

Psychology Turns Cognitive: Information Processing

"In the course of my work I seem to have become a very old-fashioned kind of psychologist. I now believe that mind is something more than a four letter, Anglo Saxon word - human minds exist, and it is our job to study them." (George Miller, 1962)

Dominance of Behaviorism only in North America

- **Germany:** Gestalt Psychology—what are the mental processes that determine perception?
- **England:** Frederick Bartlett's studies of memory
- **Russia:** Lev Vygotsky and Alexander Luria—a sociocultural perspective on development
- **France/Switzerland:** Jean Piaget

Why did Many American Psychologists Finally Turn Away from Behaviorism?

- Behaviorism began to lose some of its appeal
 - As psychologists confronted more complex behavior, it had to advance more complex explanations
 - Charles Osgood began, for example, to propose S-R connections to mediate other S-R connections
 - Results were less compelling than first exemplars of behaviorism
- Scientists don't tend to abandon an approach, even if it is confronting problems, unless there is an alternative
 - In the 1940s and 1950s an alternative emerged which still retained what many saw as the advance of behaviorism

Behaviorism's Legacy

Even as psychology *largely* rejected behaviorism's opposition to appealing to inner mental events to explain behavior, it retained behaviorism's strictures on what it sought to explain and what could count as evidence

- What was to be explained was how people behaved
- The evidence for proposed explanations had to come from behavior
- The method that was implicitly employed was the Hypothetical-Deductive (H-D) Method:
 - Hypothesize the existence of inner states to explain behavior
 - Evaluate those hypotheses by the correctness of the predictions made from them

Jerome Bruner: A sociopsychological perspective on cognition



"... we were not out to 'reform' behaviorism, but to replace it" (Bruner, 1990, 3)

Bruner's contention was that the way people *understood* their situation affected the way they behaved.

With George Miller, created the Harvard Center for Cognitive Studies

Clicker Question

Which best characterizes Bruner's approach to perception?

- Like the psychophysicists, he tried to correlate the subjective aspects of perception with features of the stimulus.
- Perception can be explained as a pairing of stimulus and response as a result of experience.
- Perception is an inherently objective process not subject to illusions.
- Perception can be affected by factors such as the social value of the object perceived

Bruner's Perceptual Hypotheses

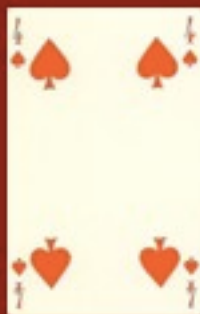
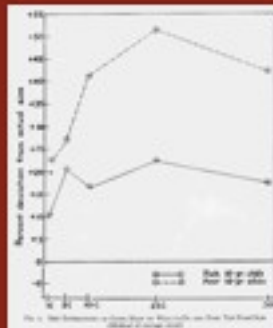
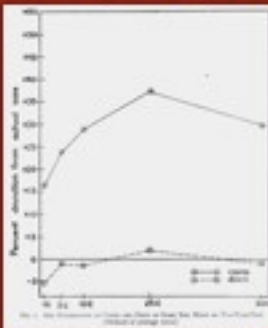
1. The greater the social value of an object, the more will it be susceptible to organization by behavioral determinants. It will be selected perceptually from among alternative perceptual objects, will become fixated as a perceptual [p. 37] response tendency, and will become perceptually accentuated.
2. The greater the individual need for a socially valued object, the more marked will be the operation of behavioral determinants.
3. Perceptual equivocality will facilitate the operation of behavioral determinants only in so far as equivocality reduces the operation of autochthonous determinants without reducing the effectiveness of behavioral determinants.

New Look Accounts of Perception

Bruner and Goodman (1947) : the value of an object (coin) affected a child's perception of its size.

Perception influenced by internal mental states, not just the stimulus

Greater impact on less well-to-do than wealthy children since coins are of greater significance



Clicker Question

What did you see?

