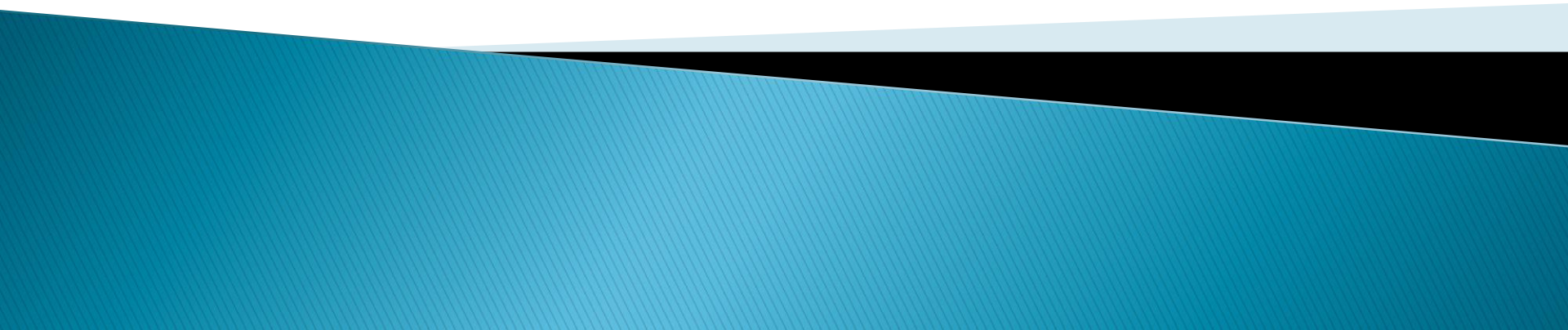


Experimental Psychology

Lecture 6: The Cognitive Revolution

Dr. Kate Williams



Cognitive Psychology

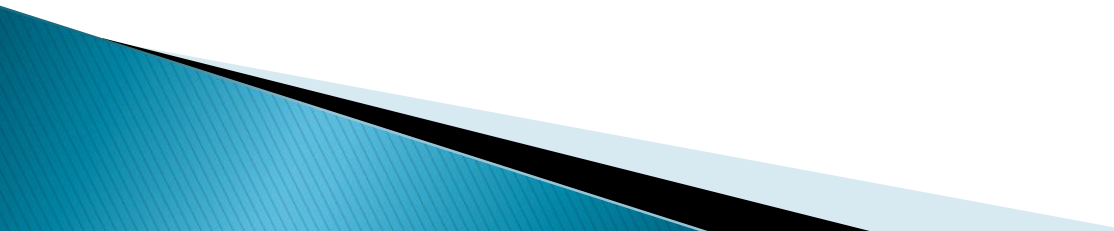
- ▶ When did Behaviourism end?
 - ▶ When did Cognitive Psychology start?
 - No specific date – instead there was a shift in to cognitive experimental research.
 - Why?
 - ▶ Started during the late 1940s and really took hold during the 1950s.
 - ▶ However, work tapping on to what we would consider cognitive processes had been studied as early as the 1800s.
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Hermann Ebbinghaus (1885)

- ▶ Wanted an objective measure of mental operations
- ▶ Studied forgetting in detail by learning a list of nonsense syllables (e.g., dap, sul), and then recall them at various intervals of time – However, most of his studies were carried out on himself as the only participant!!!

