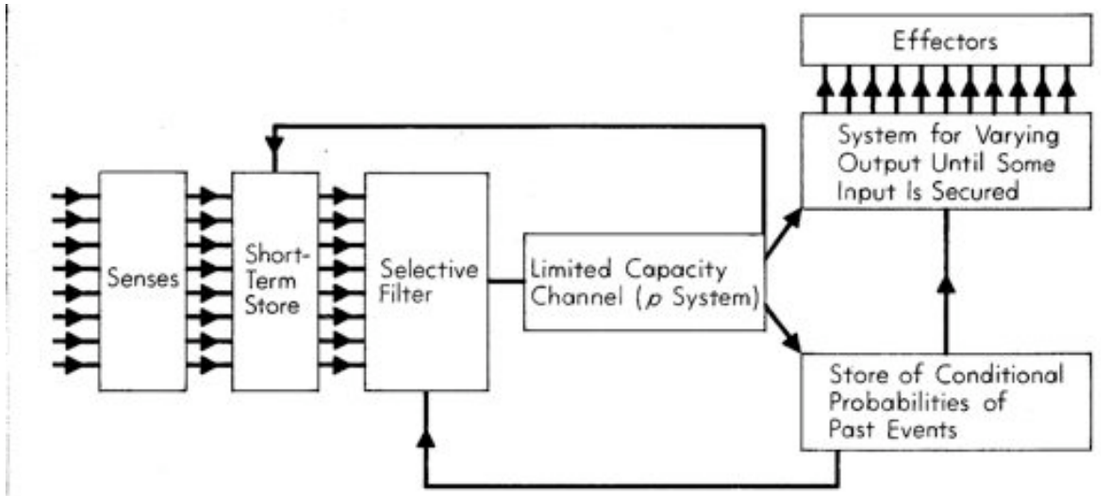
perception

Broadbent & Cherry's model



cf Brian Smith

Gardner's 5 essentials

representation

computation

minimize emotion, affect, history, culture

interdisciplinary

Western epistemological tradition

Gardner's 5 essentials

representation

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minimize emotion, affect, history, culture

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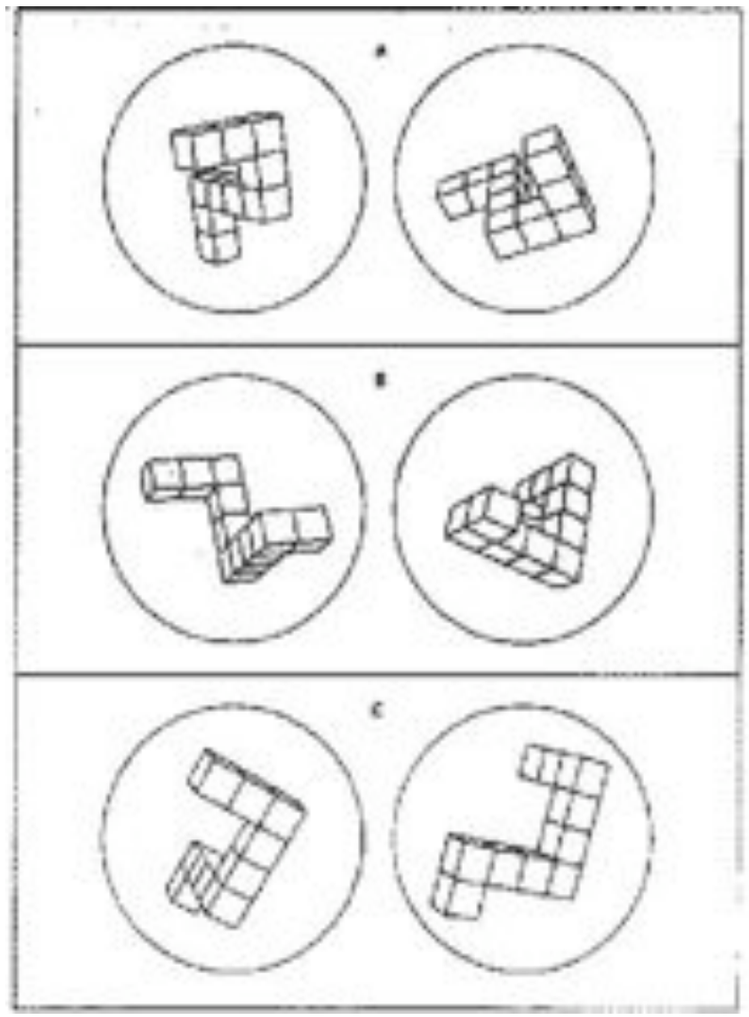
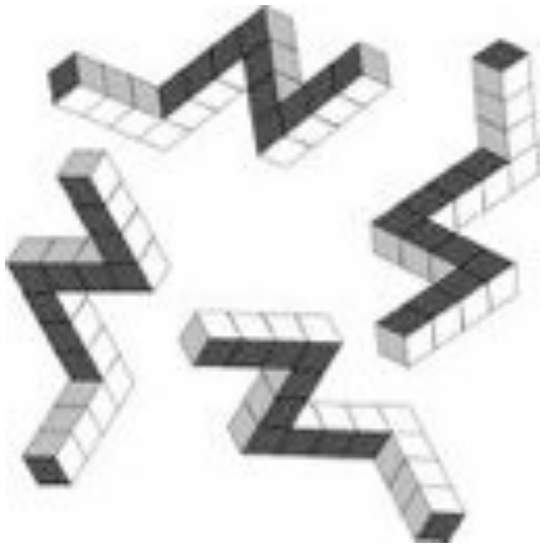
Are Mental Representations Propositional?

