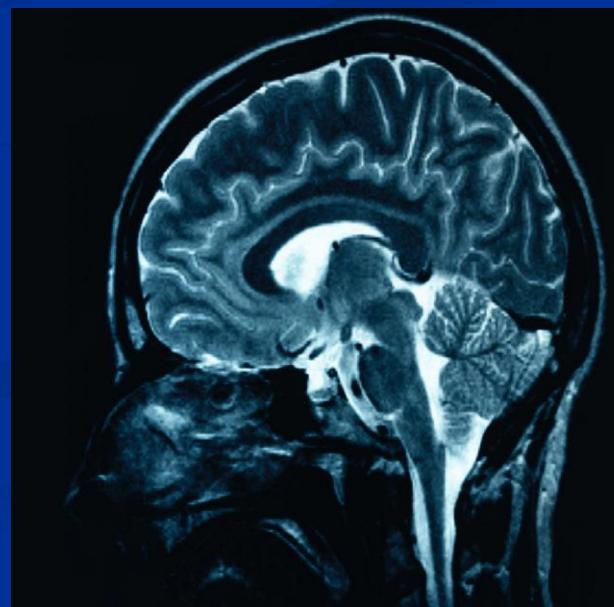
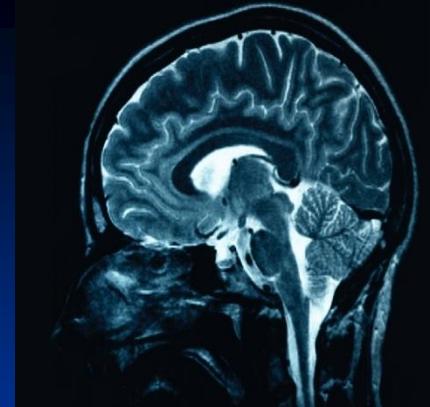


APPROACHES TO LANGUAGE

Lecture 8:
Language & the Brain I:
Language Areas & Aphasia



Overview



■ *Structure & function of the brain:*

- the linguistic & neurolinguistic underpinnings of language skills;
- consider how language skills can systematically break down in individuals who have experienced brain damage – APHASICS.

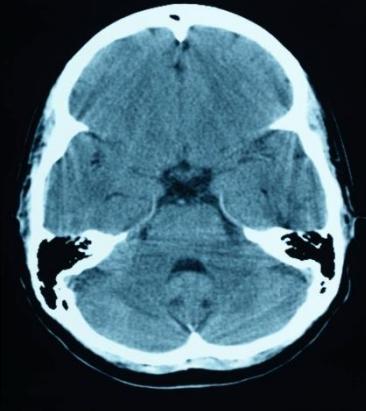
Neurolinguistics

- The study of how language structures are instantiated in the brain:
 - *psycholinguists* – study language processing in ‘normal’/typical individuals and populations &
 - *neuropsychologists/linguists* – study the breakdown of cognitive (memory/attention) and linguistic abilities due to brain damage.
- As yet no single unified theory about language localisation/storage/processing – but subtheories (e.g. sentence processing models) are available.



“ There are approximately 12 billion nerve cells in the human brain. The number of possible interconnections among the cells in a single human brain is greater than the number of atomic particles that constitute an entire universe.”

Thompson (1967:1) *Foundations of Physiological Psychology*.

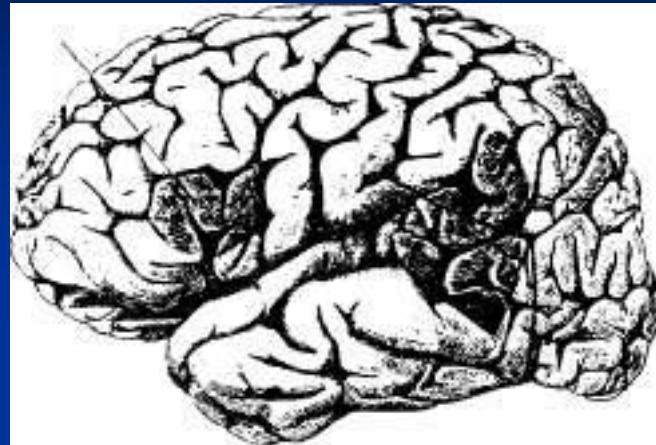


The human nervous system consists of:

1. The *central nervous system* (brain & spinal cord)
2. *Peripheral nervous system* - systems that regulate functions such as breathing, temperature + crucially for language – muscles that control our articulators – tongue, jaw (oral languages) and hands/arms/face (for sign languages).



Brain Hemispheres

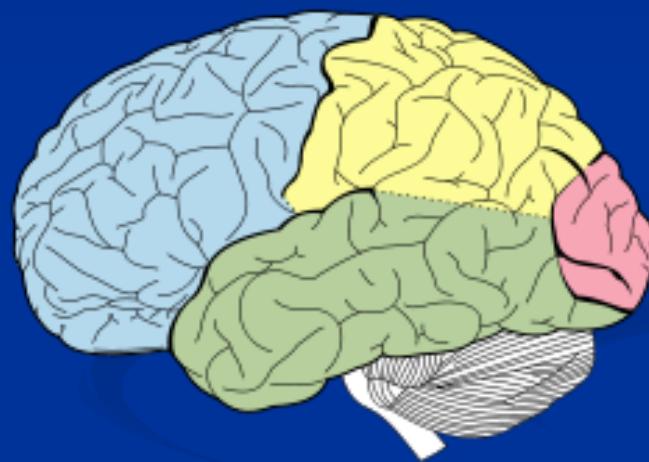


- The cerebrum - 2 hemispheres – right & left.
- Cerebral hemispheres - connected via fibre bundles – most important = CORPUS CALLOSUM.
- The surface of the cerebral hemispheres is the cortex which is distinguished by its convolutions – the hills (gyri) & valleys (sulci)

