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Course Title:

Basic Cognitive Processes

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Lecture 07: Approaches towards Cognitive Psychology

What do we know so far?

- Cognitive Psychology is the study of the human 'mind' & mental processes.

- Cognitive Psychology seeks to understand & explore the functional architecture of the human mind.

- Cognitive Psychology follows closely the human as a information processing system view or that , "*the mind is to brain what the software is to the computer*" analogy!

- In the current lecture we will try & look at this approach in more detail & often try to compare it with some other possible approaches!

- We will try to see possible architectures of the human mind.

The Problem at Hand…

- We are faced with a black box.

- The rules of engagement are quite clear: we cannot physically attempt to open the black box &

- So, in order to make some headway, we simply accept the foundational assumption that the black box contains an information processing system & set ourselves the goal of trying to understand the nature of its putative internal states & processes.
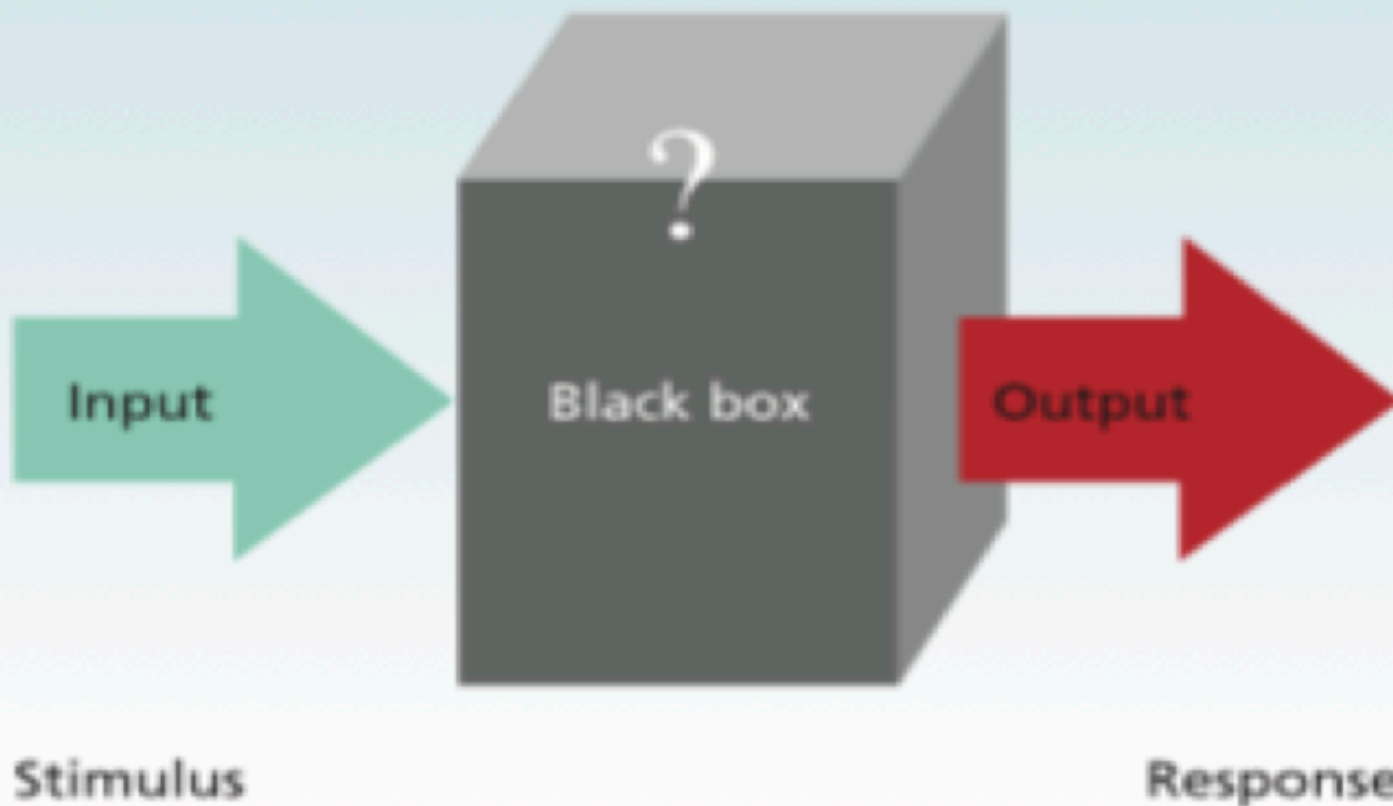
Figure 2.1 The black box that is the human mind
As cognitive psychologists, we are trying to figure out the internal workings of this black box merely from observing its behaviour.

