Chapter 12:

Language & the brain

LANE 321:

Introduction to Linguistics

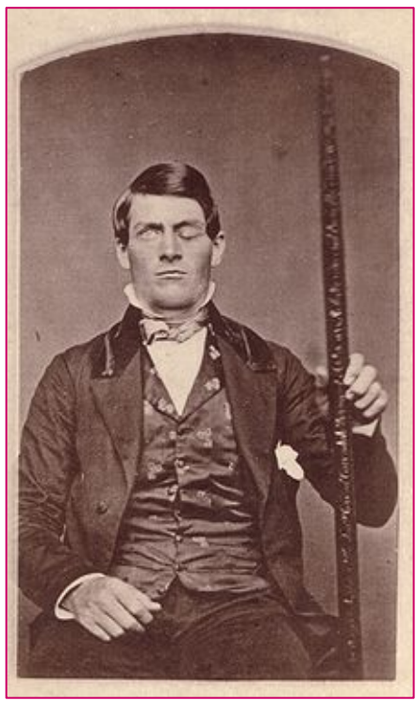
Content adapted from Yule (2010)

Neurolinguistics

- Neurolinguistics: The study of the relationship between language and the brain

Neurolinguistics

- Phineas P. Gage's story. p. 157
- The medical evidence was clear. A huge metal rod had gone through the front part of Mr. Gage's brain, but his language abilities were unaffected.
- The point of this amazing tale is that, while language may be located in the brain, it clearly is not situated right at the front.

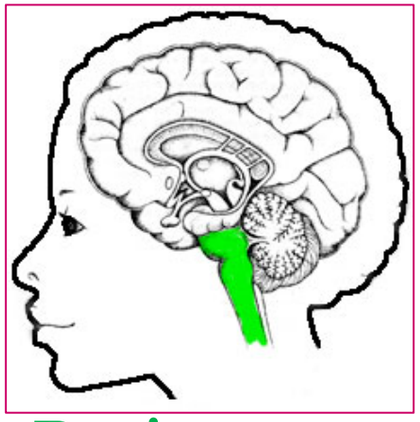


Parts of the brain

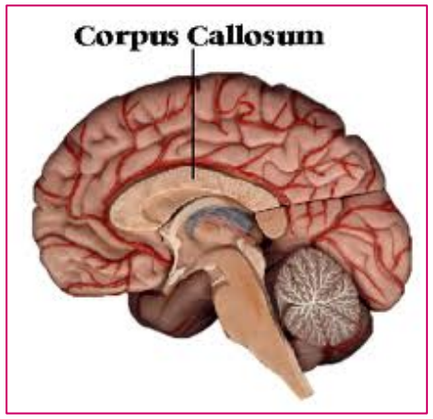
- We now know that the most important parts (the parts that are related to language functions) are in areas above the left ear.

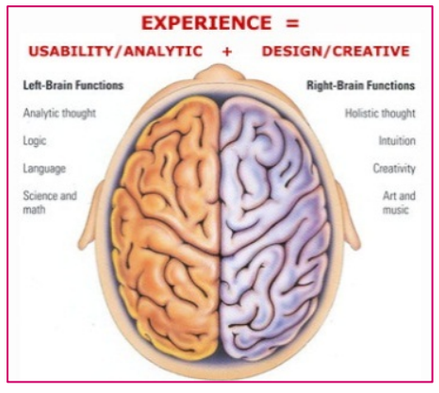
Parts of the brain

- In order to describe these parts in detail, we need to look more closely. So,
  - take a head, remove hair, scalp, skull,
  - disconnect the brain stem (connecting the brain to the spinal cord)
  - and cut the corpus callosum (connecting the two hemispheres).
- If we disregard a certain amount of other material, we will basically be left with 2 parts, the left hemisphere and the right hemisphere.



Brainstem





Parts of the brain

- If we put the right hemisphere aside for now, and place the left hemisphere down so that we have a side view, we'll be looking at something close to this:

