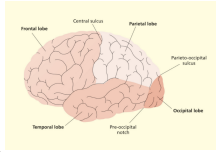
COGNITIVE PSYCHOLOGY (CH1)

The brain in action

1. **Cerebral cortex**: divided in 4 main divisions or lobes:
   a. frontal
   b. parietal
   c. temporal
   d. occipital
2. **sulcus**: divide the frontal lobes from the parietal lobes
3. **Gyri** or ridges

Brain areas activated during task performance:
1. **Dorsal** (or superior)
2. **Ventral** (or inferior)
3. **Anterior** (or rostral)
4. **Posterior**
5. **Lateral**
6. **Medial**

52 Brodmann areas: difference of distribution of cell types across cortical layers. Areas with different main focus



Intense study of brain activity (and behaviour). Structure of the brain extremely complicated. 100 billion neurons connected in complex ways,

The brain is always active. Even if we are not doing anything. **Default mode network**: when technically the brain is thinking and doing nothing. But if there would be no actual activity we would be dead

To see if a person is dead check activity in the brain. Even in coma you register activity in brain

Different techniques to study the brain divided by temporal and space precision
1. **Single-unit recording**: involves inserting a micro-electrode into the brain to study activity of a single neuron. Very localized and very detailed
2. **Event-related potentials**: pattern of electrical brain activity recorded by several scalp electrodes
3. **Positron emission tomography**: detection of positrons
4. **Functional magnetic resonance imaging**: using fMRI (magnetic resonance imaging machine), allows to analize a function of an area. Non-invasive
5. **Event-related functional magnetic resonance imaging**: separating the elements of an experiment into discrete points in time
6. **Magneto-encephalography**: measuring the magnetic fields produce by electrical brain activity
7. **Transcrinial magnetic stimulation**: coil placed to the participant head and a brief pulse of current is run through it
8. **Transcranial direct current stimulation**: weak electric current is passed through a fixen brain area for some time

Transcarnial magnetic stimulation (TMS)
Magnetic filed that create interference in brain cells. Simulate a lesion, block activity in a specific position it provides direct evidence of involvement of brain regions (causal inference)

Use double dissociation to decided if an areas is important for a specific function, do 2 tests.
- TMS in that areas, show interference with the task
- TMS in another area

Limitations:
1. Effects of TMS not fully understood
2. Brain areas not directly targeted may also be affected
3. Limited to brain areas lying beneath the skull

Cognitive neuropsychology

Extensive use in cognitive neuropsychology of single case studies.
1. Because they could only gain access to few patienets with a given pattern of cognitive impairment
2. Often assumed that every patients had a different pattern oc cognitive impairment

Recent years more case-series study, is preferable to single-case studies.
1. Proxdies much richer data
2. We can assess the extent of variation
3. We can identify the finding from patients who are outliers

Single case study: no use anymore

This are cons of cognitive neuropsychology

Focuses on the patterns of cognitive performance of **brain-damaged patients** having a lesion. Studying lesion patienets tells us much about cognition in healthy individuals

It is not about the brain. Is about the information-processing models of cognition

Search for **dissociations**: patients may perform well on one task but poorly on a second one.

Use **double dissociation**: find that some brain-damaged individiduals have intanct performance on one task but poor performance on another task and another group of individuals exhibit the opposite pattern

Limitations of double dissociations

1. Based on the assumption that separate modules exists
2. Can be explained in various ways and so provide only indirect evidence for separate modules underlying each task
3. Hard to decide which of the very numerous double dissociation are theoretically important

Cognitive neuroscience: combination of cognitive psychology and cognitive neuroscience to understand how the brain works

explore human congition in several ways

1. **Brain-imaging techniques** (resonance imaging)
2. **Electrophysiological techniques** (recording of electrical signals generated by the brain)
3. Studies on the effects of **brain damage** on cognition

AIM: understand human cognition by observing the behaviour of people with cognitive tasks

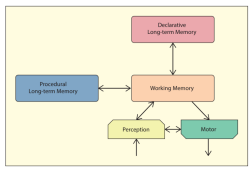


Figure 1.13
The basic structure of the standard model involving five independent modules. Declarative memory (see Glossary) stores facts and events whereas procedural memory (see Glossary) stores knowledge about actions.

Information that comes from the outside is analyzed from the senses (**perception**). Is a representation of what is outside

Working memory: information of what i am conscious of now

Declarative long term memory: storage of what we learn in our lifetime (meaning of words...). *What is the capital of Italy?* you can tell precisely the answer

Prodedural long time memory: motion-memory (how to write, to ride a bike...) Can not tell exactly to someone how to ride a bike

All the informations interact and you decided to perform a task. Your **motor** system perform it

Computational cognitive science

Computational modelling: programming a computer to model or mimic human cognitive functioning. Understand the human mind through computer stimulation. Focusen specific aspects of human cognition and provide cognitive architectures (framework for understanding human cognition in the form of a computer program)
Artificial intelligence: costructing computer system producing intelligence outcomes in ways different from humans. AI is a dedicated program that does a specific thing that can be better than human. But the brain can do multiple things togther, up to now we can not recrate a machine that is as good as our brain

This are cons of cognitive science

Visual imaging: we can recreate in our mind an image of a place where we have been. It is not imagination. Is a recreation of the same computation that the brain does when we are actually in that place.

