Pyscholinguistics & Neurolinguistics

General Linguistics

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(Most slides: Petra Hendriks)

Levels of language

• Text/Dialogue	⇨	Pragmatics	(lecture 11)
• Sentences	⇨	Syntax	(lectures 5 en 6)
		Sentence semantics	(lecture 10)
• Words	⇨	Morphology	(lecture 4)
		Lexical semantics	(lecture 9)
• Syllables	⇨	Phonology	(lecture 3)
• Sounds	⇨	Phonetics	(lecture 2)

Structure of lecture

1. Neurolinguistics
   - What brain damage can tell us about the brain and language
     - aphasia

2. Psycholinguistics
   - What studying language processes can tell us about language

Neurolinguistics

- Neurolinguistics researches the manner in which language is represented in the brain and the way it is processed by the brain

Relation between language and brain

What is the relationship between language and the brain?

This question is difficult to answer, because:

- We actually don't really know how neurons and neural networks work
- Our theory of language isn't complete
- The technical methods that can be used to research this relationships aren't advanced enough

Relation between the brain and the mind

- According to some researchers, linguistics and psychology can be reduced to neuroscience ➔ reductionisten.
- Other researchers believe that the brain is just a machine on which the software that is “the mind” is run ➔ functionalisten.

The relation between the brain and the mind is an important research area in artificial intelligence

Lateralisation

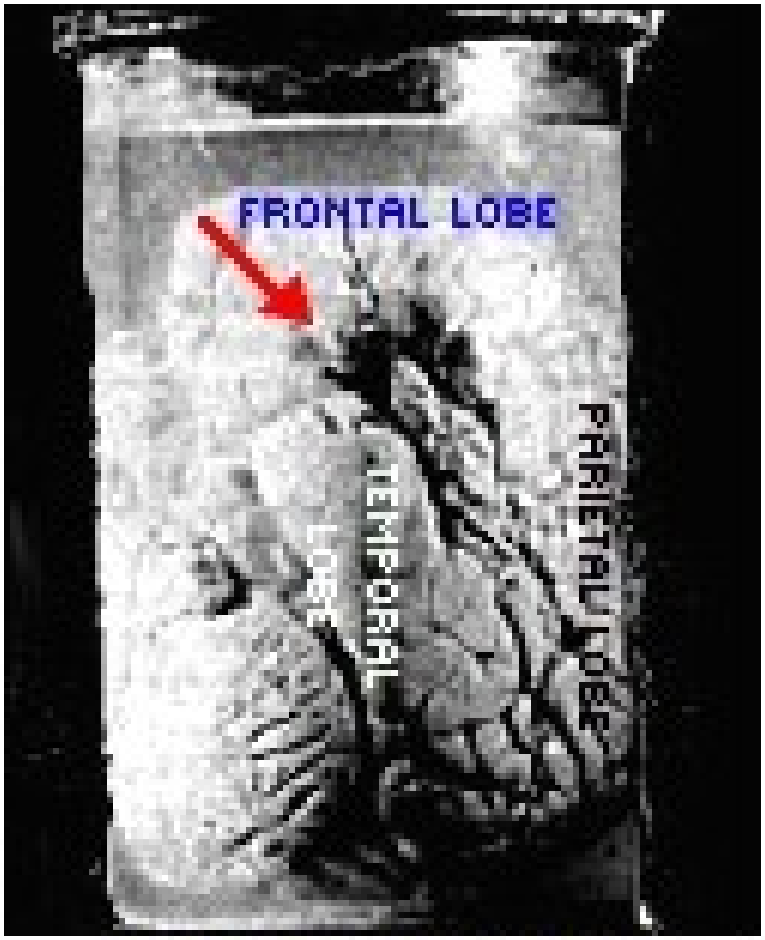
- Most language functions are located in the left hemisphere
- Although the right hemisphere does play a role in the interpretation of::
  - prosody
  - metaphors (‘een schreeuwerig shirt’)
  - humor

Pathological cases

- Much of what we know about the brain and language comes from studies of brains that have been injured
- Broca and Wernicke both noted the language abilities of patients and then after their death related their deficiencies to the results of their autopsies

- Broca's patiënt 'Tan', 1860
- in 1861 Broca was the first to present anatomical proofs for the localisation of a particular brain function.
- Phineas Gage

