

Psycholinguistics: what happens in our brain when we speak

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POLSKIE STOWARZYSZENIE - EUROPA JĘZYKÓW I KULTUR



- You probably have around 60 000 words in your mental lexicon – how is it possible that you can produce and understand them within milliseconds?

- You can articulate around 150 words per minute and people still understand you

- You can understand speech going with 20-30 speech sounds per second, but you can discern no more than 7-9 non-speech sounds per second

- We have 558 consonants, 260 vowels, and 51 diphthongs in 869 different world's languages – an infant comes well equipped to discern them all

- What happens in your brain when you understand speech?

- How did you acquire your first language?

- Where are the two languages in your brain?

- If you are bilingual and you double your lexical stock, do the two lexicons interfere with each other?

- If you think in one language, is the other one deactivated?

- Why can you eat crisps and relax when you watch films in your native language, and you must be so concentrated when you watch films in English?

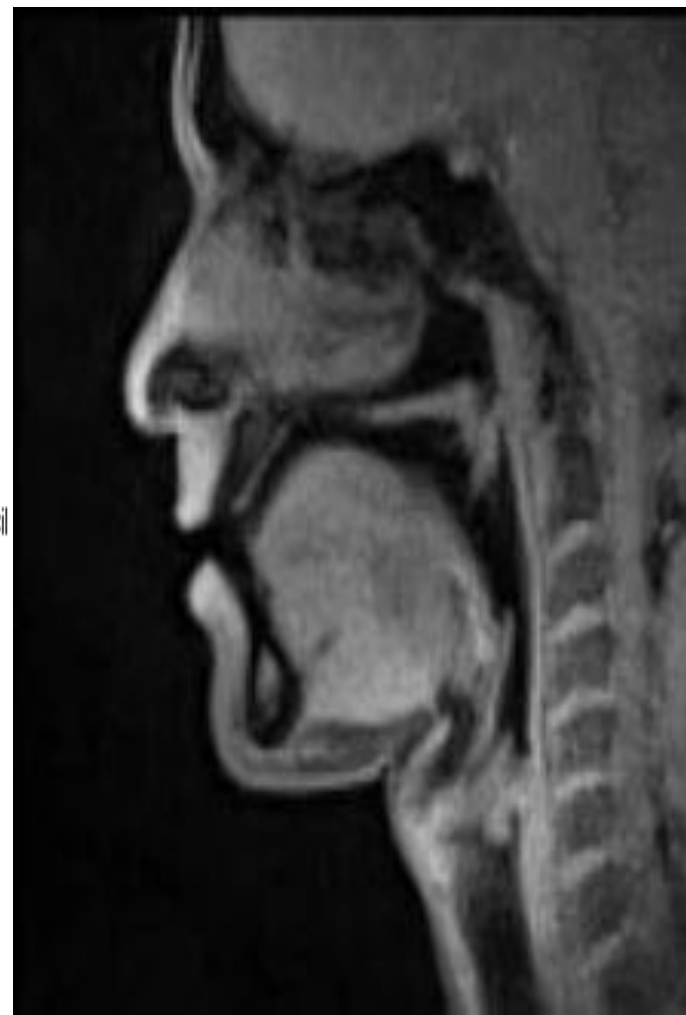
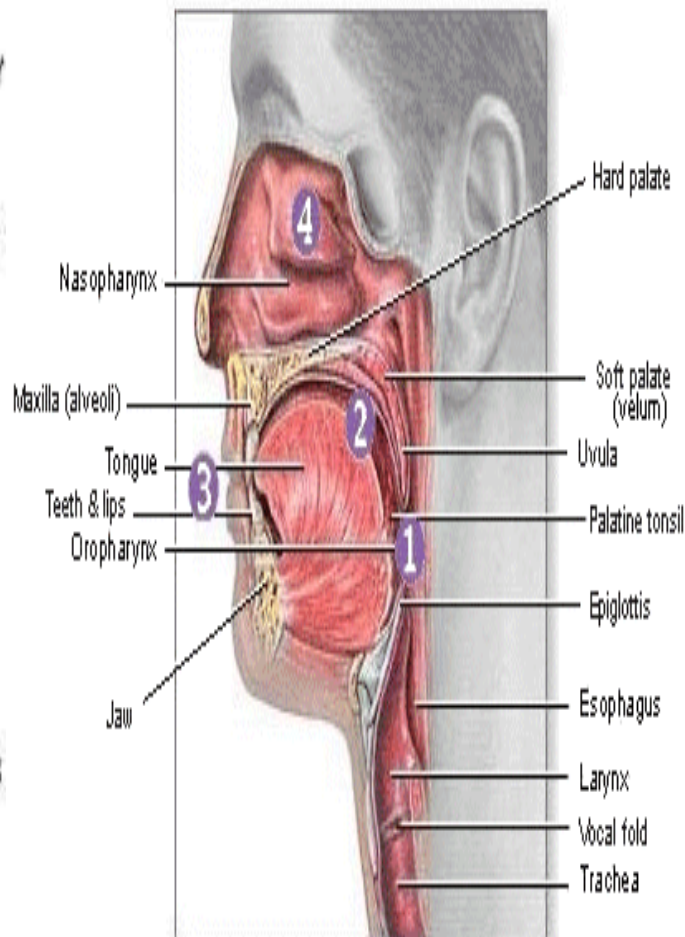
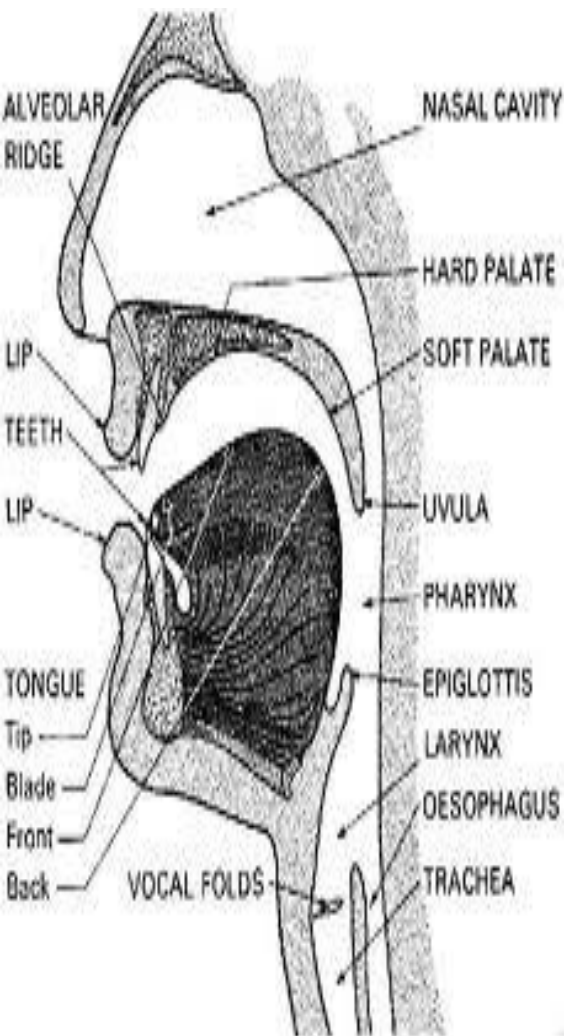
- If you are an early bilingual, does it somehow change your brain to affect your general cognitive processing?

- Is it possible to attain native-like pronunciation in a second language by precisely designed training?

