



INTRODUCTION TO COGNITIVE PSYCHOLOGY

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PSYCHOPHYSICS I

- Psychophysics: The study of the interactions between stimuli and perception
- Main issue: Threshold
- Influential scientists:
- Gustav Theodor Fechner (German psychologist)
- Ernst Heinrich Weber (German physicist)



PSYCHOPHYSICS II

- Psychophysicists proposed two types of thresholds:
- Absolute threshold (detection threshold): the minimum strength of a physical stimulus so it can be noticed. Absolute auditory threshold can be different among people and also among different frequencies.
- Relative threshold (jnd): smallest detectable difference between two stimuli. Jnd is a function of the strength of the stimuli.



EARLY WORKS

Franz Donders (Dutch ophthalmologist)

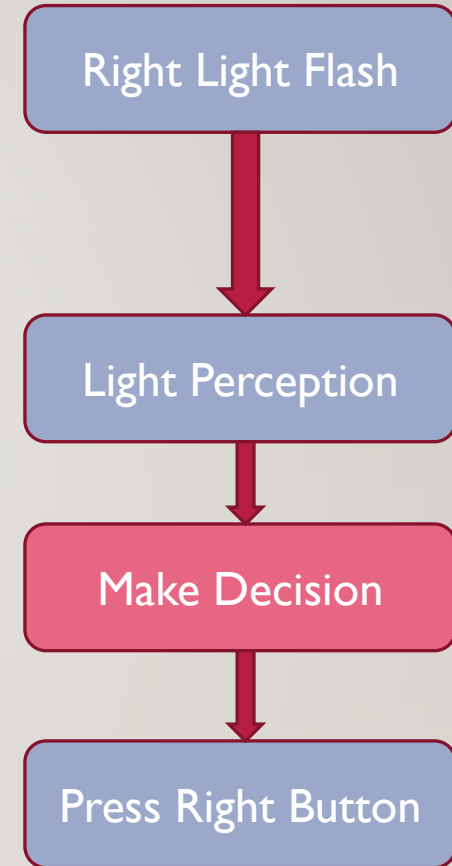
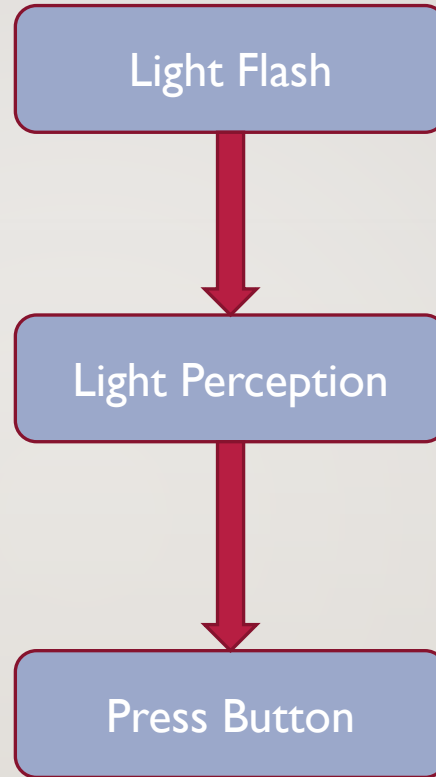
Early works on RT (reaction time)

