A Brief History of Cognitive Science

What Came Before?

- Psychology until the late 1950s was dominated by *behaviorism*
- Focus was on observable behavior of animals (including humans)
- Influenced by logical positivists here; science should not deal with unobservables (e.g., the mind)

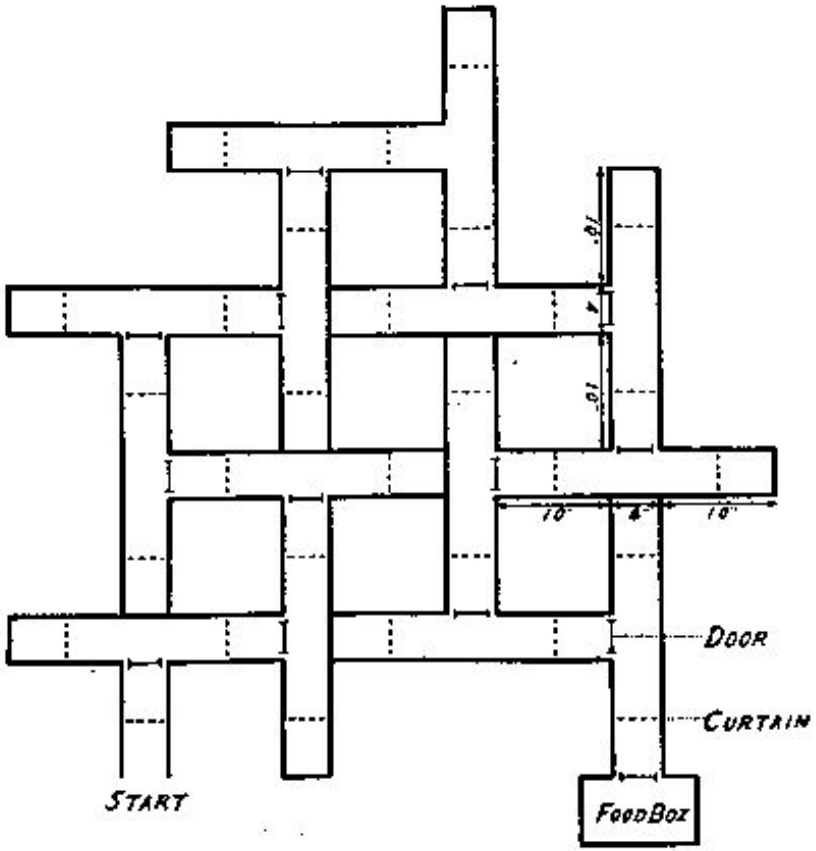
B.F. Skinner (1904-1990)

- Learning occurs through the *reinforcement* of some response (e.g., pressing a lever) with an environmental reward (e.g., food)
- Believed this was the basic way in which we learn anything (e.g., how to drive, how to speak, etc.)
- Could do psychology while ignoring mental operations

This approach started to unravel in the 1950s, in what is now known as the "cognitive revolution"

Miller refers to it as a "counter-revolution" against the behaviorist revolution that Pavlov ushered in

An early study that started to show the weakness in behaviorism was Tolman and Honzik (1930)



Plan of maze
14-Unit T-Alley Maze

FIG. 1

(From M. H. Elliott, The effect of change of reward on the maze performance of rats. *Univ. Calif. Publ. Psychol.*, 1928, 4, p. 20.)

The work suggested rats exhibited *latent learning* and formed *cognitive maps* that were *representations* of the maze

The idea of a “mental representation” is central to cognitive science (though tricky to spell out in detail)

Chomsky's Review of Skinner's (1957) *Verbal Behavior*

- Argued that the reinforcement model of learning that Skinner used could not account for how a child learns language
- Linguistic data was “impoverished” yet children learn a language quickly, which suggests innate learning principles
- Children utter phrases they have never heard (e.g., “I wented to the store”)

But these are examples of push back against behaviorism. Cognitive science itself emerged because of a confluence of developments in various areas of science.

A small sample

- Advances in logic (e.g., from Frege) that allowed for the formalization of natural languages and reasoning
- Work on computation theory
- The development of “computing machines” (1940s)
- Claude Shannon’s (1948) work on information theory

the picture that started to emerge was that:

- the brain is like (or just *is*) a computer
- it processes information
- performs complex operations over representations (or other cognitive “objects”)
- and these operations generate behavior

put another way...

- what's going on "inside" the brain should not be ignored (as behaviorists wanted), but should be the *focus* of psychology
- the internal processes are more interesting than the observable behavior and they are essential for understanding how the observable behavior is generated

A couple of “classics” from early cognitive science

Miller, George (1956) “The Magical Number Seven, Plus or Minus Two,” in *Psychological Review*, 63: 81-97

- An *information channel* is what information travels through to get from a *sender* to a *receiver* (think of the internet connection between you and a friend when you compose an email)
- Miller treated human perceptual systems as information channels between a sender (the environment) and a receiver (somewhere else in the mind) (applies to visual and auditory channels)
- He showed that these channels have a *channel capacity* (how much information they can accurately transmit)
- In particular, these channels can only transmit about seven items at a time
- Another way to think of this is that your short term memory can hold about seven items

3 digits

1, 9, 1

6 digits

4, 5, 9, 1, 7, 1

9 digits

1, 4, 9, 8, 3, 5, 1, 8, 4

15 digits

4, 7, 6, 1, 4, 9, 2, 1, 9, 1, 7, 2, 0, 1, 9,

15 digits

4, 7, 6, 1, 4, 9, 2, 1, 9, 1, 7, 2, 0, 1, 9

Chomsky, N. (1957) *Syntactic Structures*. Mouton and Co.

- This book and subsequent work by Chomsky and collaborators ushered in interest in “generative grammar”
- The idea here is that one treat’s knowledge of a grammar as possession of a set of rules that allow you to combine words (the lexicon) into acceptable utterances in the language
- To speak a language, in effect, is to run a program; to study language is to uncover the rules of that program
- This contrasts with behaviorism (and American structuralism) in a number of way)

consider the following sentences

passivization

a) Sam hit the ball.
b) The ball was hit by Sam.
c) *By Sam hit the ball was.

wh-movement

a) It was Sam who hit the ball.
b) Who hit the ball?
c) *Sam who hit the ball was it?

To work on *generative grammar* is to uncover the rules that would generate all and only the grammatical sentences of some language.