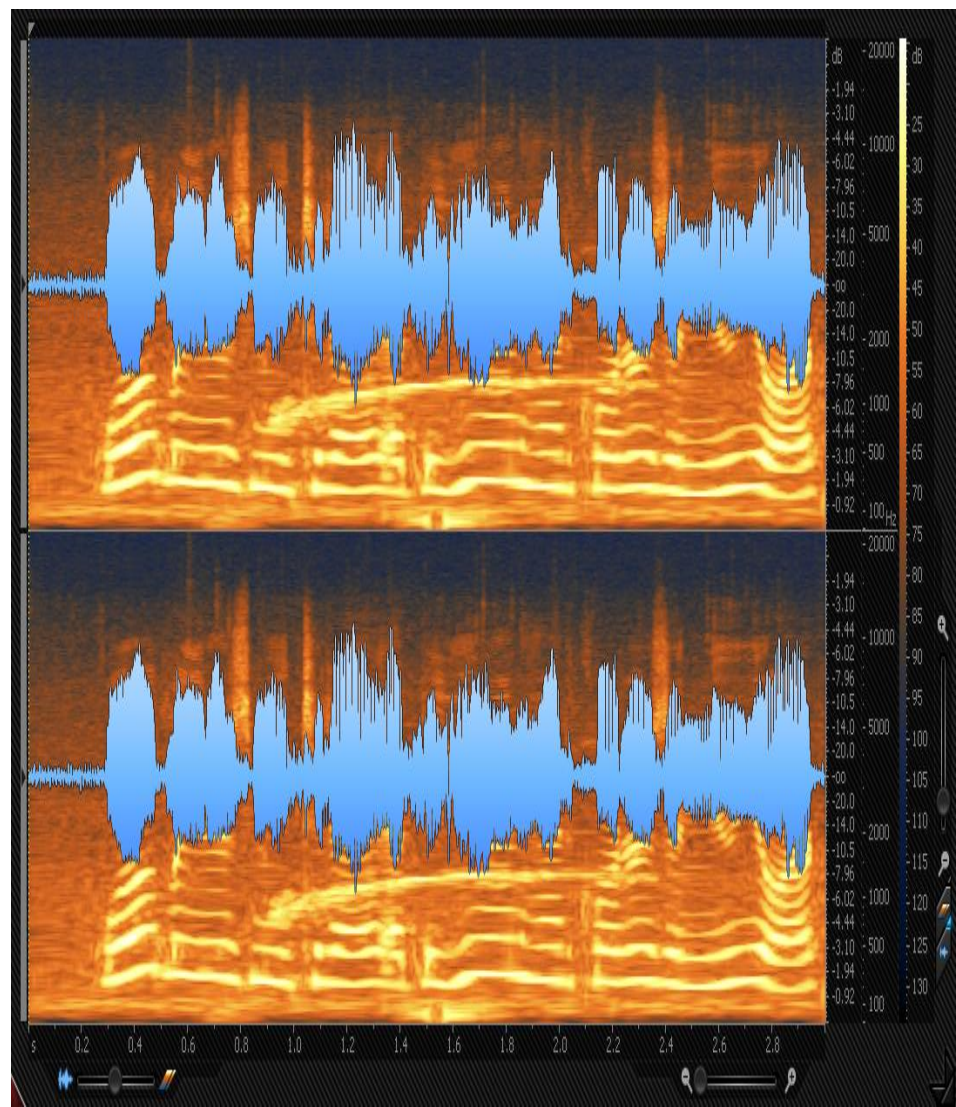
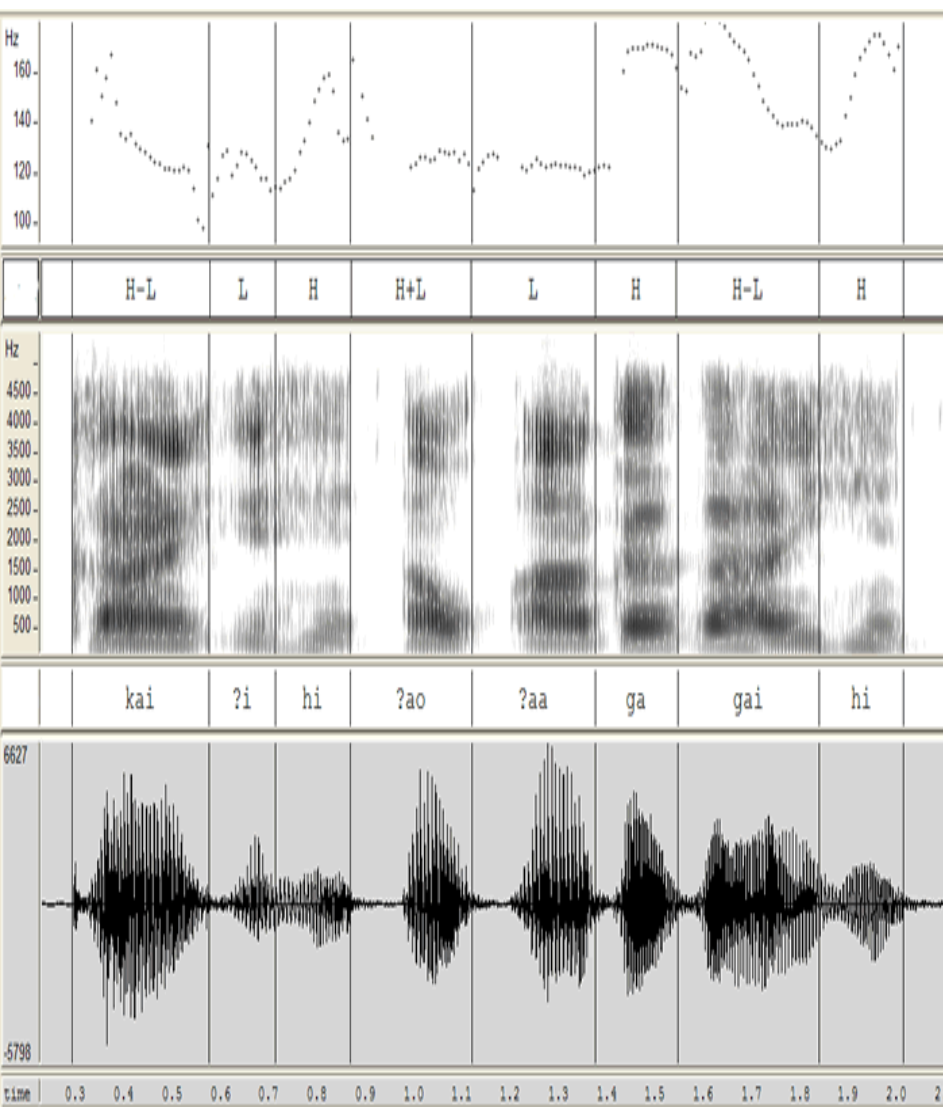
- Why do some people learn native-like pronunciation easily and the majority of others always have strong non-native accent?

- How can we measure and analyze the way you speak?

- Human articulatory apparatus is mazingly effective
- Biologically, we can produce 869 different speech sounds



- Acoustic phonetics – we can measure the sounds in the air



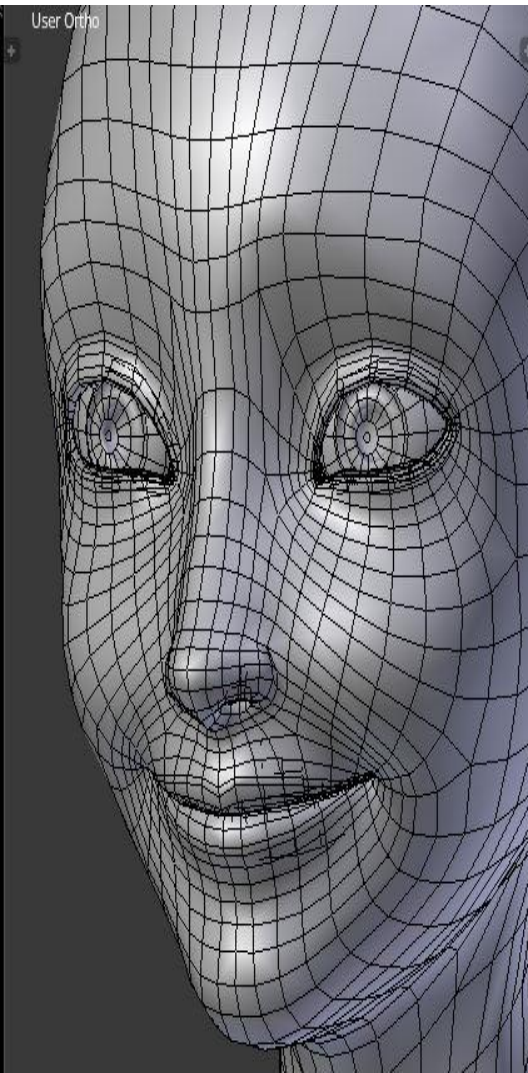
- Articulatory phonetics – 3D electromagnetic articulograph



- Articulatory phonetics – Real-time magnetic resonance imaging (RT-MRI)