PAUL BROCA



THE BRAIN OF MR. 'TAN'

Research methods

- Observation and autopsey after a brain injury
- Studies of split-brain patients
- Dichotic listening tasks
  - Each ear is presented with different stimuli
  - The right ear shows an advantage for words
  - The left ear shows an advantage for melodies
- Computerized Axial Tomography (CT scanning)
- Positron Emission Tomography (PET)
- Studies of aphasia patients

Split-brain patients

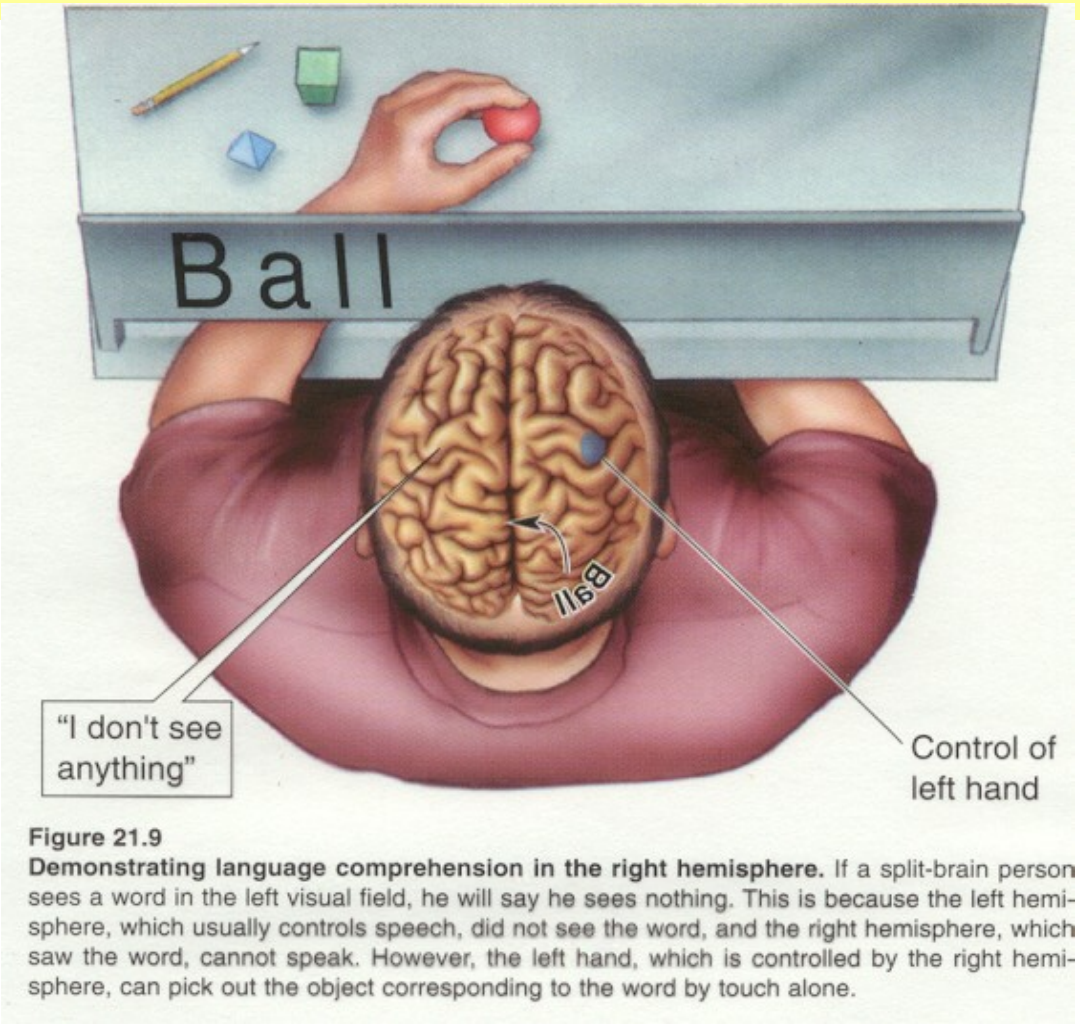
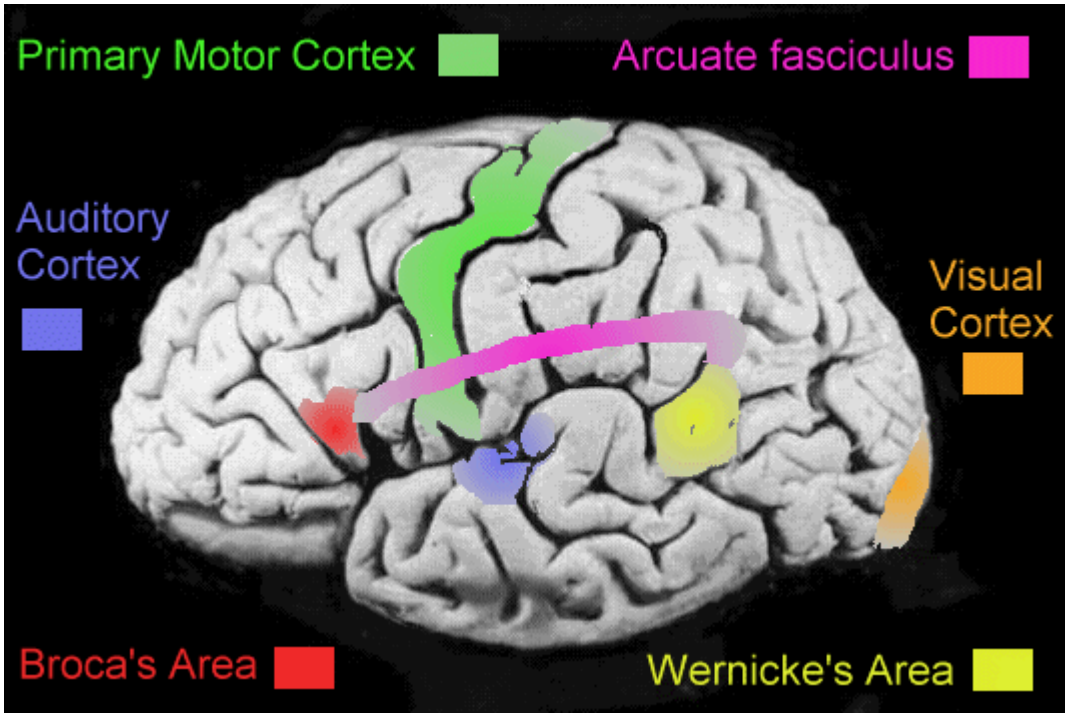


