LANGUAGE AND THE BRAIN
I once had a patient who suffered a right hemisphere stroke and fell to the ground, unable to walk because of a paralysed left leg. She lay on the floor for two days, not because no one came to her aid, but because she kept blithely reassuring her husband that she was fine, that there was nothing wrong with her leg. Only on the third day did he bring her in for treatment. When I asked her why she could not move her leg, and held it up for her to see, she said indifferently that it was someone else’s leg.
The damage was done to the right hemisphere of the patient’s brain.

The woman could no longer organise her own leg but she could still talk about it.

The ability to talk was unimpaired which means that language is located elsewhere in the brain.

So where is language located?
What is Neurolinguistics?

- **Neurolinguistics**: The study of the relationship between language and the brain.
  - Although it is a fairly new term, this study dates back to the 19th century.

- **Phineas Gage in 1848**:
  - A rod went through his upper left cheek and out from the top of his forehead to injure the front part of his brain. He suffered a type of injury no one could recover from. However, a month later he was healed.
The rod into Cage’s head
Conclusion

- **The brain is made up of two parts:**
  1. The *left* hemisphere
  2. The *right* hemisphere

- Cage’s *language* abilities were *unaffected*. This proves that language is *NOT* located at the *front* of the brain.

- The most important parts of the *brain* are in the areas *above* the *left* ear.
Parts of the Brain

The shaded areas indicate the general locations of the language functions involved in speaking and listening.

How do we know this?
From autopsies of the brains of people who were known to have specific language disabilities.
The technical term for Broca’s area is the “anterior speech cortex”.

It was named after Paul Broca.

He was a French surgeon, who reported in the 1860s that damage to this specific part of the brain was related to extreme difficulty in producing speech.
Damage to the same part in the right hemisphere did NOT have the same effect.

Language ability is located in the LEFT hemisphere.

This finding was first used to argue that language ability must be located in the left hemisphere and since then has been treated as an indication that Broca’s area is crucially involved in the PRODUCTION of speech.
The technical term for Wernicke’s area is ‘posterior speech cortex’.
It was named after Carl Wernicke.
He was a German doctor who reported in the 1870s that damage to this part of the brain was found among patients who had speech comprehension difficulties.
This confirmed that language is located in the left hemisphere of the brain.

It led to the view that Wernicke’s area is the part of the brain crucially involved in the understanding of speech.
(3) Motor Cortex

- The **motor cortex** is an area that generally **controls** the **movement** of the **muscles**.
  - i.e. controls moving the hands, feet, arms... etc.

- The **closest part** of it to the **Broca’s area controls** the **articulatory muscles** of the **face**, **jaw**, **tongue** and **larynx**.

- Two neurosurgeons in the **1950s**, **Penfield** and **Roberts**, found that by **applying** small amounts of **electrical current** to **specific areas** of the brain, they could **identify** those **areas** where the **electrical stimulation** would **interfere** with **normal speech production**.
The arcuate fasciculus was also discovered by Carl Wernicke.

- It is known to form a crucial connection between Wernicke’s and Broca’s areas.
Specific aspects of language ability can be given to specific locations in the brain, which is called the Localisation View.

The localisation view has been used to suggest that:

The brain activity involved in hearing a word, understanding it, then saying it, follows a definite pattern.
This definite pattern can be summarised as follows:

1. The word is heard and comprehended via the Wernicke’s area.
2. This signal is transferred via the arcuate fasciculus to Broca’s area where preparations are made to produce it.
3. A signal is sent to the motor cortex to physically articulate the word.
A number of researchers have noted that we all experience occasional difficulty in getting brain and speech production to work together smoothly.

Minor production difficulties provide possible clues to how language is organised within the brain.
The Tip of the Tongue Phenomenon

- This phenomenon happens when we know the word, but it just won’t come out.
- Studies on this have shown that speakers generally:
  1. Have accurate phonological outline of the word.
  2. Can get the initial sound correct.
  3. Know the number of syllables in the word.
- This also occurs with uncommon words and names.
- It suggests that our ‘word-storage’ system may be partially organized on the basis of phonological information and that some words are stored more easily than others.
Another speech error and a subtype of the tip of the tongue phenomenon is called malapropisms.

**Malapropisms:** The substitution of a word for a word with a similar sound, in which the resulting phrase makes no sense but often creates a comic effect.

- They are named after a character in a play “Mrs. Malapropism” who consistently produced such mistakes.

**Examples:**
- Fire *distinguisher* ➔ *extinguisher*
- Rainy weather can be hard on the *sciences.* ➔ *(sinuses)*
- Having one wife is called *monotony.* ➔ *(monogamy)*
Another kind of speech errors is commonly described as a slip of the tongue such as “make a long shory stort” and “use the door to open the key”.

Such slips are known as spoonerisms after William Spooner who was known for making this kind of mistakes.

