Fundamentos de Neurociencia Cognitiva
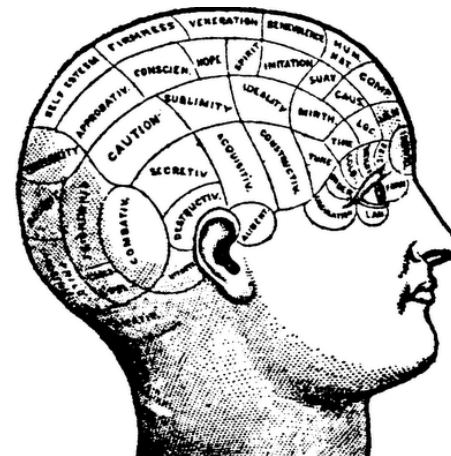
Language / Language and brain

Language and brain

- Neuropsychology
  - Classic model of aphasia

- fMRI
  - The function of Broca's area
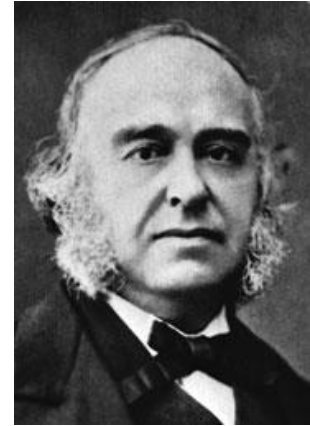
- EEG
  - The speed of word retrieval

Aphasia

- Gall (Germany, 1758-1828)

- Phrenology
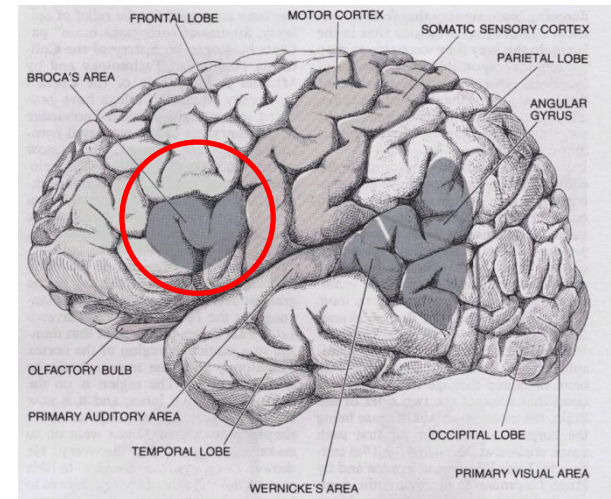
- Brain region to function

Aphasia

- **Paul Broca (France, 1824-1880)**
  - Physician

- **Patient: Monsieur LeBorgne**
  - Loss of speech
  - could only say "tan"
  - Intact comprehension

- **Post mortem: damage to frontal lobe**

Aphasia

- Broca found 6 more patients
  - Right handed
  - Right hand paralyzed
  - Expressive speech disorder

- Damage of frontal lobe (left inferior frontal gyrus)
  - This area controls speech production

Aphasia

- **Carl Wernicke (Germany, 1848-1905)**
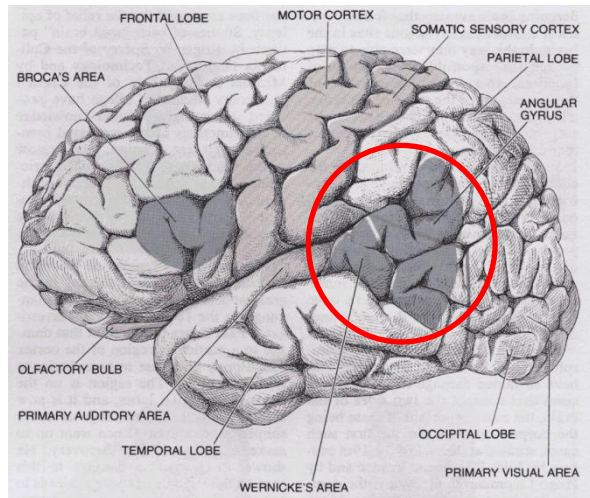 - Physician

- **2 patients**
  - Unable to comprehend speech
  - Speak fluently, but nonsense