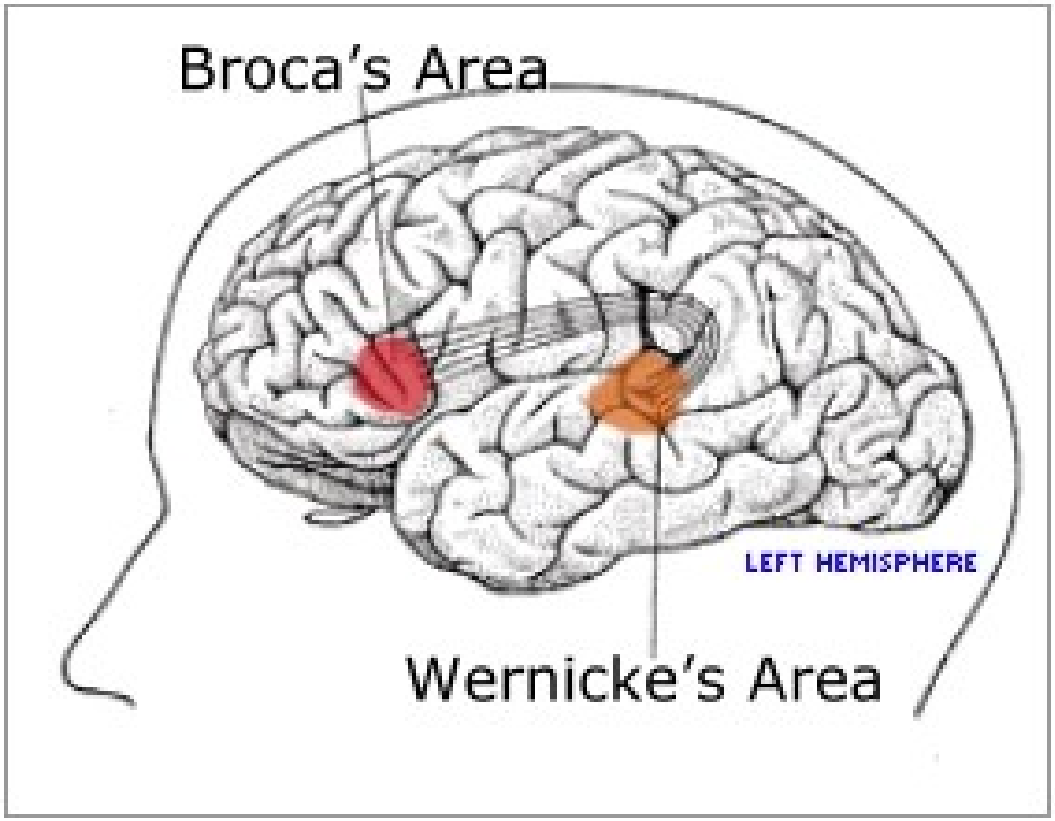
Figure 21.9
Demonstrating language comprehension in the right hemisphere. If a split-brain person sees a word in the left visual field, he will say he sees nothing. This is because the left hemisphere, which usually controls speech, did not see the word, and the right hemisphere, which saw the word, cannot speak. However, the left hand, which is controlled by the right hemisphere, can pick out the object corresponding to the word by touch alone.

