# Introduction

Steps of cognition

- Acquisition (attention, perception)
- Maintenance (memory)
- Usage (problem solving & reasoning)

Cognition: describes the acquisition, storage, transformation and use of knowledge

Cognitive psychology: theoretical approach with the emphasis on knowledge and mental processes

**Techniques in cognitive psychology**

- Experimental research
- Cognitive neuroscience
    - Combination of research techniques and assessing structures of the brain
    - Cognitive Neuropsychology: examines the consequences of brain lesions on performance. Cognitive deficits observed indicate that the damaged region was involved in that cognitive process
    - Functional imaging techniques
        - PET : - Positron Emission Tomography - measures cerebral uptake of radioactively-labelled substance (typically fluorodeoxyglucose: FDG) in the bloodstream - used to measure all kinds of cognitive task, e.g., attention, memory, language - BUT takes >30secs to produce data, so images have good spatial but poor temporal resolution
        - fMRI: - functional Magnetic Resonance Imaging - measures the amount of oxygen in the blood in different brain regions (active tissue consumes lots of oxygen) - again, used for a variety of cognitive tasks - less invasive than PET - measures brain activation over 500msec periods so better temporal resolution than PET BUT still relatively slow
        - ERP: - Event Related Potentials - records amplified fluctuations in the brain's electrical activity in response to a stimulus ("event") - electrodes placed over the scalp and record electricity generated by the neurons - cannot identify the location of activation with precision (unlike PET, fMRI) - CAN identify the time course of activation over very brief periods

# Perceiving Speech

What is sound and speech?

- Sound waves received by the ears
- Translated into a neural signal
- The brain translates the neural signal into a series of phonemes

- Grapheme: visual representations of language (letters)
- Morphemes: smallest units of language that have meaning
    - E.g. bedroom consists of two morphemes because bed and room have two different meanings, but table only has one morpheme
    - Ed and s are considered morphemes because they change the meaning of a word
- Phoneme: sounds in language
    - The position of a phoneme in a word effects its sound
    - Vary from language to language
    - Portray meaning
    - We understand phonemes at a rate of 20 phonemes per second (we can only produce speech at 15 phonemes per second)
        - When words are within their expected context, we recognise them even faster

Why is segmenting speech hard?

- Lack of invariance problem (things vary)
    - Sound of a phoneme changed when it is used in different words
        - E.g. di and du produce very different soundwaves, but we perceive the d sound in both
    - Coarticulation: when phonemes take on some of the characteristics of the letters around them (preparing for the next sound while saying the previous one)
- Problem of speaker variability
    - People's vocal tracts have different sizes and shapes
    - Differences in the same person at different times of the day and across different situations
        - E.g. morning/evening, sick/well, whispering/yelling, happy/sad
- Segmentation problem (speech passing error)
    - We rarely leave clear breaks between words
        - E.g. it is hard to understand a second language when locals speak quickly
    - Easter egg analogy
        - Eggs are put on a conveyor belt and are broken and you must sort out which pieces came from the first, second, and third egg
        - You have some idea of the order but it is hard to know exactly where one egg finishes and another starts
    - Metrical segmentation strategy
        - Using our knowledge of language to predict likely beginnings and endings of words (think of Chinese whispers)
    - Stress-based segmentation
        - In English, we tend to stress the first phoneme of a word, and we use this to help us determine which word is the start
            - This is not always the same in other languages

Categorical perception of phonemes

- We classify speech sounds as one phoneme or another

- Place of articulation
    - Different sounds are formed at different parts of the mouth, which effects the starting frequency of the phoneme (b=front, d=middle, g=back)

Context effects

- Within 200 milliseconds, we can recognise words if they are in context (the difference is not really noticed in everyday life)
- Phoneme restoration effect
    - When we don't hear a part of a word but we interpret it due to the context it is in
    - A perceptual effect (context changes what we perceive)
    - Top-down processing
- We find it more difficult to identify isolated (verbally spoken) words compared to those in a sentence

Visual cues and speech perception

- It's easier to understand people when we can see their mouth moving
- This is much more noticeable at noisy places
- When there is a conflict between what you hear and what you see (e.g. a delay in the visuals of a skype call), it can make understanding a lot more difficult (McGurk effect)
    - The sound you perceive is a compromise between the auditory and visual stream (if one mechanism is stronger, it can override the other)
    - Doesn't happen in everyone (but it does occur in most)
    - Automatic process (even when you are aware it is happening, it still effects your perception)
- VPAM hypothesis
    - Visual cues give you cues about the place of the articulation
    - Acoustic cues give you cues about the manner of articulation (e.g. nasal)

**Lexicon:** a person's knowledge of what words mean, how they sound, and how they are used in relation to other words (about 50,000 words by the time we reach adulthood)

- Corpus
    - Representative sample of utterances or written text from a language
    - Indicates the frequency with which different words are used
    - Reflects how people typically use language
    - Helps us predict what people will say

Word superiority effect

- Letters are easier to recognise when they are in a word than when they appear alone or are contained in a nonsense word
- Letters in words are not processed individually but within the context of the word
- Therefore, context affects how we see words

Word frequency effect

- We respond quicker to high-frequency words than low frequency words
- Lexical decision task

    - People are asked to decide whether stimuli are words or non-words
    - We are quicker at this task when the words are high-frequency compared to low-frequency
- We fixate longer on lower frequency words when reading
- Demonstrates how past experience with words influences our ability to process their meaning

Lexical ambiguity

- When one word has multiple meanings
- Meaning dominance: when one meaning of a word occurs more frequently than others
- Biased dominance: when words have more than one meaning with different dominances
    - People look at the word for longer when its context suggests the less common meaning than the more common meaning
- Balanced dominance: when words have more than one meaning with equal dominances
    - People look at these words for longer than when a word has biased dominance (and the context matches the more common use of the word) because the meaning is more ambiguous

## Perceiving faces

Perception of faces in infants

- Infants can discriminate between the face of their mother and the face of strangers
    - They spend more time looking at their mothers when tested

Holistic perception of faces

- We are not good at recognising someone based on one feature of their face
- You process the whole face as one unit, not separate parts
- Small children process faces one feature at a time but over time we learn to process them holistically

Models of face processing

- Bruce and Young (1986)