

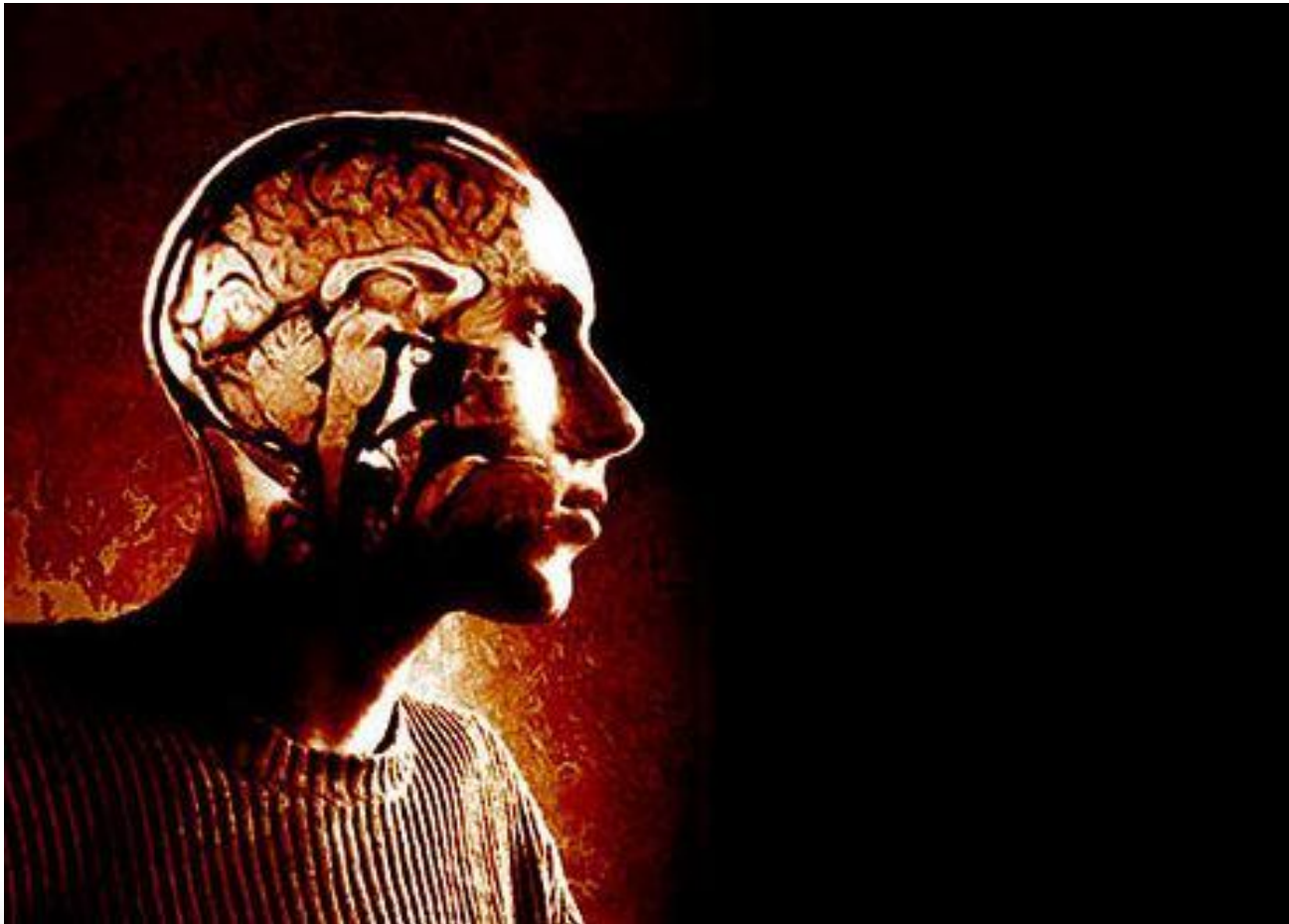
Language and the Brain

Dr Stuart Jones





Language and the Brain





Aims of the lecture.

- To Define Language
- To explore the regions of the Brain associated with Language.
- To explore Language disorders and how that has enhanced our knowledge.



- To examine the Biological basis for Answering a question, Reading aloud and Reading Silently.
- To explore The Biological Basis for performing sign language.
- To explore the work of Sperry and Split Brain Research in relation to Language.

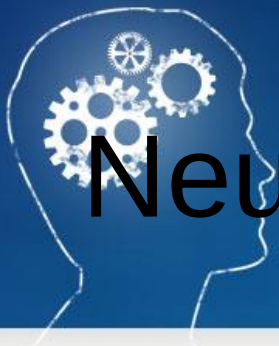


What is language?

Written, Spoken and Gestural communication

Language capabilities require learning

- but also depend on specific structures of the brain
- damage to these structures can deprive a person of some or all of these functions



Neuropsychology of Language

- Studies of brain damaged/diseased people have provided numerous insights into the language
- One of the more difficult areas to assess.
Why?



Aphasia

Aphasia = Partial or total loss of the ability to articulate ideas or comprehend spoken or written language, resulting from damage to the brain caused by injury or disease



Errors include:

- Total arrest of speech, or an inability to vocalise spontaneously
- Hesitation and slurring of speech
- Distortion and repetition of words and syllables
- Confusion of numbers while counting
- Inability to name despite retained ability to speak
- Misnaming.



Aphasia

- Aphasia – Aphatos (Greek Word – Speechless)
- Impairment in language comprehension and/or production that accompany neurological deficits.
- Aphasia = collective term, there are specific types of Aphasia (e.g. Wernicke's Aphasia)
- Common = 40% of all strokes.



Aphasia

- Primary Aphasia
 - Problems with the language processing mechanisms
- Secondary Aphasia
 - Language issues as a result of memory impairments, attention disorders or perceptual problems.



Brodmann's areas (1909)

e.g.