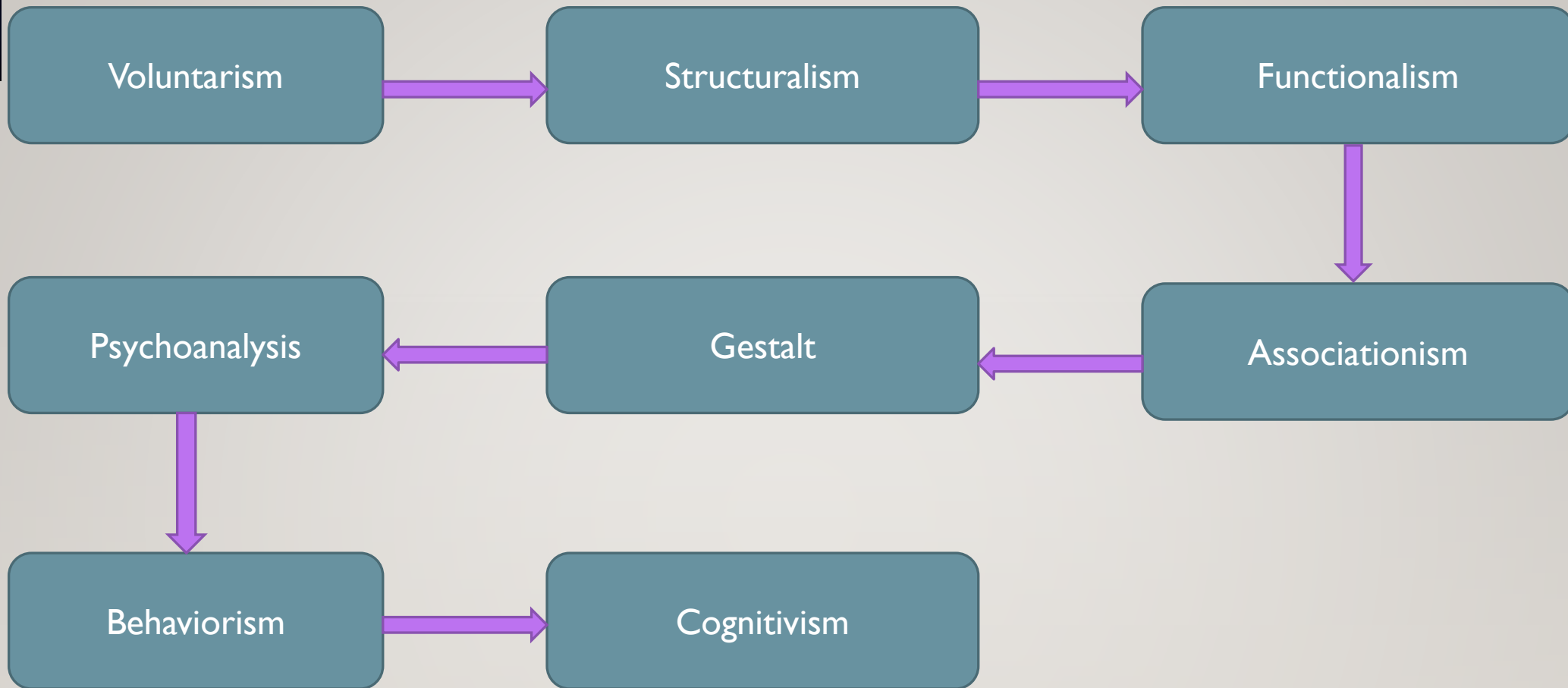
Simple RT Task

Choice RT Task

Used subtraction method

Time to make a decision = Choice RT –
Simple RT







- Voluntarism: Wilhelm Wundt. First psychology lab in Leipzig, Germany in 1879.
- Structuralism: Titchener. Periodic table for the human mind.
- Functionalism: John Dewey, James Rowland Angell. Most famous: William James; published *Principles of Psychology* and held the first course of Psychology at Harvard University.
- Associationism: Synthesis of structuralism and functionalism. Hermann Ebbinghaus and Edward Lee Thorndike.
- Gestalt: The importance of unitary wholes. Gestalt principles: proximity, similarity etc. Max Wertheimer, Wolfgang Koehler and Kurt Koffka.
- Psychoanalysis: Sigmund Freud, Carl Jung and Alfred Adler. Unconscious, subconscious and conscious. Ego, Superego and Id.



BEHAVIORISM

- Shortcomings of introspection
- Main issues: stimulus and response
- Famous diagram: $S \rightarrow R$
- Classical Conditioning
- Influential scientists:
 - John B. Watson
 - Ivan Pavlov
 - Burrhus F. Skinner (operant conditioning; added consequence to the formula)
- Dominant approach for almost 50 years especially in USA.



COGNITIVE PSYCHOLOGY I

- The Cognitive Revolution (George Miller, Allan Newell, Marvin Minsky, Herbert Simon, John McCarthy, Noam Chomsky)
- Against Behaviorism
- Mind-Computer Analogy by Broadbent in 1958:
 1. both have receptors for input and effectors for output,
 2. both have short-term memory,
 3. both have limited capacity,
 4. both have serial processing mostly.
- First Cognitive Psychology textbook by Neisser in 1967
- Other Notable Figures: Karl Spencer Lashley, Donald Hebb and Edward Tolman



COGNITIVE PSYCHOLOGY II

- Psychology: The science of mind and behavior
- Cognition: from the Latin noun *cognitio* (knowledge, learning)
- Cognition: A process by which the sensory input is transformed, reduced, elaborated, stored, recovered and used (Neisser, 1967).
- Cognitive Psychology: The scientific study of mental processes (attention, memory etc.)