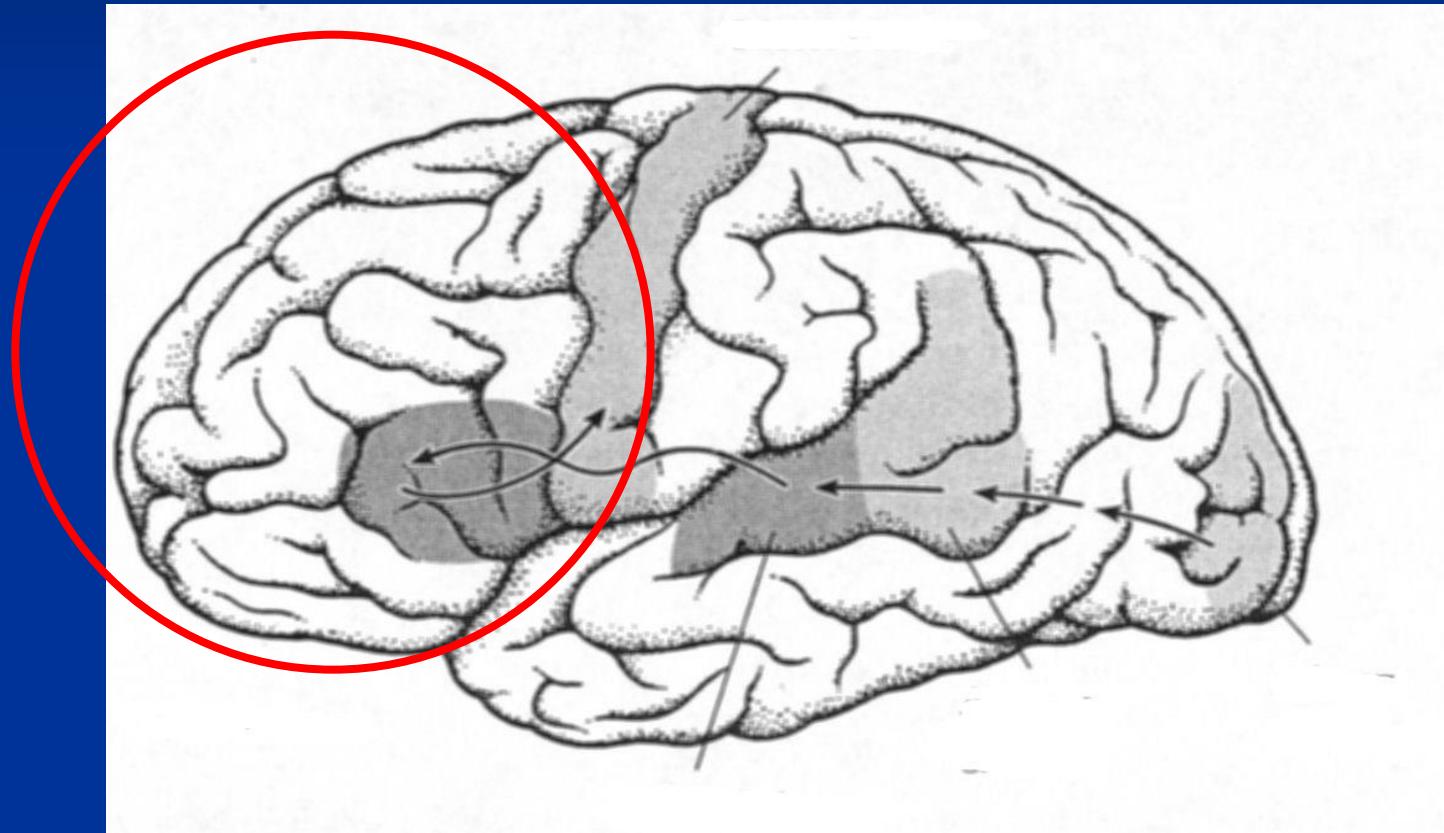
Lobes

We can distinguish 4 lobes:

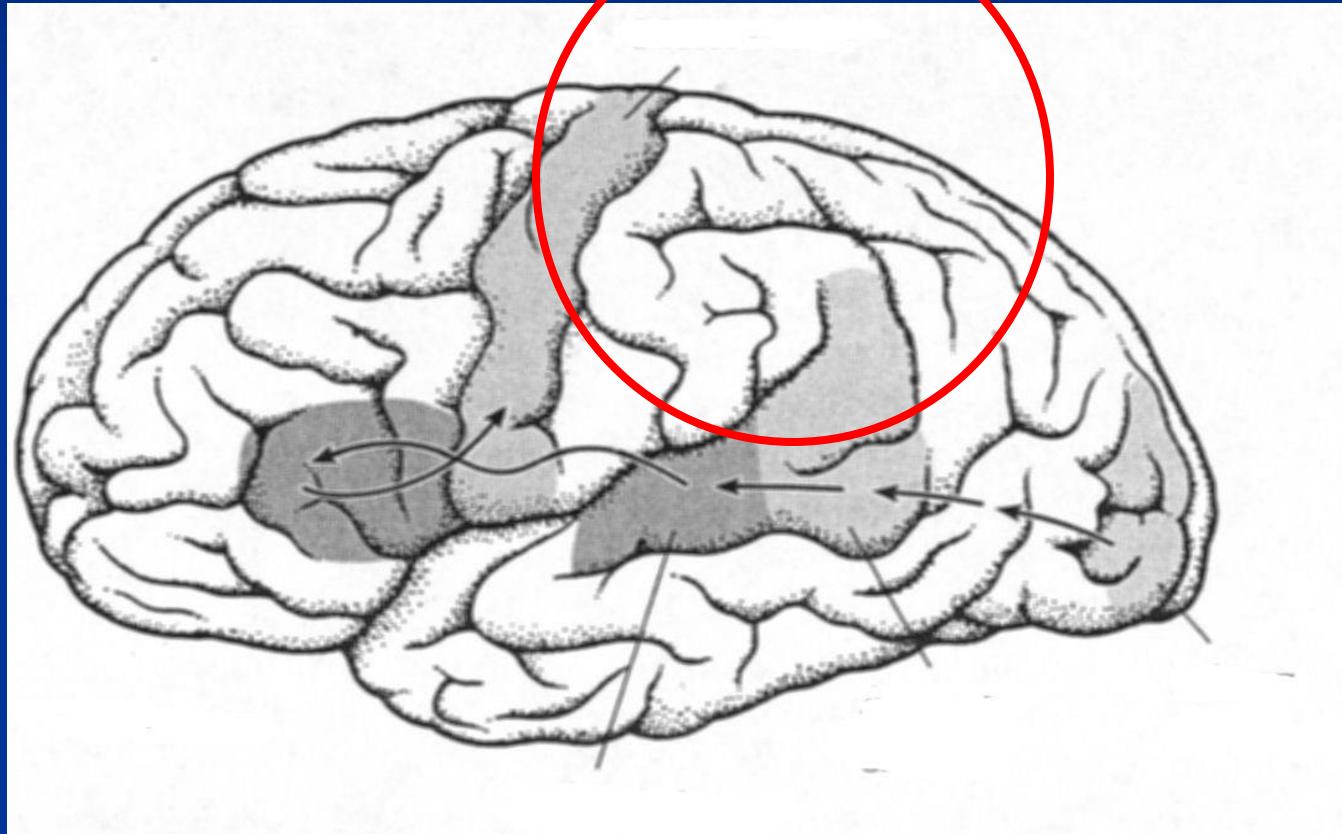
- Frontal lobe (blue)
- Occipital lobe (pink)
- Parietal lobe (yellow)
- Temporal lobe (green)