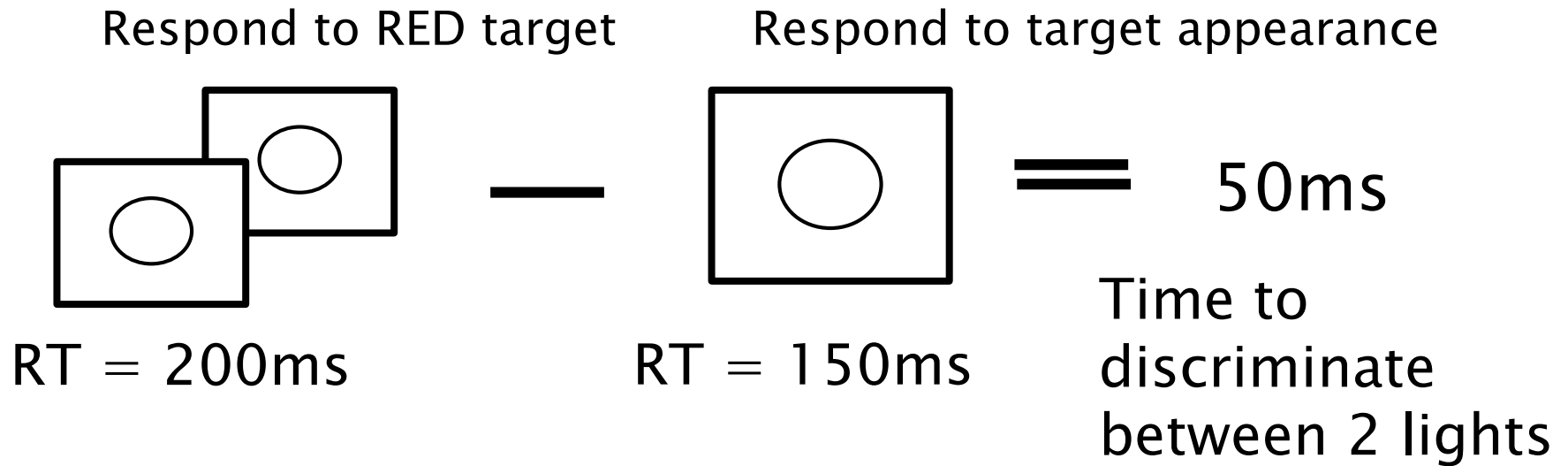


Cognitive Psychology

- ▶ Speed of mental operations: In the 1850s, Johannes Müller predicted that the speed of neural conduction would never be measured (it was faster than the speed of light).
 - ▶ Within a decade, his own student, Hermann von Helmholtz had shown it to be only 100 meters a second.
 - ▶ Mental Chronometry: Almost immediately after Helmholtz in the 1860s, the Dutch physiologist, F. C. Donders, used a very simple method to estimate the speed of mental operations.
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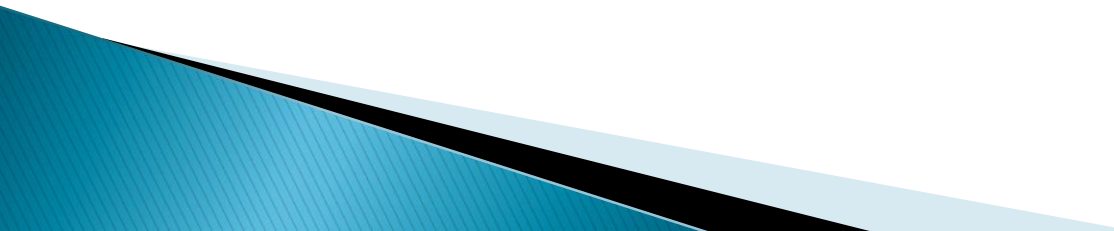
Subtraction Logic

- ▶ Donders' *Subtractive method* was the basis for modern reaction time studies.



Extended this type of experiment to measure response choice – e.g., press key 1 for red and key 2 for green. However, subtraction may not isolate specific mental operations (c.f. Sternberg's, 1968 additive factors method).

1956!

- ▶ An important year for Cognitive Psychology
 - Noam Chomsky gave a paper on his theory of language
 - George Miller discussed the “magic number 7 ± 2 ”
 - Newall and Simon discussed the “thinking computer”
 - First systematic attempt to study concept formation from a cognitive perspective (Bruner, Goodnow, & Austin).
- 

Neisser (1967)

- ▶ Seen as the “Father of Cognitive Psychology”
- ▶ Openly attacked behavioural accounts and instead believed mental process could be measured and analysed.
- ▶ Wrote the book *Cognitive psychology*
 - Measurement and hypothesising observable behaviour
 - E.g., dual-task process
 - Cognitive hypothesis: two similar tasks will take up cognitive processing abilities (‘cognitive load’)
 - Observable behaviour: poorer ability to carry out task than when separate or dissimilar tasks
 - In his other more controversial book *Cognition and reality* he suggested that memory is not a snap shot of a moment but is mainly reconstructed.

Constructive Processes

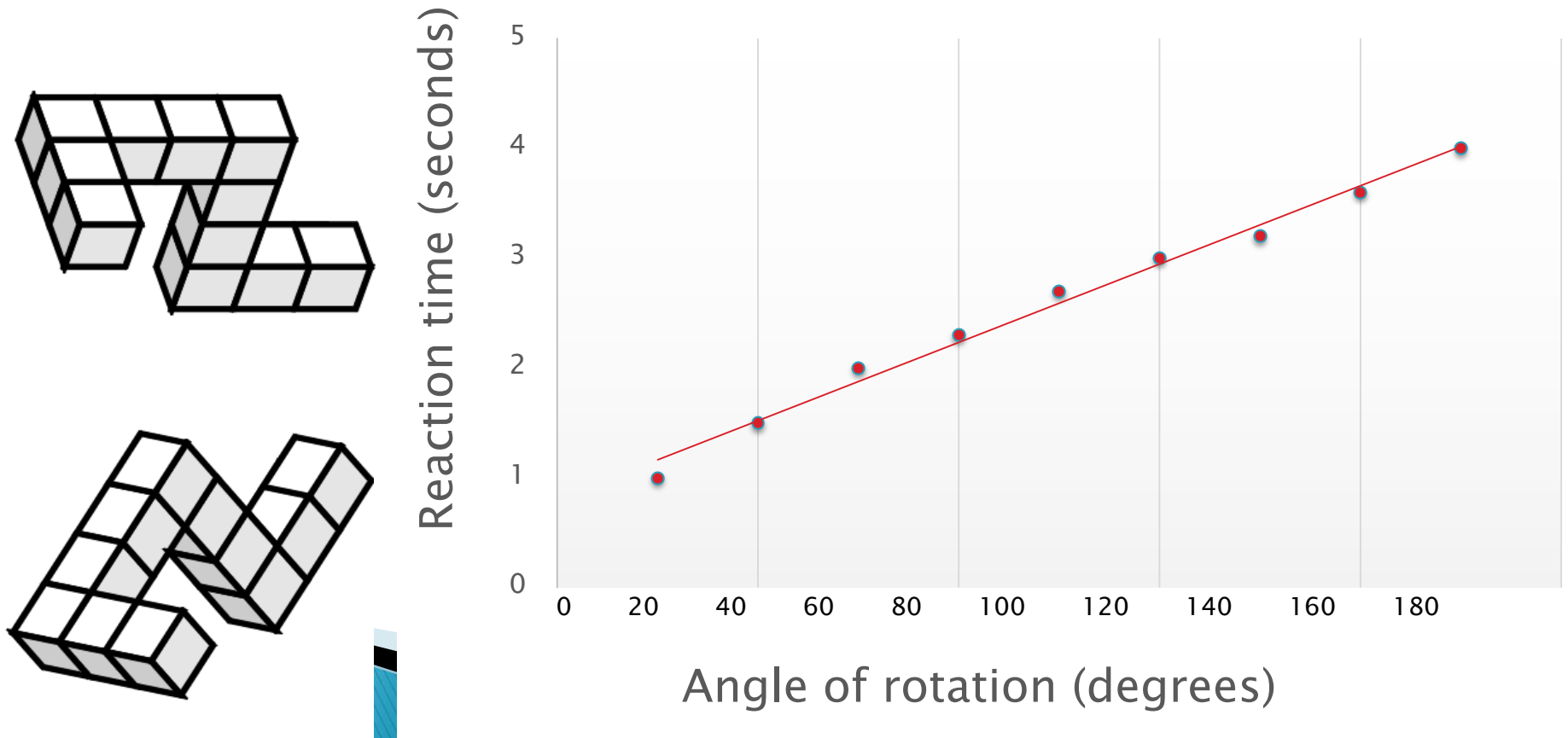
Notion of reconstructive memories had already been discussed by **Bartlett (1932)**.