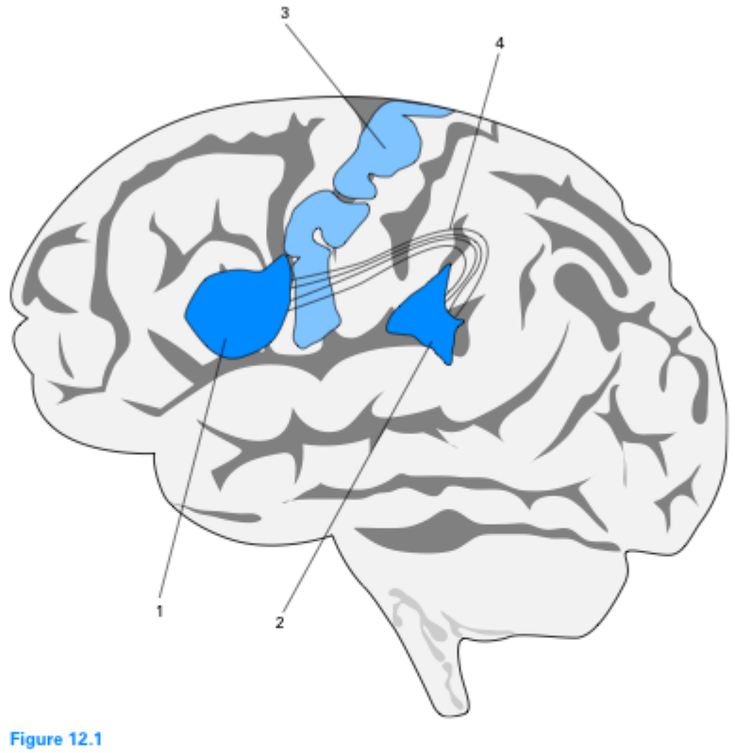
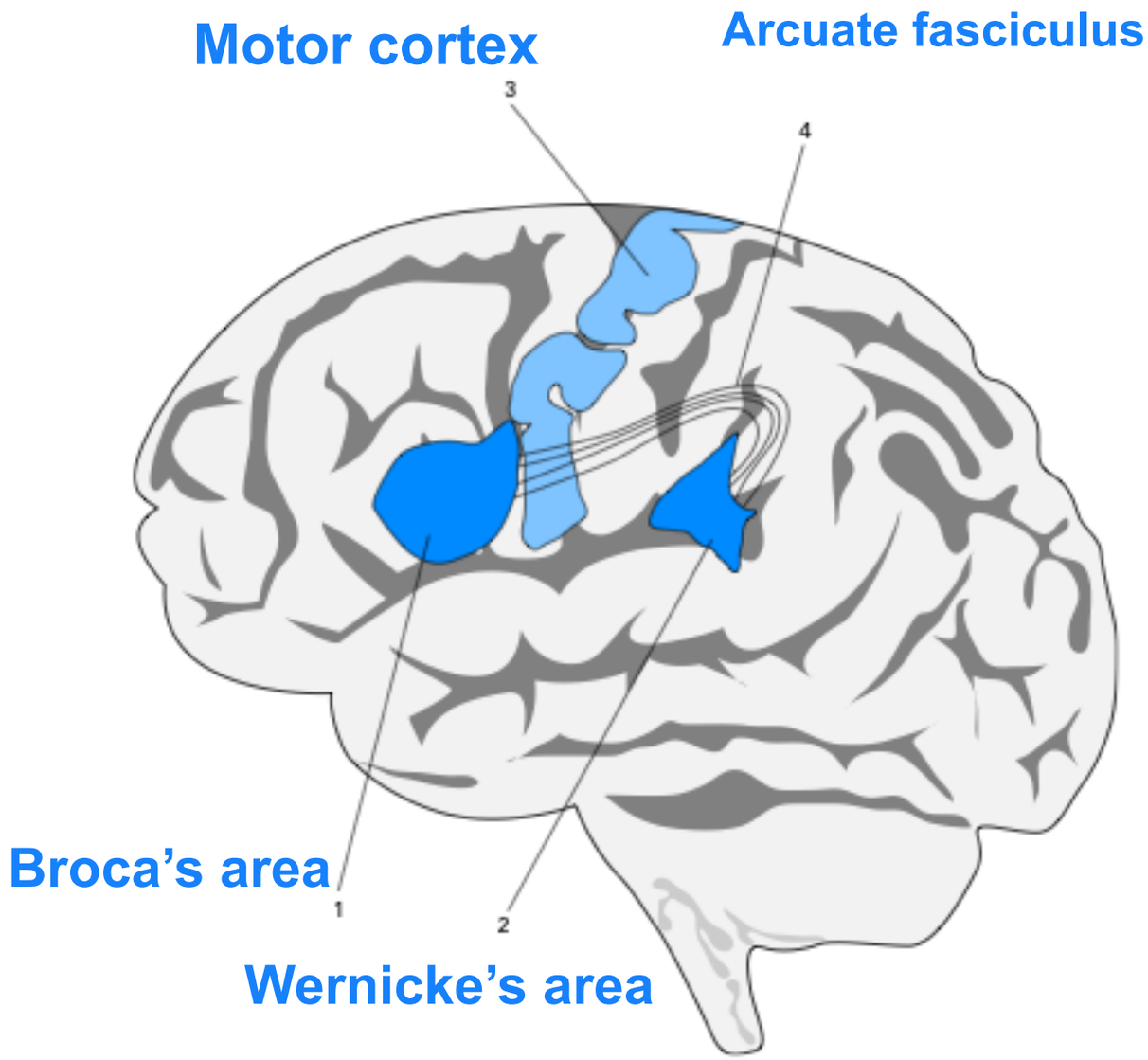