Cf work by Roger Shepard et al. on mental rotation





On "Formal Symbol Manipulation"

Thought as FSM. Device manipulates symbols purely on basis of shape; computers as "numeral crunchers." Alignment of physical and semantical boundaries, mediated by transducers.

Minds as information processing systems

> Simon: "Thinking is carried out by the brain using the same basic symbol-manipulating processes that are used by computers: reading symbols writing them, storing them in memory, copying them, comparing them for equality or inequality…. The availability of these processes provides the necessary and sufficient conditions for a system to exhibit intelligence."

Gardner's 5 essentials

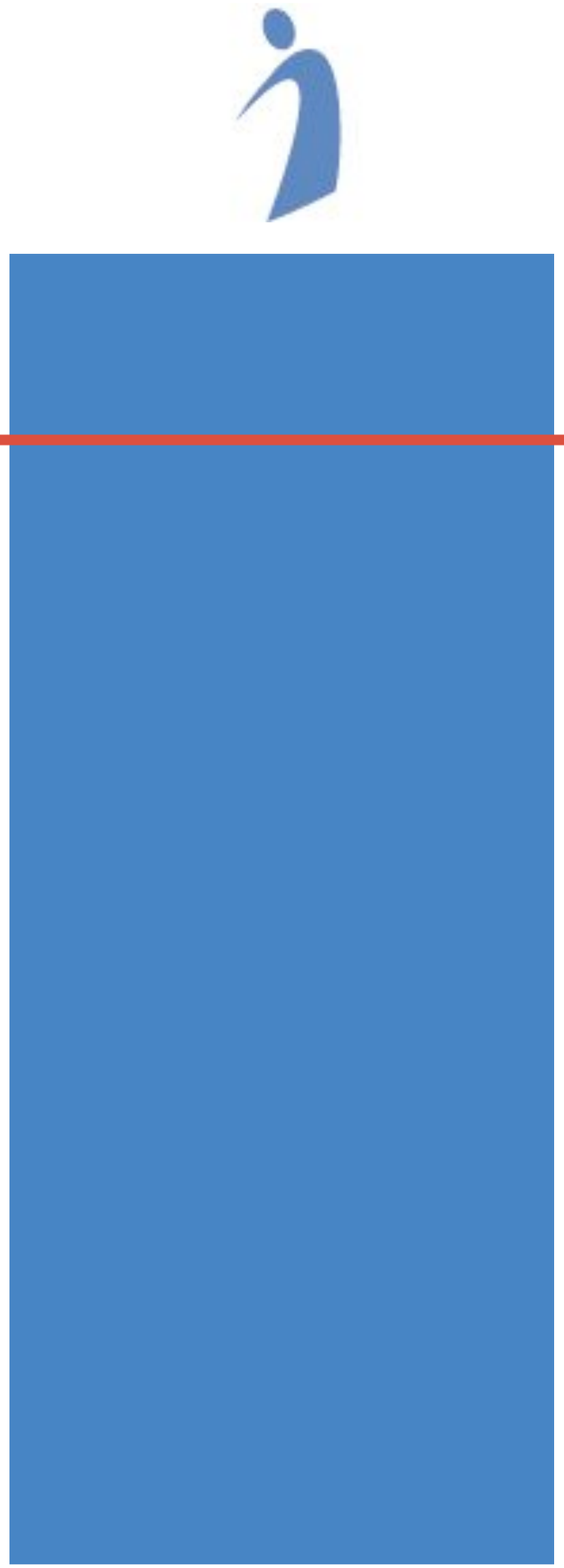
representation

computation

minimize emotion, affect, history, culture

interdisciplinary

Western epistemological tradition



towards AI

1960: Miller et al, *Plans & the Structure of Behavior*

1972: Simon & Newell, *Human Problem Solving*

DENDRAL, ELIZA, STUDENT, SHRDLU

logical impasse
or
merely logic boards?

Gardner's 5 essentials

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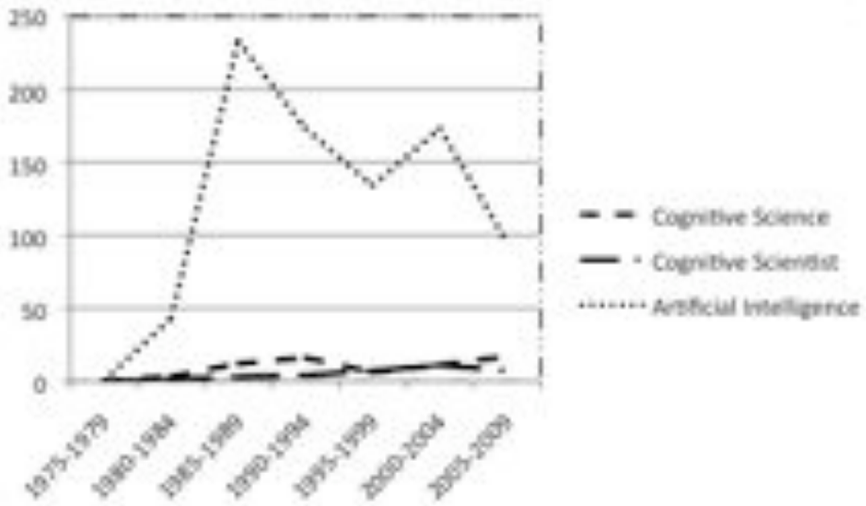

beyond AI?

modelling problems?

Dreyfus, *What Computers Can't Do*, 1972

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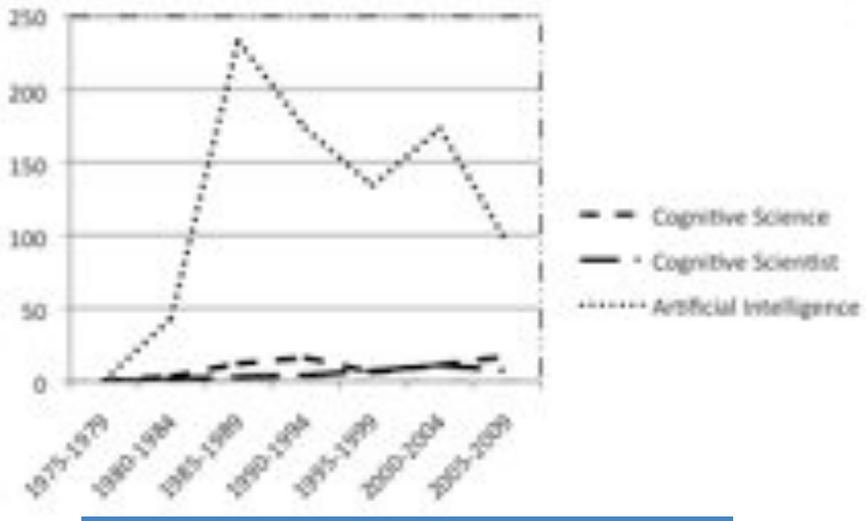
Searle, "Minds, Brains, & Programs," 1980