- Recall errors from stories – War of the Ghosts.
 - Participants remember what *should* happen or what they *expect* to happen rather than what *did* happen.
 - Memory influenced by knowledge, beliefs, etc.
 - Provides evidence of schema theory.
- Although there were some issues with Bartlett's procedures, evidence from other well controlled studies have confirmed his major findings.

Shepard and Metzler (1971)

Mental rotation of objects

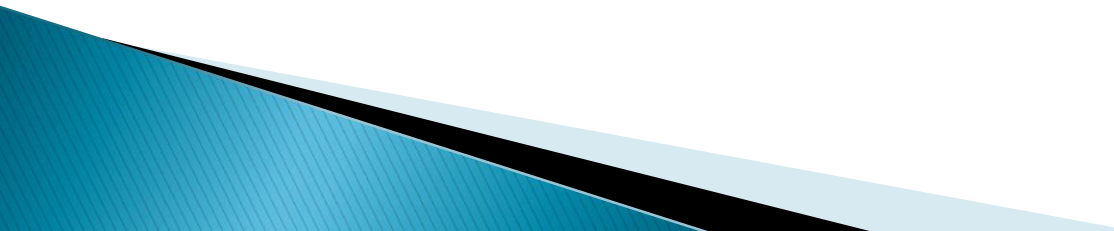
- Overt behavioural response (time taken to respond) was used to infer the nature of a process that was going on within the mind



Inattentional blindness: Neisser & Becklen (1975)

- ▶ Participants required to view two distinct, superimposed videos of people performing simple actions:
 - 1. passing a basketball
 - 2. playing a hand-slapping game.
- ▶ When asked to focus their attention on one event, they often failed to notice an unexpected event occurring in the other.
 - E.g., when counting the number of times several people passed the basketball between each other while ignoring the hand-slapping game, they often failed to notice when the people in the hand-slapping stopped and shook hands.

Cognitive Psychology: Definition

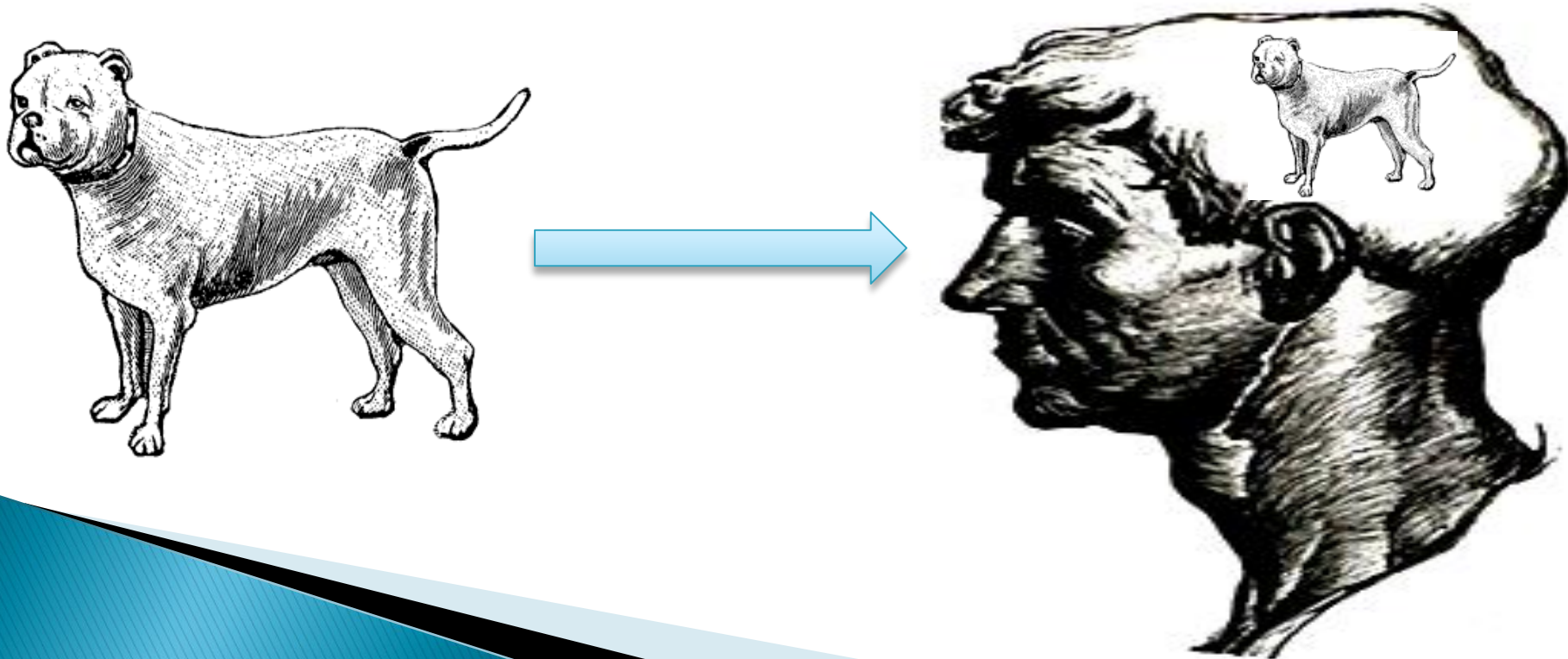
- ▶ The scientific study of the mind
 - Your mind determines and controls your behaviour
 - “Mind” is simply the name we give to the workings of a living brain.
 - ▶ Cognitive Psychology:
 - concerned with internal mental processes that allow us to make sense of the world and help us decide what action we should take when necessary.
 - Whilst observing people’s behaviour as they perform various tasks, cognitive psychology aims to understand how human cognition works.
- 

Representation

A very important word in Cognitive Psychology!!

Does your mind represent information exactly as it exists in the world?

This is the question of ‘representation’ in cognition



Cognitive Processes

- ▶ The main cognitive processes we are attempting to understand include:
 - Attention
 - Learning
 - Language
 - Memory
 - Perception
 - Problem Solving
 - Reasoning
 - Thinking



Cognitive Psychology

- ▶ Cognitive psychology suggests that information is received through the senses and is then processed by various systems in the brain.
- ▶ Some systems store the information in the form of a memory, other systems control behaviour.