- **Post Mortem: Damage to superior temporal Gyrus**

Aphasia

- Wernicke
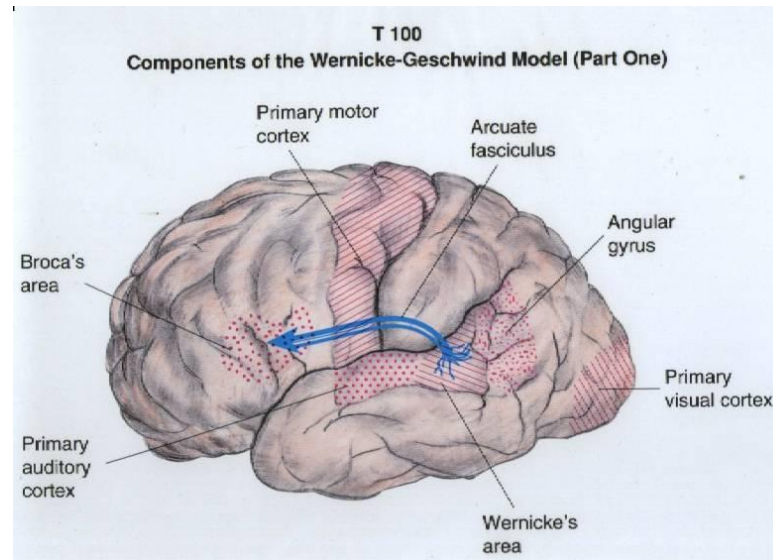
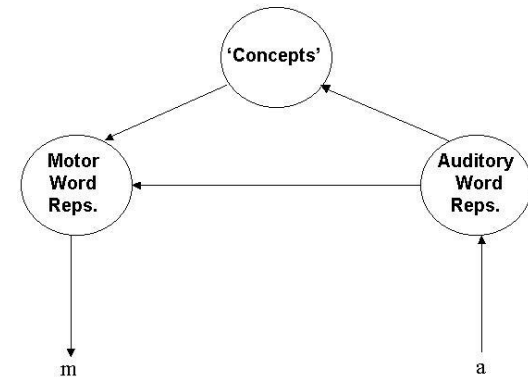- Post Mortem: Damage to superior temporal gyrus

Aphasia

- Aphasia = refers to a disorder of language apparent in speech, in writing (**agraphia**) or in reading (**alexia**) produced by injury to brain areas specialized for these functions.

- Other cognitive functions largely intact!

Aphasia

- **Classic model of language**
  - **Hearing**
  - **Speaking**
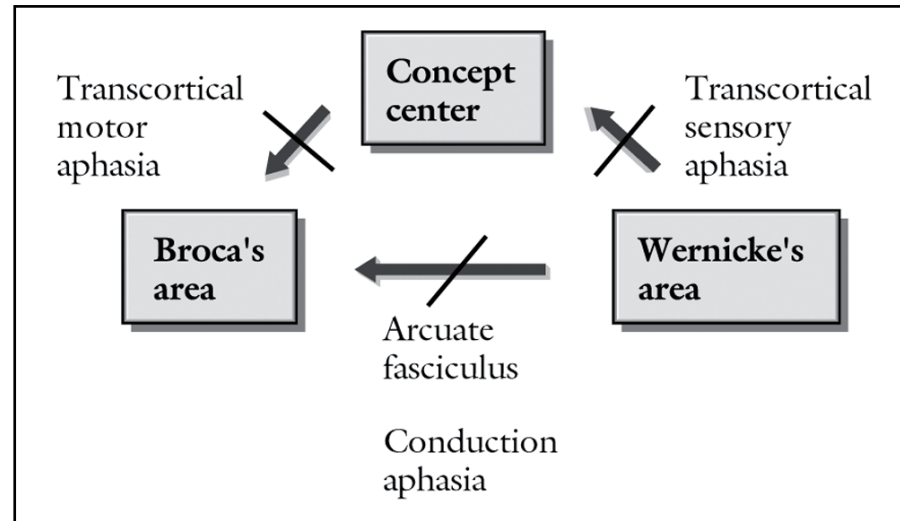 - **Meaning**

  - **Repitition**

Lichtheim (1885)

'Concepts'

Motor Word Reps.

Auditory Word Reps.

m

a

T 100
Components of the Wernicke-Geschwind Model (Part One)

Primary motor cortex

Arcuate fasciculus

Angular gyrus

Broca's area

Primary visual cortex

Primary auditory cortex

Wernicke's area

Aphasia

- **Prediction from model**

- **Conduction aphasia**
  - Cannot repeat
  - Preserved production
  - Preserved comprehension

Aphasia

- Videos of broca's + wernicke

Aphasia

- This classic model is now obsolete

- Function of Broca's area for speech production

Aphasia

- **Classic model**
  - Broca's aphasia
    - intact comprehension
    - loss of production

- **Sentence comprehension in Broca's aphasics**
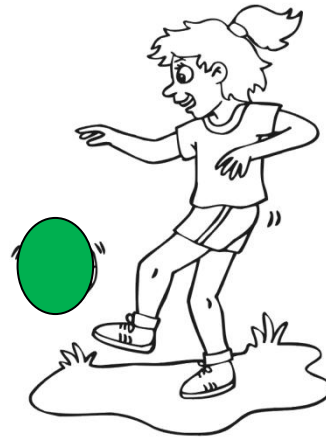