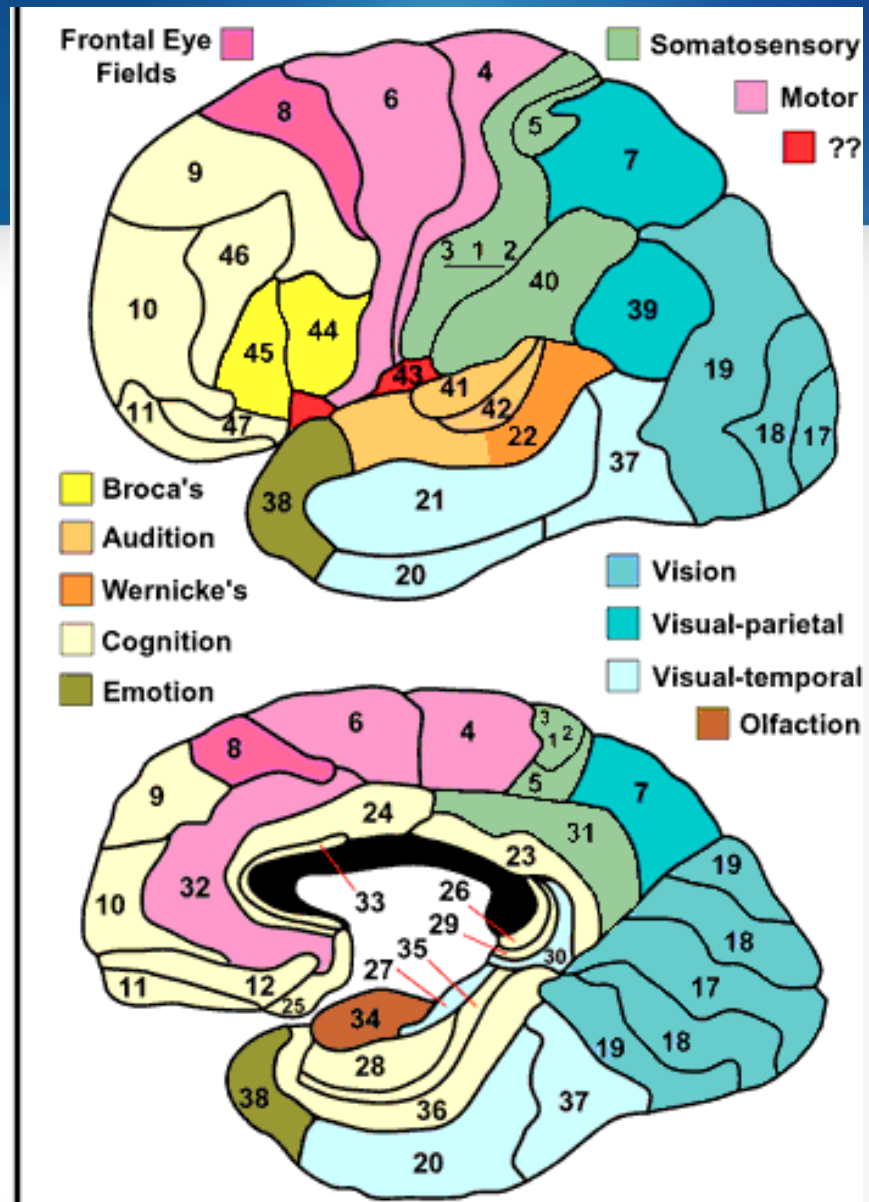
Areas 22

- **Wernicke's area**

Area 39 is the **angular gyrus**.

Areas 44 and 45 are **Broca's area**.

Area 41 is **Heschl's gyrus**, the primary auditory area.



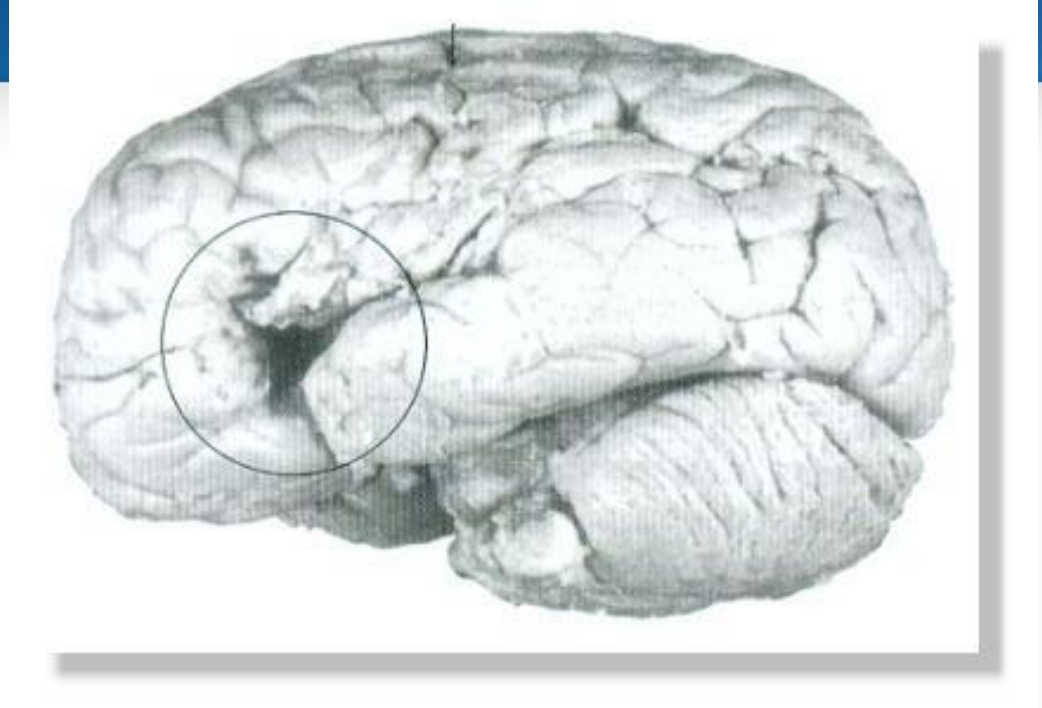


History of Language Research

- Jean-Baptiste Bouillaud (1796-1881)
 - Brain Injured Patients
 - Language resided in the Frontal Lobe
- Paul Broca (1824-1880)
 - Patient called 'Tan'- autopsy
 - Met Tan in 1861 – Tan died a few days after initial meeting in 1861.
 - Brain lesion in the posterior portion of the left inferior frontal gyrus (Broca's area).