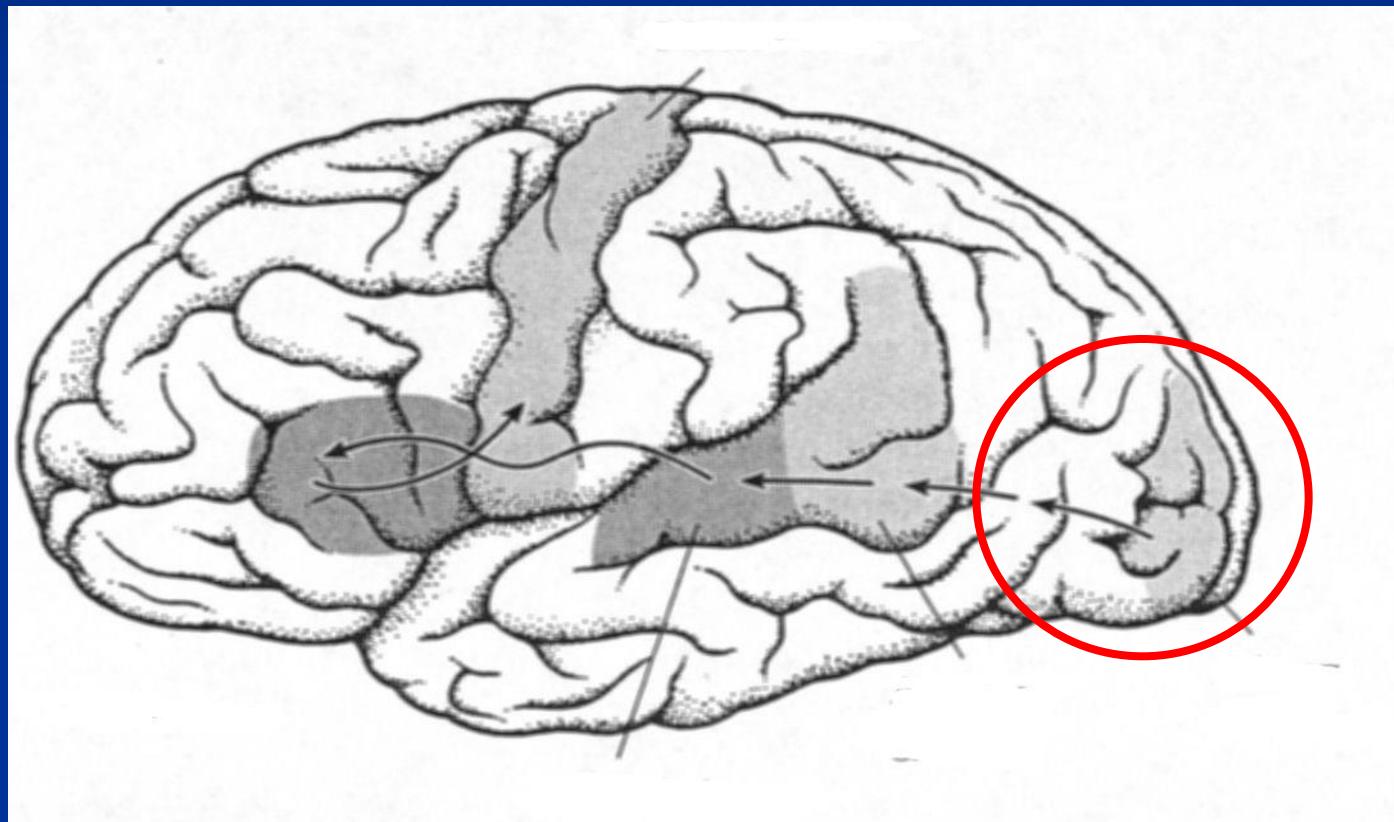
Frontal lobe



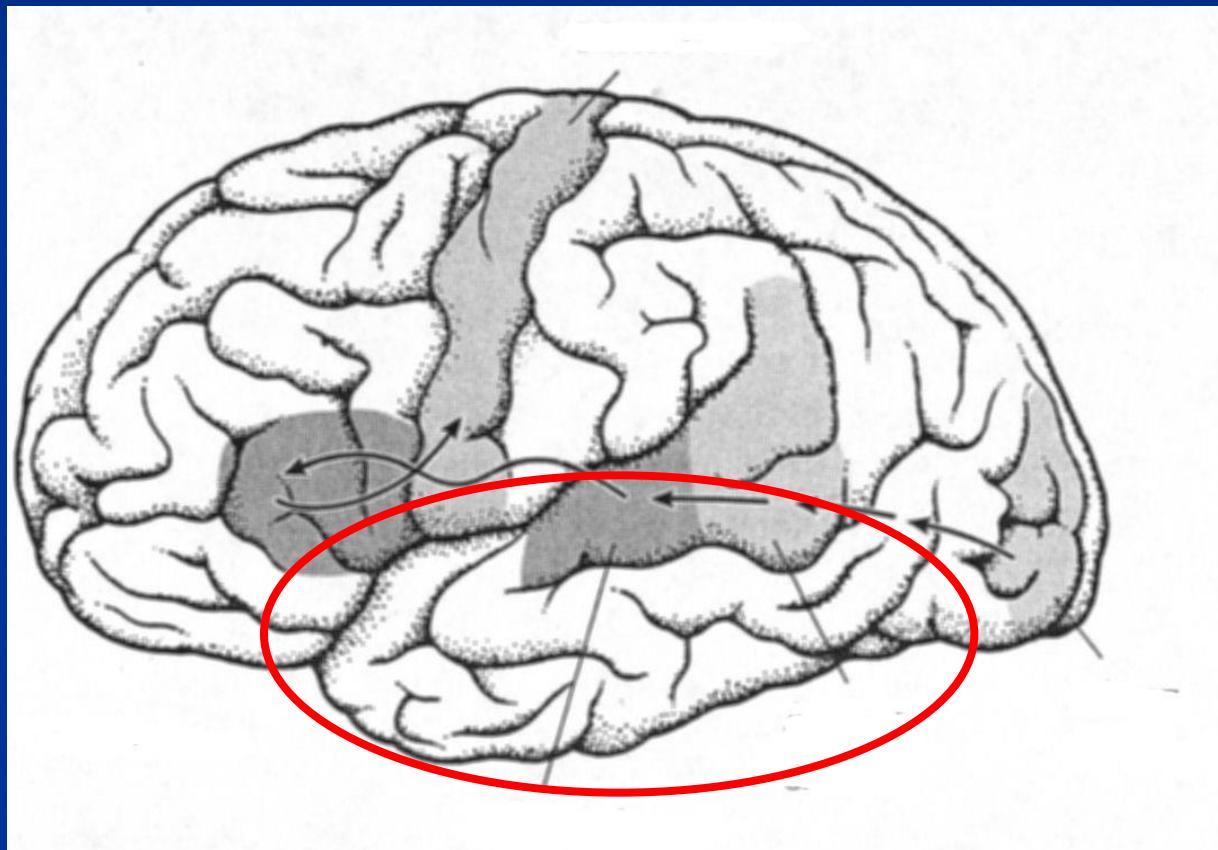
Parietal lobe



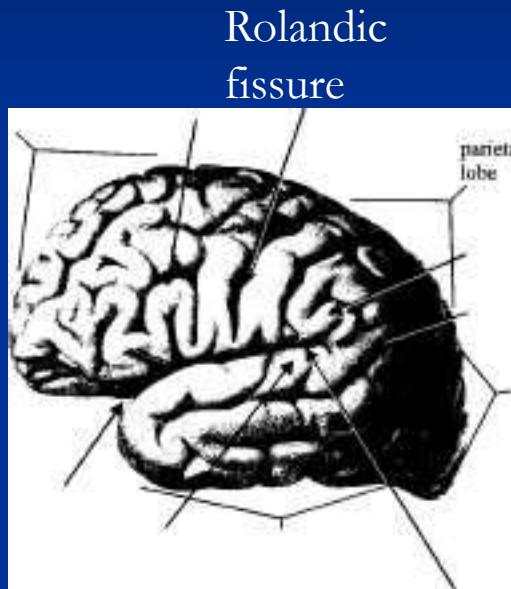
Occipital lobe



Temporal lobe



- The Rolandic fissure separates the frontal lobes from the parietal lobes (posterior lobes).
- Although the cortex (grey matter) is most crucial for language, subcortical areas also participate.



Cerebral dominance

- The phenomenon of one hemisphere being the controlling one is known as DOMINANCE. This is CONGENITAL.
- Most people are right-dominant (left-hemisphere dominant) - >% men are left-handed cf women.
- Only approx. 30% of left-handers are right-hemisphere dominant.
 - Believed to be a factor contributing to language disorders and to various reading and writing dysfunctions, such as stuttering and dyslexia.
- Why? Two hemispheres are vying with each other for dominance.

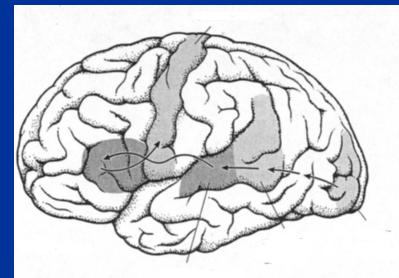
Sound preferences

- Speech sounds are differentiated from other sounds e.g. music; sounds of nature