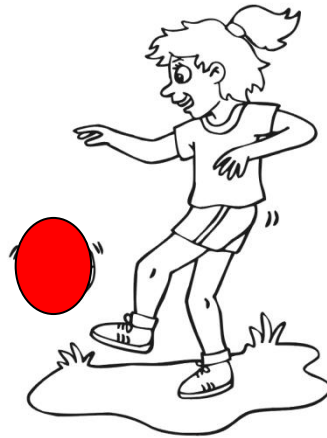**Caramazza & Zurif (1976)**

Aphasia

- **Sentence comprehension in Broca's**
  - Irreversible and reversible sentences

- **Irreversible**
  - "the ball that the girl is kicking is red"

- **Reversible**
  - "the cat that the dog is chasing is black"

Aphasia

- **Sentence – picture matching**
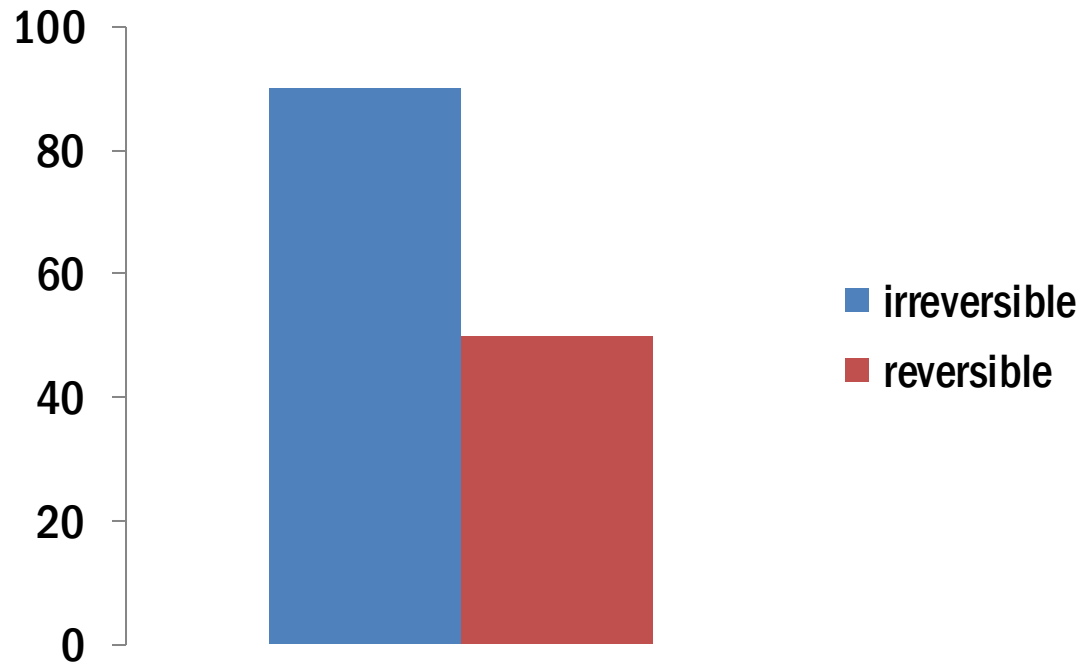 - Irreversible

"the ball that the girl is kicking is red"

Aphasia

- **Sentence – picture matching**
  - Reversible

"The horse that the dog is chasing is blue"

Aphasia

- Sentence – picture matching

Aphasia

- Broca's aphasics have problems with comprehension

- Classic model is wrong

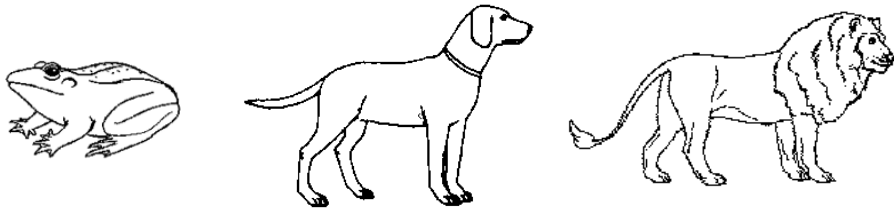- Broca's area plays role in grammatical processing

Language and brain

- More recent ideas about the role of Broca's area

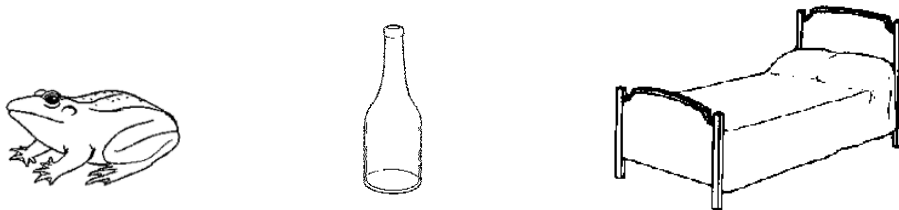- Conflict resolution (Thompson-Schill et al., 1997)

