Contribution of Psychology to Cognitive Science

Psychology

- Since this is a psychology course, most of our examples throughout the course will be psychological in nature.
- Psychology is interested in using empirical methods to examine the structure of the mind, and the operations by which the mind performs complex tasks such as perception, language, and thought.
- Thus, psychology can be thought of as an empirical epistemology.

Early Psychology - Psychophysics

- With the advent of methods for measuring the magnitude of stimuli (light, sound etc.) researchers became interested in measuring the relationship between the magnitude of a stimulus, and the magnitude of the internal sensation caused by that stimulus.
- Thus, they were getting at the mind-body problem using empirical methods.
Weber's Law

- Weber was interested in individual's ability to discriminate between two weights.
- Found that two relatively heavy weights must differ by a greater amount than two relatively light weights for an individual to be able to discriminate between them.
- Thus he posited the mathematical relationship known as Weber's Law.

Weber's Law States the Following:

\[ \frac{\Delta S}{S} = C \]

Or, in words:
the change in stimulus intensity that can just be discriminated (\(\Delta S\)) is a constant fraction (\(C\)) of the starting intensity of the stimulus (\(S\)).
- Thus, we have a mathematical relationship between the physical stimulus magnitude, and the person's judgement about that stimulus magnitude.

Gustav Fechner

- Fechner was interested in developing a precise relationship between the physical and the mental.
- Built upon the work of Weber.
- Attempted through measurement and quantification to develop a mathematical relationship between physical events and conscious experience.
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• Proposed that sensation magnitude could be quantified indirectly by relating the values of $\Delta S$ on the physical scale to the corresponding values of the just noticeable difference (jnd) on the psychological scale.
• Thus, the jnd can be considered as a psychological unit of measurement.
• Even though jnd’s may differ in actual magnitude, they are equal units of psychological magnitude.

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• Based on his work, Fechner posited the following equation:

$$\Psi = k \log S$$

Where $\Psi$ = the sensation magnitude of the stimulus.

K= a constant multiplier

S = the physical magnitude of the stimulus.

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Ernst Mach

• Ernst Mach, the German Physicist and Philosopher after whom the Mach number is named, was also interested in the relationship between the physical world, and the world as perceived by the mind.
• In 1865 he discovered the Mach Bands illusion.
The Mach Bands are a good example of a mismatch between the actual physical stimulus, and the stimulus as perceived by the observer.

Another good example is colour. Colours are not actually present in the physical world, but rather are the result of the way in which the mind interprets different wavelengths of light.

What do they tell us about the structure of the mind, and the mental and/or physical operations performed upon them?

These examples lie at the juncture of psychology and neuroscience, which we will discuss later.
The Hermann Grid Illusion

Behaviourism - a negative heuristic

- Pavlov’s early work on classical conditioning heavily influenced the psychological school of behaviourism.
- Pavlov’s work showed that a previously neutral stimulus could acquire the ability to evoke a response from an animal if it was paired with a stimulus that did have some effect on the animal.

- In the famous classical conditioning paradigm:
  CS (bell) - paired with- UCS (food) elicits a CR - drooling dog
  - Watson built upon this foundation his school of Behaviorism
  - Wanted an objective, quantifiable, science of behaviour. This was at least partly reactionary.
  - Actively discouraged the study of the mind as a “black box”
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- Why? - since the psychologist did not have access to the operations performed by the mind, any attempt to deduce them is inherently unscientific. Interestingly, we are able to view the mind at work today using modern functional neuroimaging methods.
- This ethos was further developed by B.F. Skinner, who won acclaim by investigating Operant Conditioning.
- Skinner regarded all behaviours as Stimulus-Response in nature.
- Thus, the mind is not a necessary element of the behavioural equation.

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The Cognitive Revolution

- The Reign of behaviourism came to an end following a famous debate between Skinner and the Linguist Noam Chomsky.
- Skinner had attempted to apply the principles of operant conditioning to complex behaviours such as language.
- Chomsky’s arguments demolished the Skinnerian view, paving the way for modern investigations of the mind.

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INFORMATION PROCESSING MODELS IN PSYCHOLOGY
Atkinson and Shiffrin’s (1968) Three Store Model of Memory

An information processing paradigm

Maintenance
Rehearsal
Sensory Register
Short-term Store
Long-term Store

Sensory input
Information is lost in 0.5 to 3 sec
Unrehearsed information is lost in about 15 sec
Some information may be lost over time

George Sperling’s demonstration of the visual icon
Problem With the Standard Information Processing Paradigm

• Often an individual’s prior knowledge or beliefs regarding a scene or situation can influence their perception or memory.

• This is often referred to as “top-down” or schematic based processing.
Bartlett’s Research on Memory For Stories

- Bartlett (1932) studied individuals’ memory for various stories.
- Found that memory does not *reproduce* the original story, rather it is *reconstructive*.
- Memory is constructed by combining elements from the original material with existing knowledge.
- Presented individuals with stories and asked them to recall them after a few minutes.

Findings:

1) Omissions - subjects leave out specific details about the story: names (Egulac) specific events (“his face became contorted”)
   - minor events omitted, loss of information.

2) Successive recalls rationalize and normalize the story.
   - Often added to or altered the story. (e.g. island added)
   - Had effect of making the story more reasonable.
   - (e.g. ghosts less prominent in retellings)
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Where does this information come from? - Schemata

- Bartlett argued that this new information came from the subjects’ past knowledge, or schemata.
- Schema - a stored framework or body of knowledge about some topic.
- So - when subjects encounter the story they try to relate it to their own experience (their knowledge of “Indian warriors doing battle?”).
- If it does not match an existing schema it tends to be altered to make it fit.

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Therefore:
Recall is not a true, exact reproduction of the original material. It is a reconstruction based on elements of the original story and existing schemata.

Hence - “top down” or “schematic based”.

A problem for strict “information processing” or “bottom up” models.
Tells us something important about the structure and organization of the mind.