Broca

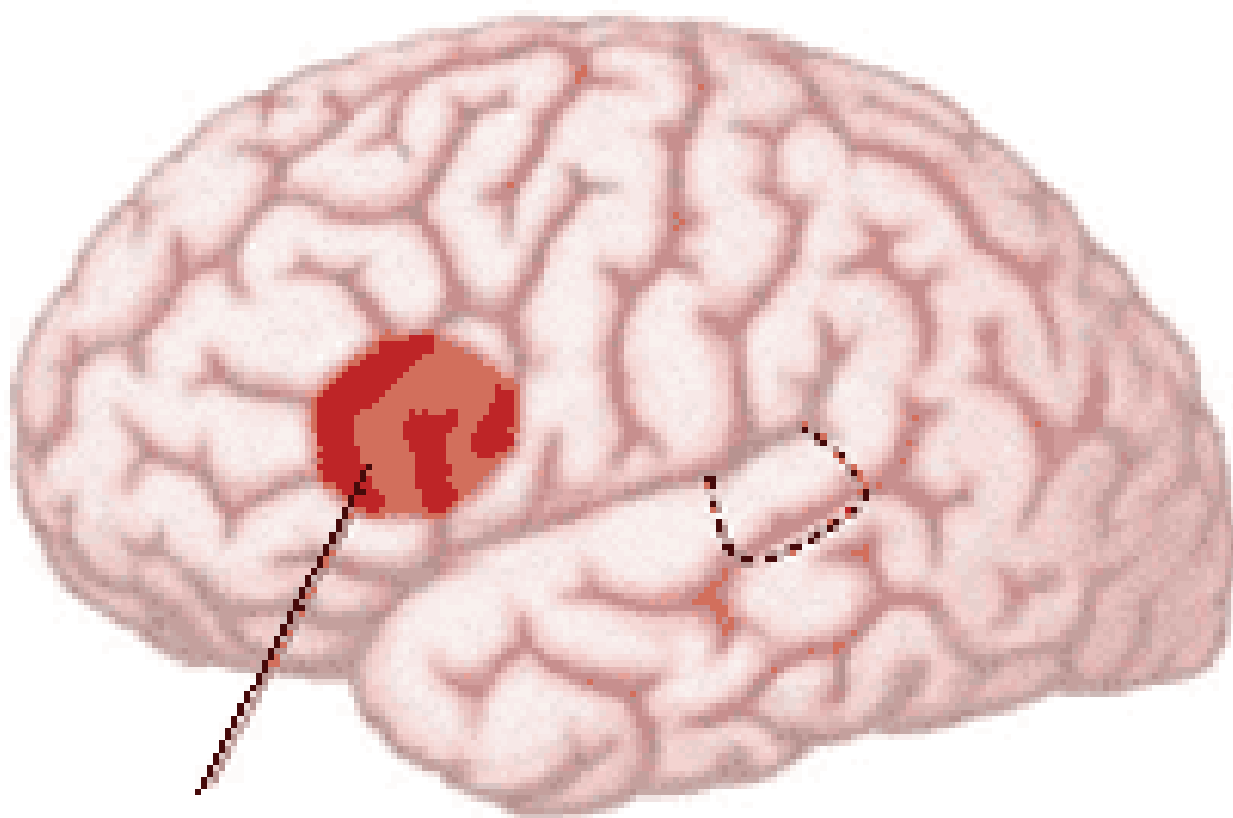


Tan's brain - large lesion in the frontal cortex

Identified the existence of a “language centre”
in posterior portion of frontal lobe of left hemisphere



- Broca's studies noted that patients with language problems also generally had right hemiparesis.
- Led to the deduction that speech is localised in the 'Broca's Area' – Inferior frontal lobe of the left hemisphere.



Broca's Area



Carl Wernicke (1848-1905)

- His stroke patients had fluent speech but spoke nonsensical sounds, words and sentences.
- Deficits in comprehending what was spoken to them.
- Autopsy revealed damage to a specific region of the temporal lobe.



Wernicke



Discovered a part of
the brain involved in
understanding language

In the posterior portion
of the left temporal
lobe



- Wernicke concluded that this region participated in the auditory storage for words – as it was located close to where auditory processing takes place.
- Wernicke's area
 - Damage produces poor language comprehension – lost word related memories