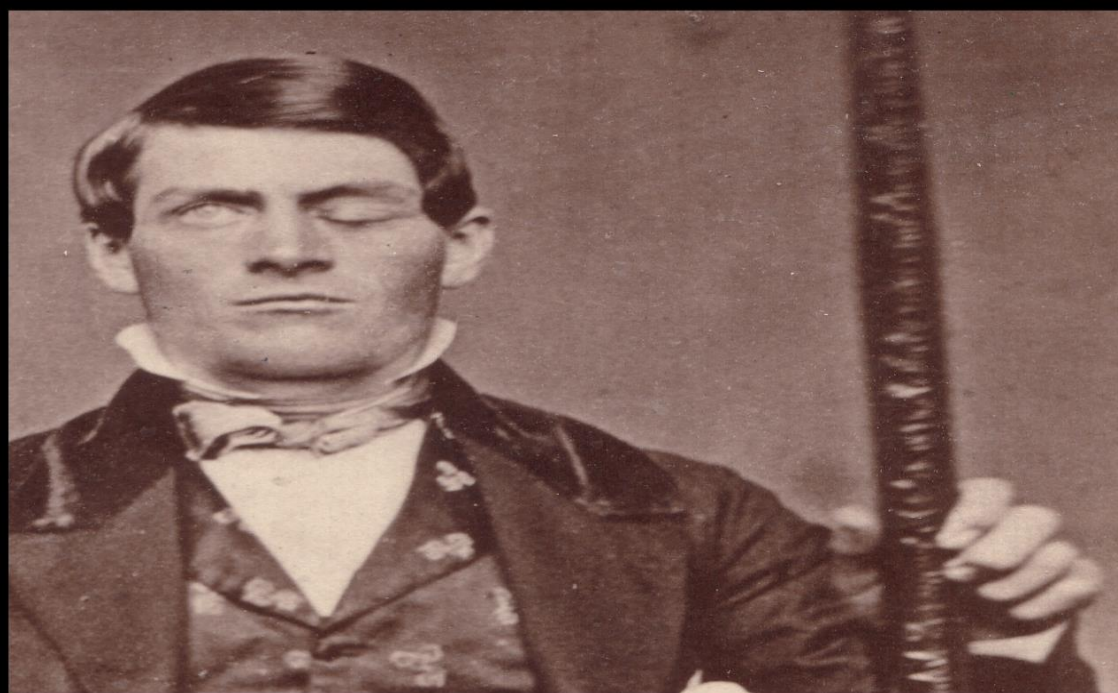
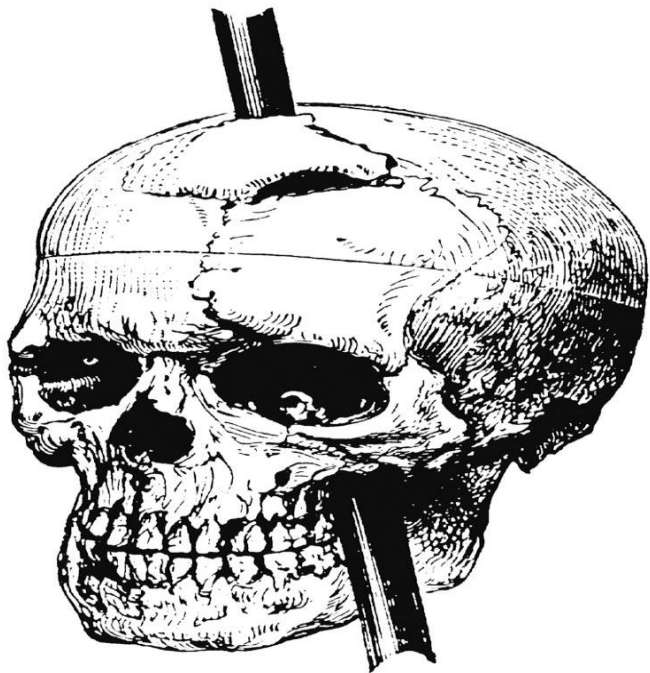


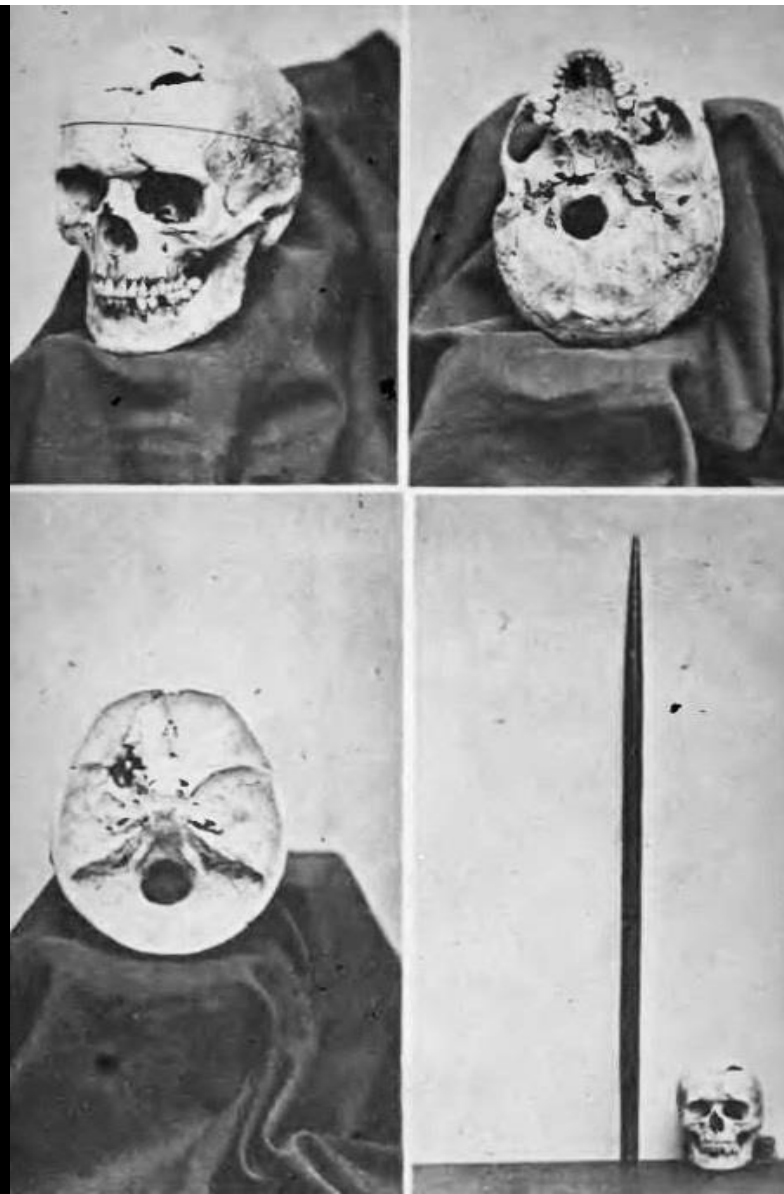
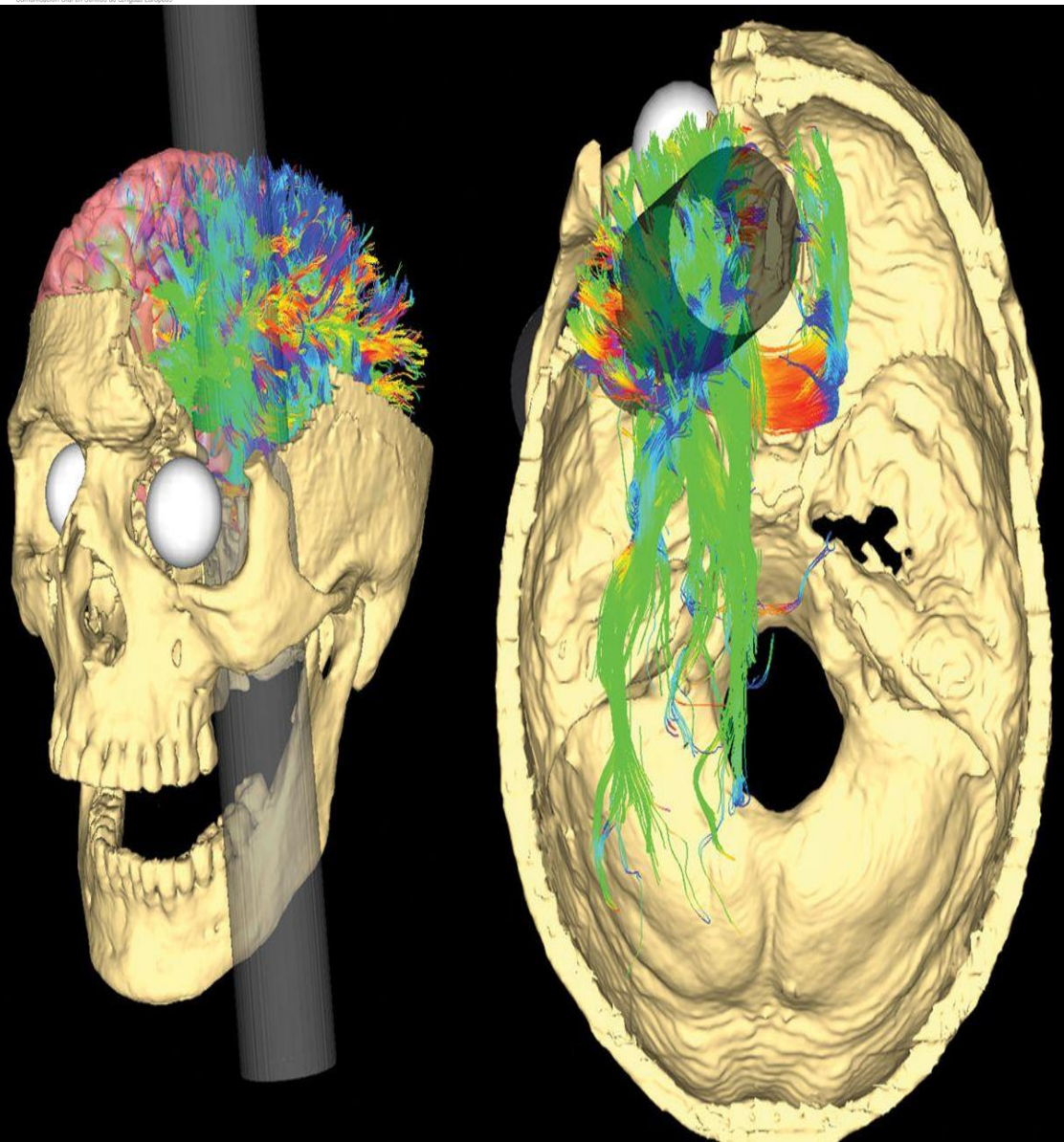
- Articulatory phonetics – Facial motion capture