Language and brain

- Semantic blocking task (Schnur et al., 2008)
  - Picture naming
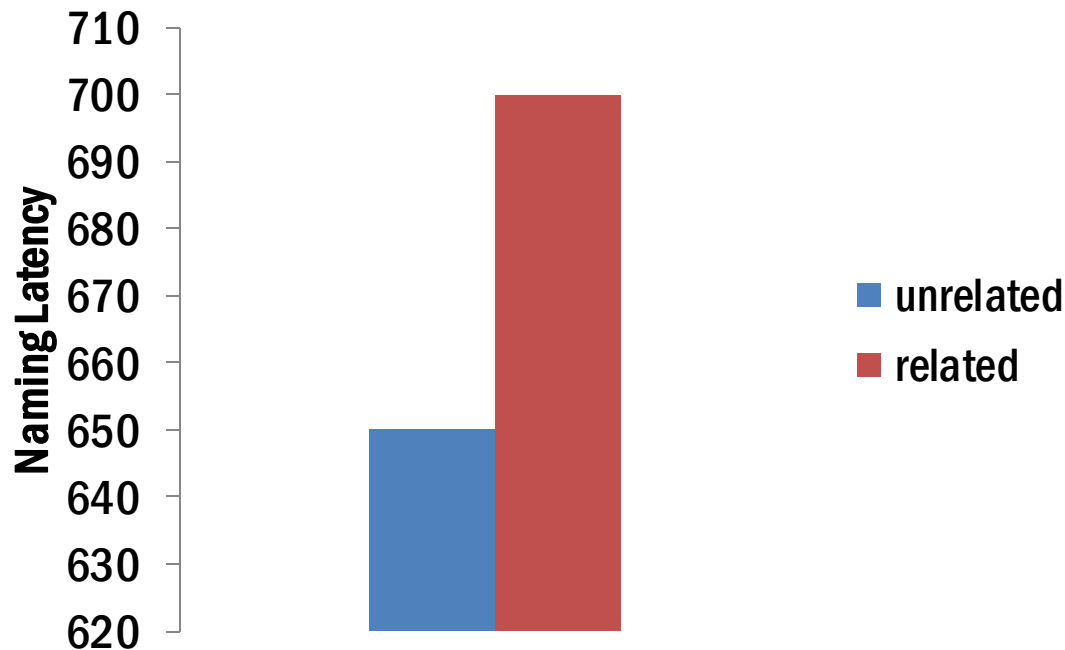 - Groups of related pictures
  - Groups of unrelated pictures

RELATED

UNRELATED

Language and brain

- Semantic blocking task (Schnur et al., 2008)
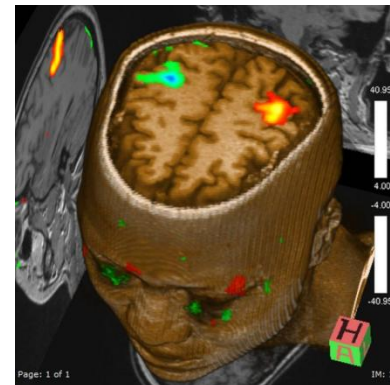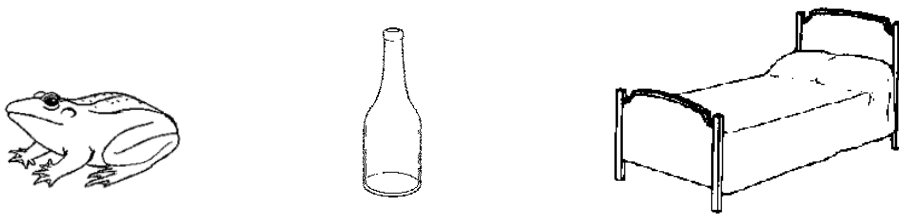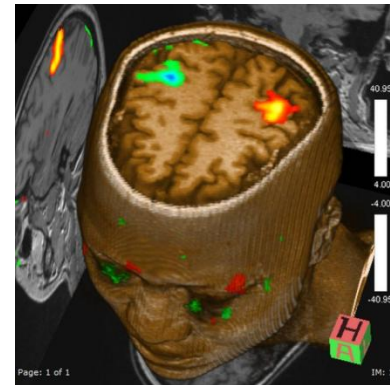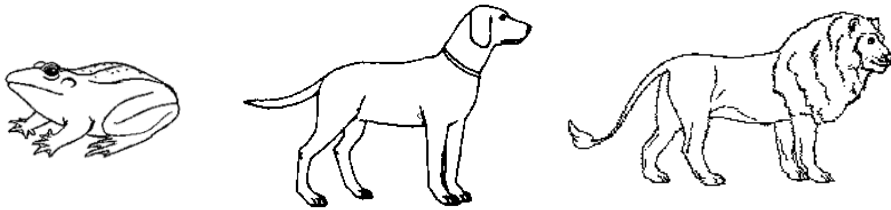 - Conflict resolution