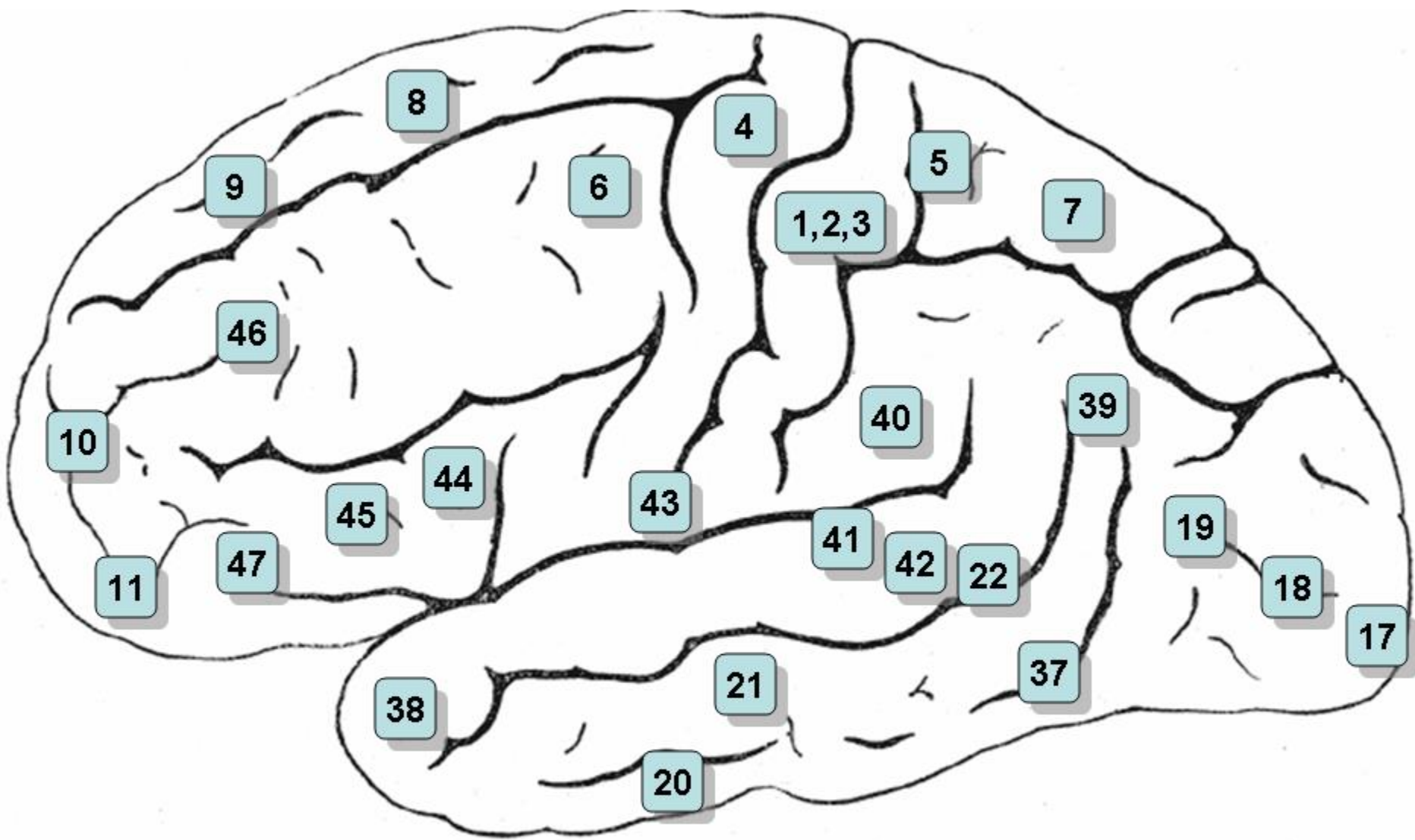


The Wernicke-Geschwind model (Geschwind, 1970, 1972, 1979)

The meaning of words is represented in Wernicke's area.

When a person listens to speech, word sounds are sent through the auditory pathways to the primary auditory cortex, Heschl's gyrus (Brodmann's area 41) also Brodmann's area 42.

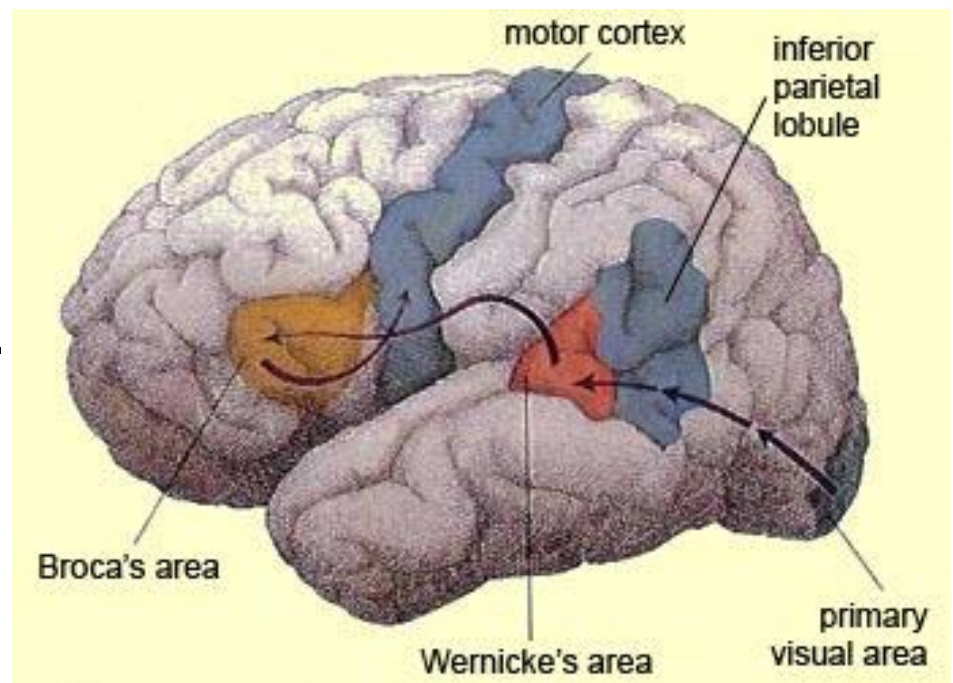
From there, they are relayed to Wernicke's Area (Brodmann's Area 22), where the sense of words is extracted





To speak, word meanings must be sent over the arcuate fasciculus to Broca's area (Brodmann area 44 and 45), where morphemes are assembled.

The model proposes that Broca's area holds a representation for articulating words