- A. A 4 of hearts
- B. A 4 of spades
- C. A 4 of diamonds
- D. None of the above



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Anomalous Cards



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A Study of Thinking (1956)

Bruner, Goodnow, and Austin



Focus on concepts and how they are learned

Construed concepts as defined by rules and focused on how subjects figured out the rules

Stimuli: arrays of cards with geometric patterns

Strategy: find a positive instance and then test cards that vary in one attribute at a time

- If positive instance, then attribute doesn't matter
- If not, attribute does matter, so revise definition

George Miller



- Graduate student in psychophysics with S. S. Stevens, conducting classified military research on signal jamming.
- Adapted the results for these studies for his dissertation by focusing on the effect of noise on the intelligibility of a signal
 - To xllxstxatx, I cxn rxplxcx vxexy bxirx lextex of x sextexce xibx an x, anx yox stxll xan xanxge xo rxad xt wixh sxme xifxixltx.
 - Some stimuli were ordinary grammatically correct and meaningful sentences
 - Others were grammatical but nonsensical: *Furry jewelers create distressed stains*
 - Others were completely ungrammatical

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George Miller Meets Information Theory

- Claude Shannon's information theory
 - Information measured in terms of ability to distinguish alternatives
 - A binary unit (bit) could distinguish between two alternatives, two bits (e.g., 10) could distinguish between four alternatives, etc.
 - Signals were redundant to the degree one unit could permit reliable guessing of the next
 - What is the next letter (in the word)?
 - a
 - ar
 - Arb
- Miller: more redundant signals (grammatically correct meaningful sentences) were less affected by noise than strings of meaningless symbols because they were redundant
- Miller and Frick (1949): "statistical behavioristics" measured in terms of ability to distinguish alternatives

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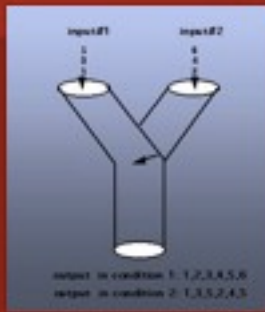
Clicker Question

Miller reported being haunted by the number 7. How did it show itself, according to him, in memory?

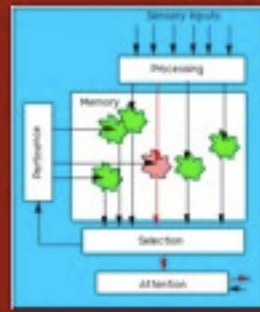
- A. A person can typically hold about 7 items in memory.
- B. A person can typically hold about 7 digits in memory.
- C. It typically takes at least 7 seconds of exposure before one can remember something.
- D. IQ tests at the time typically contained 7 alternatives

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Modeling Attention

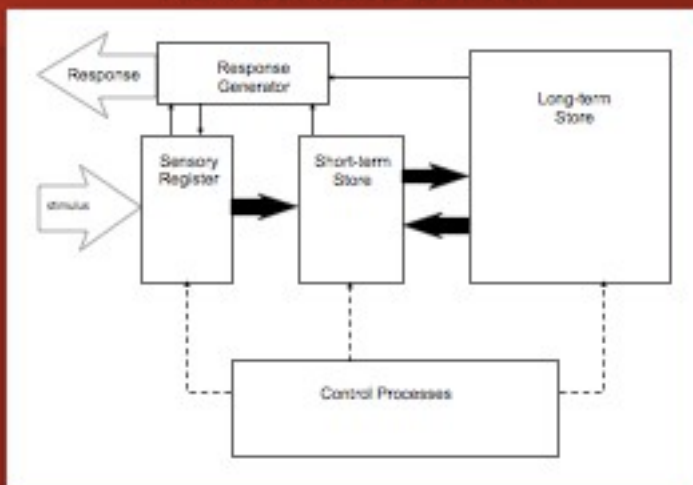


Broadbent (1958): Early attention before recognition



Norman (1968) late attention

Different Memory Stores: Atkinson and Shiffrin



Miller, Galantner, & Pribram: Plans and the Structure of Behavior

At one point, George proposed that we examine some intentional human act.

'Flying a plane,' I suggested.

'No - too much. How about crossing a street. An equally dangerous act in the bay area,' Karl responded. I went to the blackboard and started a flow chart. The boxes, lines, and arrows snaked around the board as step after step was drawn. 'No,' George said, 'all that stuff on the board is only a string of reentrant reflexes. Let a whole piece of the action be repeated until it's finished.'

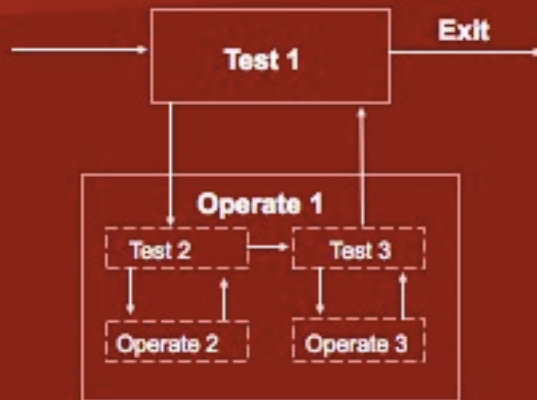
'How will it know?' from Karl.