Aphasia

- A language impairment that is caused by an injury to the brain (usually a stroke (beroerte) :
  - Broca's aphasia
  - Wernicke's aphasia
  - Other types of aphasia, e.g. global aphasia

Parts of the brain




Broca's Area
LEFT HEMISPHERE
Wernicke's Area

Broca's aphasia

- Problems with language production
- Slow speaking
- Difficulties speaking, not fluent
- Difficulties finding words
- Telegraphic speak, function words left out
- Syntactic errors

Broca's aphasia

Passive sentences

3. The mouse was chased by the cat.

5. The cat was chased by the mouse.

Broca's aphasia (2)

Passive sentence

2. The mouse was chased by the cat.

Understood because it is consistent with world knowledge.

4. The cat was chased by the mouse.

Not misunderstood because it conflicts with world knowledge.

Conclusion: Broca's aphasics can't understand the difference between passive and active…

Agrammatism

Agrammatism: "using a paucity of connecting and modifying words in speech, which gives it a telegraphic quality (I work factory make steel)"

Why might agrammatism arise? hypotheses:

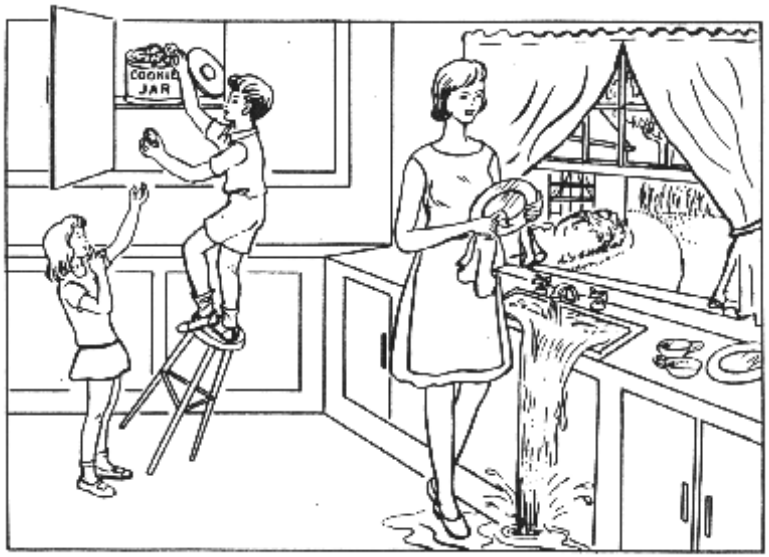
- Loss of the ability to make hierarchical representations:
  - Sentence is treated as a flat sequence of content words
  - Interpretation strategy: first NP is agent: The cat was chased by the mouse.
- Loss of the ability to represent traces? :
  - The cat_i was chased t_i by the mouse.