**Spoonerisms**: The interchange of two sounds, usually initial, in words.

- An example by Spooner:
  - You have hissed all my mystery lectures.

**Spoonerisms** are a result of a sound being carried over from one word to the next. **Examples:**

- black bloxes ➔ black boxes, Noman numerals ➔ Roman numerals
- Tup of tea ➔ cup of tea, Shu flots ➔ flu shots
- Beel fetter ➔ feel better, Stick neff ➔ stiff neck
- Loop before you leak ➔ Look before you leap
Slips of the Ear

- Slips of the ear may provide some clues to how the brain tries to make sense of the auditory signal it receives.

Example:
- To hear ‘great ape’ instead of ‘gray tape’
- A: "I just bought a new hearing aid. It cost me four thousand dollars, but it's state of the art. It's perfect."
  B: "Really, what kind is it?"
  A: "Twelve thirty."
Some people live with these ‘slips’ **constantly**. They suffer from different types of language disorders, generally described as ‘aphasia’.

**Aphasia**: An impairment of language function due to localised brain damage that leads to difficulty in understanding and/or producing linguistic forms.

**What causes Aphasia?**

- A **stroke** is the most common cause *(when a blood vessel in the brain bursts or is blocked)*.
- **Traumatic head injuries** from **violence** or **accidents**.
Broca’s Aphasia

- **Broca’s aphasia**, a serious language disorder, is also known as ‘motor aphasia’. In this type of aphasia, comprehension is much better than production.

- **Production** is characterised by:

  1. **Reduced** amount of speech
  2. **Distorted** articulation
  3. **Slow** and **effortful** speech.
  4. **Use** of **lexical morphemes** (nouns, verbs, adjectives, adverbs).
  5. **Omission** of **functional morphemes** (articles, prepositions) and **inflections** (Plural –s, past tense -ed).

  That is why it is categorised as “agrammatic” speech.

- **Example of minor aphasia:**
  - I eggs and eat and drink coffee breakfast.
Wernicke’s Aphasia

- Wernicke’s aphasia, a serious language disorder, is also known as ‘sensory aphasia’. It results in difficulties in auditory comprehension.

- People who has Wernicke’s aphasia:
  1. Can actually produce very fluent speech which is difficult to make sense of.
     - Example: “I can’t talk all of the things I do, and part of the part I can go alright, but I can’t tell from the other people.”
  2. Suffer from “anomia” i.e. difficulty in finding the correct word.
     - To overcome this, speakers use different strategies like:
       - Trying to describe the object.
         - Example: “the thing to put cigarettes in” for “ashtray”.
Conduction Aphasia

- **Conduction aphasia** has been associated with **damage** to the **arcuate fasciculus**.

**People who suffer from conduction aphasia:**

1. Mispronounce words but they **don’t** have articulation problems.
2. Are **fluent** but may have **disrupted rhythm** because of **pauses** and **hesitations**.
3. Have **good comprehension of spoken words**.
4. Find it **difficult** to **repeat a word or phrase** uttered by someone else.
   - Because what the **speaker hears and understands** **CANNOT** be **transferred** very successfully to the **speech production area**.
     - **Example**: Fosh for wash and vaysse for base.
Many of the symptoms mentioned such as the word-finding difficulty can occur in all types of aphasia. Difficulties in speaking can also be accompanied by difficulties in writing (production). Impairment of auditory comprehension tends to be accompanied by reading difficulties (understanding). These types of aphasia are almost always the result of injury to the left hemisphere.
The critical period

- The specialisation of the left hemisphere for language is described in terms of lateral dominance or lateralisation (one-sidedness).
- Lateralisaton begins in early childhood.
  - i.e. when language acquisition takes place.
- During childhood, there is a period when the human brain is most ready to learn a language. It is known as the critical period.
Genie’s case:

- She was a girl referred to as “Genie” in 1970, who was admitted to a hospital in LA.
- She was 13 years old and spent most of her life tied to a chair in a small closed room because of her father.
- Her only human contact was with her mother who was forbidden to spend more than a few minutes to feed her.
- She spent her whole life in a state of physical, sensory, social and emotional deprivation.

As a result:

- She was unable to use language when she was first brought into care.
- Contact with others allowed her to imitate sounds and to communicate.
- Syntax remained very simple.
Notes on Genie’s Case

- Her **limited capacity to develop complex speech** supports the idea that part of the **left hemisphere** of the brain is open to **accept** a language program during childhood.
  - If no program is provided, as in Genie’s case, then the facility is closed down.

- **Tests proved** that she had **NO left hemisphere language facility**.

- She was using her **right hemisphere** for language functions.
  - This raises the possibility that our capacity for language is **NOT limited** to only one or two **specific areas** but is based on **more complex connections** extending throughout the **whole brain**.

- When Genie was **beginning to use speech**, it was noted that she went through some of the **same** early ‘stages’ found in **normal child language acquisition**.