'With a cybernetic test,' replied George.

'But how do I draw it?' I asked.

'Like this,' said George, and the TOTE replacement for the reflex was designed." (p. 40)

TOTE Units



Neisser and Cognitive Psychology (1967)

"By 1964, it had come together in my head. In principle, I thought, one could follow the information inward from its first encounter with the sense organ all the way to its storage and eventual reconstruction in memory. The early stages of processing were necessarily holistic (an idea I borrowed from Gestalt psychology) and the later ones were based on repeated recoding (an idea borrowed, even more obviously, from George Miller). But the processing sequence was by no means fixed; at every point there was room for choice, strategy, executive routines, individual constructive activity. Noam Chomsky's linguistic arguments had shown that an activity could be rule governed and yet indefinitely free and creative. People were not much like computers (I had already sketched out some of the differences in a 1963 *Science* paper), but nevertheless the computer had made a crucial contribution to psychology: It had given us a new definition of our subject matter, a new set of metaphors, and a new assurance" (Neisser, 1988, p. 86).



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Cognitive Psychology at UCSD

- UCSD was a new university in the 1960s, admitting its first undergraduates in 1964

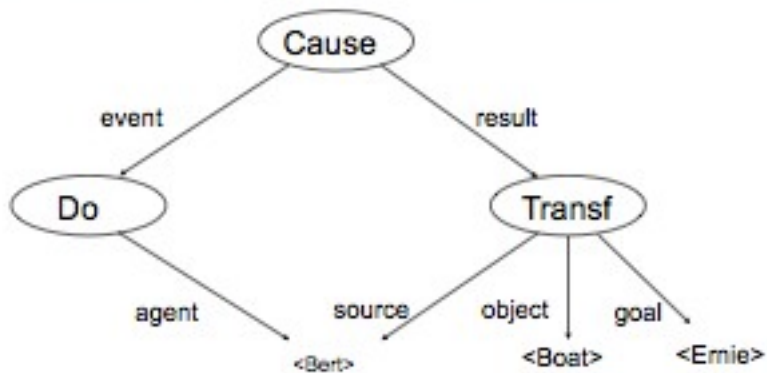


First psychology faculty were first generation cognitive psychologists: George Mandler, Peter Lindsay, Donald Norman, David Rumelhart
Explorations in Cognition (1975)



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LNR Analysis of Verb Structure: Bert **gives** a boat to Ernie



Clicker Question

Which of the following best characterizes the relation between behaviorist and cognitivist psychology

- A. Behaviorists restricted psychology to what could be studied behaviorally whereas cognitive psychologists viewed the mind as something that could be directly investigated.
- B. Both behaviorists and cognitive psychologists restricted psychology to behavioral evidence, but differed as to whether one could get such evidence about the mind.
- C. Behaviorists denied that anything relevant was going on inside people's heads whereas cognitive psychologists thought that was where the action was.

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The Epistemological Challenge for Cognitive Psychology

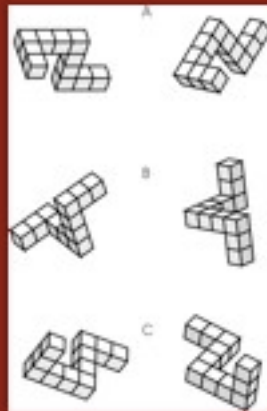
- The characterization of cognitive psychology is information processing psychology
 - How do psychologists determine the processes involved in manipulating information?
- Advance hypotheses as to the kinds of procedures that would generate the behavior
- Make additional behavioral predictions (deductions) from these hypotheses—additional behaviors, reaction times, error patterns—and evaluate according to the success of the predictions
 - Sternberg on exhaustive serial search—RTs correlate with number of items to be searched
 - Shepard and Metzler on mental rotation—RTs correlate with angle of rotation

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Shepard on Mental Rotation

The time it takes someone to decide whether one figure is in fact a rotation of another correlates with the degree of rotation

Suggestion—you perform in your head an operation corresponding to rotation



Kosslyn on mental scanning

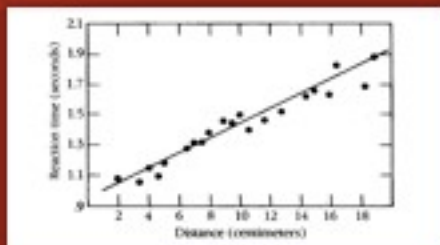
Subjects memorize this map with landmarks such as a hut, a swamp, and a well.