Language and brain

- fMRI

Language and brain

- fMRI
  - Measures neural activity by detecting location of deoxygenated blood

  - Neural activity → increased blood flow → this blood has special magnetic properties → picked up by fMRI machine

  - Good spatial resolution
  - Bad temporal resolution

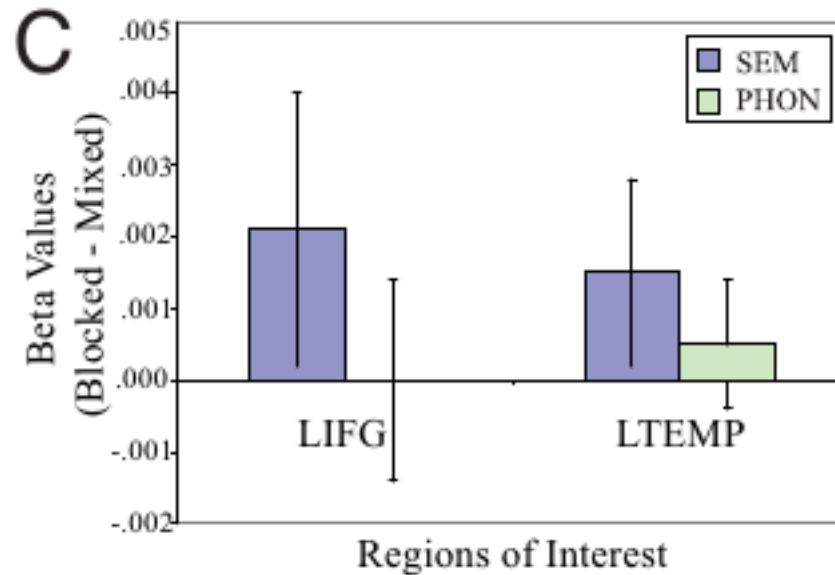# Language and brain

- **fMRI – Schnur et al. (2008)**

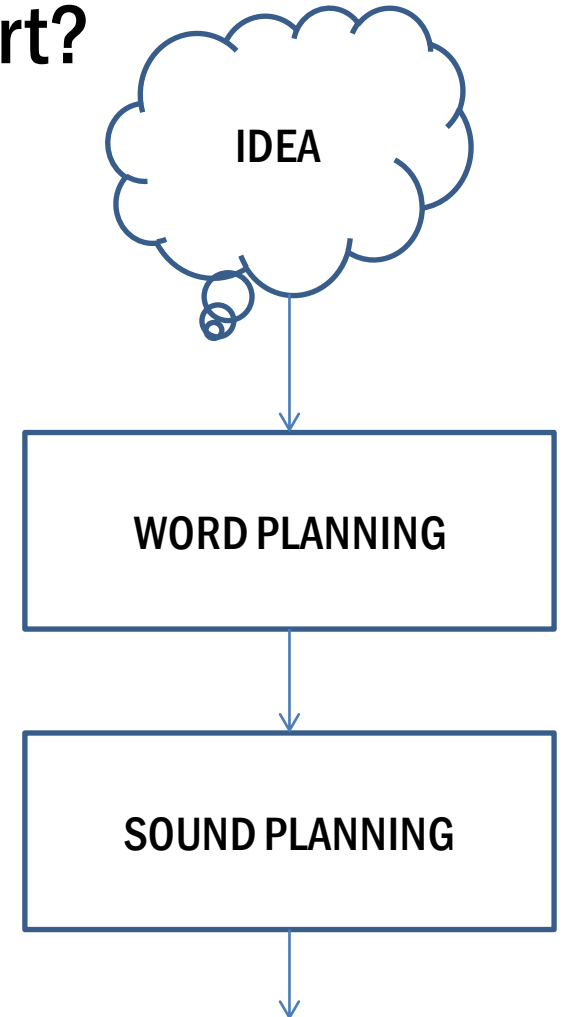RELATED
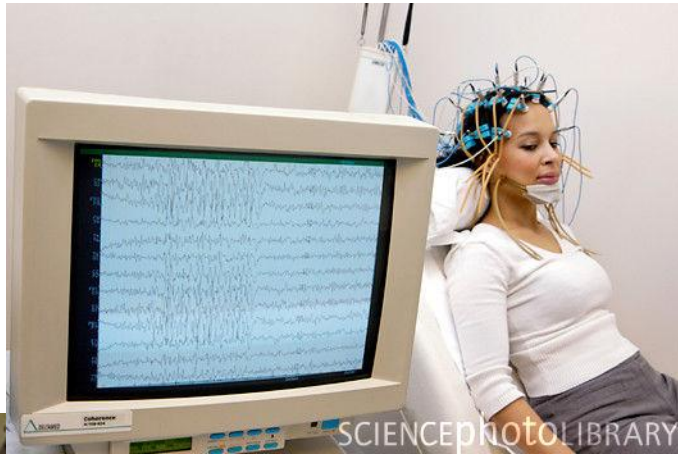
UNRELATED