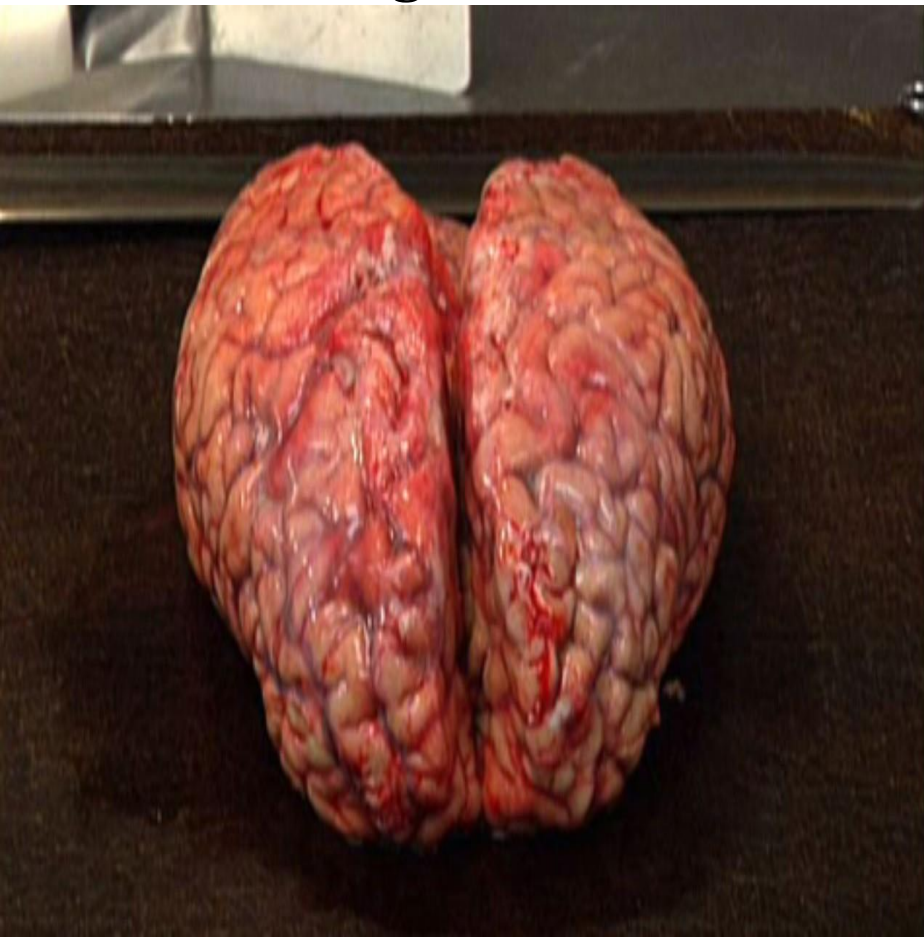
- An important part of psycholinguistic research is investigating biochemical processes in the brain – we call it neurolinguistics
- The beginning of neurolinguistics was an accident

- 1848: Phineas Gage had an accident on the railroad construction site
- An iron rod was driven completely through his head
- Language skills mostly unchanged
- Strong personality and behaviour changes
- Why?
- His skull exhumed and reconstructed after his death
- Frontal lobe damage and no serious damage to language areas



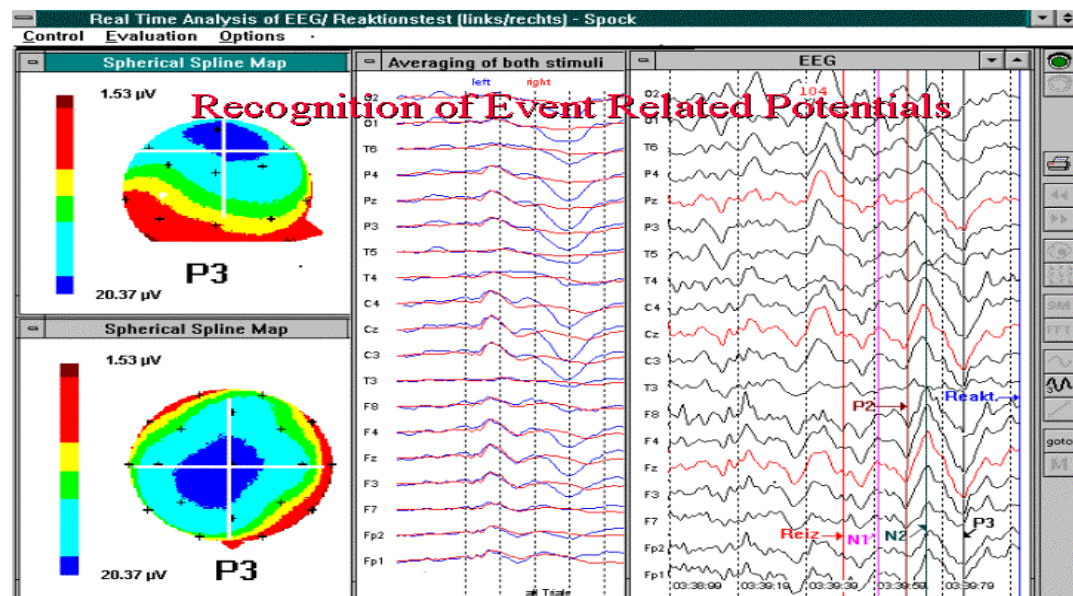


- Autopsy of the dead brain makes little sense in neurolinguistics – we want to see the living brain working



- How can we see the living brain working?:
- (EEG) Electroencephalography
- (PET) Positron Emission Tomography
- (fMRI) Functional Magnetic Resonance Imaging

- EEG
- Measures bioelectrical activity produced by the brain
- The activity of many types of receptors results in a flow of ions into or out of the dendrite
- Great temporal resolution: scanning brain processes in real time
- Measure ERP (event-related potentials)
- Less precise in localist terms than metabolic imaging methods