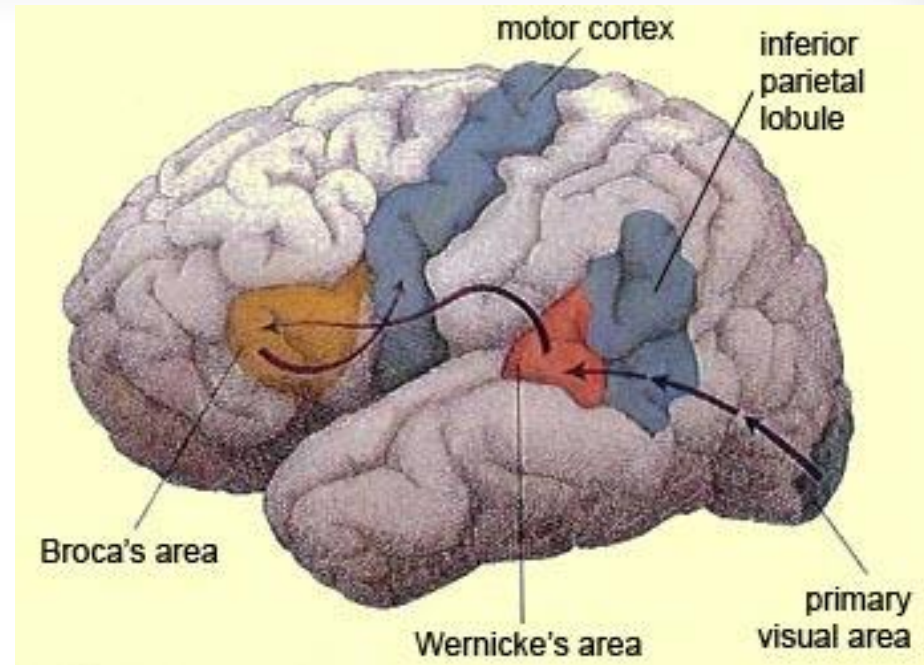




To answer a verbal question - progression of activity from the auditory cortex, to Wernicke's area, and then to Broca's area.

Broca's area then formulates articulation of the verbal response and sends the result to the facial area of the *motor cortex* (*Brodmann's area 4*)

From there, instructions are sent to facial motor neurons in the brainstem, which relay movement commands to facial muscles which produces the speech

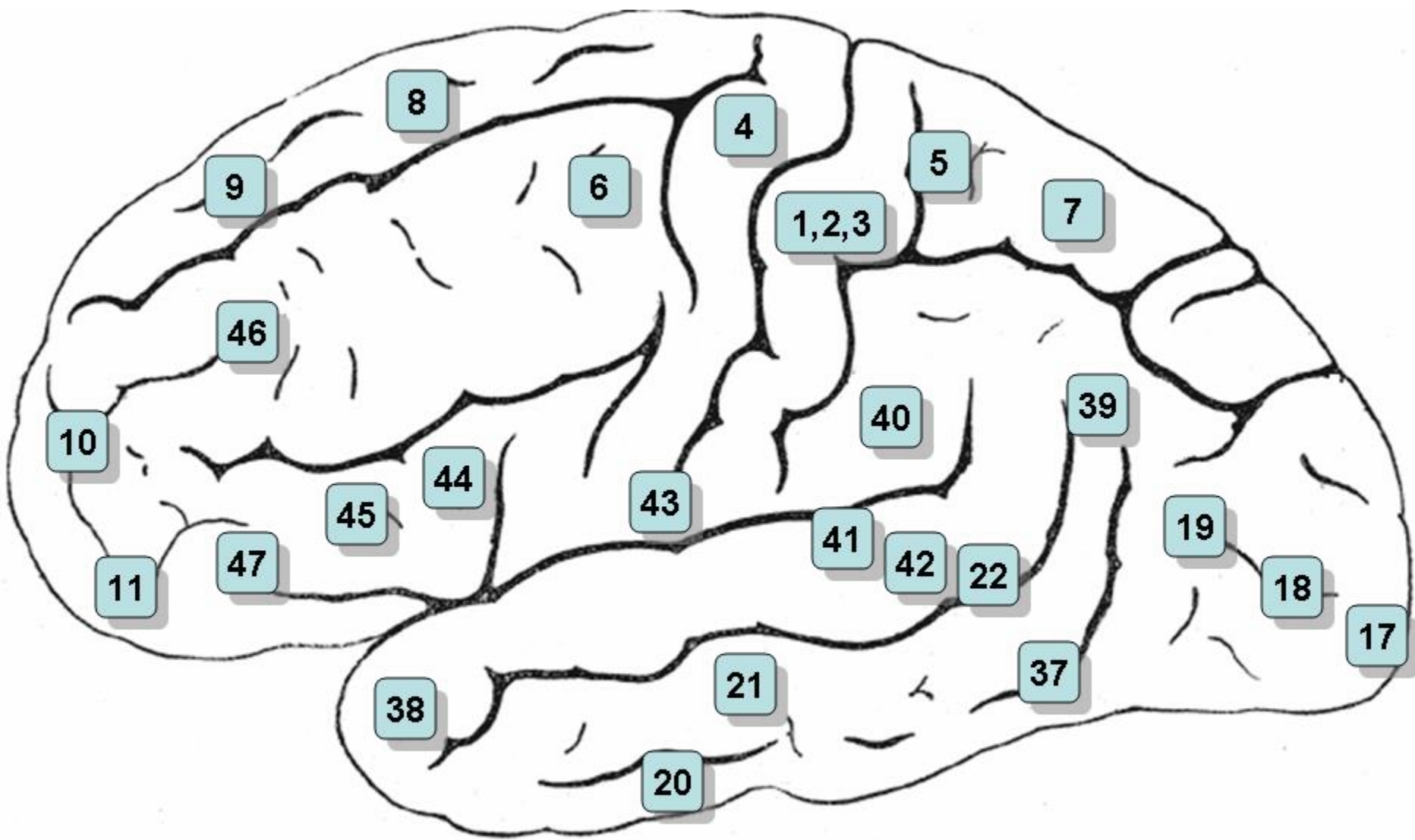




Reading requires that information concerning handwritten or printed words be sent from visual areas 17, 18 and 19

.....to the angular gyrus (area 39)

.....from there to Wernicke's area, which reads silently, or in conjunction with Broca's area reads aloud





Brodmann's areas (1909)

e.g.