Cognitive Psychology:

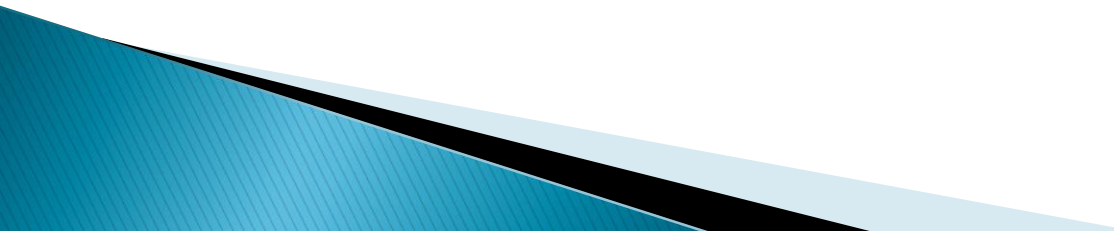
- ▶ Is about trying to learn the rules and discover how information in the brain is represented.
 - ▶ Aims to study knowledge and how we use our knowledge.
 - Cognition from the Latin “Cognoscere” – to know.
 - ▶ Early approaches to cognition focused on very general purpose routines or mental operations.
 - ▶ More recently, research has focused on particular domains – i.e., examining cognitive systems.
 - ▶ Some systems in the brain operate automatically and unconsciously, while others are conscious and require a great deal of effort by the individual.
- 

Approaches to Human Cognition

1. Experimental Cognitive Psychology
 - Uses behavioural evidence
 2. Computational Cognitive Science
 - Uses computational models (takes account of our knowledge of behaviour and the brain).
 3. Cognitive Neuropsychology
 - Involves studying brain-damaged patients
 4. Cognitive Neuroscience
 - Behavioural evidence + evidence from the brain
- Although there are 4 main approaches, researchers nowadays make use of two or more combined to achieve the most comprehensive account of cognition.
- 

Cognitive Psychology: Information Processing

Much of Cognitive Psychology adhered to an approach called
“Information Processing”

- This refers to information being received through the senses, which is then **Processed** by various systems in the brain.
 - The brain is an active, systematic processor of information.
 - Information from the external world is acquired, selected, represented, stored, organised, transformed, and used by the brain according to rules.
- 

RESPONSE OR ACTION

Decision

Thought processes

Perception

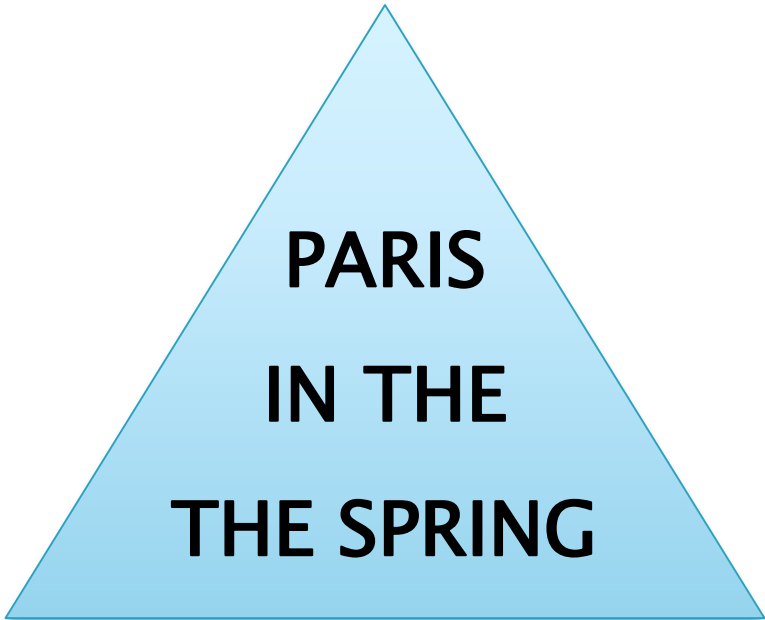
Attention

STIMULUS

- An early version of the information processing approach.
- Stimulus causes internal cognitive processes to occur and these produce a desired response.
- Processing is directly affected by stimulus.
- Known as *Bottom-up processing*.
- Only one process occurs at a given time: *Serial processing*.
- One process must be completed before the next one starts

Major issue 1: Direction of processing

- ▶ Oversimplified explanation of complex mechanisms.
- ▶ *Top-down information processing* exists:
 - Influenced by an individual's expectations and knowledge rather than just looking at a stimulus.
 - E.g., look at the triangle and read the words out aloud...



PARIS
IN THE
THE SPRING

Major issue 2: Type of processing

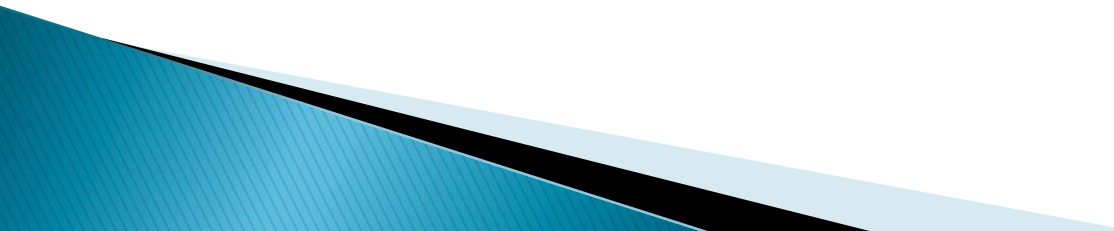
- ▶ Oversimplified assumption that processing is serial
- ▶ *Parallel Processing* exists:
 - Some processes need to be carried out at the same time during a cognitive task.
 - E.g., the difference between an experienced and a learner driver.
- ▶ Because the information-processing approach was first devised to describe the operations of complex physical systems, such as computers, the model of the human brain for many cognitive psychologists was the computer.