Beta (β) 13-30 Hz
Parietally and frontally

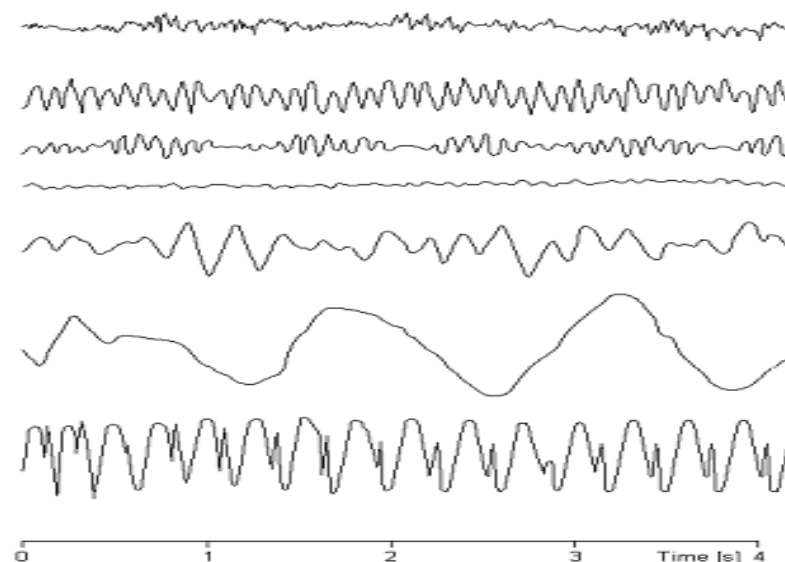
Alpha (α) 8-13 Hz
Occipitally

Theta (θ) 4-8 Hz
Children, sleeping adults

Delta (δ) 0.5-4 Hz
Infants, sleeping adults

Spikes 3 Hz
Epilepsy - petit mal

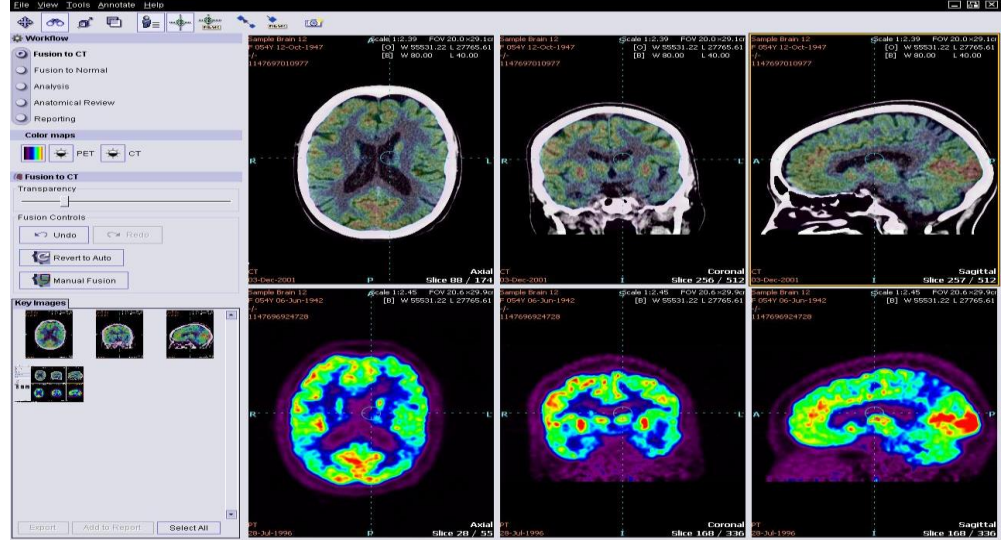
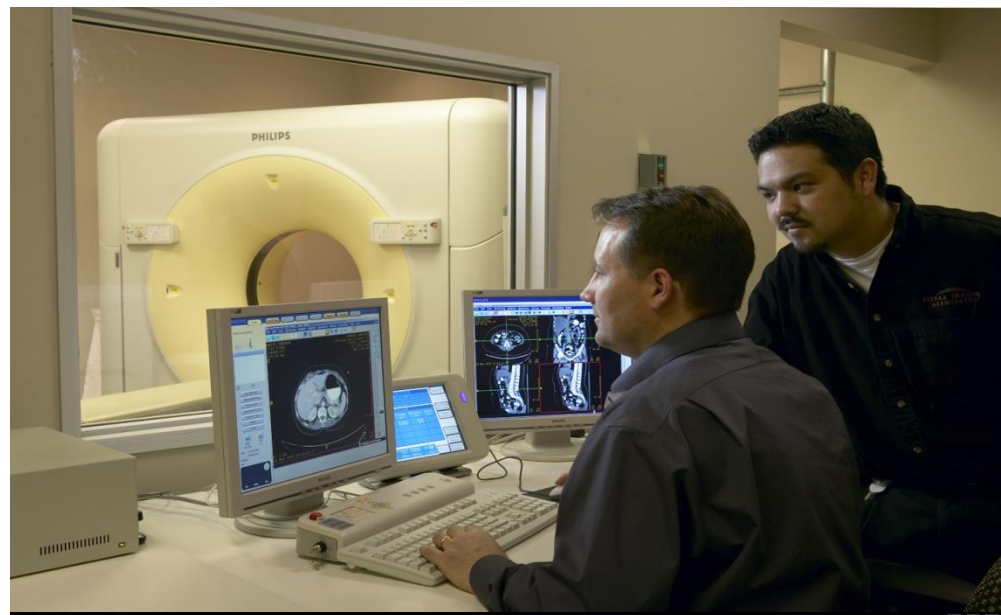
V [μV]



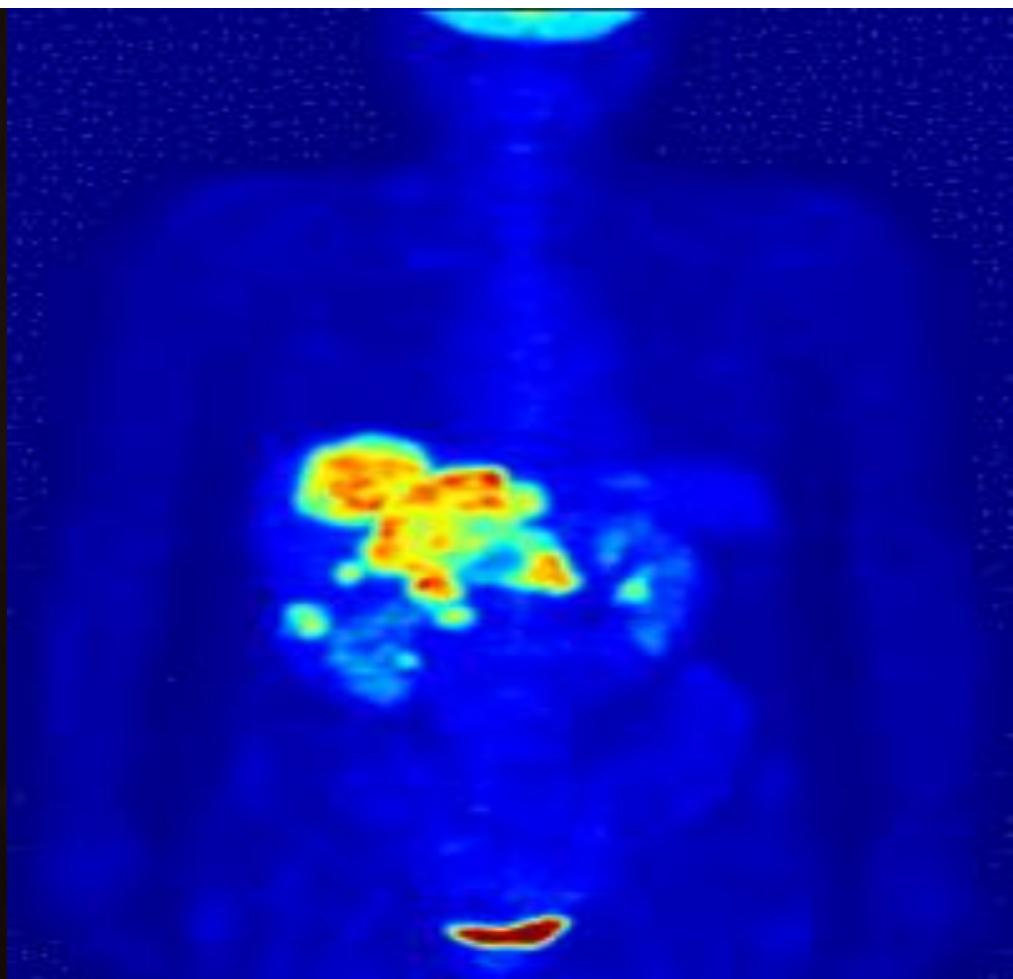
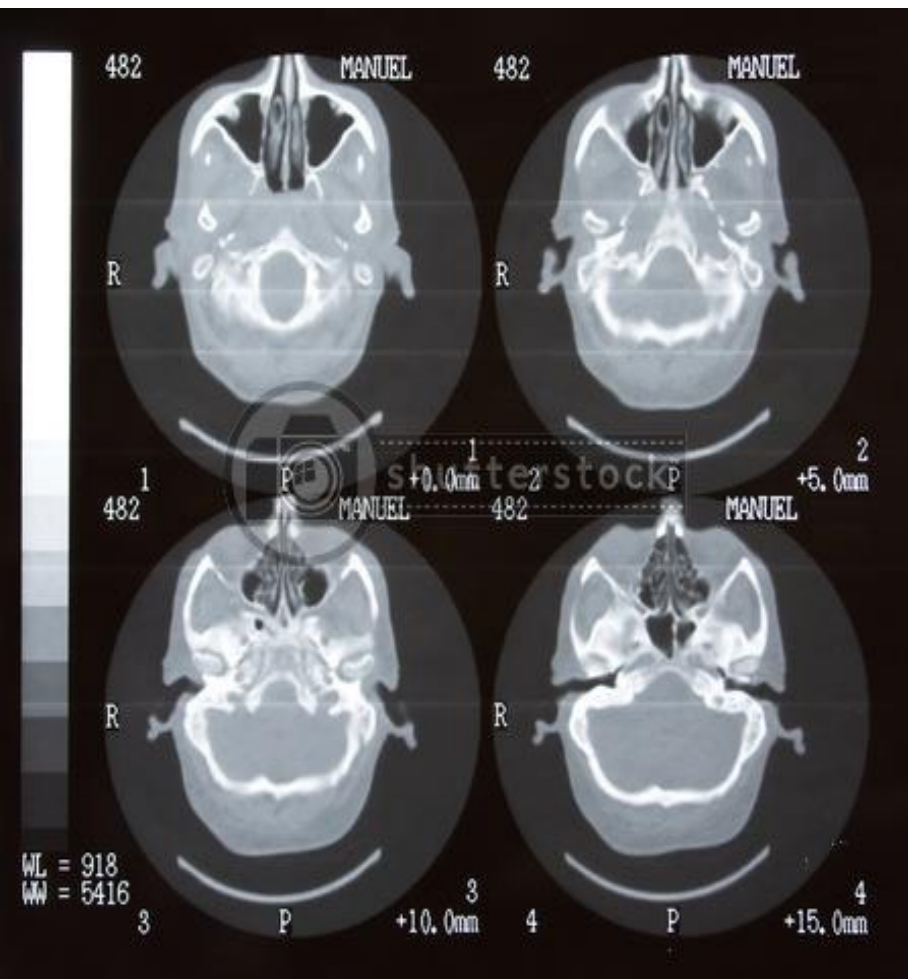
EEG