Language and brain

- fMRI results

- Broca's area does conflict resolution

Language and brain

- Summary
- Aphasia
  - Classic model
- Role of Broca's area
  - Speech production
  - Grammatical function
  - Conflict resolution

Language and the brain
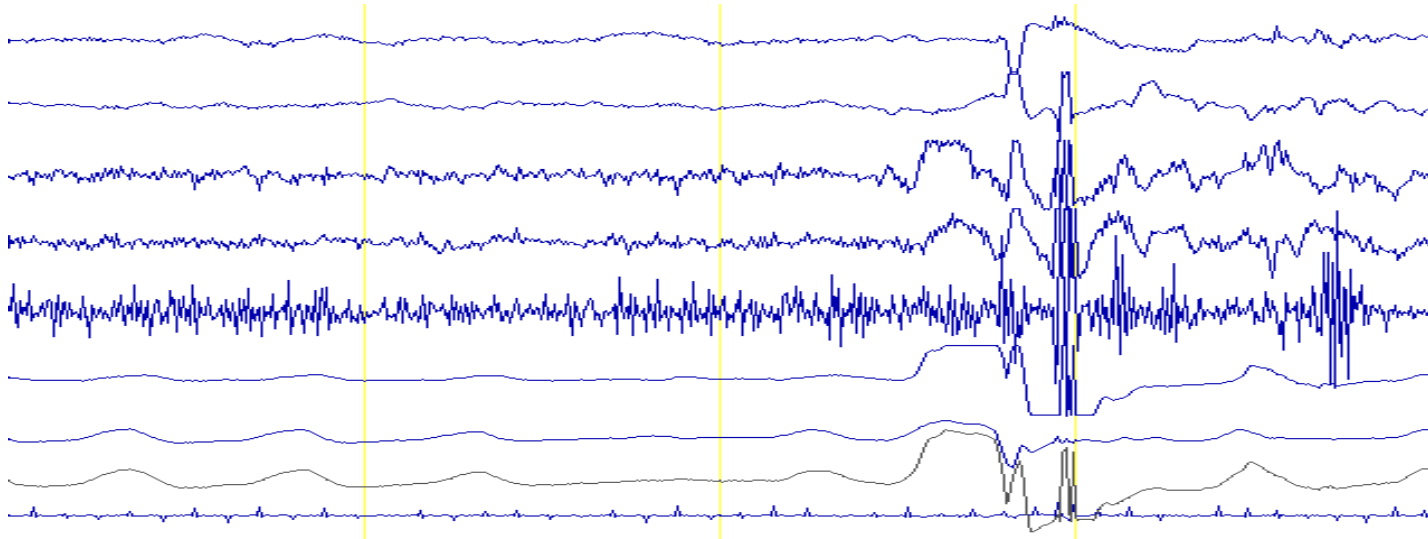
- **When does word planning stage start?**

IDEA

WORD PLANNING

SOUND PLANNING

Language and brain

- EEG (Electro Encephalo Graphy)

- Measure electric activity in the brain

Language and brain

- **EEG set up**
  - Cap
  - Electrodes
  - Amplifier

Language and the brain

- Opposite of fMRI
  - Good temporal resolution
  - Bad spatial temporal resolution

- But, noisy and need lots of averaging

- Can be used to examine timing of cognitive processes

Language and brain

- When does word planning start?

- How to measure word planning?
  - Semantic effect in
    Picture-word interference

  - Frequency effect in picture naming
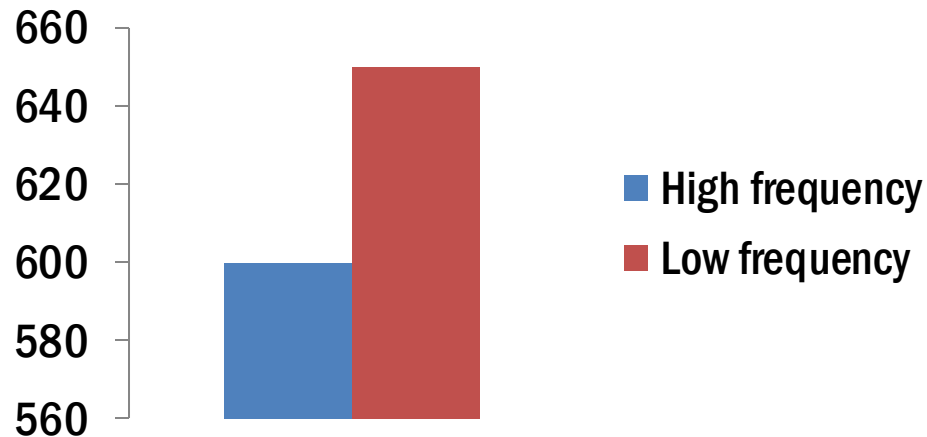
IDEA