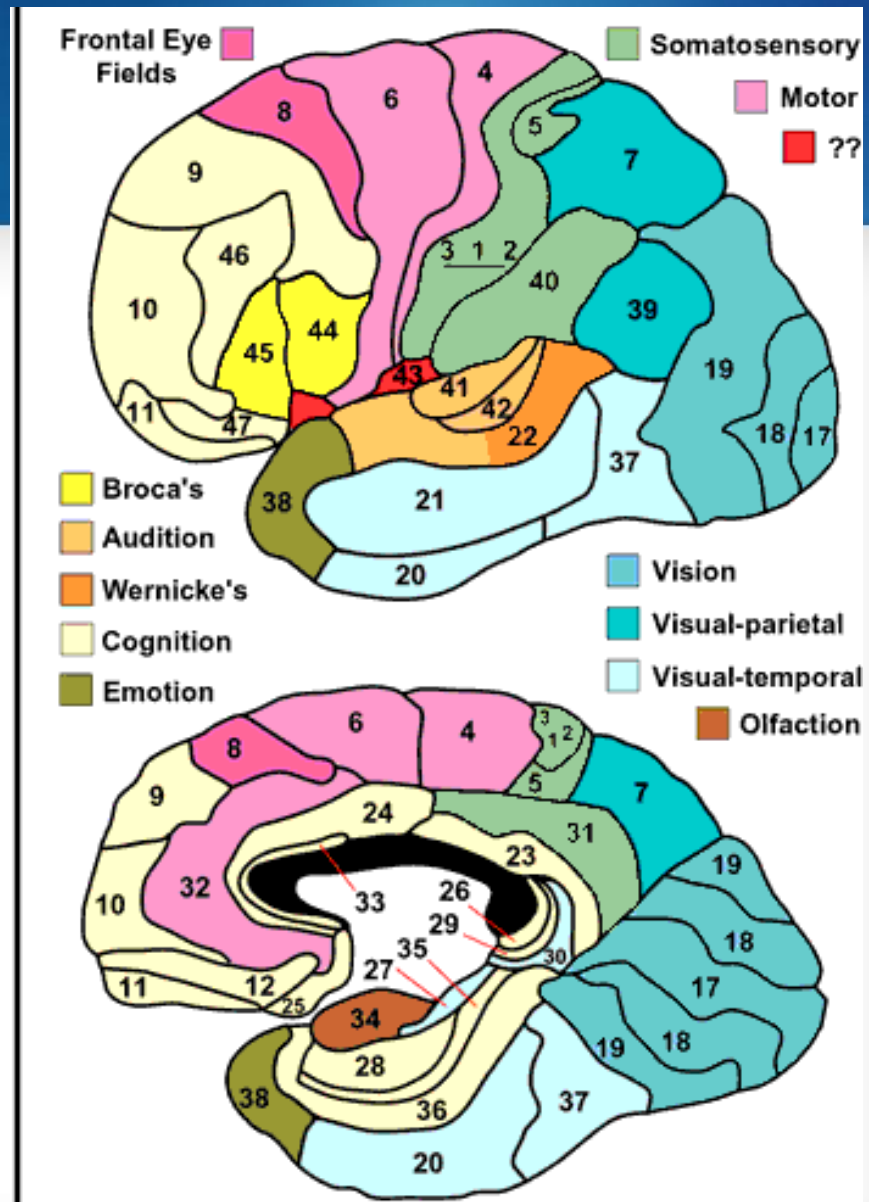
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If we read aloud, the visual information is translated in the auditory form by the angular gyrus.....

.....then passed to Wernicke's area, where a response is generated.....

.....then sent to Broca's area which allows us to verbalise words



Classification of Aphasia

- Three main test parameters for language disorders
 - Spontaneous Speech
 - Auditory Comprehension
 - Verbal Repetition



Broca's Aphasia

- Speech difficulties
- Wide range of symptoms include
 - Unintelligible mutterings
 - Simple sentences that lack functional words or grammatical markers.



Broca's Aphasia

- Speech is often telegraphic and uneven.
- Dysarthria.
- Speech Apraxia.
- Sometimes the patient can sing, count and/or recite phrases.



Broca's Aphasia.

- <http://www.youtube.com/watch?v=f2liMEbMnPM>



Wernicke's Aphasia

- Primarily a disorder of language comprehension
- Problems understanding spoken or WRITTEN language
- Can speak fluent sounding speech but the speech is meaningless.



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Wernicke's Aphasia.

- <http://www.youtube.com/watch?v=aVhYN7NTIKU>



Biological Basis of Language

- <http://www.youtube.com/watch?v=NUTpel04Nkc>



What about sign language.

- People use hands and arms when they speak.
- Formal arrangement form the basis of sign language.
- Many similarities in form and fluency in comparisons to vocal language (Klima and Bellugi, 1979).



Sign Language.

- Meckler et al (1979).
- Raised by deaf-mute parents, but used both spoken and sign language regularly.
- Accident.
- Impairments in both spoken and sign language.
 - Same for people who can speak more than one vocal language.



Sign Language.

- Chiarello et al (1982).
- Older deaf-mute woman.
- Stroke – damaged left Wernicke's area.
- Unable to generate sign language.



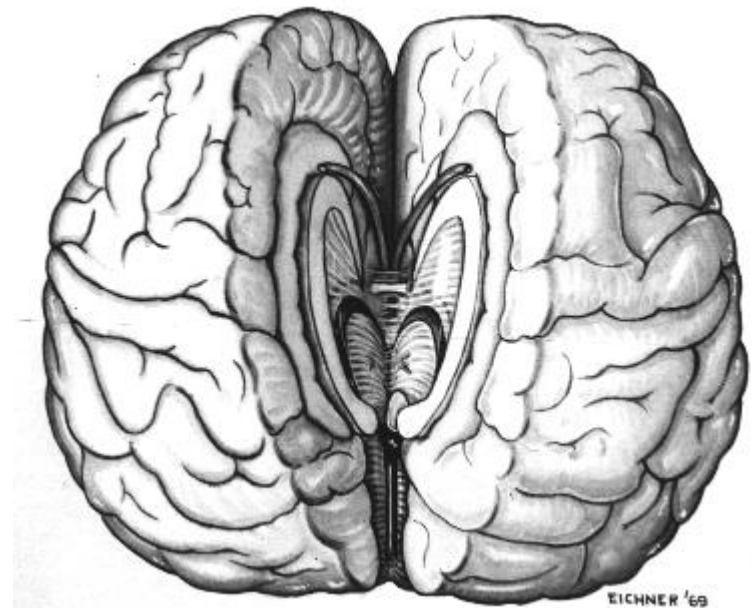
Left Brain is different from the Right Brain.

- Finger (1994) – Left Hemisphere described as the dominant hemisphere in Language.
- Cerebral specialisation or lateralization.
- Some functional systems are connected more to one side of the brain than the other.