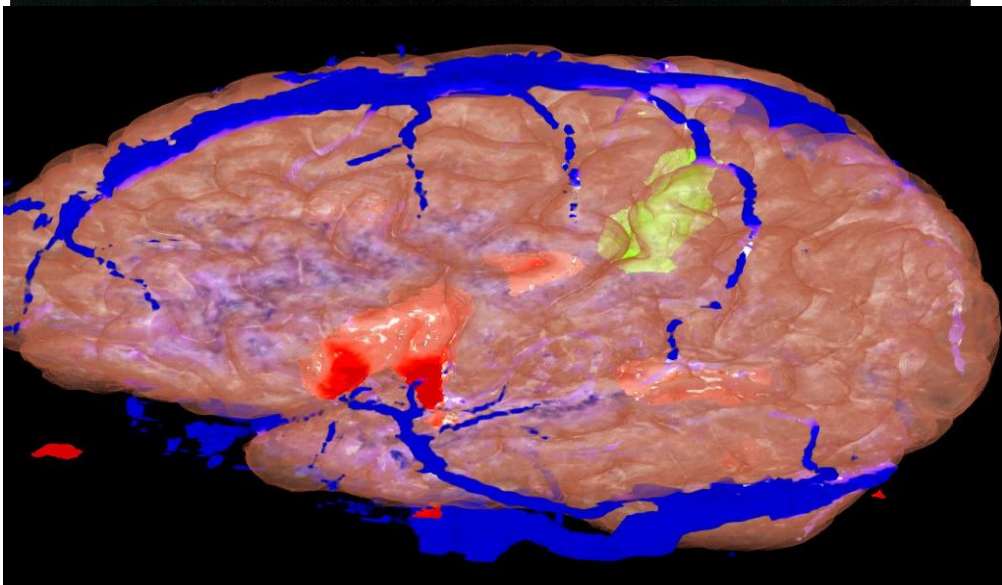
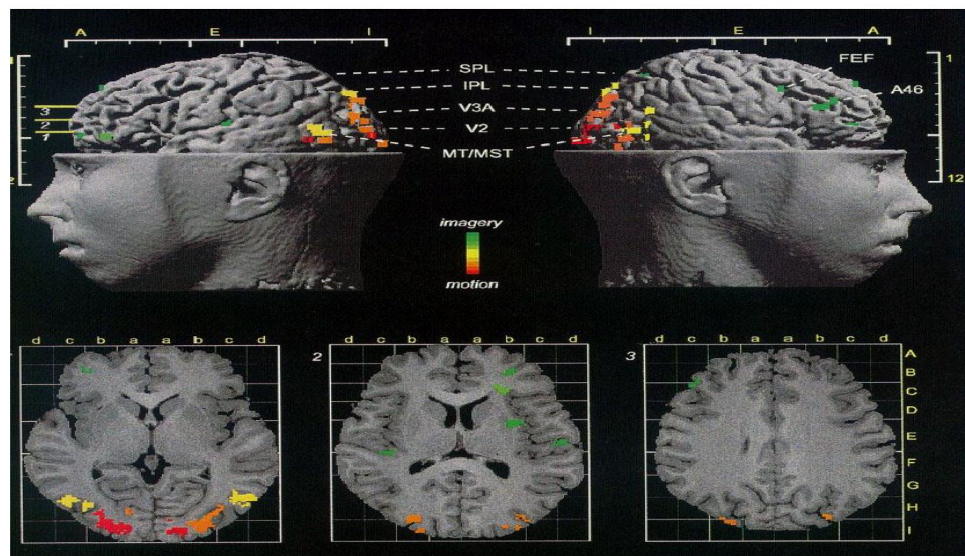
- PET
- Three-dimensional image
- Imaging is created by detecting pairs of gamma-rays
- Problem! It's invasive: a short-lived tracer-isotope must be injected into blood circulation of a subject



PET



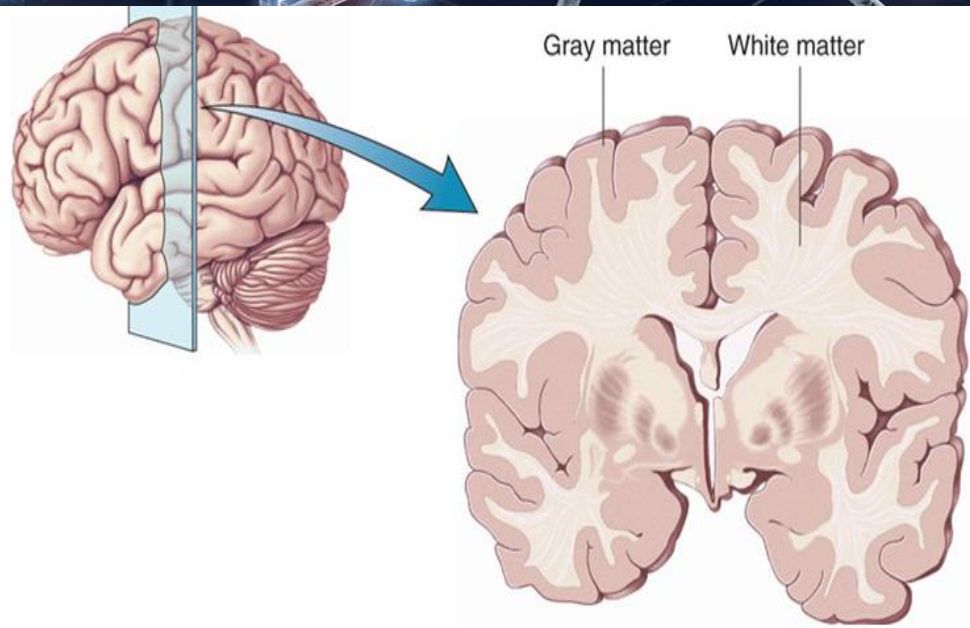
- fMRI
- Haemodynamic measures of brain activity
- Neural activation in a particular brain region triggers increased blood flow to that region
- We measure BOLD (blood oxygen-level dependent contrast)
- Volume elements: voxels
- No contrast injection!