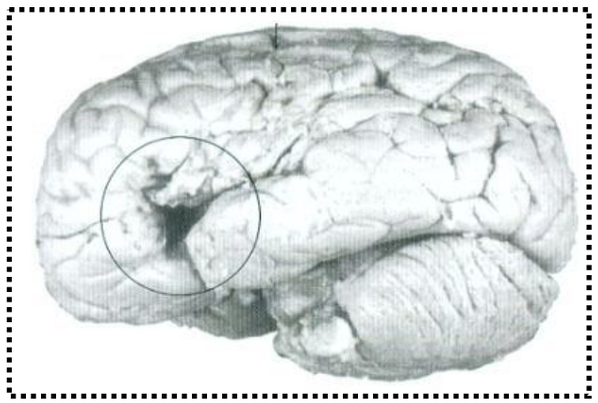
Figure 12.1

Parts of the brain



Broca's area

- Paul Broca, a French surgeon, reported in the 1960s that damage to this specific part of the brain was related to extreme difficulty in producing speech.
- It was noted that damage to the corresponding area on the right hemisphere had no such effect.

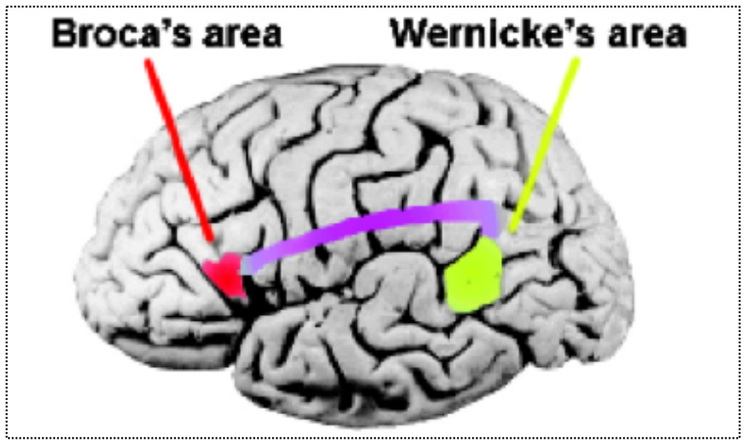


So..

- Language ability must be located in the left hemisphere
- Broca'a area is crucially involved the production of speech.

Wernicke's area

- Carl Wernicke, a German doctor, reported in the 1970s that damage to this part of the brain was found among patients who have speech comprehension difficulties.