BASIC ASSUMPTIONS I

- Representation: A symbol that represents something else.
- Types of Representation:
 1. Concepts; apple, book, plate etc.
 2. Propositions; a statement about the world: It's going to rain.
 3. Analogy; a comparison between two things: The human mind is like a computer
 4. Laws; if-then bonds. If I fail this exam, (then) I won't graduate.
 5. Digital; digits and alphabet letters
 6. Analogue; images.



BASIC ASSUMPTIONS II

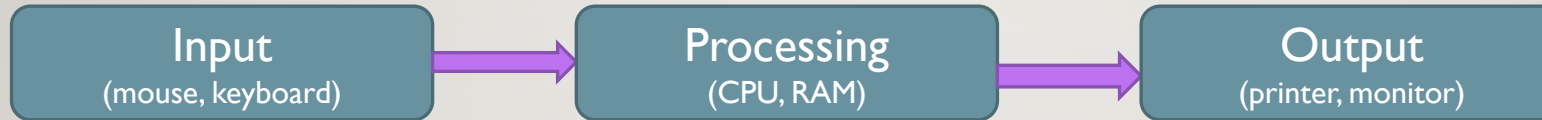
- Computation: Functions that manipulate representations.
- Computer: Data + Algorithm = Running program
- Human Mind: Representation + Computation = Thought
- Information Processing (David Marr, 1982):
 - Computational; abstract level. The reason for solving the problem at hand.
 - Algorithmic; how the problem is solved. What are the steps of problem solving?
 - Implementational; what is the structure of the information processor (computer, human mind etc.)
- CRUM: Computational-Representational Understanding of Mind



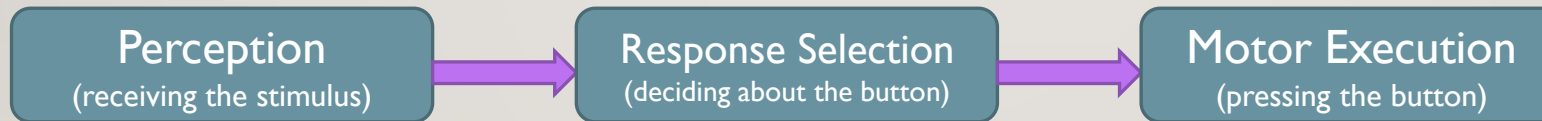


INFORMATION PROCESSING

- Computers



- Human Mind





MAIN APPROACHES (EYSENCK)

- Cognitive Experimental Psychology
- Cognitive Neuropsychology
- Cognitive Modeling and AI
- Cognitive Neuroscience



COGNITIVE EXPERIMENTAL PSYCHOLOGY

- The oldest of the four main approaches.
- Designing controlled experiments in labs like RT tasks.
- Limitations:
- May not necessarily have biological plausibility
- Individual differences are overlooked





COGNITIVE NEUROPSYCHOLOGY

- Main issue: How injuries to specific regions in the brain may effect cognitive functioning.
- Example: People with left PFC lesions perform worse in London Tower task.
- Main assumption: Modularity of the brain. A module is a specific cognitive system that is specialized only in one function e.g. face recognition. If the module is injured, the function is compromised e.g. prosopagnosia.
- Limitations:
 - Different brain regions are involved in every single cognitive functions.
 - One given brain region is activated across a variety of cognitive functions.
 - Individual differenced are overlooked.