- True right-handers – believed speech is mainly processed in the left hemisphere – while music etc is processed in the right hemisphere.

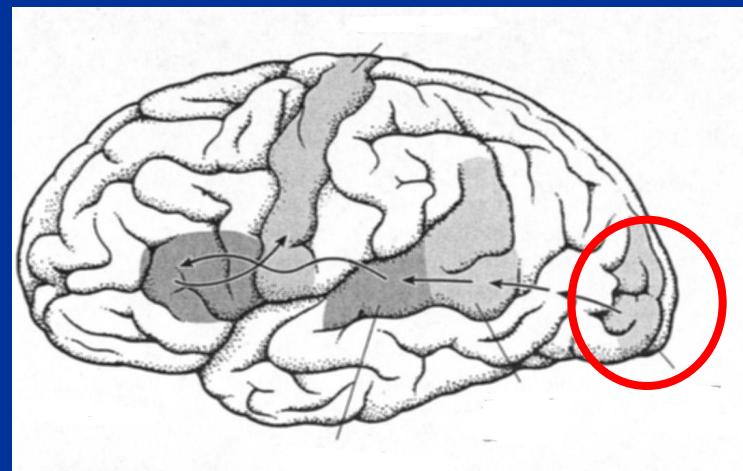
Cortical areas important for language

- **The Brodmann's area** – lies at the back of the frontal lobe just in front of the Rolandic fissure - responsible for generating movement.

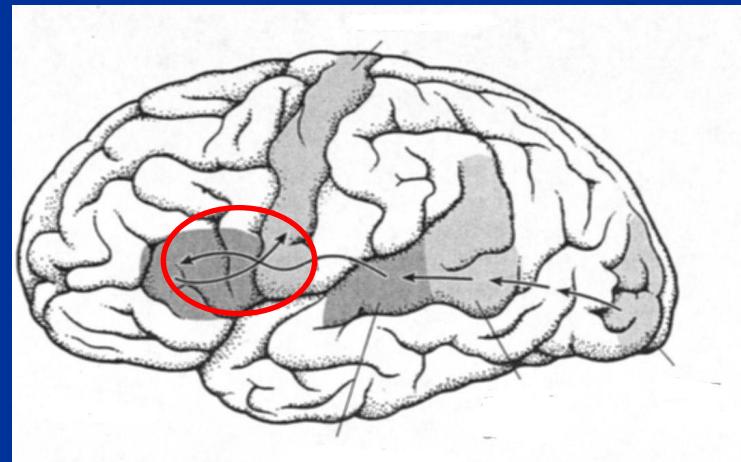
This motor cortex exists in both hemispheres of the cerebral cortex and when stimulating a cortical area in one hemisphere makes the muscles on the opposite side of the body move – known as the '**contralateral side**'.



- Within the occipital lobe – the ‘somatosensory’ areas, e.g. the primary area for the reception of visual stimuli (important for reading/sign languages/interpretation of gestures).



- The temporal lobe contains Heschel's gyrus – a structure particularly important for the reception of auditory stimuli (environmental noise/music/language) – behind Heschel's gyrus is Wernicke's area - necessary for interpreting auditory speech.
- Broca's area – involved in motor planning and syntactic processing specific to speech production.