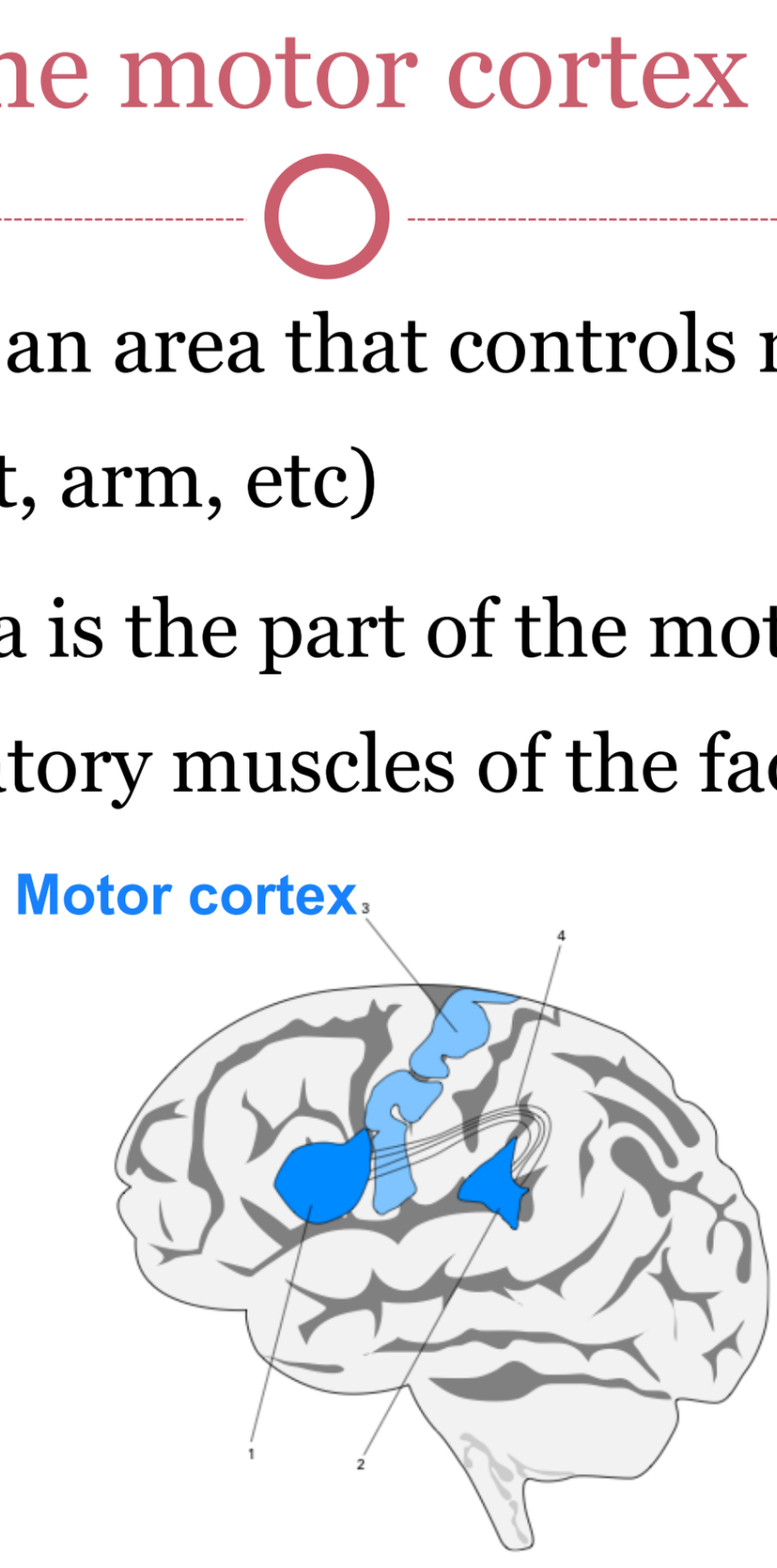


So..

- This confirmed that language ability must be located in the left hemisphere
- Wernicke's area is crucially involved the understanding of speech.

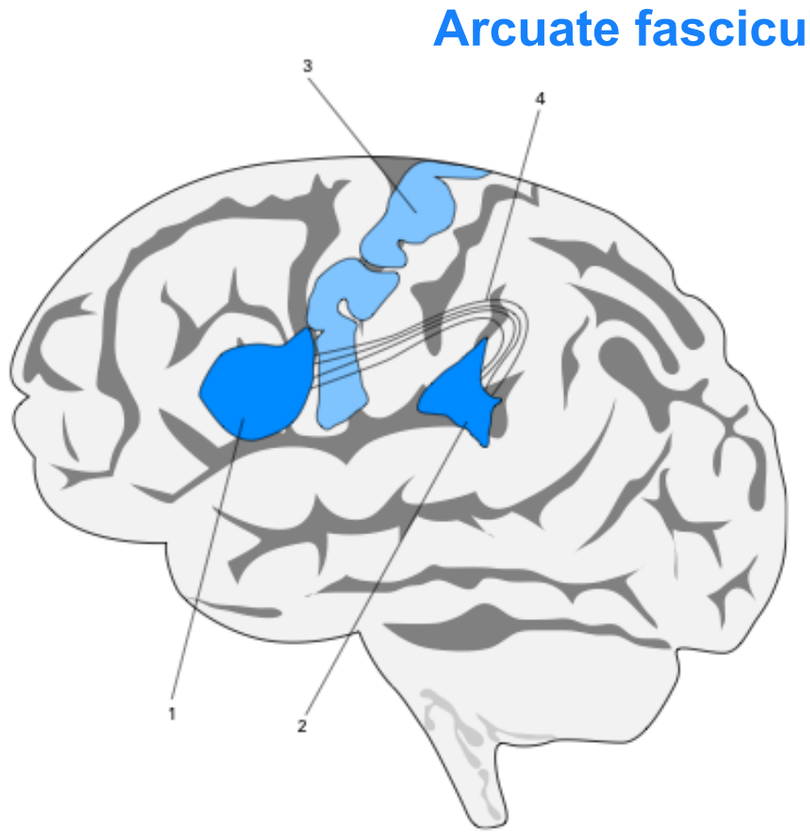
The motor cortex

- The motor cortex is an area that controls movement of the muscles (hands, feet, arm, etc)
- Close to Broca's area is the part of the motor cortex that controls the articulatory muscles of the face, jaw, tongue and larynx.



The arcuate fasciculus

- The arcuate fasciculus is a bundle of nerve fibers that connects Wernicke's area to Broca's area.