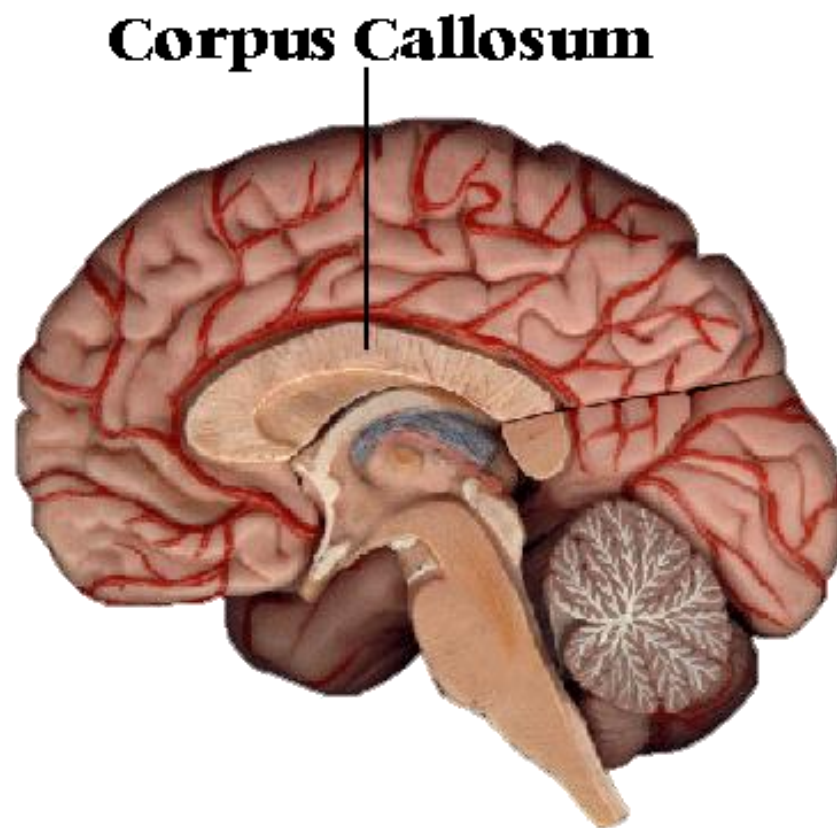
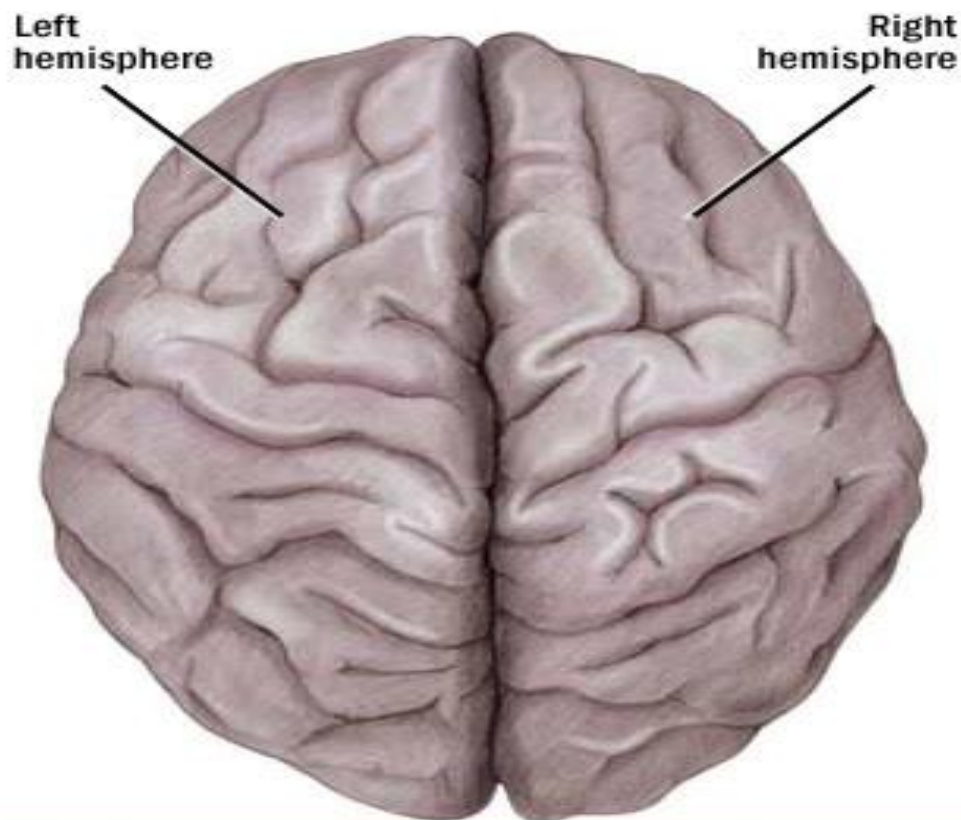
fMRI



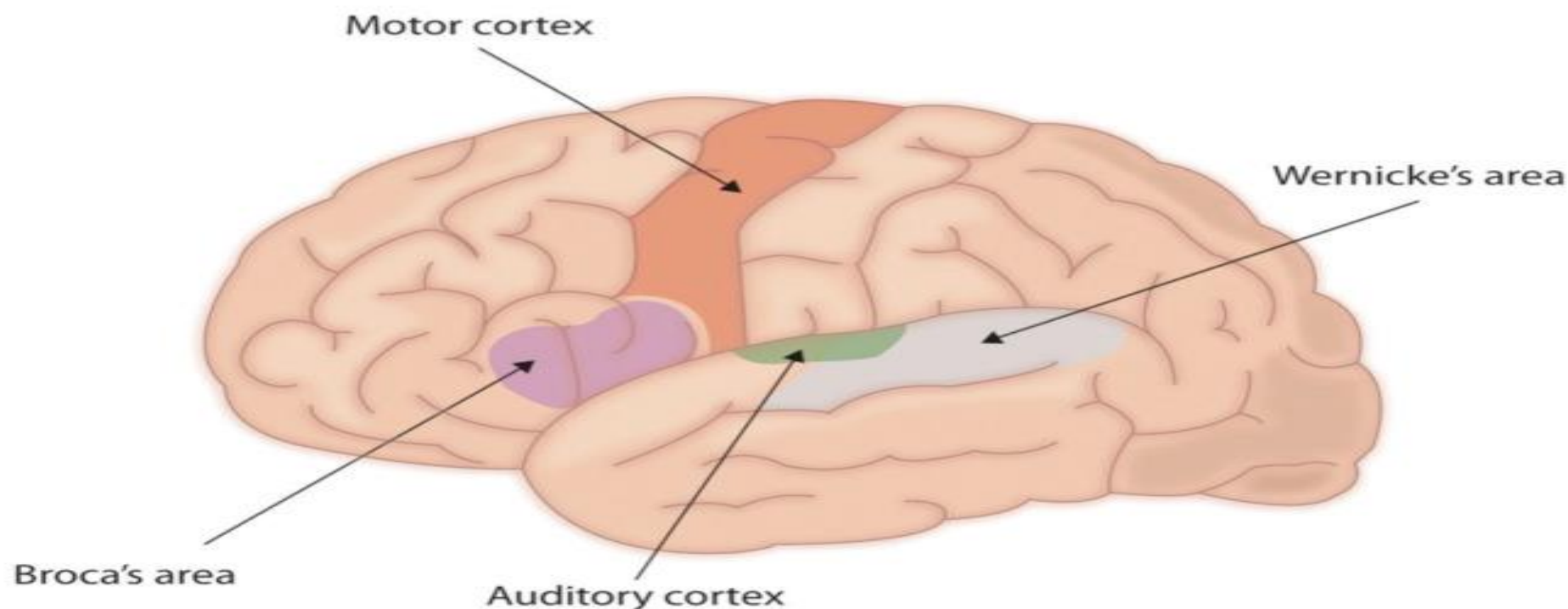
- So what do we know about the brain?
- You have around 10 billion nerve cells (neurons) in your brain
- The surface of the brain is the cortex (gray matter)
- Beneath the cortex – the white matter – consists of connecting fibres



- Two hemispheres – right and left
- Connected by the corpus callosum



- Two critical areas in the left hemisphere responsible for language
- Broca's area (Paul Broca)
- Wernicke's area (Carl Wernicke)



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 - no function words

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 - but nonsense words and impaired comprehension

