PSYC230

Cognitive Psychology

Lecture # 2

A Brief History of Cognitive Psychology

Why Psychology Lost its Mind
(& how it found it again)

In the beginning….

psych ology

mind	study of

Psychology = the study of mind

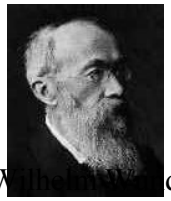
Psychology was part of philosophy

Plato **Descartes**
Aristotle **Locke**

"What is consciousness?" *"What is knowledge?"*
"What is our experience of reality?"
"Are we products of experience or of heredity?"

Our story moves to Leipzig -1879

1st "School" of experimental psychology



Wilhelm Wundt

Structuralism
mapping the structure of mind

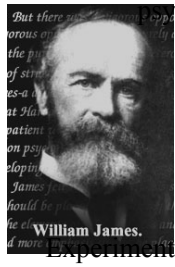
conducted laboratory experiments
using introspection
to answer their questions

"What are the elements of experience?"
"How does perception affect consciousness?"
"How do mind & language develop in children?"

Edward Tichner **James McKeen Cattell** **Hugo Munsterberg**
G. Stanley Hall **H.C. Warren** **Carl Lange** **Emil Krapelin**

Shortly thereafter …

The next great "School" of experimental psychology was established



Functionalism

William James
John Dewey
Edward Thorndike

Experiments on mental elements & adaptive processes using introspection & observation

Laboratories of experimental psychology were established throughout the US & Europe

Then, with the Functionalists' help …

Another great "School" of experimental psychology was established

Behaviourism began as a rejection
to the "unscientific" methods of
the Structuralist school of Psychology

"Psychology as the behaviorist views it is a purely objective experimental branch of natural science. Its theoretical goal is the prediction and control of behavior."

John B. Watson -- 1912

Through the groundbreaking work of several experimental pioneers:

Edward L. Thorndike (1911)
Ivan P. Pavlov (1911)
Edwin B. Twitmeyer (1904)

(& with the support of the Functionalists John Dewey, Wm James, G. Stanley Hall)

behaviourism captured the hearts & minds of the public

by 1930, behaviourism was flourishing, a vibrant, diverse science of behaviour

Many different laboratories were conducting an incredible volume of experiments and developing numerous competing theories of learning and behaviour

(contrary to modern misconception) Theory building was an integral part of behaviourism. Theories energized and guided the research, just as it had for the physical sciences.

Behaviourism

The study of **behaviour**, not mind

By conducting experiments on behaviour and building theories of behaviour, Psychology could become a real science, ***"just like physics"***

Watson S-R associationism

Tolman S-S contiguity theory

Hull S-R-S incentive theory

Guthrie S-R contiguity theory

Premack R-R response probability theory

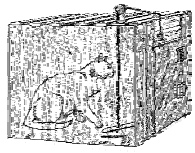
Example:
The debate over "*What is learned?"*

Thorndike's connectionist theory: S-R

Stimulus-response associations constitute learning, and behaviour change follows

Law of Effect: connections between a stimulus and a response are strengthened when followed by satisfiers, decreased when followed by annoyers

E.L. Thorndike's Puzzle box experiments (1898 - 1911)



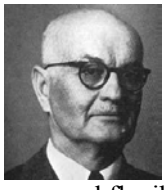
Found gradual, **trial & error problem solving**, no effect of imitation, led to *Law of Effect*

Law of Exercise – Associations grow stronger with use

Law of Disuse – Associations grow weaker as time passes

Tolman's Expectancy Theory: S-S

Stimuli associated with other stimuli to form a "cognitive map"



A given situation results in sign-gestalt-expectation

Behaviour is purposive and flexible, it varies to suit the situation

Expectancies are either confirmed or disconfirmed based on what happens next

A key aspect of Tolman's theory is that learning is sudden, not gradual trial & error

Wolfgang Kohler

psychologist from the University of Berlin, marooned at a primate research facility on Tenerife (Canary Islands) at the start of WWI. He had nine chimpanzees of various ages in a large outdoor pen to watch & study.