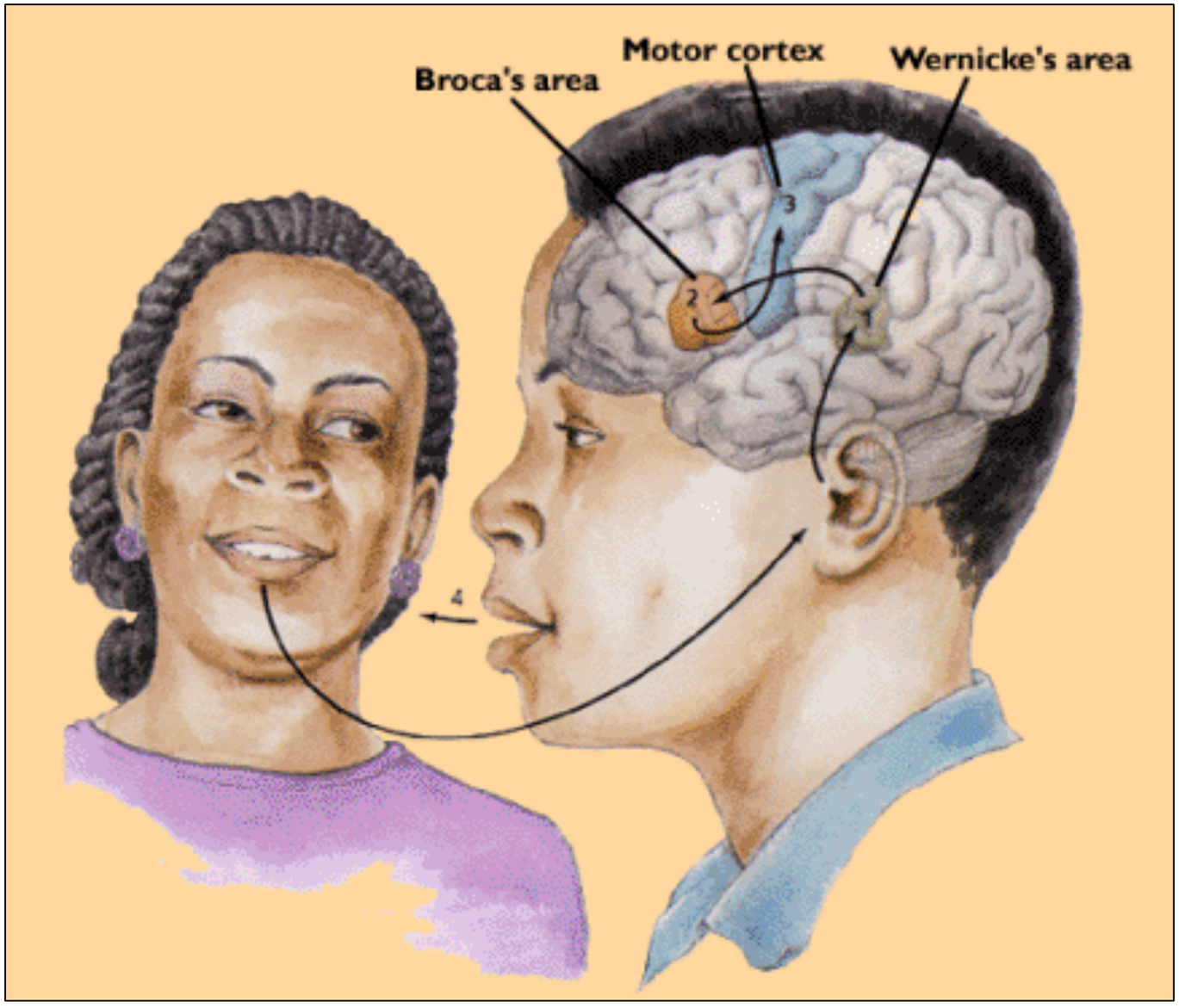


The localization view

- The localization view: Specific aspects of language ability can be accorded specific locations in the brain.
- The brain activity involved in hearing a word, understanding it, then saying it, would follow a definite pattern:

1. The word is heard and comprehended via Wernick's area.
2. The signal is transferred via the arcuate fasciculus to Broca'a area. Preparation are made to produce the signal in Broca'a area.
3. A signal is sent to part of the motor cortex to
4. physically articulate the word.

The localization view



The localization view

- Because we have no direct access, we generally have to rely on what we can discover through indirect methods.
- Most of these methods involve attempts to work out how the system is working from clues picked up when the system has problems or malfunctions.
  - The tip of the tongue phenomenon
  - Slips of the tongue
  - Slips of the ear
  - Aphasia

The tip of the tongue

- The feeling that we know the word, but it just won't come to the surface.
- Studies of this phenomenon have shown that speakers
  - generally have an accurate phonological outline of the word,
  - can get the initial sound correct
  - and mostly know the number of syllables in the word.
- It mainly occurs with uncommon words and names.
- It suggests that our 'word-storage' system may be partially organized on the basis of some phonological information and that some words in the store are more easily retrieved than others.

The tip of the tongue

- When we make mistakes in this retrieval process, there are often strong phonological similarities between the target word we're trying to say and the mistake we actually produce.
- *Fire extinguisher* → *Fire distinguisher*
- *Eastern and Pacific Time* → *Eastern and specific Time*
- Mistakes of this type are sometimes referred to as malapropisms.
- Malapropisms was named after a character called Mrs. Malaprop (in a play by Sheridan) who consistently produced 'near-misses' for words, with great comic effect.

Slips of the tongue

- *To make a long shory stort.* (Instead of …. Guess?)
- *Use the door to open the key.* (Instead of …. Guess?)
- *Spoonerism* – William Spooner. Read p. 16
- Most of the slips attributed to him involve the interchange of two initial sounds.
  - *You have hissed all my mystery classes.* (Instead of …. Guess?)

Slips of the tongue

Any explanation?

1) The result of a sound being carried over from one word to the next. (*black bloxes*) for …. Guess?

2) A sound used in one word in anticipation of its occurrence in the next word (*I need comeone to come, tup of tea*)

3) Reversing - interchange of word-initial sounds (*beel fetter*)

4) Reversing – interchange of word-final sounds (*suffering from* a *stick neff*)

Slips of the tongue

It has been argued that:

- slips of this type are never random,
- they never produce a phonologically unacceptable sequence,
- they indicate the existence of different stages in the articulation of linguistic expressions.