WORD PLANNING

SOUND PLANNING
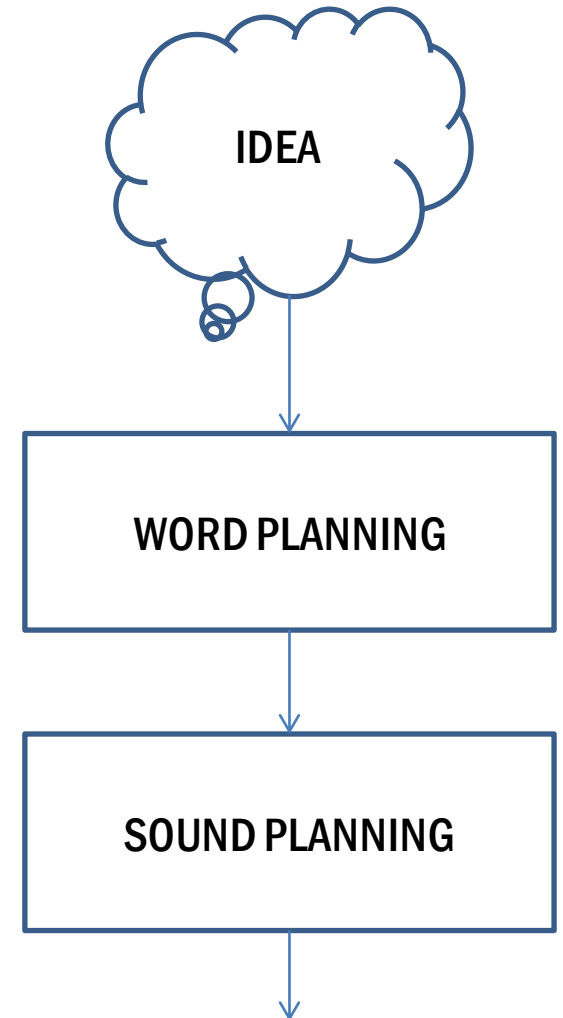
Language and Brain

- EEG and frequency effect (Strijkers et al., 2009)

- Word frequency
  - Number of times word appears in language

- Example:
  - "casa" frequency = 1000 = high frequency
  - "mofeta", frequency = 10 = low frequency

Language and brain

- Frequency effect

■ High frequency
■ Low frequency

Language and brain

- **Explanation of frequency effect**

  – During word planning

  – High frequency word have higher activation than low frequency word

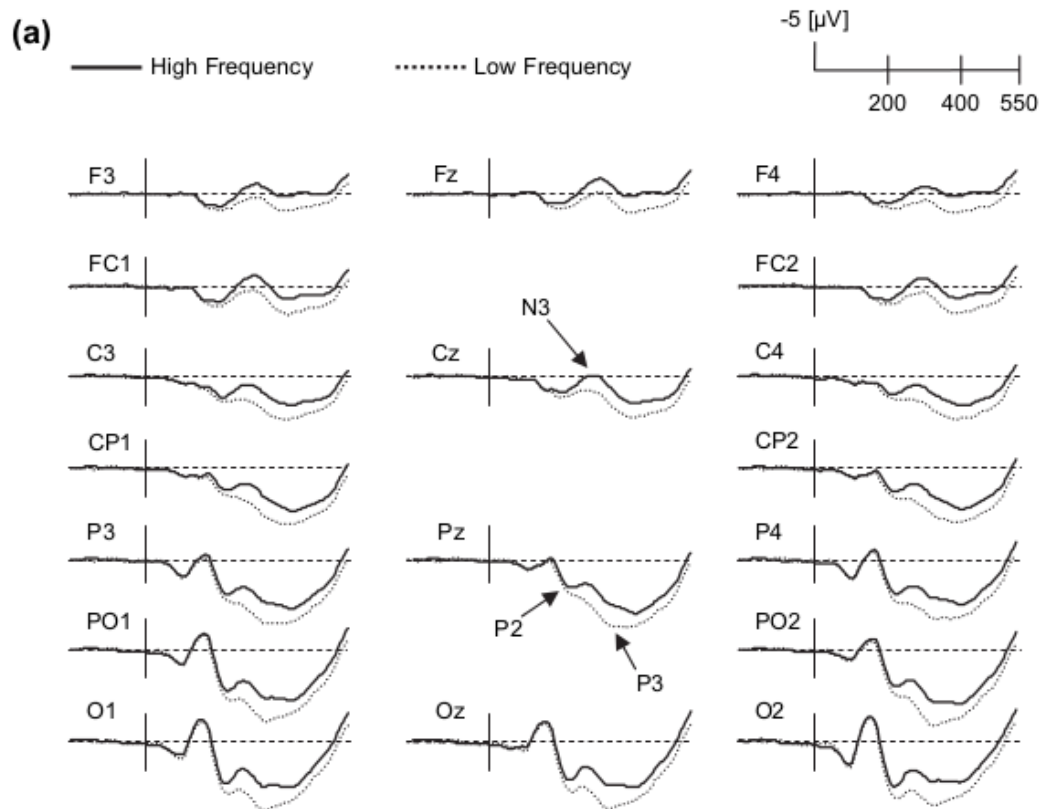 – Frequency effect measures word planning