The computer metaphor

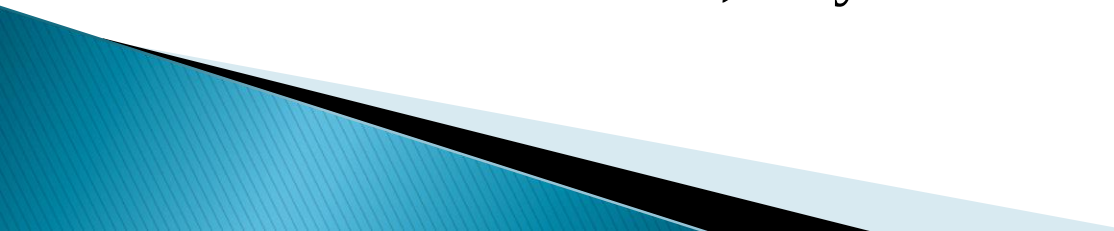
▶ Neisser (1967)

- “The task of....trying to understand human cognition is analogous to that of... trying to understand how a computer has been programmed” (p.6).
- Hardware = brain structures etc.
- Software = mental processes and abilities

David Marr

- ▶ Early work on human physiology
 - ▶ Most famous for pioneering computational approach to vision and despite dying tragically young influenced a whole generation of vision researchers.
 - ▶ Marr's Levels:
 - Computational level: **what** a cognitive system computes & **why**
 - Algorithmic level: **how** is computation achieved, **what** are the processes and representations
 - Implementation level: **Where** is computation realised, underlying hardware.
- 

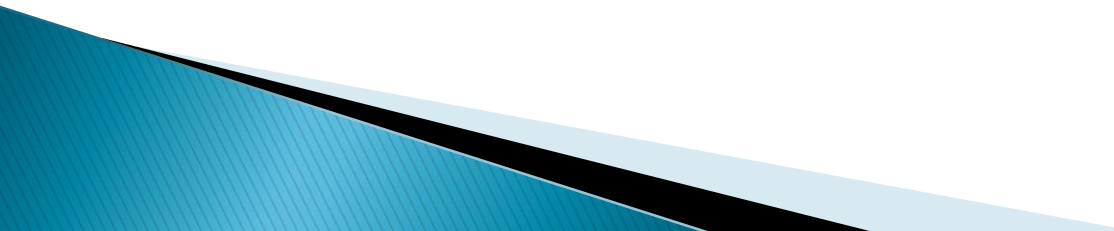
Alan Turing

- ▶ Mathematical and computer scientist who played a role in cracking the German Enigma code during WW2.
 - ▶ Believed humans and computers were not that different:
 - Follow a series of rules in a step-by-step manner and manipulate symbols according to rules.
 - ▶ Turing Test/Imitation Game
 - Can a computer be created that could fool a human with responses?
 - Thinking defined in terms of computer output (verbal behaviour)
 - ▶ If human and machine perform the same in the Imitation Game then the material is irrelevant; only the function matters
- 

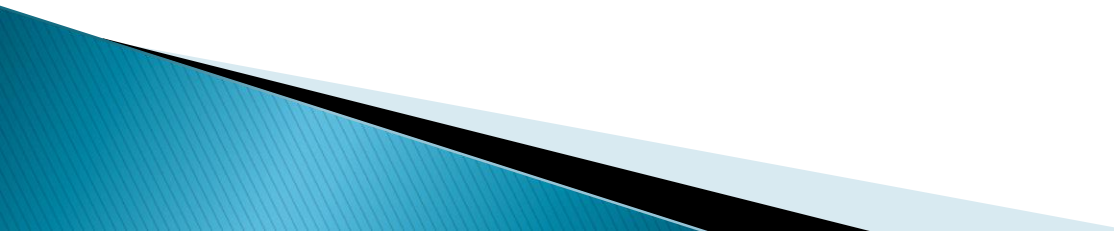
Artificial Intelligence (AI)

- ▶ So, I've been asking you over the past few weeks:
 - “Do animals think?”
 - ▶ Well now we have moved on to the question:
 - “Do computers think?”
 - ▶ If computers and the human mind are similar in the way they take in information, transform it and produce an output, then could we understand the nature of human mental states by instantiating (representing) them in computer models?
 - ▶ Because we have to design what happens between the input and output stage, we should understand what goes on in-between these stages in humans.
- 

Artificial Intelligence (AI)

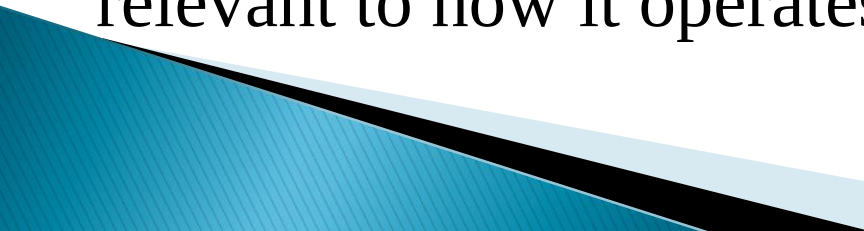
- ▶ Two of the main proponents of AI were Simon & Newell.
 - Humans and computers could be compared because both were mechanisms that manipulated symbols or representations.
 - ▶ ELIZA (created by Weizenbaum, 1966).
 - Similar to imitation game of Turing but designed to mimic interaction between a client and a therapist.
 - ▶ So, manipulating symbols (linguistic in this case) could produce a plausible output no different to a human – so for functionalism the programme would be thinking.
- 

However!