Found sudden, **insightful**, discontinuous problem solving in apes

The Mentality of Apes (1925) argued that problem solving is the result of cognitive restructuring

Guthrie's S-R contiguity theory

Stimuli are associated with responses in just one trial, no reinforcement or reward required

In any given situation, you will do just what you did the *last time* you were in that situation

Reward serves merely to change the situation

Gradual changes in performance results from organisms selective attention to different aspects of the situation

Hull's incentive theory: S-R-S

hypothetico-deductive theory, 133 theorems deduced from 17 postulates

For example, behaviour at a choice point could be defined as:

$$sE_R = [sH_R \times (D+K) \times V - I_R + sI_R] - sO_R$$

Generalized drive & drive stimuli, micromolar responses & feedback stimuli, rewards & specific anticipatory responses

$$S_1 - r_G - s_G - R_1 - SR_2 - r_G - s_G - R_2 - SR_3 - r_G - s_G - R_3 - S_G - R_G$$

Chains of Ss & Rs, some internal, some external guiding the organism along a path of behaviour

Premack's Response probability theory: R-R

Responses are associated with other responses

Reward is simply an opportunity to perform more enjoyable response, high-probability responses serve as rewards for low-probability responses.

Eat your vegetable before you have your sweet!

Incredibly rich, productive time for experimental psychology

But the questions were getting harder and harder to answer with strictly behavioural theories

There were difficulties extending behavioural principles and theories to complex behaviours, (especially human behaviours)

Theorists found that they had to consider cognitive phenomena like thoughts, perceptions, and memories to make their theories work on more complicated questions

What reinforces avoidance behaviour?

light - shock - response (escape) - light - response (avoidance) - no shock

how can the non-occurrence of shock maintain behaviour?

Classic S-R: escape removes shock, reinforces S-R assoc., but avoiance should extinguish without more reinf.

S-S: avoidance of light, which is a sign for shock, expectancy is confirmed.

Contiguity: escape response removes shock, situation is changed and response is preserved.

Incentive: escape from secondary aversive stimuli is reward.

Probability: avoidance response is the only un-punished response, nothing reinforces avoidance behaviour!

Karl Lashley -- in search of the engram

interested in the physiology & structures of learning & behaviour

found mass action & equipotentiality

Donald Hebb -- arousal theory

studied cue value and arousal function of stimuli & the reticular activating system

found that early learning is S-R establishment of cell assemblies, later learning is S-S rearrangement of phase sequences

Karl Lashley
University of Chicago
& Harvard University
(student of Watson)

The problems raised by the organization of language seem to me to be characteristic of almost all other cerebral activity. This complex behavior requires advance planning, of a hierarchical sort; it cannot be analyzed as a series of acts, each caused by the environment and the previous act....

Attempts to express cerebral function in terms of the concepts of the reflex arc, or of associated chains of neurons, seem to me doomed to failure because they start with the assumption of a static nervous system. Every bit of evidence available indicated a dynamic, constantly active system, or, rather, a composite of many interacting systems

Stimulus Sampling & Information theories

Estes, Bower, Sheffield

developed sequential statistical models to describe process of attention

Verbal Learning and Memory theories

studied retention interval, clustering, and meaningfulness effects
Spence, Logan, Amsel

Biological (evolutionary) Learning theory

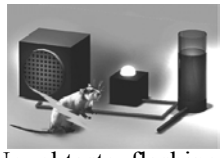
biological constraints and predispositions for learning

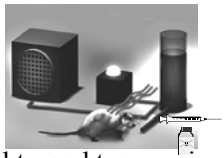
Bolles, Garcia, Shettleworth, Charlton

Biological Constraints on Conditioning

The "laws of learning" didn't appear to apply equally to all responses or organisms

Bright noisy water experiments &
the sauce béarnaise syndrome



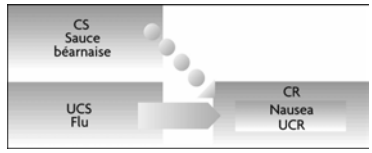


Novel taste, flashing lights, and tones paired with either shock or nausea (classical conditioning)

Biological Constraints on Conditioning

Rats will associate lights and noise with shock but not nausea
Rats will associate taste with nausea but not shock
(also the CS-UCS interval can be quite long for the second case) (Garcia & Koelling 1966)

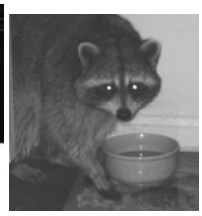
Taste aversions are a "prepared" association



Seligman's "Sauce béarnaise syndrome"

Biological Constraints on Conditioning

Instinctive drift and the "misbehaviour of organisms" (Keller & Marion Breland)



Innate predispositions and fixed action patterns "intruded" on learned behaviours

Biological Constraints on Conditioning

Response specific constraints on conditioning

Bright lights and mild shock increase rates of operant lever pressing for food by hamsters

Triggered a hoarding response

FR schedules of food pellets would *decrease* rates of grooming (*a punisher*?)

Experimental psychology was in a state of scientific crisis....