Lucy Suchman, *Plans & Situated Actions*, 1987

Jean Lave, *Cognition in Practice*, 1988



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Responses to Turing

Intentionality: Searle's Chinese Room

Suppose that I'm locked in a room and given a large batch of Chinese writing. Suppose that …to me, Chinese writing is just so many meaningless squiggles.

Now suppose further that after this first batch of Chinese writing I am given a second batch of Chinese script together with a set of rules for correlating the second batch with the first batch. The rules are in English, and I understand these rules as well as any other native speaker of English. They enable me to correlate one set of formal symbols with another set of formal symbols, and all that 'formal' means here is that I can identify the symbols entirely by their shapes.

Responses to Turing

Intentionality: Searle's Chinese Room

Now suppose also that I am given a third batch of Chinese symbols together with some instructions, again in English, that enable me to correlate elements of this third batch with the first two batches, and these rules instruct me how to give back certain Chinese symbols with certain sorts of shapes in response to certain sorts of shapes given me in the third batch. Unknown to me, the people who are giving me all of these symbols call the first batch "a script," they call the second batch a "story. ' and they call the third batch "questions." Furthermore, they call the symbols I give them back in response to the third batch "answers to the questions." and the set of rules in English that they gave me, they call "the program."

Responses to Turing

Intentionality: Searle's Chinese Room

Suppose also that after a while I get so good at following the instructions for manipulating the Chinese symbols and the programmers get so good at writing the programs that from the external point of view that is, from the point of view of somebody outside the room in which I am locked -- my answers to the questions are absolutely indistinguishable from those of native Chinese speakers. Nobody just looking at my answers can tell that I don't speak a word of Chinese.

On "formal symbol manipulation"

Intentionality: Searle's Chinese Room Suppose also that after a while I get so good at following the instructions and the programmers get so good at writing the programs that from the external point of view… my answers to the questions are absolutely indistinguishable from those of native Chinese speakers. Nobody just looking at my answers can tell that I don't speak a word of Chinese.

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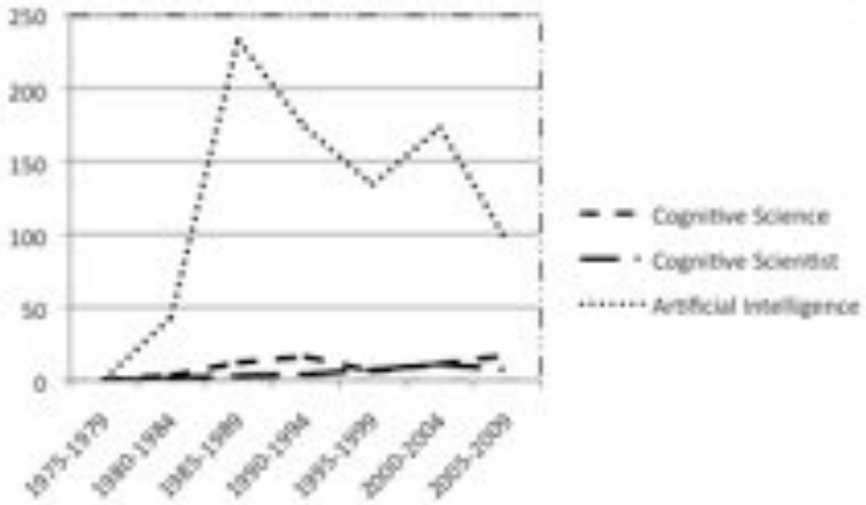

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towards information technology