Although the slips are mostly treated as errors of articulation, it has been suggested that they may result from “slips of the brain” as it tries to organize linguistic messages.

Slips of the ear

- One other type of slip may provide some clues to how the brain tries to make sense of the auditory signal it receives.
- *I'm looking for a great ape*
- Why should someone be looking for a great ape in his office.
- *gray tape!*

Slips of the ear

- *“Gladly” the crossed-eyed bear.*
- A similar type of misunderstanding seems to be behind the child’s report that in Sunday school, everyone was singing about a bear called ‘Gladly’ who was cross-eyed.
- The source of this slip turned out to be a line from a religious song that went *Gladly the cross I’d bear*.
- *I teach speech signs*
- *I teach speech science.*

- Some of these humorous examples of slips may give us a clue to the normal workings of the human brain as it copes with language.
- However, some problems with language production and comprehension are the result of much more serious disorders in brain function.

Aphasia

- Many people suffer from different types of language disorders, generally described as ‘aphasia’.

Aphasia is defined as an impairment of language function due to localized brain damage that leads to difficulty in understanding and/or producing linguistic forms.

Aphasia

Why?

- The most common cause of aphasia is a stroke (when a blood vessel in the brain is blocked or bursts)
- Other causes are head injuries from violence or an accident

Those effects can range from mild to severe reduction in the ability to use language.

Aphasia

- Someone who is aphasic often has interrelated language disorders (e.g. difficulties in understanding can lead to difficulties in production)
- Consequently, the classification of different types of aphasia is usually based on the primary symptoms of someone having difficulties with language.

Broca's aphasia

- **Broca's aphasia** (motor aphasia) is a serious language disorder.
- It is characterized by:
  - a substantially reduced amount of speech
  - distorted articulation
  - slow, often effortful speech
  - What is said often consists almost entirely of lexical morphemes (e.g. nouns, verbs).

Broca's aphasia

- The frequent omission of functional morphemes (e.g. articles, prepositions) and inflections (e.g. plural -*s*, past tense -*ed*) has led to the characterization of this type of aphasic speech as 'agrammatic'.
- In **agrammatic** speech, the grammatical markers are missing.
- In Broca's aphasia, comprehension is typically much better than production [Remember? Broca's area is responsible for … ?].

Broca's aphasia

Examples:

- someone whose aphasia was not severe answering a question regarding what he had for breakfast:

  I eggs and eat and drink coffee breakfast.

- speech with lots of hesitations and really long pauses:

  my cheek . . . Very annoyance . . . main is my shoulder . . .

  achin' all round here.

- lots of difficulty in articulating single words, (e.g. 'steamship'):

  a stail . . . you know what I mean . . . tal . . . stail.

Wernicke's aphasia

- The type of language disorder that results in difficulties in auditory comprehension is sometimes called 'sensory aphasia', but is more commonly known as **Wernicke's aphasia**.

- Someone suffering from this disorder can actually produce very fluent speech which is, however, often difficult to make sense of.

Wernicke's aphasia

- Very general terms are used, even in response to specific requests for information,

  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.

- **Anomia** (Difficulty in finding the correct word) also happens in Wernicke's aphasia.

Wernicke's aphasia

- To overcome their word-finding difficulties, speakers use different strategies such as trying to describe objects or talking about their purpose

Example:

the thing to put cigarettes in (for 'ashtray').