- ▶ Fodor: mental states should not be thought of as functioning in a relationship with the environment, instead they should be viewed as entirely internal.
 - To be in a certain mental state is to stand in a certain relation to a mental representation.
 - E.g., whether it's raining or not makes no difference to the mental states of knowing it is raining vs. worrying it is raining.
 - ▶ Descartes believed that the mind could exist even if there was no external world – So, mental states could be investigated in their own terms without reference to the environment.
 - ▶ But how would information feed in to the representation if there was no external world?
- 

- ▶ That question is one that concerns the source of information and not the representation itself.
 - ▶ But, according to Fodor the representation itself **and** what can be done with it can be understood without reference to the external world.
 - ▶ The computational rules that symbolic representations are manipulated on is independent of the environment in which the mind exists.
 - ▶ Computational theory of the mind allowed the strengthening of this idea – a computer manipulates symbols according to rules encoded in its program, the accuracy of the information the computer is given makes no difference to the way it works – it still follows the same program without reference to the external world because it is irrelevant.
- 

Fodor: methodological solipsism and modularity

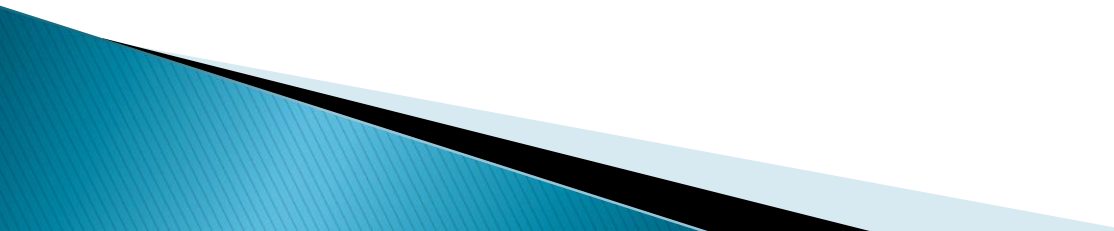
- ▶ Fodor: the research strategy of cognitivism is one of Methodological solipsism – a philosophical position according to which the person believes that they are actually the only person in existence and everything else is just an illusion in their mind.
 - ▶ Fodor didn't actually believe in solipsism (just as Descartes didn't believe there was no external world).
 - ▶ The point they are making is that we can understand the workings of the mind as if there was nothing outside of it.
 - ▶ Even though there are things outside of it, they are not relevant to how it operates.
- 

Do computers understand input and produce outputs in the same way as humans?

Searle's 'Chinese Room' argument (1980)



Criticisms of AI

- ▶ Searle: thinking must be more than manipulating symbols according to formal rules.
 - ▶ Also, the human brain is made of completely different material to computers.
 - ▶ Dreyfus: We are not incidental to cognition – e.g., we are involved in many open-ended task where there are an infinite number of ways to perform.
 - Skilled actions like riding a bike cannot be encoded from rules.
 - The role of the situation is critical and environmental situations in which thinking takes place needs to be taken into account.
- 

Modularity and the mind

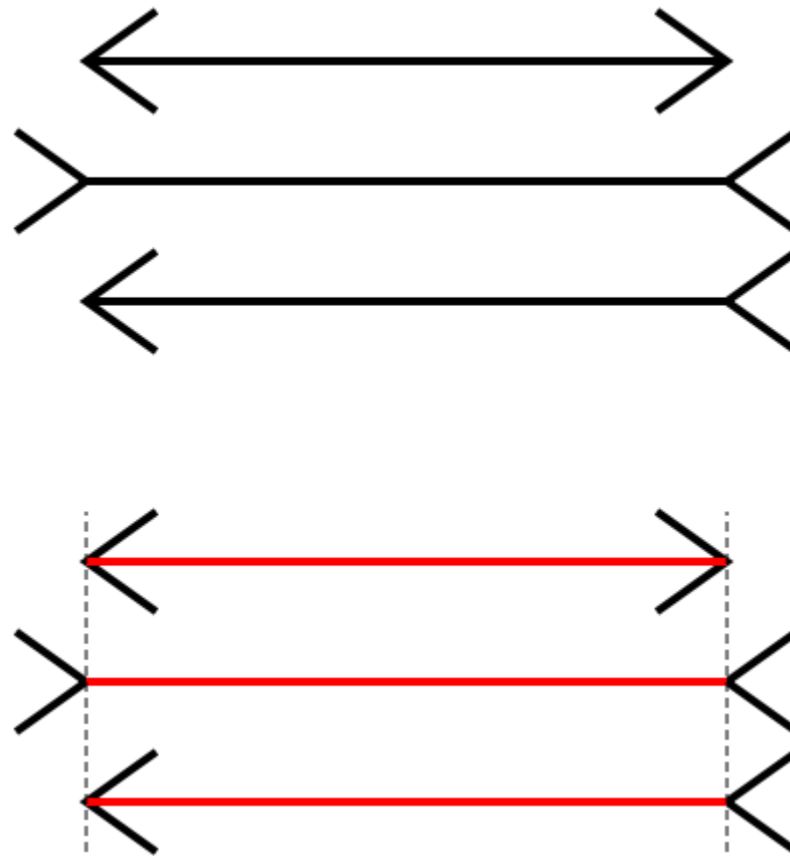
- Question: what is the nature and structure of mental organisations.
 - Fodor: the mind is organised in terms of a collection of modules - functional units that do a particular task or processes a particular type of information (domain specific).
 - Chomsky: compares mental modules to physical organs - heart or liver are isolated structures that perform specific functions.
 - But: they do **not** correspond to isolated brain regions - instead they are functional units.
- 

