Cognition

1. The mental process of acquiring knowledge and understanding through thought, experience and the senses.
2. A mental representation (perception, sensation, idea, or intuition) resulting from the process of cognition.

Definitions of the **mind**:

1. The mind creates and controls mentals functions such as perception, attention, memory, emotions, language, deciding, thinking, and reasoning.
2. The mind is a system that creates representations of the world so that we can act within it to achieve our goals.

Cognitive agents are able to

1. Sense and act on the environment.
2. Construct mental models to represent the causal structure of their environment.
3. Adapt their mental models in response to feedback from their behavior.
4. Use mental models to guide future behavior.
5. Form inferences to make sense of experience.

Mental representations are physically implemented via neural computations.

1. Sensorimotor representations (*sense of embodiment, movement, sensory experiences*)
2. Mental images (*visual-spatial representations*)
3. Symbolic representations (*logical, linguistic, semantic, narrative, schemas, frames*)

Franciscus Donders (1868) examined how long it takes for a person to make a decision.

Reaction time: Time taken to respond to presentation of a stimulus.

He measured *simple reaction time* by asking his subjects to push a button as rapidly as possible when they saw a light go on.
Simple reaction time: Time between the presentation of the stimulus and the behavioral response.

He measured *choice reaction time* by using two lights and asking his subjects to push the button corresponding to the light that came on.

Donders reasoned that the difference in reaction time between the simple and choice conditions would indicate how long it took to make the decision.

Mental responses cannot be measured directly, but must be inferred from behavior.

Wilhelm Wundt (1879) used analytic introspection is his structuralist approach, which produced no reliable results.

Structuralism: Our overall experience is determined by combining basic elements of experience called sensations.

Analytic introspection: A technique in which trained subjects described their experiences and thought processes in response to stimuli. Analytic introspection required extensive training because the subjects' goal was to describe their experience in terms of elementary mental elements.

Hermann Ebbinghaus (1885, 1913) examined the nature of memory and forgetting - how rapidly information that is learned is lost over time - via a quantitative method.

Ebbinghaus repeated lists of 13 nonsense syllables (so that his memory would not be influenced by the meanings of the words) to himself one at a time at a constant rate, and determined how long it took to learn a list for the first time. He then waited for a specific amount of time (the delay) and determined how long it took to relearn the list.

Savings = (Original time to learn the list) - (Time to relearn the list after the delay)

Longer delays result in smaller savings.
The savings curve (percent savings versus time) shows that memory drops rapidly for the first 2 days after the inital learning and then levels off.

Concepts and Categorisation

Concepts:

- The mental representation of a class or individual. (Smith, 1989)
- The meaning of objects, events, and abstract ideas. (Kiefer & Pulvermüller, 2012)

Categorisation: The ability to form equivalence classes of discriminable entities.

1. Categorisation provides a basis for deciding appropriate action.
2. Categorisation provides a means for identification.
3. Categorisation reduces the complexity of the environment.
4. Categorisation allows the organisation of knowledge.
5. Categorisation allows for generalisation.

Universal Law of Generalisation: Probablity of generalisation deceases with dissimilarity of stimuli from one another in a *negative exponential function*.

Categorisation Induction

Osherson *et al.* (1990): Generalisation is affected by

1. **Typicality of instances**: Typical instances are more strongly related to their category and so allow for greater generalisation.
2. **Typicality of category**: Generalisation is greater to more typical category members.
3. **Category size**: Generalisation is greater to more specific categories.
4. **Category variability**: Generalisation is greater when examples are more variable.

Cognitive Models of Language and Bilingualism

Linguistic modalities (auditory, visual, or visuo-spatial) are for *perceptual word forms* (arbitrary signs) that map onto *lexical representations* and *concepts* (semantics).

Lexical access: The process whereby the memory for a specific word form is located and activated.

Pre-lexical models rely on characteristics of the speech stream that might mark a likely word boundary (i.e., silence, rhythm of speech).

Cutler & Norris (1988): Pairs of nonsense syllables were played to listeners, who were asked to monitor for any familiar word embedded in the speech (*wordspotting*). For a sequence with two strong syllable onsets (therefore spanning a hypothesised word boundary), recognition of the embedded word was obscured. A sequence with a strong syllable followed by a weak syllable was segmented as a single unit, easing wordspotting.

Cutler & Otake (2002): Similar sensitivities have been demonstrated in languages where different rhythmic units dominate, such as French or Japanese. Early in life, people tune into their native language and optimise segmentation strategy accordingly.

Lexical models rely on knowledge of phonological representation.

Each word in utterance is recognised sequentially, predicting a new word at the boundary of the existing word. Backtracking is required to locate word boundaries for words that are short and cannot be recognised within the time-span of their acoustic waveforms.