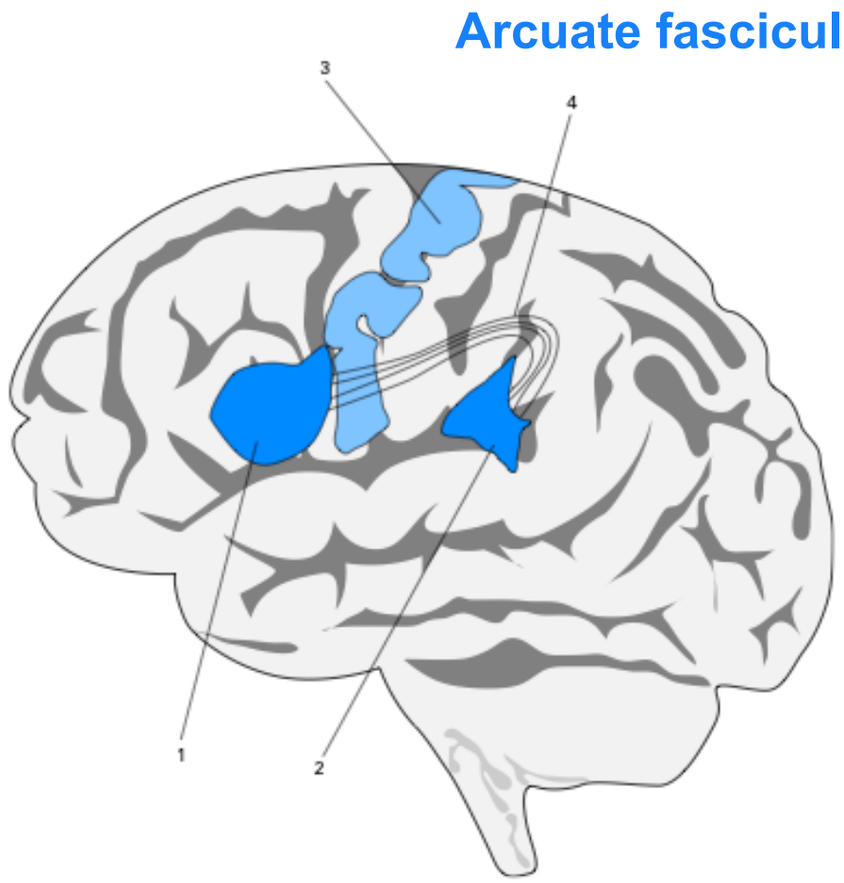
Wernicke's aphasia

In the following example (from Lesser & Milroy, 1993), the speaker tries a range of strategies when he can't come up with the word ('kite') for an object in a picture.

it's blowing, on the right, and er there's four letters in it, and I think it begins with a C – goes – when you start it then goes right up in the air – I would I would have to keep racking my brain how I would spell that word – that flies, that that doesn't fly, you pull it round, it goes up in the air

Conduction aphasia

- One other, much less common, type of aphasia has been associated with damage to the arcuate fasciculus and is called **conduction aphasia**.



Conduction aphasia

Symptoms:

- sometimes mispronounce words, but typically do not have articulation problems.
- They are fluent, but may have disrupted rhythm because of pauses and hesitations.
- Comprehension of spoken words is normally good. However, the task of repeating a word or phrase (spoken by someone else) creates major difficulty
  - e.g. *vaysse* and *fosh* being reported as attempted repetitions of the words 'base' and 'wash'.
- What the speaker hears and understands can't be transferred very successfully to the speech production area.

- Many of these symptoms (e.g. word-finding difficulty) can occur in all types of aphasia.
- They can also occur in more general disorders resulting from brain disease, as in dementia and Alzheimer's disease.
- Difficulties in speaking can also be accompanied by difficulties in writing.
- Impairment of auditory comprehension tends to be accompanied by reading difficulties.

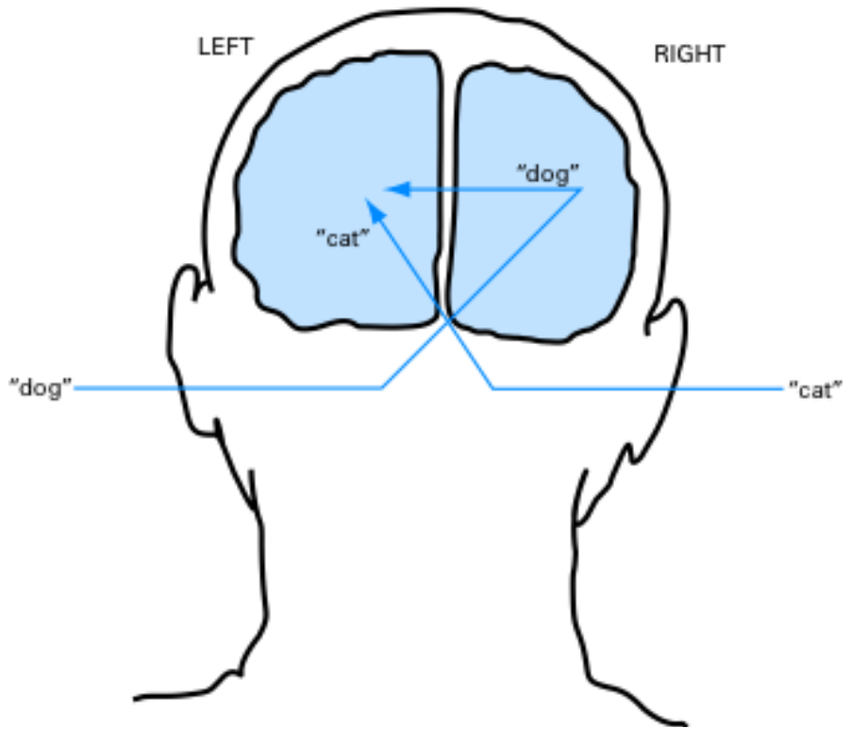
- Language disorders are almost always the result of injury to the left hemisphere.
- This left hemisphere dominance for language has also been demonstrated by another approach to the investigation of language and the brain.

Dichotic listening

- **The dichotic listening test** is an experimental technique that has demonstrated a left hemisphere dominance for syllable and word processing.

Dichotic listening

- This technique uses the generally established fact that:
  - anything experienced on the right-hand side of the body is processed in the left hemisphere,
  - and anything on the left side is processed in the right hemisphere.