Modularity and the mind

- Differs to how the associationists view the mind –
 - the mind operates with one general purpose mechanism, i.e., association.
 - The same processes and principle explain everything in the mental domain.
 - But for Fodor the existence of particular modules, precedes the processing of information. Information can only be processed because the modules exist. The structure of the mind is the cause of the processing that takes place and not the effect of that processing. Furthermore, these modules can develop and change over time as we mature.
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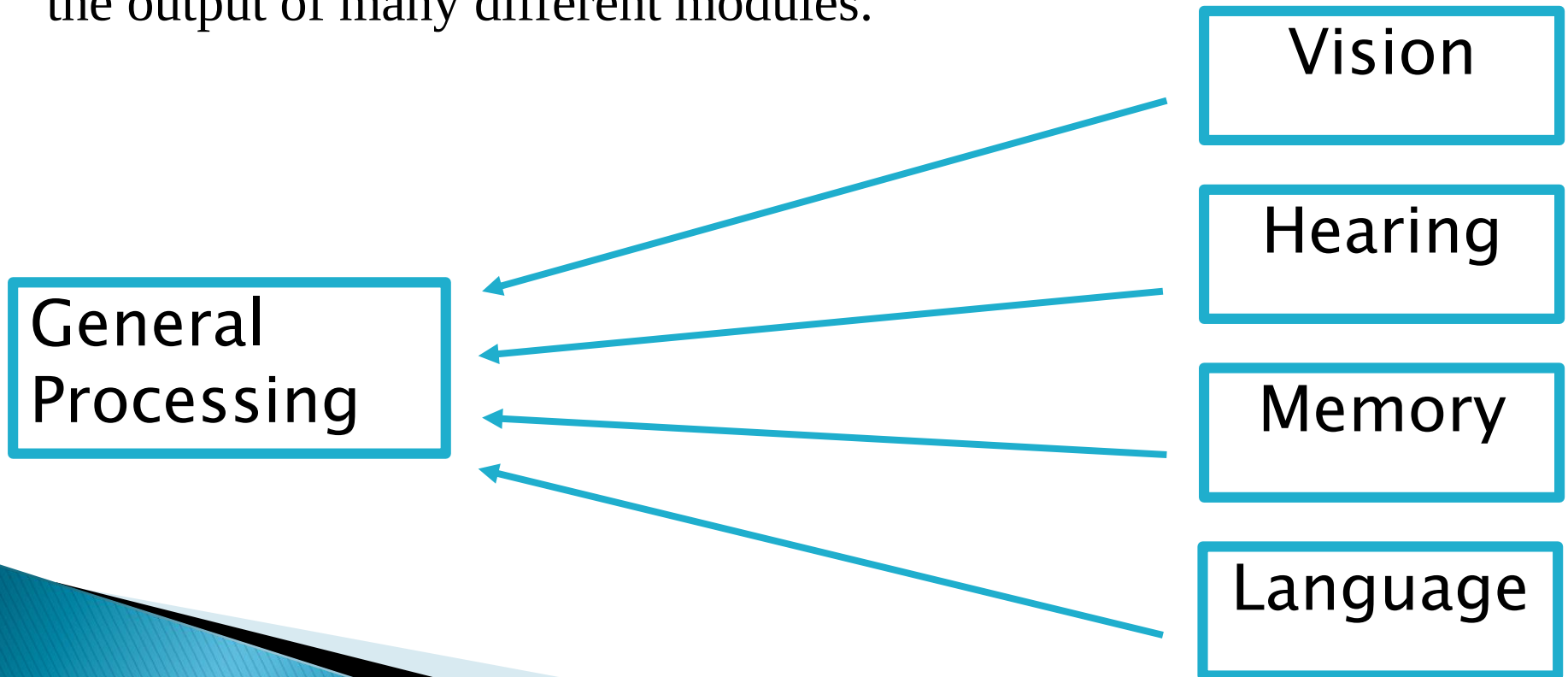
Müller-Lyer Illusion & Fodor's theory of modularity

- Through automatic processing, modules deal with specific information with minimal interference from other modules: known as information encapsulation.

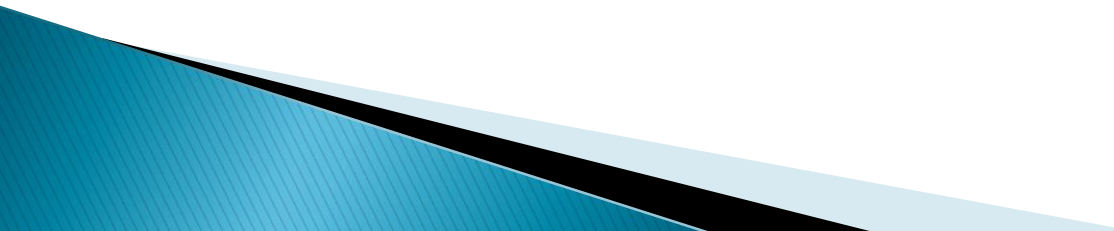


Modularity and the mind

- System of modules = more efficient - able to deal with threats quicker - if no independent then any information entering one type could slow down another.
- But at times we need to combine/coordinate information, so Fodor imagines there are a set of more general processes that can deal with the output of many different modules.



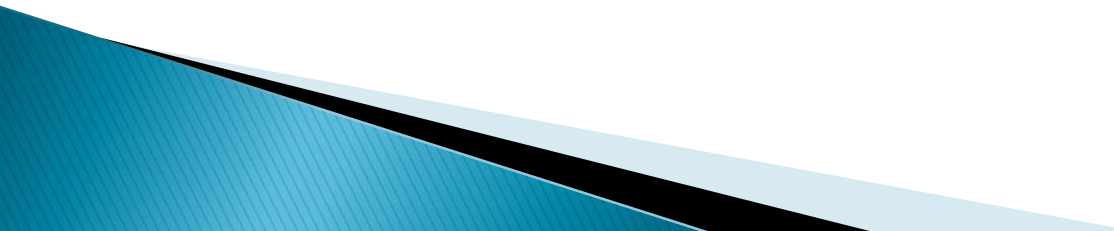
Connectionism

- ▶ An alternative to the digital computer metaphor of cognition
 - ▶ Also known as Parallel Distributed Processing (PDP).
 - ▶ The main difference is that PDP proposes that information can be processed in parallel – different parts of the brain process different sorts of information at the same time.
 - ▶ Secondly, rather than encoding symbols, information is represented by a pattern of activation across a network of neurons (P. M. Churchland 1986, p.460).
- 

Connectionism

- ▶ Gained most of its recognition following the work of Rumelhart and McClelland (1986).
 - ▶ Connectionist models have been proposed for many different domains of cognitive processing.
 - E.g., cognitive control, language processing, perception and memory.
 - ▶ Although the architecture of the models put forward to explain certain areas of cognition may differ to each other, the underlying concept of connectionism is common amongst them all.
- 

The Location of Thought?