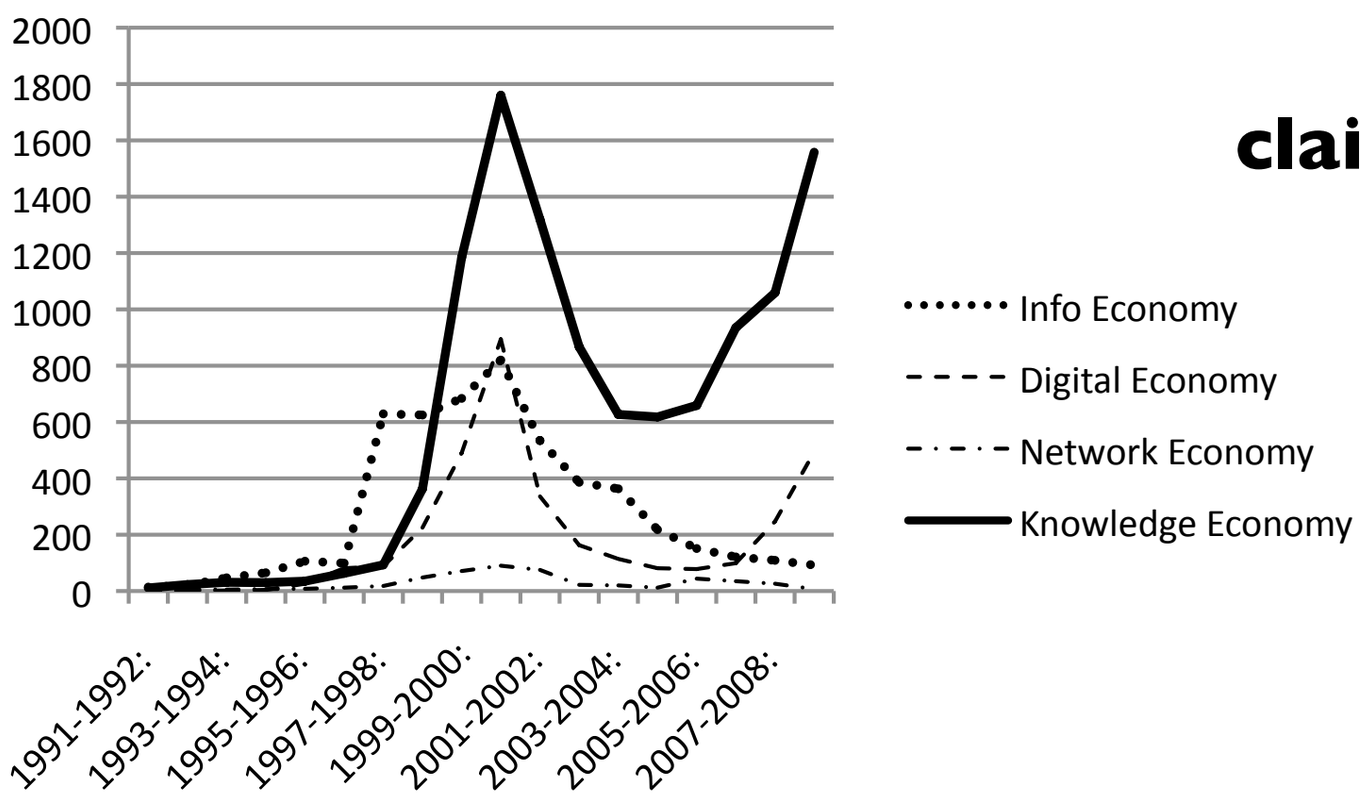
"The term *information technology* arose in management science in the United States in the 1960s, where it signified computer-based mathematical techniques designed to replace mid-level managers. By the early 1980s, several discourse communities -- policy analysts, business writers, managers, information scientists, and social scientists -- had transformed this knowledge-based meaning into the artifactual meaning ... . This contested process occurred during the 1960s and 1970s, a period of rapid change in computers and communications that formed the basis of what became widely known as information technology."