Split Brain Patients.

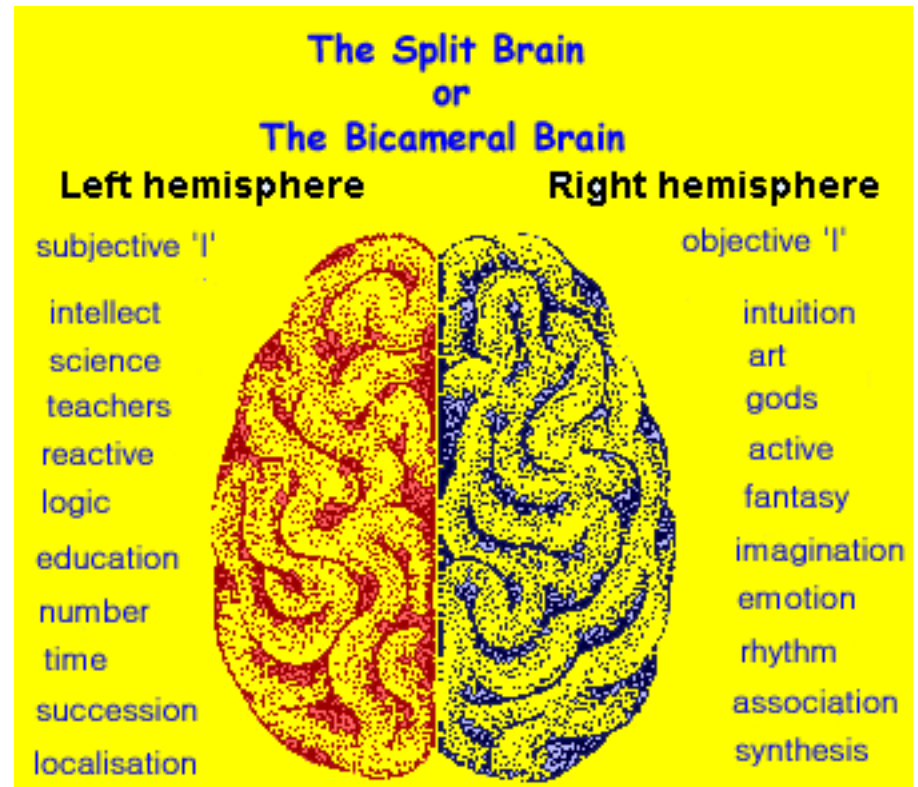
- Normally – connection of hemispheres masks evidence of hemispheric specialization.
- Split Brain Patients – interhemispheric pathways have been disconnected.
 - Cognitive, perceptual, emotional and motor activities.





Two minds in one head?

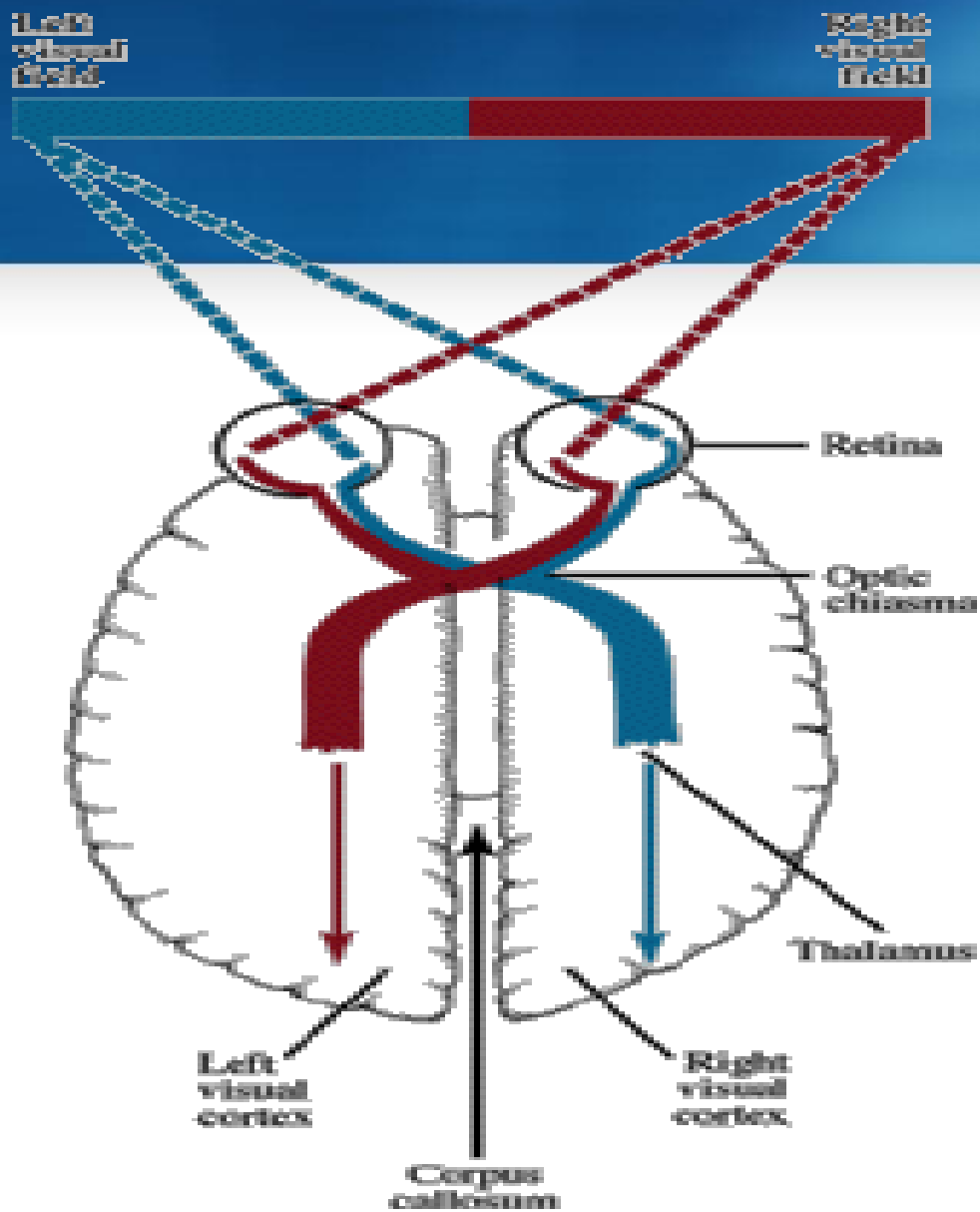
- Operations to split the brain as relief from seizures – 1930's.
- Originally thought no impairment – normal brain function in IQ tests etc.