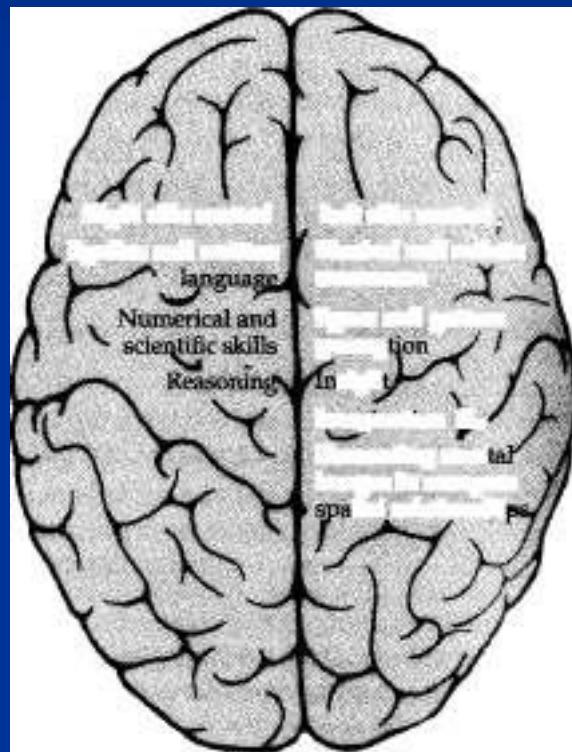
Lateralised brain functioning

Right side control

Spoken & written language

Numerical & scientific skill

Reasoning



Posterior view

Left side control

Music & artistic awareness

Space & pattern perception

Insight

Imagination

Generating mental images to compare spatial relationships

Approaches to Neurolinguistic Study

- 2 dominant schools of thought: *Localisation* & *Connectionism* (Holistic School)
- **Localisation**
 - the central parts of the outer surface more crucially linked to language
 - as different patterns of aphasia were observed, areas within the left-hemisphere cortical language area were identified by localisationists – e.g. areas for the production and comprehension of language (cf Broca's & Wernicke's areas).

Holistic School

- argue that localisation is a false compartmentalisation of linguistic abilities - these are supported by large areas of the brain and these areas are interconnected.
- focus - on how the areas of the brain are interconnected + ways in which language is dependent on cognitive abilities (memory, abstract thinking, attention etc).

Populations: insights into brain structure & function

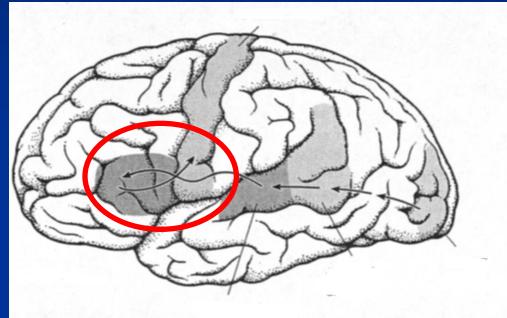
1. Aphasic subjects – those experiencing language disorders due to brain damage.
2. Alzheimer's & demented patients – consideration of the ways language performance & abilities interact with other cognitive abilities.
3. Individuals with disturbances of reading (dyslexia) and writing (dysgraphia) or spelling – the abstract components necessary for processing written language in normals and the way visual language systems are organised in the brain.

4. Bilinguals and polyglots – how their various languages/dialects can break down and recover after brain damage –how ‘modular’/independent the organisation is of similar materials to be processed in the brain; how specific languages may be differently organised relative to each other in the brain; etc.
5. Smaller populations – e.g. ‘split brain’ patients.
6. Signers – those who use visual-gestural systems & polyglot savants (formerly known as ‘idiot savants’).

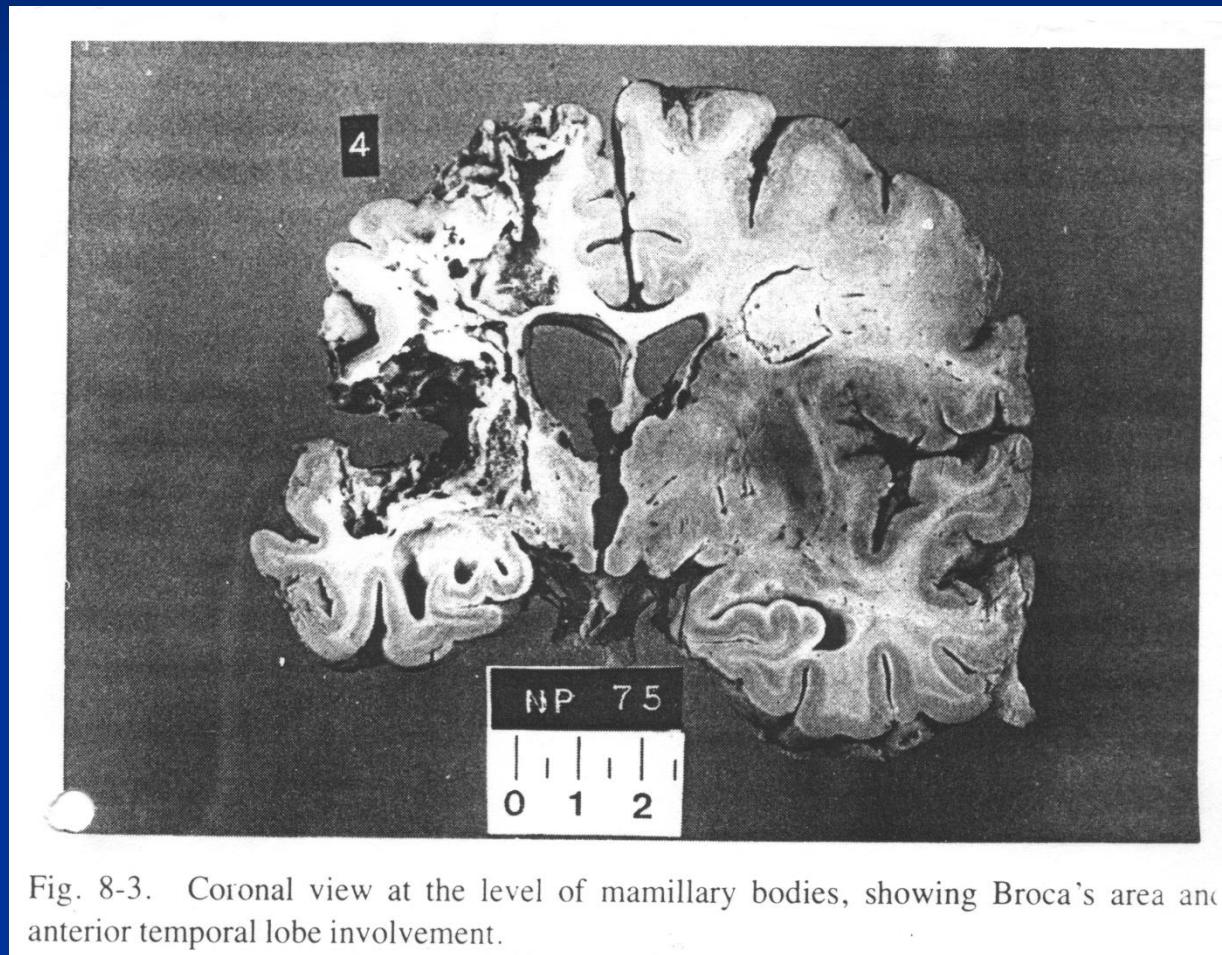
APHASIA

- **Causes** – closed (e.g. stroke/tumour) & open (wounds) head injuries.
- **TYPES**
 - GLOBAL – (damage to large areas of the brain) ltd productive capacity; poor understanding
 - BROCA'S - ‘non-fluent’ – speech is slow, deliberate and effortful; omission of grammatical markers.
Comprehension is spared – depending on complexity of grammatical structure.