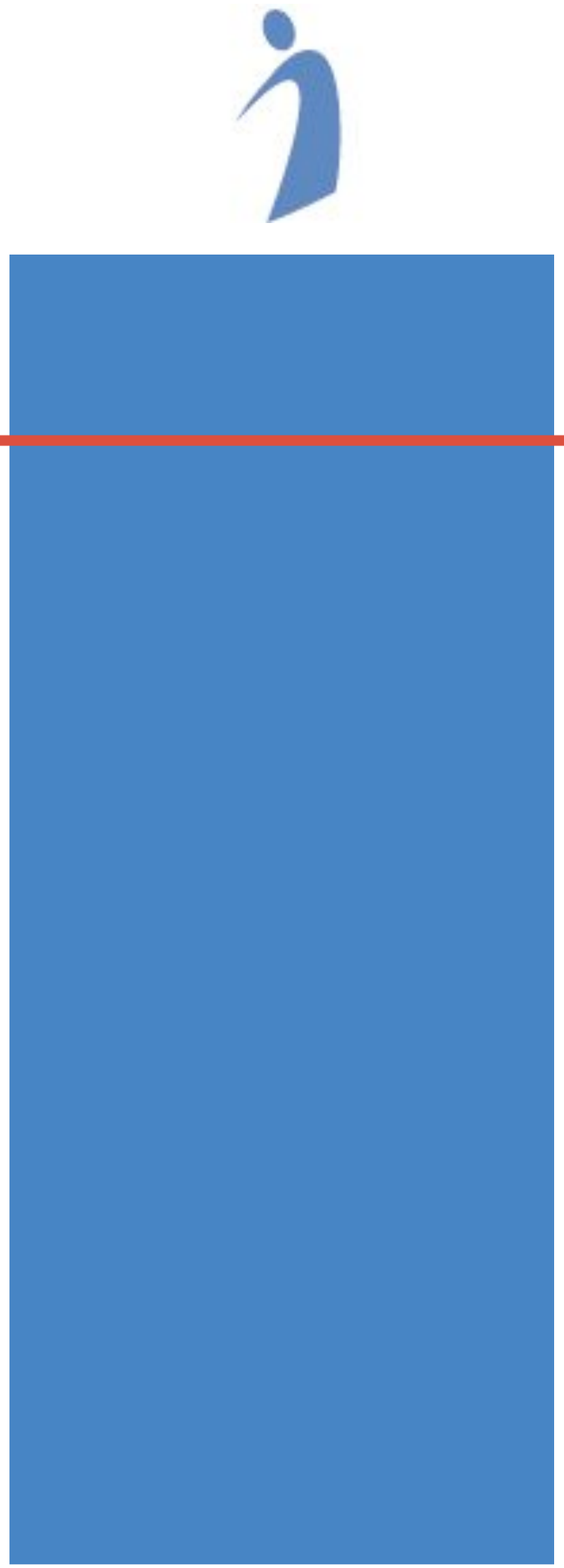
Ronald Klein, "Cybernetics, Management Science, and Technology Policy," 2006

and back to knowledge

"In 1969, management guru Peter Drucker claimed that the 'information industry' and 'information revolution' were helping to create a 'knowledge society' and 'knowledge economy.'" -- Klein

claiming high ground?





many shapes

"A native hunter in New Guinea is as truly an expert system as is a medical diagnosis program for a computer ...

"Knowledge is linked with economics in a myriad of ways ...

"simply one among many commodities ... a rather special commodity"