With the map gone, subjects were asked to form an image of the map. Focus on the well and image a speck there.

Now move the speck in a straight line to the tree.



Kosslyn on mental scanning - 2

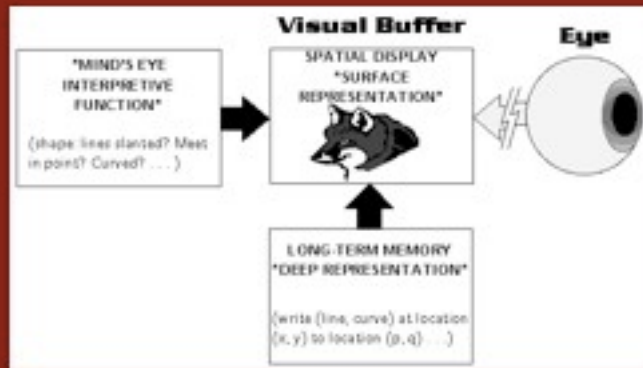


Kosslyn, Ball, and Reiser (1978) showed that reaction times corresponded to the distance between objects, suggesting that they were actually performing an operation comparable to scanning a map.

Kosslyn's proposal

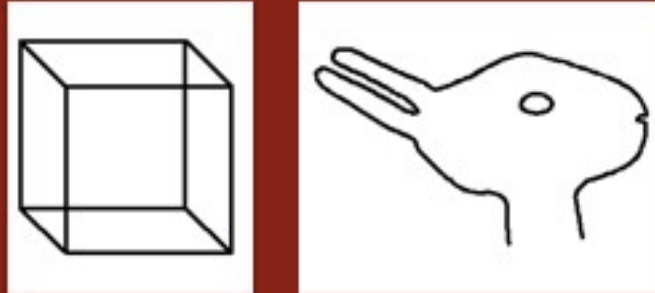
Image processing reactivates areas of visual cortex involved in visual processing

Long-term storage in a propositional format—comparable to computer code that generates an image on the CRT



Mental images not processed exactly like pictures

Chambers and Reisberg found that subjects who were briefly exposed to reversible figures could not find the alternate interpretation from a mental image, but could if they were allowed to draw a picture from their image.



Can we monitor accurately how our minds work?

Cognitivists generally share behaviorists suspicion of introspection

Yet, sometimes we seem to be aware of steps we take in thinking
Verbal protocols while solving cryptarithmic problems

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DONALD
+ GERALD
-----
ROBERT      D=5
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Nisbett and Wilson—"Telling More Than We Can Know: Verbal Reports on Mental Processes"

Our self reports are often demonstrably wrong

"knowledge of the self is produced by the same strategies as knowledge of other social objects. . . Collecting, coding, and recalling data, assessing covariations, inferring causal relations, and testing hypotheses."

Status of our own ability to report on our conscious activities

- We are aware of our mental processes
 - But—there are many processes of which we are not aware, such as how you remember to come to class
- We are aware of the contents of our mental states
 - But—there are contents we use but are not aware of, e.g., in dichotic listening experiments. Cannot list all the things we believe. And sometimes a third person is better situated to tell us what we believe than we are ourselves
- Even if we are not aware of the whole process responsible for our behavior, we are aware of the causes of our behavior
 - But—Nisbett and Wilson's results: we tell more than we can know
- I know whether I am believing or doubting

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Cognitive psychology begins to challenge cherished beliefs

- Socrates' legacy: Terms have definitions, and we can find them
 - Definitions specify necessary and sufficient conditions
 - What is the definition of game? Of bird?
- Eleanor Rosch: Concepts have a prototype structure:
 - Some examples of a concept are better than others
 - What is a prototypical bird?
- How good a bird is a
 - Chicken?
 - Cat?
 - Airplane?
 - Chair?

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Cognitive Psychology Challenges our Rationality

Which of the following cards do you need to turn over to either confirm or falsify the hypothesis that **if a card has an even number on one side, it has a vowel on the other?**

X

2

X

B