Thomas Kuhn --*The structure of scientific revolutions*

Some young psychologists argued that it was time for a cognitive revolution, on the grounds of emergentism

The revolutionaries said "*Interesting human behaviours are complex and emergent"*

Emergentism: complex issues cannot be understood by analysis of simpler elements

Can't predict properties of water from knowledge of hydrogen & oxygen, or language from studying rats in mazes

The Cognitive Revolution

Time to return to the original focus of psychology

the mind

Using sound scientific methods of course...

Was it really a revolution?

Not all of the change was sudden or violent ... there were earlier influences

Herman Ebbinghaus

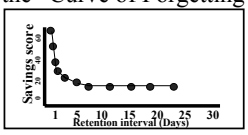
University of Berlin (1885)

the "Meaningfulness Effect"

Digit Span

the number of syllables remembered after one reading without error = 7

the "Curve of Forgetting"



Schema Theory

Schema(ta) are mental frameworks for organising and representing knowledge

Bartlett argued that memory is a reconstructive process

Sir Frederic Bartlett (1932)

Gestalt Psychology

Insight and incubation in problem solving

Figure-ground and perceptual redintegration

THE CAT

Cybernetic Theories

Hixon Symposium at Cal Tech -- September 1948

Karl Lashley "*The problem of serial order in behavior*"

McCulloch & Pitts "*A logical calculus of the ideas immanent in nervous activity*"

von Neumann presents "*The digital computer*" (which he had been designing);

Information was flowing both ways

11 September 1956
MIT Symposium on Information Theory

Chomsky's Three models of language

Miller's Magical number 7

Newell & Simon's Logic Theory Machine

Bruner's paper on concept formation

Focus on cognitive processes, not behaviour

1967 – *Cognitive Psychology*, by Ulrich Neisser

The Cybernetic Synthesis

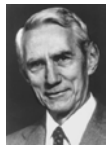
"anything that can be exhaustively and unambiguously put into words is ipso facto realizable by a suitable finite neural network."

The Computer and the Brain
(von Neumann, posthumous, 1958)

John von Neumann

Shannon's Information Theory

(electrical engineer at MIT and Bell Labs)



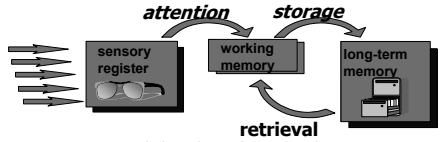
Information is what is *not redundant* in a message -- a quantifiable value.

$\Sigma\ p_i \log (p_i)$

Claude Shannon

Human Information Processing Model

A model for organising research findings about cognition



Sequential series of processing stages

We do not believe that this functional equivalence between brains and computers implies any structural equivalence at a more minute anatomical level...Discovering what neural mechanisms realize these information processing functions in the human brain is a task for another level of theory construction. Our theory is a theory of the information processes involved in problem-solving and not a theory of neural or electronic mechanisms for information processing.

Newell & Simon, 1964

Why a computer metaphor?

Technology has always informed models of mind

The water technology of Greece & Rome
Greek pneumatic concept of the soul
Hippocrates' Four humours (phlegm, bile (black, yellow), & blood)
Galen's *animal spirits*

I wish that you would consider all of these as following altogether naturally in this Machine from the disposition of its organs alone, neither more nor less than do the movements of a clock or other automaton from that of its counterweight and wheels... Descartes

(the human brain and body) *a machine that winds its own springs -- the living image of perpetual motion ...man is an assemblage of springs that are activated reciprocally by one another."*
de la Mettrie *L'Homme Machine, 1747*

Telegraph network – Helmholtz' basic neural metaphor
reverberating relay circuits and solenoids – Hebb's model of memory

Evolution of behavioural theory

Tolman's work on cognitive maps was followed by other theorists interested in stimulus value and network models of knowledge representation

Theories in the Hullian tradition led to verbal learning & memory paradigms, ultimately leading to human associative memory & ACT* models of cognition

Guthrie's work led directly to stimulus sampling theory, selective attention, and computational models of problem solving and procedural knowledge

Since the 1960s, cognitive psychology has been dominant school of experimental psychology

Conducting research on memory, attention, perception, language, problem solving, neuropsychology, and artificial intelligence

Cognitive science - multidisciplinary approach of psychologists, philosophers, linguists, and computer scientists

Moral of the story

Behaviourism did not require empiricism

There are no crucial experiments or proven theories

Narrow views or philosophies can't adapt, evolve or progress

A good question always leads to more questions

Science (cognitive & otherwise) is good fun