Simon,"The Many Shapes of Knowledge," 1999

many shapes

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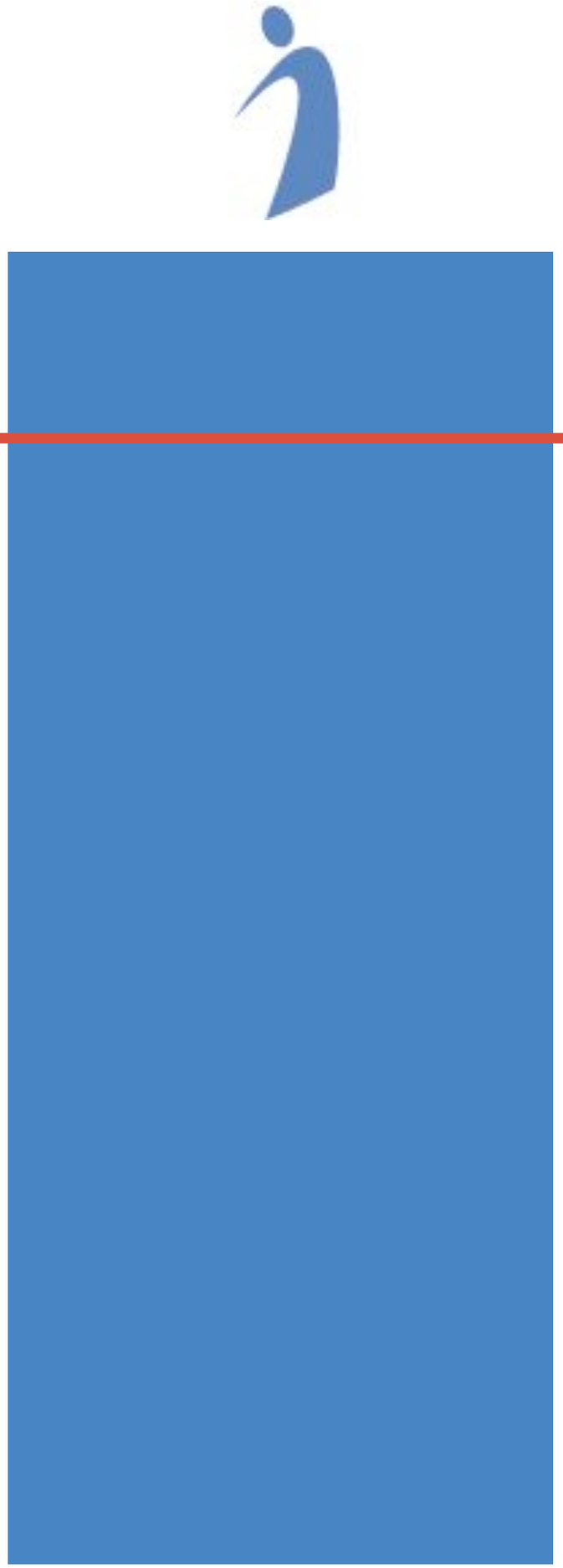
"evolutionary force of knowledge acquisition depends ... on the rate at which knowledge can be transferred from one person or one computer to another ... humans ... slow ... computer ... almost instantaneously.

"knowledge of course is held in individual human heads ...

"the organization as a processor of knowledge"



many shapes

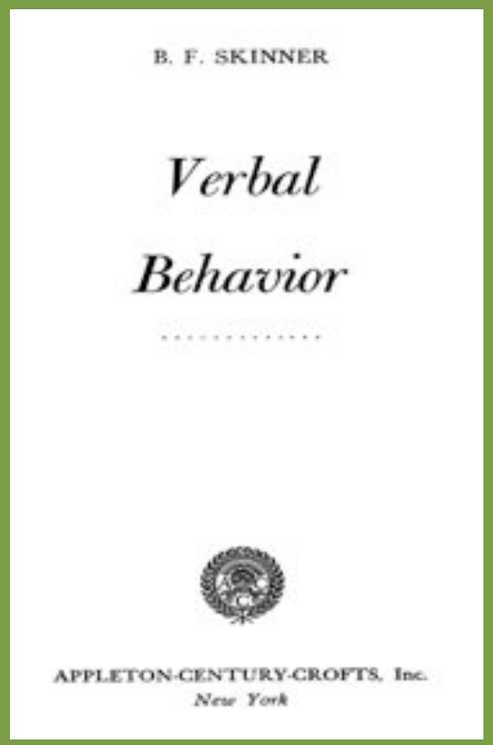
so to i-school?

"the domain of information science, and the economics of information as part of it, has become too big for information scientists"

or back to cg-school?

"economists must learn some modern cognitive psychology"

Chomsky's Review of *Verbal Behavior*



Verbal Behavior: 1957 book by B. F. Skinner outlining view of linguistic behavior in terms of "operant conditioning" ("radical behaviorism").

> Much of the time, a man acts only indirectly upon the environment from which the ultimate consequences of his behavior emerge. Instead of going to a drinking fountain, a thirsty man may simply "ask for a glass of water"--that
> is, may engage in behavior which produces a certain pattern of sounds which in turn induces someone to bring him a glass of water….The glass of water reaches the speaker only as the result of a complex series of events including the behavior of a listener.