Dichotic listening

- A stroke in the right hemisphere results in paralysis of the left leg.
- So, a basic assumption would be that:
  - a signal coming in the right ear will go to the left hemisphere
  - and a signal coming in the left ear will go to the right hemisphere.

Dichotic listening

Experiment:

- a subject sits with a set of earphones on and is given two different sound signals simultaneously, one through each earphone.

For example:

- Through one earphone comes the syllable *ga* or the word *dog*,
- and through the other earphone at exactly the same time comes *da* or *cat*.

- When asked to say what was heard, the subject more often correctly identifies the sound that came via the right ear. This is known as the **right ear advantage** for linguistic sounds.

Dichotic listening

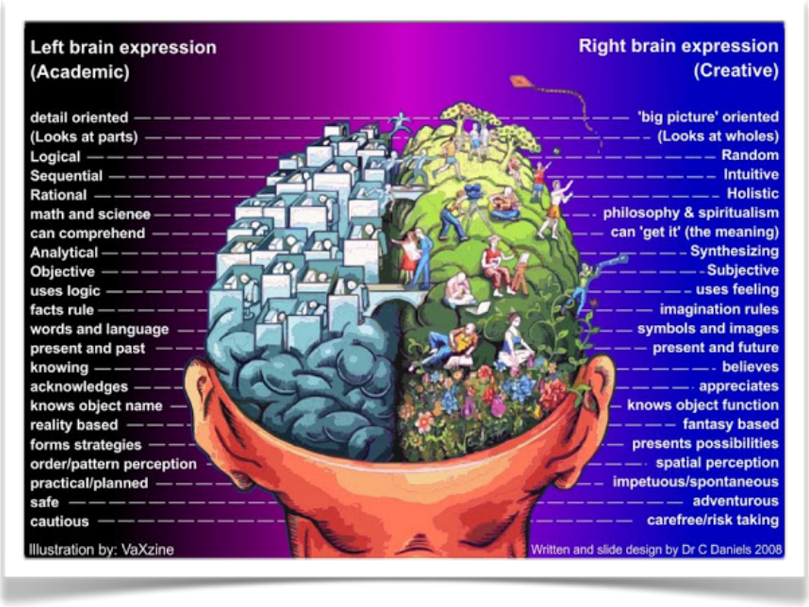
- In this process, the language signal received through the left ear is first sent to the right hemisphere and then has to be sent to the left hemisphere (language center) for processing.
- This non-direct route takes longer than a linguistic signal received through the right ear and going directly to the left hemisphere.
- First signal to get processed wins.

Dichotic listening

- The right hemisphere appears to have primary responsibility for processing a lot of other incoming signals that are non-linguistic.
- In the dichotic listening test, it can be shown that non-verbal sounds (e.g. music, coughs, traffic noises, birds singing) are recognized more often via the left ear, meaning they are processed faster via the right hemisphere.
- So, among the specializations of the human brain,
  - the right hemisphere is first choice for non-language sounds (among other things)
  - the left hemisphere specializes in language sounds (among other things too).

Dichotic listening

- These specializations may actually have more to do with the type of processing, rather than the type of material, that is handled best by each of the two hemispheres.
- The essential distinction seems to be between:
  - analytic processing, such as recognizing the smaller details of sounds, words and phrase structures in rapid sequence, done with the 'left brain',
  - holistic processing, such as identifying more general structures in language and experience, done with the 'right brain'.



The critical period

Lateralization

- The lateralization process begins in early childhood.
- It coincides with the period during which language acquisition takes place.
- During childhood, there is a period when the human brain is most ready to receive input and learn a particular language. This is known as the critical period.

The critical period

The critical period

- The general view is that the critical period for the 1st language acquisition lasts from birth until puberty.
- If a child does not acquire language during this period, then he or she will find it almost impossible to learn language later on.

Genie

In one unfortunate but well-documented case, we have gained some insight into what happens when the critical period passes without adequate linguistic input.

Genie

- 1970
- 13 years old
- Spent most of her life tied to a chair in a small closed room.
- Her father was intolerant of any kind of noise and had beaten her whenever she made a sound as a child.
- There had been no radio or television
- Genie's only other human contact was with her mother who was forbidden to spend more than a few minutes with the child to feed her.

Genie

- She was unable to use language when she was first brought into care.
- However, within a short period of time,
  - began to respond to the speech of others
  - try to imitate sounds
  - syntax remained very simple

Genie

- The fact that she went on to develop some speaking ability and understand a fairly large number of English words provides some evidence against the critical period hypothesis.

- Yet her diminished capacity to develop grammatically complex speech does seem to support the critical period hypothesis.

Genie

- In Genie's case, tests demonstrated that she had no left hemisphere language facility.
- How was she able to learn any part of language, even in a limited way?
- Those same tests appeared to indicate that Genie was using the right hemisphere of her brain for language functions. In dichotic listening tests, she showed a very strong left ear advantage for verbal as well as non-verbal signals.
- Such a finding 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.

Genie

- 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.
- In the next chapter, First language Acquisition, we will investigate what these normal stages are.

Thank you