Image: Quinlan, P. & Dyson B. (2008). Cognitive Psychology. *Prentice Hall*.

Where do we begin?

- "How do we understand what a computer is doing when it is running a particular program?'

  o the aim is to try to get someone else (a naive observer) to uncover what is going on when the computer runs the program.

- this is an example of the program:

- Line 1: **Program** Fun Yet
- Line 2: **Begin**
- Line 3: **Print** "Are we having fun yet?"
- Line 4 **Get** (response)
- Line 5: **If** response = "Yes" **GOTO** Line 6 **OTHERWISE** **GOTO** Line 3
- Line 6: **End.**

Various Approaches...

The Cognitive Approach

- the observer adopts a non - invasive method of studying the device.

- the observer attempts to vary the input to the program (i.e. types in different responses) and notes down any systematic changes tat relate to this variation.

- by noting any such systematic variation in what is typed in and what occurs as a consequence, the observer expects to generate a flow diagram of hypothesized component processes.

  - for instance:

    - certain input processes will be proposed, certain decision processes will be proposed & finally, certain output processes will be proposed.

The AI approach

- the aim is to try & generate a new computer program that mimics the behavior of the observed program.

- Success would be gauged if the new program mimics the behavior of our observed program in all critical aspects.

- Not only we have thought of a flowchart description, we have operationalized our ideas in the new computer program.

- we have provided a **demonstration proof** that the particular representations and processes embodied in the new program are sufficient to solve the task.

- a claimed benefit of this approach is that it forces the theorist to formulate, very precisely the assumptions that underlie theory.

- the ideas must be precise as they are to be operationalized in a computer program.

- we have a demonstration proof that the operations specified in the program are sufficient to explain the behaviour. & the theory has been shown to work.

- Such an AI approach provides the means to address detailed issues at the level of representation and the algorithm (Marr, 1982).

The neuroscience approach

- Or, we might just decide to try to observe & measure the inner workings of the particular computer that the program is supposed to run on.

- Now because we are following a non - invasive approach & are not allowed to break open the the computer's casing, nor tamper with any of the internal components in any way - maybe we should measure changes in the magnetic fields that are generated by the computer's components as the program runs?

- the ultimate hope, is that if we observe the changes in the states of its physical components (i.e. of the transistors) as we run the program, then this will tell us something fundamental about the nature of the program itself.

- The idea is very similar to the neuroscience approach that is being adopted.

- We are beginning to map out which areas of he brain become particularly exercised when a person is engaged in certain cognitive tasks.

- However, so far, little has been learnt about cognitive processes that are assumed to be associated with such changes in brain activation.

- Much is being learnt about the structural organisation of the brain (where stuff happens) but, little has been learnt about cognitive functioning (what is happening & how).

Information Processing Approach

- Information theory was introduced by Shannon and Weaver (1949) as a mathematical account of the operation of any type of communication system.

- It provides basic assumptions that underpin our ideas about information processing systems.

- Consider the example of two (Speaker Andy & Listener Lou), conversing over the telephone where both participants are talking via a landline phone.

- An information source (i.e. Speaker Andy)

- A transmitter (i.e. Speaker Andy's telephone).

- A channel (i.e. the cable interconnecting the two handsets)

- A receiver (i.e. Listener Lou's telephone)

- The destination (Listener Lou)

Figure 2.2 The basics of a communication system
A schematic representation of a communication system as described by Shannon and Weaver (1949) in their discussion of information theory.

Source: Haber, R. N. (1974). Information processing. In E. C. Carterette, & M. P. Friedman (Eds.), *Handbook of perception* (Vol. 1, fig. 1, p. 315). London: Academic. Reproduced with permission from Elsevier.
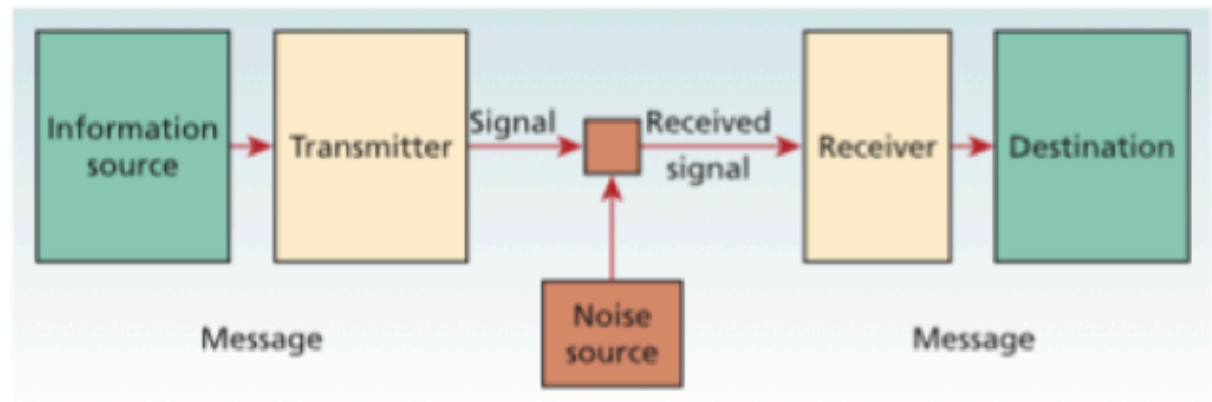
Image: Quinlan, P. & Dyson B. (2008). Cognitive Psychology. *Prentice Hall*.