Broca's Area



- First described by Paul Broca (French neurologist) in 1861.
- The first detailed case history and autopsy-based anatomical description of the brain-language relationship



‘Classic Broca’s Aphasia’

- ‘Non-fluent’/agrammatic - speech is slow, deliberate and effortful, often with omission of grammatical markers – tense; agreement; determiners etc. i.e. ‘closed class/function words’ & affixes = telegraphic speech (dependence on nominal lexical forms – uninflected N, V, A, P.)
- Difficulty controlling the articulators of speech: the tongue, lips, jaws, soft palate, vocal cords etc.
- Comprehension is spared.

The Cookie Theft Picture



L.M (Goodglass & Kaplan 1972)

‘The Cookie Theft Picture’

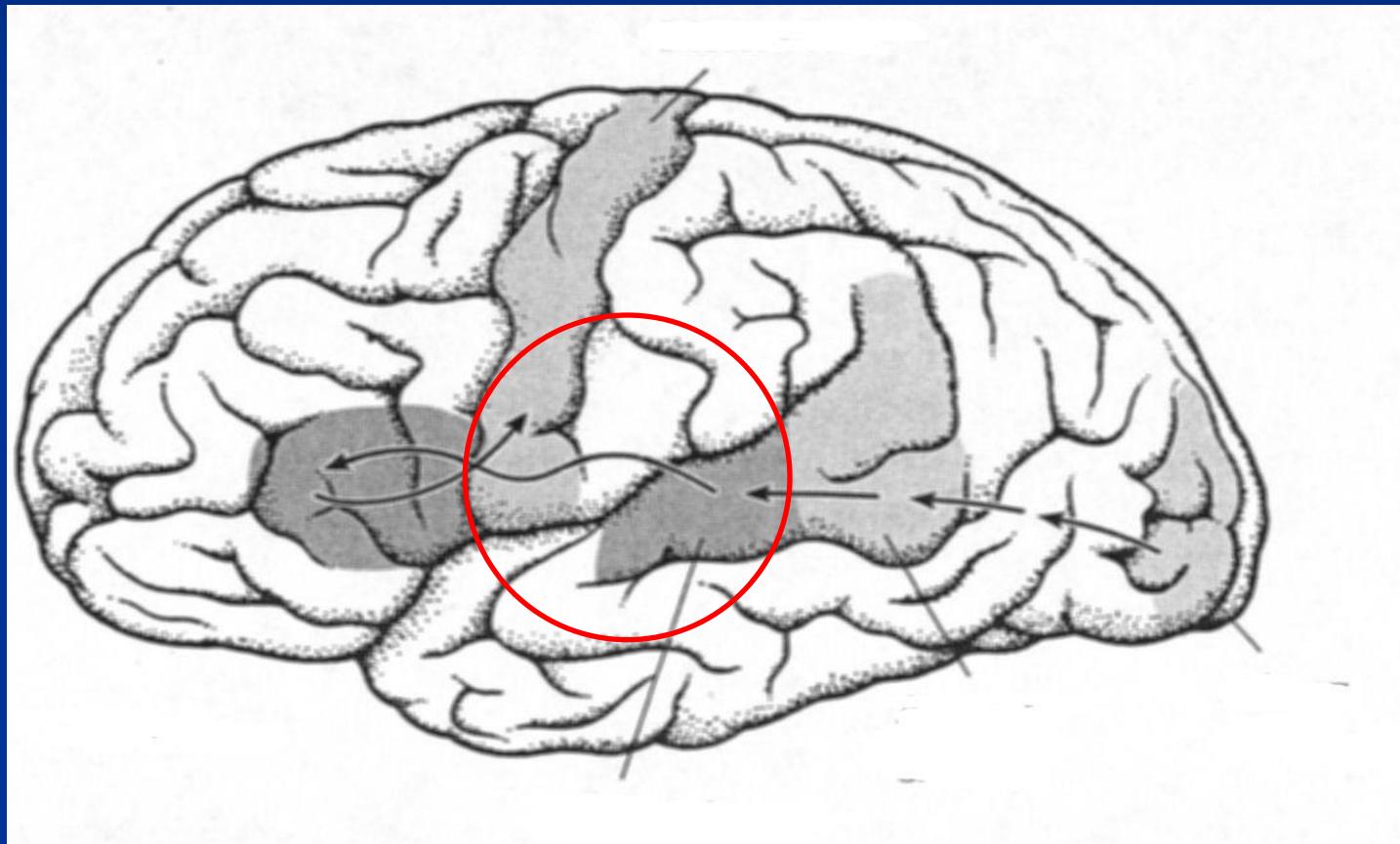
Kid...kk..can...candy...cookie...caandy...well don't
know but it's writ...easy does
it...slam...early...fall...men...many no...girl.
Dishes...soap...water...falling pah that's
all...dish...that's all.

cookies...can...candy...cookies
cookies...he...down...That's all. Girl...slipping
water...water...and it hurts...much to do...Her...clean
up...Dishes...up there...I think that's doing it.

Wernicke's Aphasia

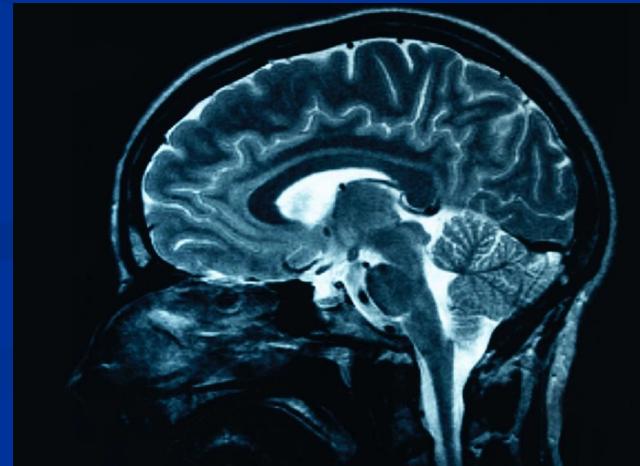
- Discovered by Carl Wernicke (1874) – German neuropsychiatrist.
- Patients presented with:
 - difficulty in comprehending speech (misdiagnosed as deaf);
 - spoke fluently but made no sense to listeners (sounded like jargon)

Temporal-parietal area (close to auditory cortex)



Presenting Disorder

- Paragrammatism
- Speech is fluent
- Affected elements of speech:
 - Organisation
 - Selection of words and phrases
 - Meaning
 - Nouns (especially concrete)
- Not affected
 - Production – articulation of speech sounds & words



Sample Extract

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

P: They're XX you know, boom? (makes hand gesture)

T: What's this? (copies gesture)

P: You know the – these – under right there – er – end of the football

T: End of the football?