- ▶ Is there a specific place in the brain where consciousness of a particular event occurs?
 - ▶ ‘Cartesian materialism’ - consciousness arises in a particular location in the brain (based on Descartes belief that the mind and body interacted in the Pineal gland).
 - ▶ Daniel Dennett: consciousness is the result of processes going on over a period of time in different parts of the brain. There are multiple processing sites and streams not a single privileged one of consciousness. Information in any one of the multiple processing streams may enter in to conscious awareness depending on the task.
- 

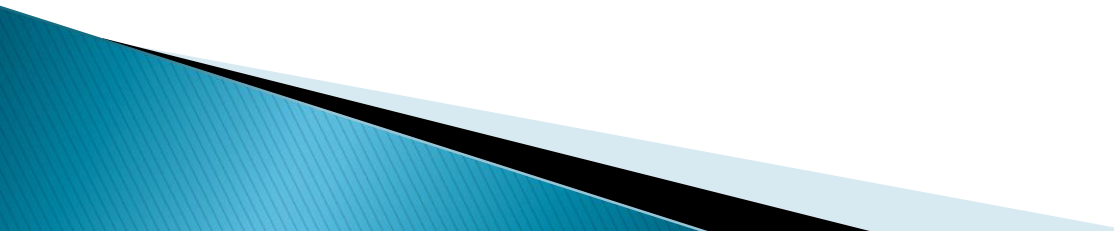
The Location of Thought?

- ▶ Antonio Damasio: not enough to just look at the brain, we must consider the whole body as well.
 - ▶ If rationality cannot be understood just by looking at the brain, we would need to look at how feelings are generated in various organs of the body during our process of thinking.
 - ▶ The body is not just machinery attached to our brain that allows us to move and keep us alive – is critical for our mental lives – e.g., in things like reasoning.
 - Feeling pain in your chest at the thought of something really sad.
- 

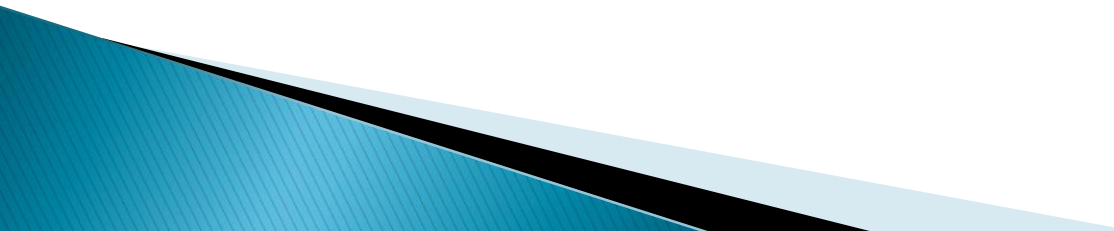
Embodied cognition

- ▶ The importance in recognising the brain, body and the environment in the psychological.
 - ▶ Perception and cognition are for the control of action not just gaining knowledge for the sake of it.
 - ▶ Perception and cognition are themselves considered forms of action, and as particular types of behaviour performed on the organisms environment.
 - ▶ Gibson: **Affordance of action** - we perceive objects not in an abstract mathematical or geometrical term but in terms of the actions that they support (afford).
 - ▶ E.g., instead of just thinking “that stream looks about 1.5m wide” you would think in terms of gauging whether you could jump over it.
- 

Embodied Cognition

- ▶ Too much of psychology was focused on knowing ‘**that** something’, at the expense of knowing ‘**how** something’,
 - ▶ E.g., a disembodied brain would not be able to ride a bike.
 - ▶ Clark: when searching for a yellow cup, vision is not concerned with creating a representation of the cup nor the scene in which it may be found.
 - Instead the aim of vision is to perform a practical task in the simplest way possible. Other visual characteristics (e.g., shape of other objects in the environment) do not need be considered in the initial search at least. The creation of a detailed inner representation is replaced by a quick and efficient behaviour directed to the environment.
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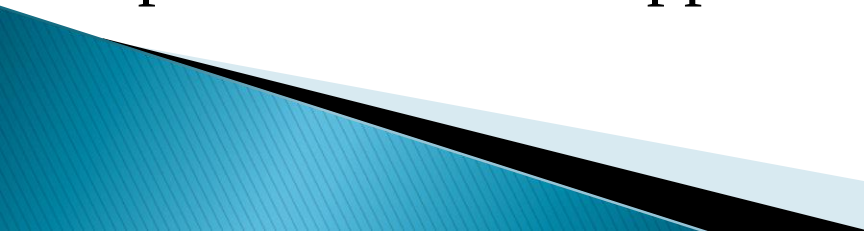
Cognition and Perception

- ▶ Perception: a way of interacting with the world, not by following rules but by knowing how to skilfully explore it.
 - ▶ Some embodied cognition theorists reject the idea of internal mental representations – they don't believe there is a duplicate view of the world in our heads.
 - ▶ O'Regan (1992): no need to store large amounts of information in our heads because the information needed to control our behaviour is outside in the environment – the world can be thought of as an external memory.
- 

Cognition and Perception

- ▶ The notion of a representation was only needed because traditional cognitivism separated the mind from the world.
 - ▶ If mental processes interact with the environment then mental representations are no longer needed.
 - ▶ However, Clark argues that not all activities are driven by interaction with the environment.
 - ▶ Can you think of anything that requires internal processing?
 - Planning.
 - However, this representation is not seen in the same way as the symbolic representations of traditional cognitivism.
 - Thinking about what you will do at the weekend stimulates the actions you may perform but in a mental way.
- 

Cognitive Psychology: Limitations

- ▶ Low Ecological validity: most cognitive psychology experiments take place in the lab – how well does this relate to real life?
 - ▶ Indirect evidence of internal processes: Cognitive Psychology experiments typically measure speed and/or accuracy of a participant during a task.
 - ▶ Vague theories: Difficult to make connection between verbal description and what's actually going on in the brain.
 - ▶ Paradigm specificity: Findings are so specific that they cannot be generalised to other tasks.
 - ▶ Specific theories applicable to narrow range of tasks.
- 

Next Week...

▶ Lecture: Cognitive Neuroscience

- A look at how the examination of brain damaged patients could attempt to help explain how normal cognitive functioning works.
- A look at how development in technology paved the way for Cognitive Neuroscience to examine the brain.

▶ Seminar: Change blindness - Cognition in Action

- Links provided on Moodle to 2 of the most important empirical papers in this field of study.
- In preparation for the seminar you should read these papers and consider how instances of change blindness may impact upon our day-to-day interactions in the real world.
 - Simons and Levin “Change Blindness”
 - Simons and Levin “Failure to detect change”