- In this communication system, the auditory input is converted by the transmitter into an electrical signal which then travels downtime line.

- This signal is then re-converted into an auditory output at the receiver.

- For Shannon & Weaver (1949), the important issues concerned how efficiently such a system might operate. In this regard, they attempted to quantify a number variables, namely:
  - the channel capacity
  - the rate of transmission
  - redundancy of encoding
  - noise

- Shannon & Weaver (1949) developed a general statistical formulation for describing the inter - relationships between the variables.

- importantly, their account was couched at an abstract level because their ideas were developed independently of how the communication system might actually be physically instantiated.

- Haber (1974) wrote that their objective was to develop a communication system with general statistical concepts 'independent of the specific types of channels; the types of senders & receivers and most critically, the nature or the content of the information flowing through the channels'.

- **Information Theory & Redundancy**

    o the notion of redundancy can be used to refer to the amount of information present in a given signal (here the signal refers to a given stimulus).

    o the important point is that in being able to define and quantify information, it s also possible to measure it.

    o this was a vital addition as now psychologists could conceive of ways measuring something couched at the psychological level; that is independently of stimulus & responses.

- another way of thinking about redundancy is in terms of how much of the signal can be correctly predicted from the other parts of the signal.

  - a highly redundant signal is highly predictive. But how is this to be measured?

  - in addressing this, the aim was now to try & quantify how predictive signals are. for e.g. if a message is highly predictive, we could get away with deleting the irrelevant bits and just leaving the relevant.

- Shannon & Weaver took it upon themselves to try to quantify information purely in terms of statistical means by using things like the frequency of co-occurrence of parts of the message. for instance, they realized that the amount of information increases with the number of things that might have occurred at a given point in the signal.

- e.g. in the message, "We should meet tonight because that's a good time to elope'. it has very low redundancy as Lou would be unable to reconstruct the intended meaning if all that he heard was "We should meet ****** because that's a good ***** to ****."

- here Andy could have asked Lou to meet "at the corner" or "at 9 pm" etc.

- In contrast if you take another example: if y invariably follows x and hearing x implies hearing y, then y is fully redundant with respect to x.

- **Information Theory & human information processing**

  o We now know that the modern world depends upon the telecommunication systems that are fundamentally based on the properties & principles identified by Shannon & Weaver (1949).

  o these early ideas also influenced cognitive psychologists; for example by providing them a framework for thinking about how the human mind might operate in the abstract.

  o it also provided the foundations for the assumption that the mind may be characterized as an information processing system whereby stimulation at the senses enters into a complex communication system.

- Models of cognitive processing based on the central tenets of this information processing framework soon began to appear.

- Psychologists were quick to realize that for humans, the notion for information was more difficult to define than by the simple sorts of statistical measures used in the information processing theory.

- It is not so much about the words which are spoken but the what meanings are trying to conveyed (Mac Kay, 1961): 'dog bites man' is much less informative than 'man bites dog'.

- But the approach forced psychologists to consider a whole new way of thinking about human cognition.

- The classical information processing view is that the human organism consists of certain sensory systems (eyes, ears etc.) which operates as receivers of external inputs; these receivers operate to encode these inputs via sensory transduction.

- the encoded information is then passed on, via abstract information processing channels, to more central systems.

- the central system operate on the information in such a way that an appropriate response can be made.

- While it might resemble the behavioral stance, cognitive psychologists are more concerned with the internal (abstract) events that intervene between the stimuli & responses.

To sum up...

- In this lecture we talked about a variety of possible approaches that can be taken towards understanding the architecture of the human mind.

- Also, we looked at the information processing approach to the human mind & possible consequences that had for cognitive psychology.

References

- Quinlan, P. & Dyson B. (2008). Cognitive Psychology. *Prentice Hall*.