P: Yes. Is it – it it – influence of football right here – it /k k/ cause it to comes in, see?

T: Yeah

P: The end of it, see? Oh we a lot of XX see.

T: I don't understand.

P: Well. It's er. Well it's XX XX XX XX see. You don't understand it but it but it ...

Comparison of Broca's & Wernicke's Aphasia

Broca's	Wernicke's
Disfluent	Fluent
Agrammatic	Paragrammatic
Production	Comprehension
Linguistically: function words; inflections; limited syntactic production	Linguistically: Organisation; word/phrase selection; meaning; nouns (concrete)

Neural pathways involved in processing spoken language

- **Speech production:**
 - >basic structure of utterance is produced in Wernicke's area, sent to
 - > Broca's area for morphosyntactic/motor encoding,
 - > motor programme passed on to motor area responsible for directing articulatory organs

- **Speech comprehension:**
 - >Signals are sent from the ear to the auditory cortex;
 - these are transferred to the Wernicke's area for interpretation

Broca's Aphasia & neural pathways

- <http://youtu.be/NUTpel04Nkc>

Other techniques used to study brain organisation

- Tests involving medical intervention:
 - The Wada test
 - Direct cortical mapping

- Other tests:
 - Tachistoscopic presentation
 - Dichotic listening tests

The Wada Test

- Alternatively: “intracarotid sodium amobarbital procedure”
- Devised by Canadian neuropsychologist Juhn Wada
- Often used prior to surgery for epilepsy, in which the corpus callosum is severed
 - Disassociates one side of the brain from the other

The Wada Test: Procedure

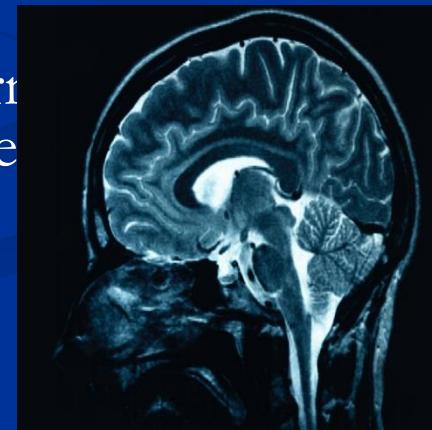
- An anesthetic (sodium amobarbital) is injected into the artery leading to one side of the brain.
- As the drug is delivered to the language side of the brain, a temporary paralysis of language function is experienced – such that speech sounds agrammatic.

Results confirm statistics of incidence of aphasia after brain injury:

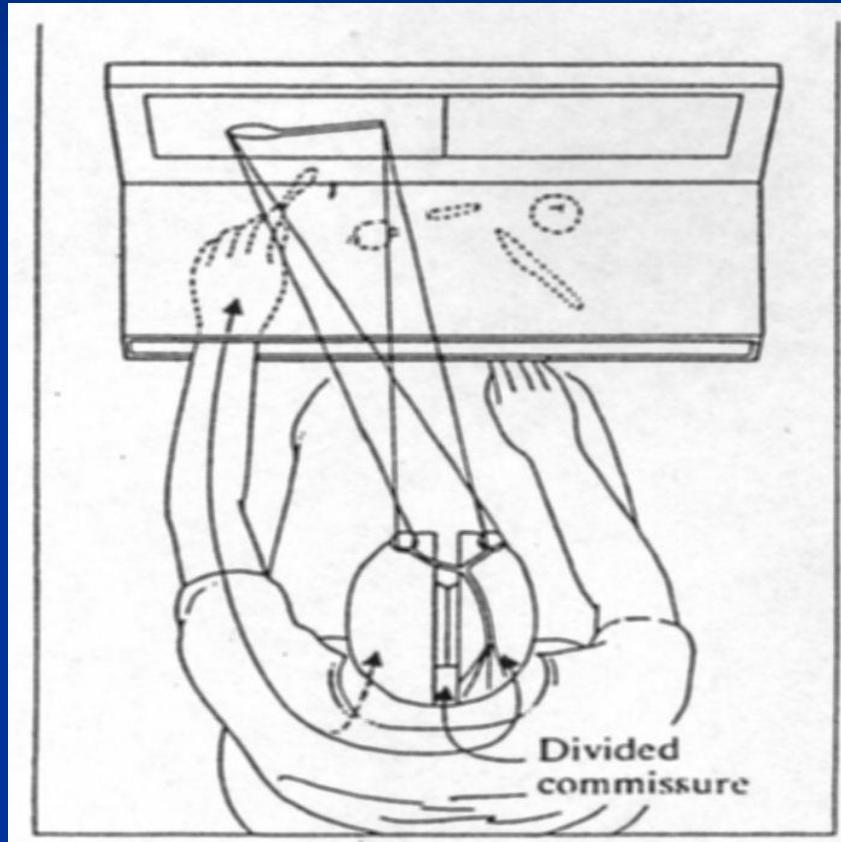
- Among right handers – approx 95% experience temporary interference with language after the injection to the left carotid artery.
- Approx 70% of left-handers experience temporary interference
 - of remaining 30% - 15% only have temporary paralysis of language function after R carotid injection
 - the other 15% would seem to have some degree of bilateral speech control.
- With sign languages – there is some research suggesting greater R hemisphere involvement in processing sign language.

Direct Cortical Mapping

- **Direct cortical mapping** (Penfield 1959). Involves electrical stimulation of the brain.
- Administered to patients undergoing brain surgery (e.g. tumour/epilepsy) to determine brain functioning & ensure critical areas aren't damaged during surgery.
- A silver electrode is applied to the brain of an anaesthetised but fully conscious patient to map the brain surface.
- Electrodes are placed on the scalp & patient performs a number of tasks – if electrodes stimulate language centres speech becomes hesitant and slurred.