Language and brain

- EEG and frequency (Strijkers et al., 2009)

- Name pictures with low and high frequency names

Language and brain
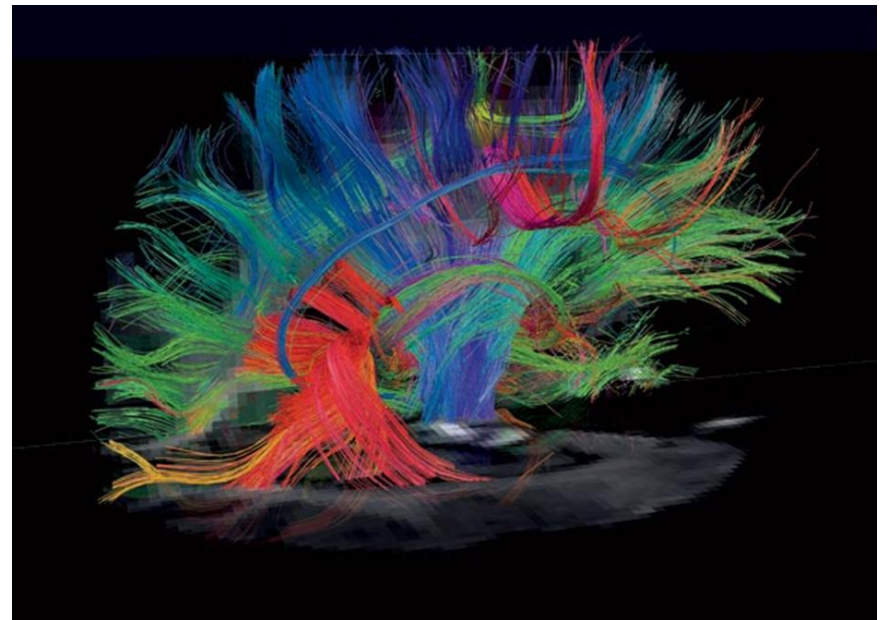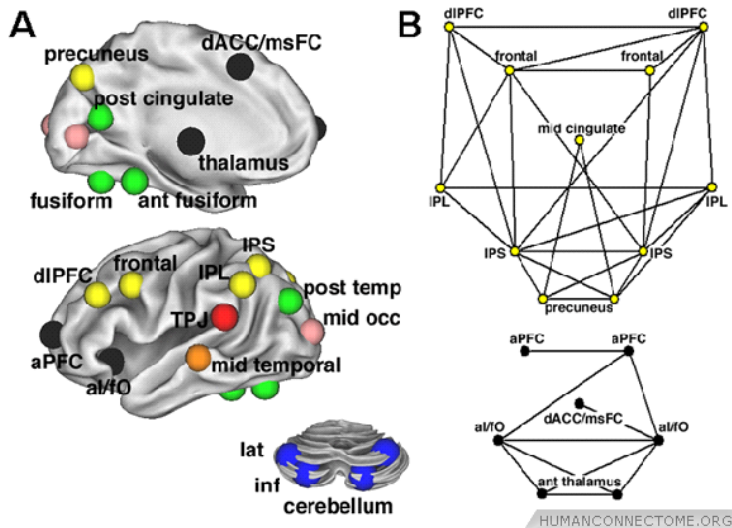
- Results

Language and the brain

- Low and high frequency waves diverge around 200 ms

- Word planning stage starts 200 ms (0.2s) after seeing picture

- Very fast!

Language and brain

- fMRI and EEG used to tell us about cognition

- Relationship between function and brain

- Work in progress

The future

- **fMRI and connectivity**

The future

- Combining fMRI and EEG

The future?

- Neuro-imaging outside the lab

GRACIAS