Sperry et al (1956).

- Studies in Vision highlighted that items viewed in the left visual field activates the right occipital lobe
- And Vice Versa – Right Visual Field = Left occipital lobe.





Sperry.

- Experiment.
- Split Brain Patients.
- Participants shown words (everyday words) shown only in the Left Visual Field, Right Visual Field
- Asked to name the object.



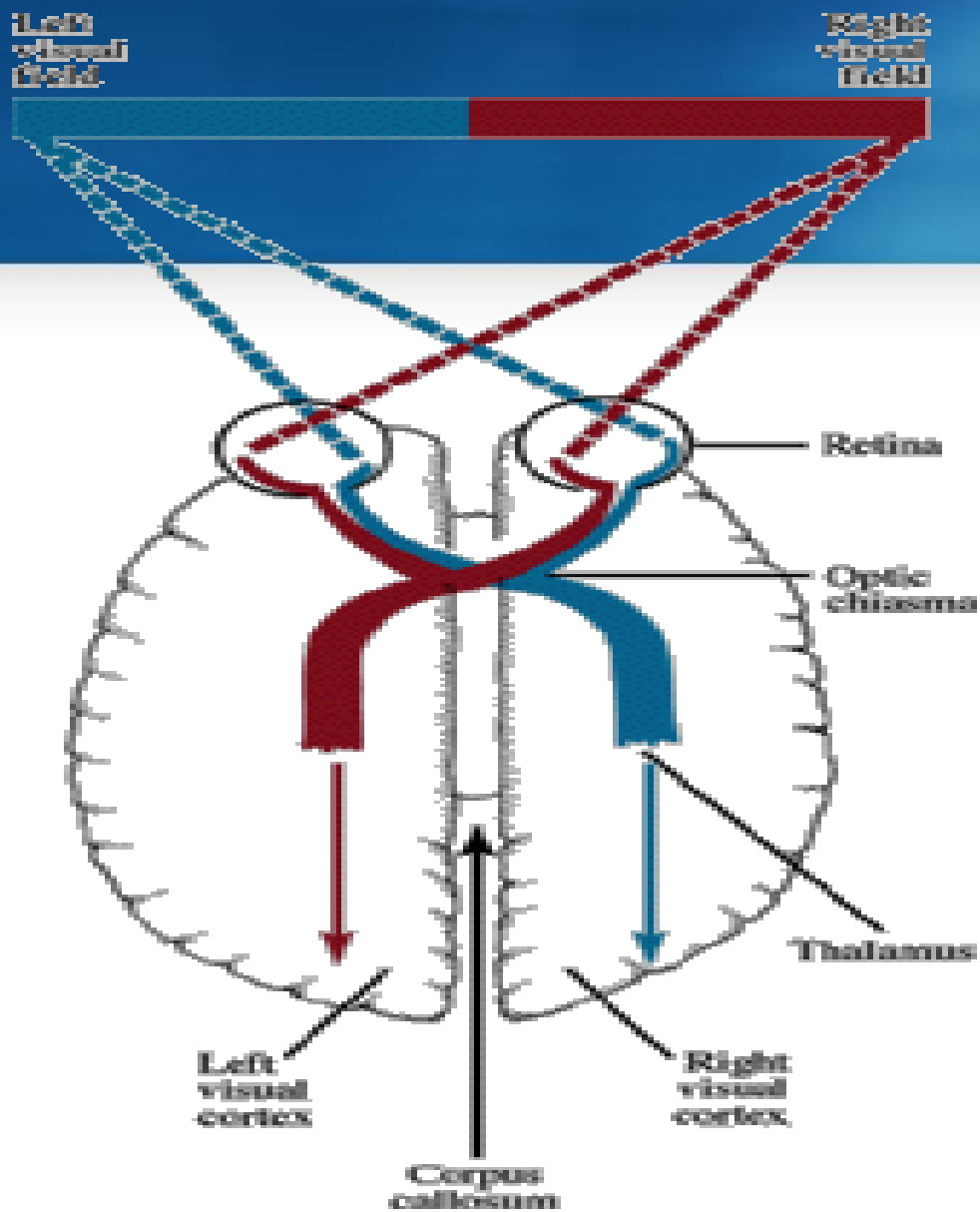
Findings.

- Participants could name words when only in the right visual field.
- Participants could not name objects when shown only in the left visual field.
- Why?



Sperry's conclusions.

- Rozenweig et al (4th edition) – P598.
- Left Hemisphere is the dominant area for language.
- Typically when we see information in the left visual field – this information goes to the right hemisphere... then to SAY it, it needs to be transferred back to the left hemisphere
- Split Brain Patients cannot do this.





Other Split Brain Studies.

- Non Verbal means.
- Picture of an object shown in Left Visual Field (Right Hemisphere).
- Ask to touch the object that he/she has seen.
 - Left Hand (Right Hemisphere) – Correct.
 - Right Hand (Left Hemisphere) – Incorrect.



Does the Right Hemisphere do anything in Language.

- Well.... Yes.
- Zaidel (1976) – yes, recognise simple words.... Also involved in the emotional tone of verbal material.
- In addition.
 - Replicating Sperry's studies but with familiar faces and not printed words.
 - Left Visual Field (Right Hemisphere) better.



And for a bit of fun.....

- <http://www.bbc.co.uk/science/humanbody/mind/surveys/smiles/>



Left or Right Brained

- <http://lateralaction.com/articles/left-brain-or-right/>
- <http://braintest.sommer-sommer.com/en/>