Tachistoscopic presentation

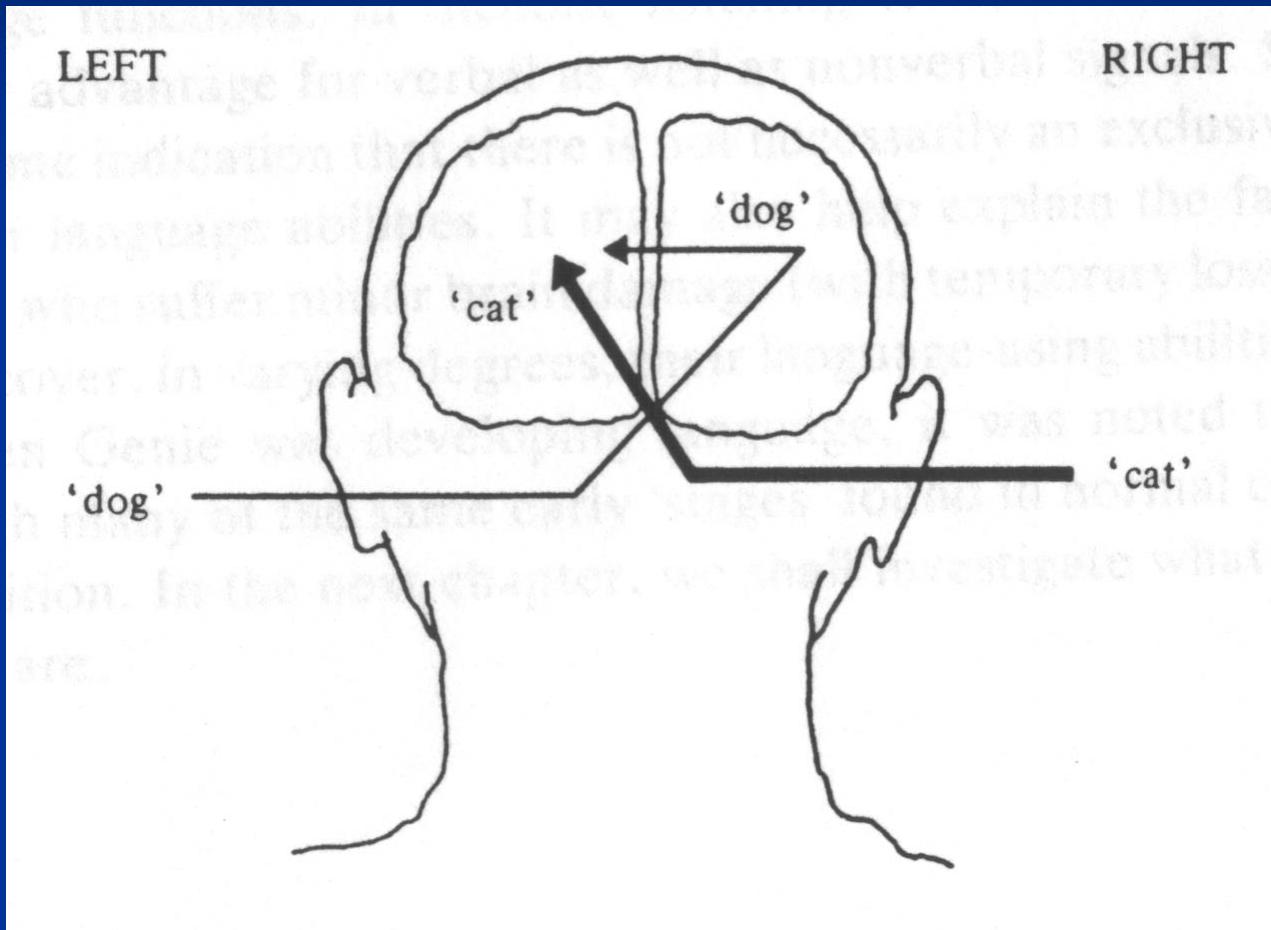


Dichotic Listening

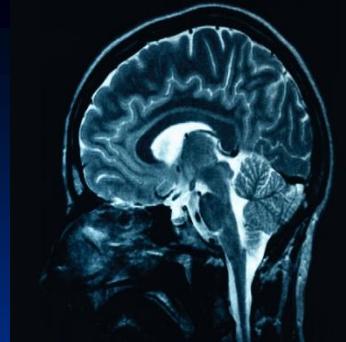
- Tachistoscopic presentation uses visual stimuli – dichotic presentation uses auditory stimuli.
- We generally use both ears to hear:
 - Binaural hearing
 - Signals from the ears are processed on opposite sides of the brain
 - Then sent to the left hemisphere for linguistic recognition

Dichotic listening test

- Stimuli in the left ear therefore travel further.
- Two different linguistic stimuli presented simultaneously to each ear.
- The listener is most likely to report hearing the stimulus to the right ear.

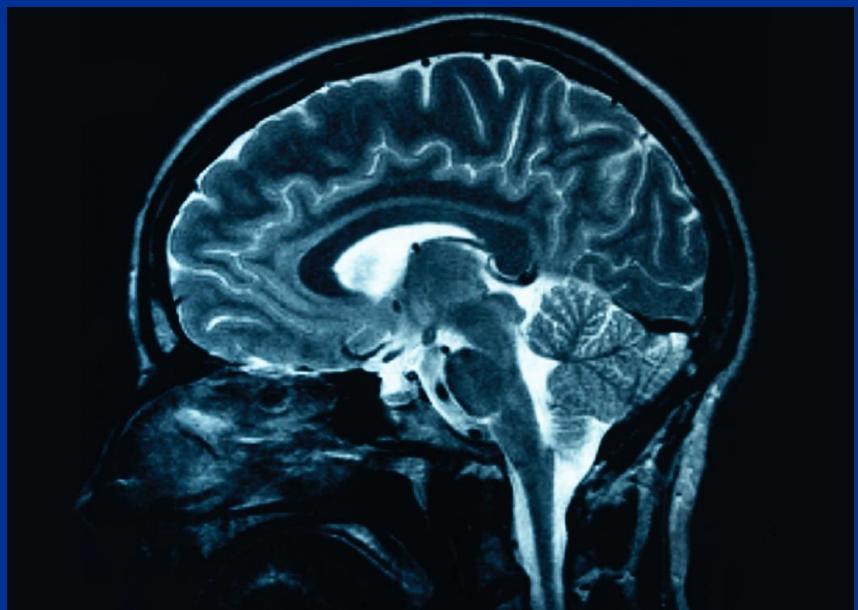


Summary



- The dominance of the L hemisphere for language for most people is largely uncontroversial.
- Determining the particular areas in the L and R hemisphere responsible for different language functions is more difficult.
- Modern aphasiologists are still not entirely in agreement as to which specific language functions are subserved by specific brain areas.

- To be continued next week.....



Post-class reading & references

- Fromkin, Rodman & Hyams, chapter 9
- Trask, chapter 7
- Yule, chapter 13
- Bloomer et al, chapter 11
- Crystal encyclopaedia, section 46

- Obler, L. & Gjerlow, K. (2005) Language & the Brain. Cambridge: Cambridge University Press.

Concepts Introduced

- Brain hemispheres
- Broca's aphasia/agrammatism
- Brodmann's area
- Cerebral dominance
- Connectionism/Holistic school
- Contra-lateral responsibility
- Corpus callosum
- Lobes of the brain: Frontal; Occipital; Parietal & Temporal.
- Localisation
- Nervous system: central/peripheral
- Rolandic fissure

- <http://www.youtube.com/watch?v=aVhYN7NTIKU>
- <http://youtu.be/NUTpel04Nkc>