Linguistic acts are "operants"of various types ("mands," "tacts," "echoic," etc.) whose strength and frequency (and probability?) are determined by stimuli and reinforcements.

Chomsky's Review of *Verbal Behavior*

Chomsky's review of *Verbal Behavior* published in *Language* in 1959

What is so surprising is the particular limitations [Skinner] has imposed on the way in which the observables of behavior are to be studied…. One would naturally expect that prediction of the behavior of a complex organism (or machine) would require, in addition to information about external stimulation, knowledge of the internal structure of the organism, the ways in which it processes input information and organizes its own behavior. These characteristics of the organism are in general a complicated product of inborn structure, the genetically determined course of maturation, and past experience. Insofar as independent neurophysiological evidence is not available, it is obvious that inferences concerning the structure of the organism are based on observation of behavior and outside events. .

Chomsky's Review of *Verbal Behavior*

A typical example of stimulus control for Skinner would be the response to a piece of music with the utterance Mozart or to a painting with the response Dutch. These responses are asserted to be "under the control of extremely subtle properties" of the physical object or event. Suppose instead of saying Dutch we had said *Clashes with the wallpaper, I thought you liked abstract work, Never saw it before, Tilted, Hanging too low, Beautiful, Hideous, Remember our camping trip last summer?*.... Skinner could only say that each of these responses is under the control of some other stimulus property of the physical object. If we look at a red chair and say red, the response is under the control of the stimulus redness; if we say chair, it is under the control of the collection of properties chairness, and similarly for any other response. This device is as simple as it is empty…. the word *stimulus* has lost all objectivity in this usage

Chomsky's Review of *Verbal Behavior*

Consider some examples of reinforcement. … "A man talks to himself... because of the reinforcement he receives"; "the child is reinforced automatically when he duplicates the sounds of airplanes, streetcars ..."; "the young child alone in the nursery may automatically reinforce his own exploratory verbal behavior when he produces sounds which he has heard in the speech of others"; … An individual may also find it reinforcing to injure someone by criticism or by bringing bad news, or to publish an experimental result which upsets the theory of a rival, to describe circumstances which would be reinforcing if they were to occur…

The phrase "X is reinforced by Y …is being used as a cover term for "X wants Y," "X likes Y," "X wishes that Y were the case," etc. Invoking the term reinforcement has no explanatory force, and any idea that this paraphrase introduces any new clarity or objectivity into the description of wishing, liking, etc., is a serious delusion.

Chomsky's Review of *Verbal Behavior*

It is also perfectly obvious that, at a later stage, a child will be able to construct and understand utterances which are quite new, and are, at the same time, acceptable sentences in his language. Every time an adult reads a newspaper, he undoubtedly comes upon countless new sentences which are not at all similar…, to any that he has heard before, and which he will recognize as sentences and understand. Talk of "stimulus generalization" in such a case simply perpetuates the mystery under a new title.

Chomsky's Review of *Verbal Behavior*

Skinner defines the process of confirming an assertion in science as one of "generating additional variables to increase its probability," and more generally, its strength. If we take this suggestion quite literally, the degree of confirmation of a scientific assertion can be measured as a simple function of the loudness, pitch, and frequency with which it is proclaimed, and a general procedure for increasing its degree of confirmation would be, for instance, to train machine guns on large crowds of people who have been instructed to shout it.

Chomsky's Review of *Verbal Behavior*

"From the perspective of most behavior analysts, Chomsky's review of Skinner's *Verbal Behavior* was a kind of ill-conceived dam in the progress of science, a rhetorically effective but conceptually flawed document that would eventually be overborne." David C Palmer, 2006 "A Half Century of Misunderstanding"

"Chomsky's review has come to be regarded as one of the foundational documents of the discipline of cognitive psychology, and even after the passage of twenty-five years it is considered the most important refutation of behaviorism." Frederick Newmeyer, 1986

"…Noam at his best, mercilessly out for the kill, daring, brilliant, on the side of the angels … in the same category as St. George slaying the dragon." Jerome Bruner, 1983