Debate: it is a recreation or is reasoning because there is no brain activity dedicated to visual imaging? answer: is a mixture of the two

This are cons of cognitive neuroscience

First approach: **behaviourism** (first half 20th century). Psychologists should focus on stimuli and responses

Next approach: **bottom-up processing**: processing is directly influenced by environmental stimuli. Taste processing usually involves also top-down processing: stimulus processing is influenced by the invidual's past experience and expectations

1. **Cognitive psychology**: using behavioral evidence to enhance our understanding of human cognition. Try to understand how the human brain works. Select a specifi task, make a prediction, collect empirical data and check if hypothesis is right. Don't look at the brain activity but we study the behaviour
2. **Cognitive neuropsychology**: study brain-damaged patients to understand normal human cognition. Compare the results of brain-damaged patienets with not-brain-damaged patients
3. **Cognitive neuroscience**: using evidence from behaviour and the brain to understand human cognition. Measure brain activity when we do a task
4. **Computational cognitive science**: using computational models to understand human cognition. Usign algorithm

This approaches to human congition

Replication crisis: only 50% of results of cognitive psychology are reproduced. Even very small changes can induce people to perform differently. Some psychology publish not all the data but only the data of the results.

The 50% of the replicated results are actually very imprecise

CHAPTER SUMMARY

- **Introduction.** Cognitive psychology used to be unified by an approach based on an analogy between the mind and the computer. This information-processing approach viewed the mind as a general-purpose, symbol-processing system of limited capacity. Today there are four main approaches to human cognition: experimental cognitive psychology; cognitive neuroscience; cognitive neuropsychology; and computational cognitive science. These four approaches are increasingly combined to provide an enriched understanding of human cognition.
- **Cognitive psychology.** Cognitive psychology focuses on internal mental processes whereas behaviourism focused mostly on observable stimuli and responses. Cognitive psychologists assume top-down and bottom-up processes are both involved in the performance of cognitive tasks. These processes can be seen as parallel. Various methods (e.g., latent-variable analysis) have been used to identify the underlying processes and to identify the processes within cognitive tasks. Cognitive psychology has massively influenced theorising and the tasks used across all major approaches to human cognition. In spite of its enormous contributions, cognitive psychology sometimes lacks ecological validity, suffers from paradigm specificity and is theoretically vague.
- **Cognitive neuropsychology.** Cognitive neuropsychology is based on various assumptions including modularity, anatomical modularity, uniformity of functional architecture and subtractivity. Double dissociations provide reasonable (limited) evidence for separate modules or systems. The case-study approach is more informative than the single-case approach. Cognitive neuropsychology is limited for several reasons: its assumptions are mostly too strong; patients can develop compensatory strategies; there is brain plasticity; brain damage can cause widespread reduced connectivity within the brain; and it underestimates the extent of integrated brain functioning.
- **Cognitive neuroscience: the brain in action.** Cognitive neuroscientists study the brain as well as behaviour using techniques varying in spatial and temporal resolution. Functional neuroimaging techniques provide basically correlational evidence, but transcranial magnetic stimulation (TMS) can indicate if a given brain area is necessarily involved in a given cognitive function. The study of patients with brain damage has contributed considerably to the assessment of functional specialization and brain integration. Cognitive neuroscience is a flexible and potentially self-correcting approach. However, correlational findings are sometimes over-interpreted, underpowered studies make replication difficult, and relatively few studies in cognitive neuroscience generate (or even test) cognitive theories.
- **Computational cognitive science.** Computational cognitive scientists develop computational models to understand human cognition. Connectionist networks use elementary units or nodes connected together. They can learn using rules such as backward propagation. Production systems consist of production or "IF THEN" rules. ACT-R is a highly developed model based on production systems. Computational models have increased in scope to provide detailed theoretical accounts of findings from cognitive neuroscience and cognitive neuropsychology. They have shown progress via the use of nested incremental modelling. Computational models are often hard to falsify, de-emphasise motivational and emotional factors, and often lack biological plausibility.
- **Is there a replication crisis?** There is increasing evidence that many findings in psychology (including cognitive psychology) are hard to replicate. However, this does not mean there is a replication crisis. Meta-analyses indicate that numerous findings have been successfully replicated many times. In addition, experimental research practices have improved considerably in recent years which should increase successful replications in the future.