Saffran *et al.* (1996): 8-month-old infants were tested, using a 'head-turning' procedure, on their perception of a long continuous stream of speech containing an artificial language made up of three-syllable words, which contained no acoustic or rhythmic cues to the location of word boundaries. Infants began to pick out words from the stream of syllables after two minutes of the speech. Speech segmentation makes use of implicit learning.

Speech Perception

1. Speech is 'noisy' due to coarticulation of speech sounds.

   Coarticulation of phonemes causes the same phoneme to be pronounced differently depending on the context of the surrounding phonemes. Hence, speech input is often ambiguous.

   Ganong (1980): When speakers hear a word created so that the initial sound is ambiguous between /l/ and /r/, they report hearing "lab" rather than "rab".

2. Speech unfolds over time due to memory limitations and the demands of comprehension processes.

   If the lexical access process begins only after a word has finished, there would not be enough time to process the meaning of speech.

   Speech is evaluated and re-evaluated continuously against numerous potential lexical candidates via **parallel activation** of multiple word forms.

   Spivey & Dale (2004): When participants saw pictures of a piece of candy and a candle on the computer screen and were instructed to "click the candy", the trajectory of their mouse movements tended to exhibit spatial attraction to both objects, thus initially gravitating toward their midpoint before eventually curving toward the target object. The majority of the trajectory's time is spent in intermediate regions of state space that are partially consistent with multiple lexical representations.

   Marslen-Wilson (1987): Using cross-modal priming, participants decided whether the target was a word or not as quickly as possible. **Semantic similarity between a prime-target pair leads to faster responses to the target.** Responses to the target word were facilitated before the uniqueness point had been reached. Spoken fragments of the prime word also faciliated responses to target words semantically related to alternative cohort members (i.e., "capt-" primes response to the visual forms of both ship and guard). **Cross-modal priming effects are larger for higher frequency competitors** than for lower frequency competitors (i.e., "d-" primes response to "dog" more than "dock").

   Cross-modal priming technique: Subjects hear a spoken prime word, followed swiftly by a visual target word. This technique examines the extent to which the meaning of a spoken word has been retrieved.

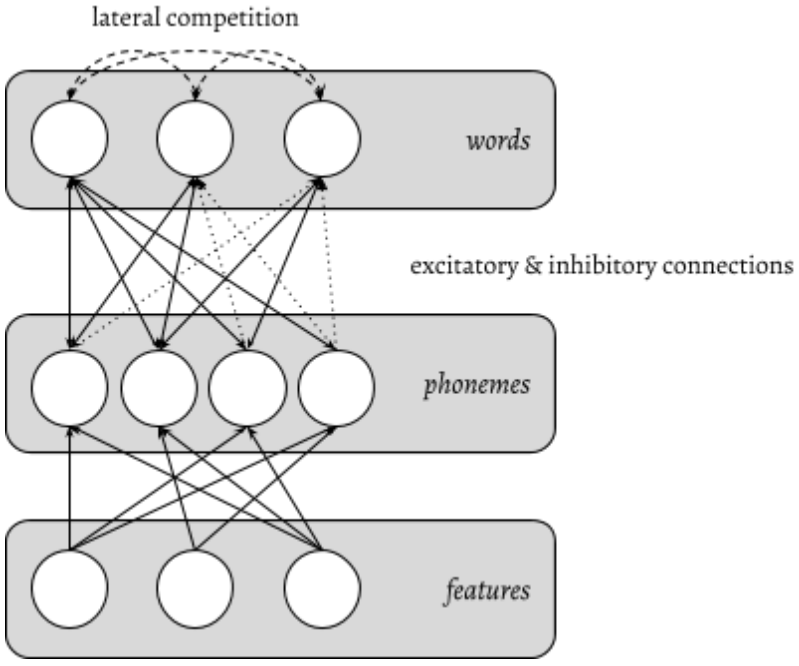
Cohort Model (Marslen-Wilson *et al.*)

As the beginning of a word is encountered, the word-initial cohort (a set of words that match the speech so far) is activated. As more of the word is heard, the recognition process whittles down the set of potential candidates. At the uniqueness point, the candidate set should be reduced to a single word.

The meanings of other words beginning with the same phonemes are activated before the perceptual system identifies the word being heard, ensuring that the relevant meaning is retrieved by the time the word is identified.

Gaskell & Marslen-Wilson (2002): Meaning activation is limited; if many meanings are activated at the same time, the resultant priming effect is relatively weak. Activating more than one meaning can only occur partially; the gradual reduction of the cohort set of matching words is accompanied by a gradual isolation and amplification of the relevant meaning.

The TRACE Model of Spoken Word Recognition (McClelland & Elman, 1986)



1. Nodes represent elements of information within the system, corresponding to the possible occurrence of a particular linguistic unit.
2. Each node (phonetic features, phonemes, or words) has a **resting level** and a **threshold for activation** based on its frequency of occurrence in language.