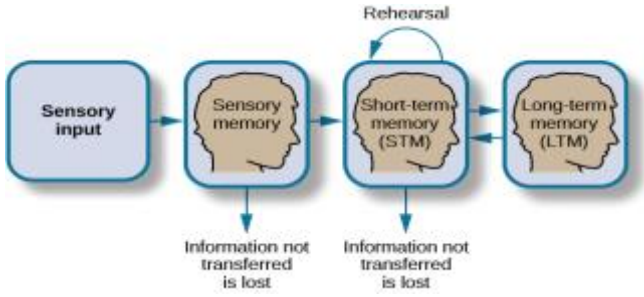
Chapter 1 – Introducing Cognitive Neuroscience

Philosophical approaches to mind and brain

- Cognition – A variety of higher mental processes such as thinking, perceiving, imagining, speaking, acting and planning
- Cognitive neuroscience – Aims to explain cognitive processes in terms of brain based mechanisms
- Mind-body problem – How can a physical substance (the brain) give rise to feelings, thoughts and emotions (mind)
    1. Dualism – belief that mind and brain are made of different substances (Descartes 1600's)
    2. Dual-aspect theory – mind and brain are two levels of description of the same thing
    3. Reductionism – mind-based concepts will eventually be replaced by neuroscientific concepts

Scientific approaches to mind and brain

- Phrenology – Failed idea that individual differences in cognition could be mapped on differences in skull shape
    - Assumed 1) that different regions of brain where associated with different behaviour an performed different functions; 2) the size of these regions produced distortions of the skull and correlates with individual differences in cognition and personality
    - Functional specialization – Different regions of the brain are specialized for different functions
- Cognitive neuropsychology – Study of brain-damaged patients to inform theories of normal cognition
- Information-processing – An approach in which behaviour is described in terms of a sequence of cognitive stages (computer metaphor of the brain)



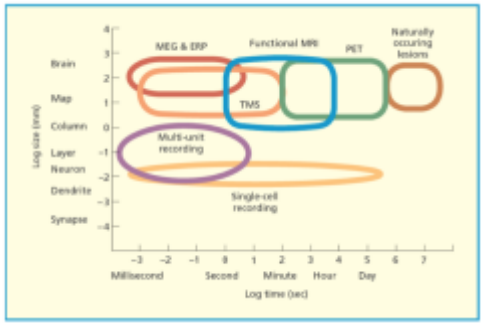
    - Interactivity – Later stages of processing can begin before earlier stages are complete
    - Top-down processing – The influence of later stages on the processing of earlier ones (e.g. memory influences on perception)
    - Parallel processing - Different information is processed at the same time (i.e. in parallel)
    - Neural network models – Computational models in which information processing occurs using many interconnecting nodes
        - *Nodes:* basic units of neural network models that are activated in response to activity in other parts of the network ('carry' information by responding to set of particular inputs e.g. letters, sounds etc. and producing a restricted set of outputs)

Cognitive neuroscience: Dimensions

- Temporal resolution – the accuracy with which one can measure when an event (e.g. a physiological change) occurs
    - EEG, MEG, TMS and single-cell recordings have millisecond temporal resolutions
    - PET and fMRI have minutes (because of slower hemodynamic response)
    - Brain damage is permanent and thus has no temporal resolution
- Spatial resolution – Accuracy with which one can measure where an event (e.g. a physiological change) is occurring
    - Lesion and functional imaging methods ~ millimeter level spatial resolution
    - Single-cell recordings ~ neuron level spatial resolution
- *Invasiveness* – whether or not equipment is located internally or externally
    - PET = invasive (injection of radio-labeled isotope)

THE DIFFERENT METHODS USED IN COGNITIVE NEUROSCIENCE

Method	Method type	Invasiveness	Brain property used
EEG/ERP	Recording	Non-invasive	Electrical
Single-cell (and multi-unit) recordings	Recording	Invasive	Electrical
TMS	Stimulation	Non-invasive	Electromagnetic
MEG	Recording	Non-invasive	Magnetic
PET	Recording	Invasive	Hemodynamic
fMRI	Recording	Non-invasive	Hemodynamic



Does cognitive psychology need the brain?

- Cog psyc developed from information processing models (no direct reference to brain)
- Cog neuroscience theories inform theories/experiments for cog pscy (vice versa)
- Computer analogy – possible to learn about software (information processing) without knowing anything about hardware (the brain)
- Biological measures provide constraining factors on nature and dev of info-processing models of cog science

Does neuroscience need cognitive psychology?

- Yes, requires insights from cog psyc to frame appropriate research questions
- To avoid a new instance of phrenology
- Cognitive, mind-based concepts have an essential role to play in cognitive neuroscience

Is the brain modular?

- Modularity – The notion that certain cognitive processes (or regions of the brain) are restricted in the type of information they process
    - *Domain specificity* – the idea that a cognitive process (or brain region) is dedicated solely to one particular type of information e.g. words, colours, faces