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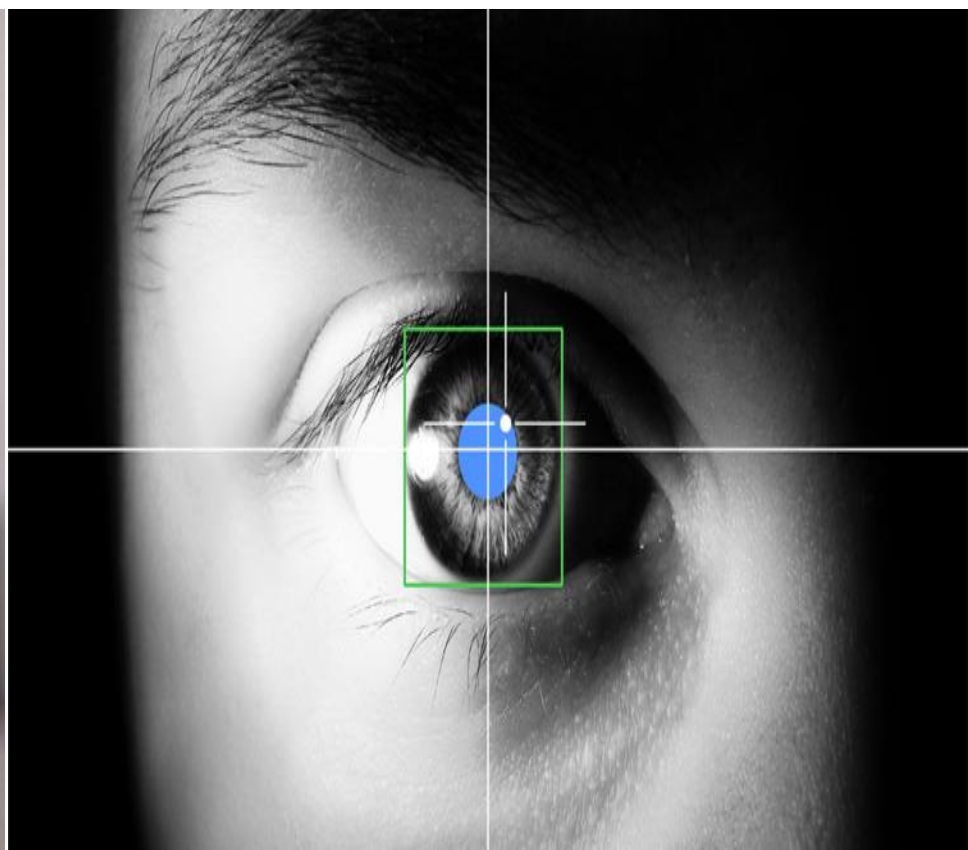
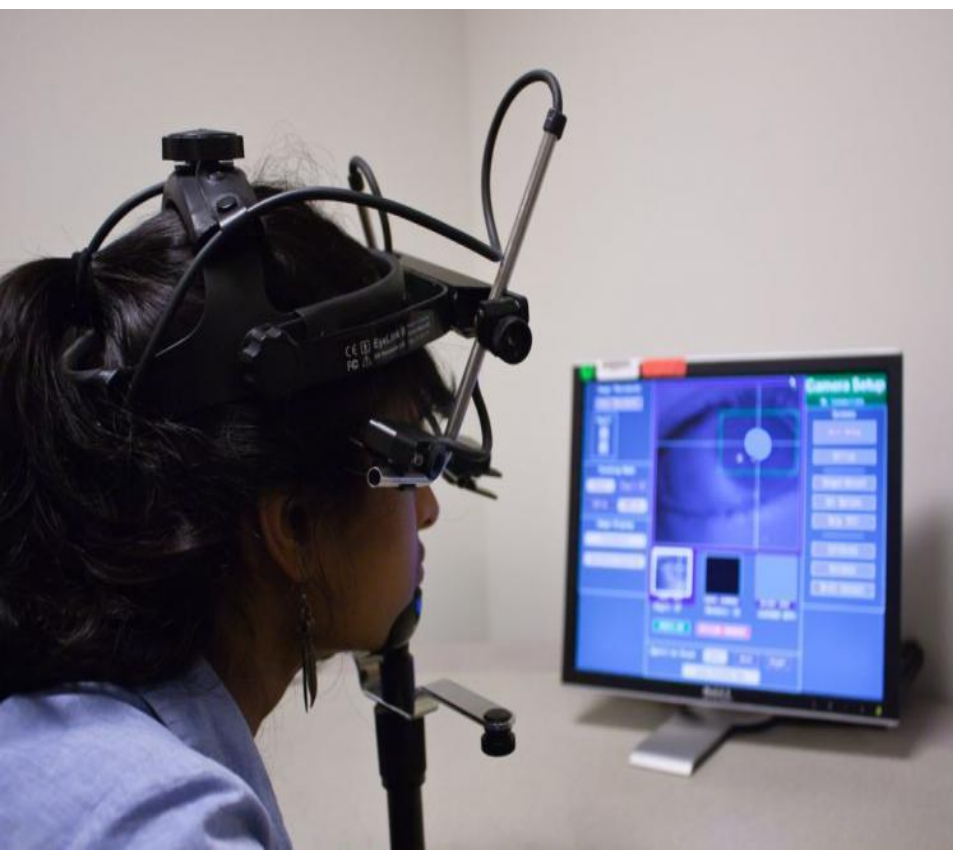
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- beginner learners show significant activity in the areas responsible for cognitive control (extra concentration)

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Eye-tracker



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- It works because generally we have two systems in our brain

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- **System 2:** concentrates attention to the effortful mental activities.

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 - you drive a car on an empty road

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 - you tell someone your phone number
 - you park in a narrow space

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- **System 2** is evolutionarily recent. It is slow and tiring. It has limited capacity, because it operates in the central working memory system

- Let's check the capacity of your **System 2**

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- Count how many times the players wearing white pass the ball

- The effect is so strong that you can replicate the experiment outside the laboratory: the ‘door’ study by Simon and Levin (1998)

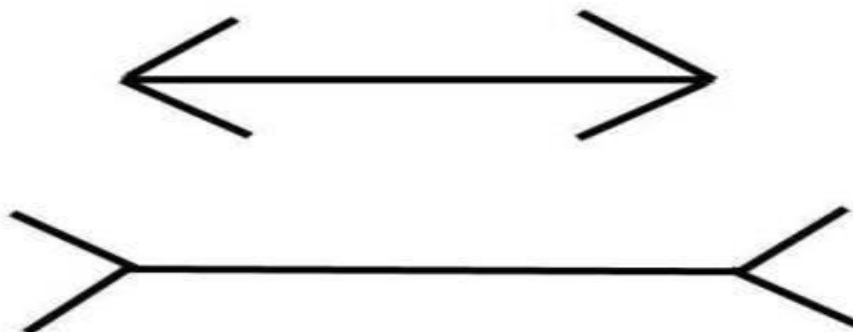
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- As you see, using **System 2** is really tiring and needs a lot of concentration, that's why we like using **System 1**.
- **System 1** is quick and likes giving easy answers. However...
- It has biases, stereotypes, and systematic errors. And you cannot turn it off.

- Which line is longer?

- Which line is longer?



- What's your first answer to this puzzle?:

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A bat and a ball cost \$1.10.

The bat costs one dollar more than the ball

How much does the ball cost?

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Did you think 10 cents?

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How much does the ball cost?

Did you think 10 cents?

No, it's 5 cents: $1.05 + 0.05 = 1.10$

System 1 gave you a quick and effortless answer which was wrong

- Is this logical argument true?:

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*All roses are flowers.
Some flowers fade quickly.
Therefore some roses fade quickly.*

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Most people say YES but it's NO

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Most people say YES but it's NO

Some flowers don't have to be roses

- **System 1 and System 2 in conflict**

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- Stroop test – we need one volunteer

- **System 1** and **System 2** in conflict
- Stroop test – we need one volunteer
- Say the colour of the font and not what the words say. Be as quick as you can. Remember, say the colour of the words and don't read them.

Orange Blue Green Pink Orange Purple Pink
Purple Yellow Green Blue Green Blue Purple
Yellow Orange Gray Red White Red Pink
Blue Gray Red Blue Orange Red Blue
Purple Red Purple Orange Gray Red Green
Blue Purple Pink Yellow Pink Green Yellow
Orange Yellow Red Yellow Pink Orange Green
Purple Gray Red Orange Green Blue Green
Pink Gray Red Yellow Purple Blue White
Pink Blue Green Purple Yellow Gray Yellow

Thanks for your attention!