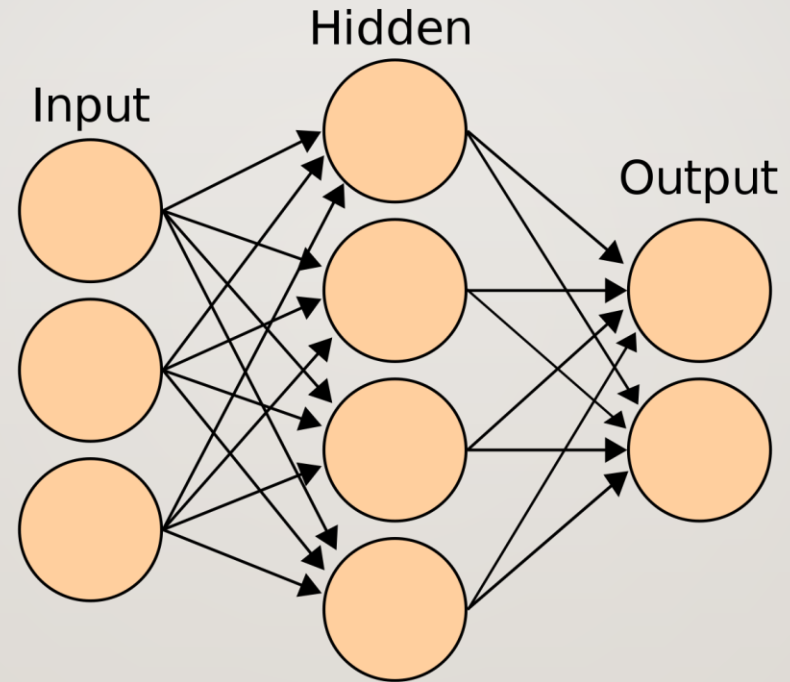
COGNITIVE MODELING AND AI

- Cognitive Modeling: Creating computer models that can mimic cognitive functions of the human mind in the most similar manner
- Artificial Intelligence: Creating systems that have intelligent performance.
- Models help us create a ground for explaining and predicting cognitive functions.





CONNECTIONISM I





CONNECTIONISM II

- Connectionism is a modeling technique that consists of nodes and links.
- Nodes = neurons. Links = axons.
- Connectionist networks can have three types of layers: input, hidden and output.
- Nodes can have excitatory or inhibitory effects on each other. Once the sum of weight for every given node surpassed its threshold, it is activated. Concepts are distributed across nodes as a pattern of activation. These networks can learn by Back Propagation.
- Limitations:
 - Since there are more than 10 types of neurons in the human brain cortex, nodes cannot be plausible representatives for neuros.
 - Hormones and emotions are ignored



COGNITIVE NEUROSCIENCE

- This field studies cognitive functions according to their neural substrates.
- Different techniques: EEG, ERP, MRI, fMRI, MEG and PET.
- Each technique has its own pros and cons. As an example, PET has high spatial resolution but low temporal resolution. EEG has the advantage of very high temporal resolution while its spatial resolution is not as good.



MAIN TOPICS IN COGNITIVE PSYCHOLOGY

- Memory
- Attention
- Problem solving
- Decision making
- Cognitive flexibility
- Social cognition
- Inhibition
- Etc.





CHALLENGES

- Mostly ignoring emotion
- Not Taking into Account Human-Machine Differences
- Embodiment
- Dynamic Systems
- Social Factors





EMOTION

- Most early works in cognitive psychology ignored emotion. However, new studies have taken emotion as a noteworthy component of the human mind. In his theory on decision making, Damasio asserted that deficits in emotion-related system in the brain can lead to ineffective decision making. The Gage model developed by Thagard in 2004 is also a model that considers emotion as an integrative part of decision making.



EMBODIMENT

- According to the theory of embodiment, the human body is inseparable from the human cognition and human beings interact with the outer world using their bodies. George Lakoff and Mark Johnson believe that if we had a different form of a body, our cognition would not exist the way it does.
- Embodiment has been used in robotics to develop tiny robots that learn directly from the environment without the need for complex representations and complex codings.





DYNAMIC SYSTEMS

- According to this approach, the human mind is an unpredictable dynamic system that operates in a nonlinear manner and, similar to chaotic systems, can shift phases without any previous clues. This is why the human behavior can sometimes be hard to predict.
- This theory has been supported in some domains of cognition like decision making and language development.



SOCIAL FACTORS

- The social challenge is based on the idea that human beings are not solitary beings living in utter isolation. On the contrary, people are born and raised among people in societies. As a result, their cognition is shaped by the social interactions. According to the idea of Distributed Cognition, effective thinking is achieved when multiple minds are engaged e.g. sports teams or collective works of scientists.
- This idea can also be found in AI, where many intelligent agents (robots or computers) collaborate to achieve a common goal e.g. robotic football teams. This is similar to connectionism except that every node here is an intelligent agent but not a single neuron.

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THANKS FOR YOUR TIME