Examples of agrammatism

- Differences in the accuracy of regular (20%) and irregular verbs (52%) in Broca's aphasia (Ullman et al. (1997))
  - Evidence for dual mechanisms in the processing of regular and irregular inflections?
    - we have already seen something similar in child language
  - syntactic rules associated with regular forms impaired
  - irregular forms only require lexical retrieval, which was less damaged

Wernicke's aphasia

- Interpretation problems
- Often they produce well-formed sentences with normal intonation
- Fluent
- Content is nonsense

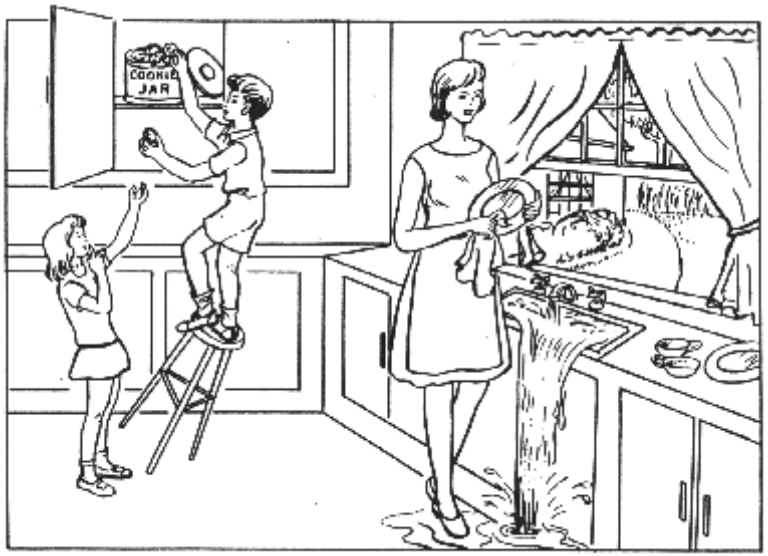


Subject: “Cookie jar … fall over … chair … water … empty … ov …. ov …”

Examiner: “Overflow?”

Subject: “yeah”.

- Well, this is … mother is away here working out o'here to get her better, but when she's working, the two boys looking in the other part. One their small tile into her time here. She's working another time because she's getting, too.



Psycholinguistics

- Psycholinguistics investigates the mechanisms that are behind language production and comprehension

- Research methods
  - Not introspection!
    - doesn't work because language processes are too fast!
  - Experimentation

Research Methods

- Mispeakings (observatie)
- Lexical decision tasks
- Priming experiments
- Reaction time experiments (RT)
- Timed-reading experiments
- Eye-tracking expreiments
- Event Related Potentials (ERP)
- Functional Magnetic Resonance Imaging (fMRI)

Priming paradigm

When a *target* is preceded by a (semantically) related prime, subjects can more quickly jduge if a *target* is an existing word or not.

E.g:

- Prime: *dog* / *pen*
- Target: *cat* (More quickly identified as a real word if the prime is *dog*)

Timed-reading experiments

- Assumption: the more complicated the processing of a sentence is, the longer it will take to read it.
- Often used method: Subjects read a sentences word by word and push a button when they have read the word
- Patterns of button pushing often mirrors the syntactic structure of the sentence:
  - The most time is needed for content words
  - Less time necessary for function words
  - Pauses at sentence borders

Read a bit to text

Count the number of times that the letter F appears in this text:

FINISHED FILES ARE THE RESULT OF YEARS OF SCIENTIFIC STUDY COMBINED WITH THE EXPERIENCE OF YEARS.

Reading

Aoccdrnig to rscheearch at an Elingsh uinervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are, the olny iprmoetnt tihng is taht frist and lsat ltteer is at the rghit pclae. The rset can be a toatl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae we do not raed ervey lteter by it slef but the wrod as a wlohe.

Eye movement

- Measurements of the movement of an eye with the help of an *eye tracker*.
- E.g. reading garden path sentences
  - The horse raced past the barn fell.
- A grammatical, but unexpected, structure: *raced* is not the main verb, but the begin from a relative clause
- The reader reexamines (zgn. achterwaartse saccades) every word that doesn't fit in with his/her expectations
  - Ik dacht dat Jan de man die had gewacht op de bus naar Zaltbommel zette.

ERP

Peeks in the EEG-signaal can be related to certain characteristics of a sentence

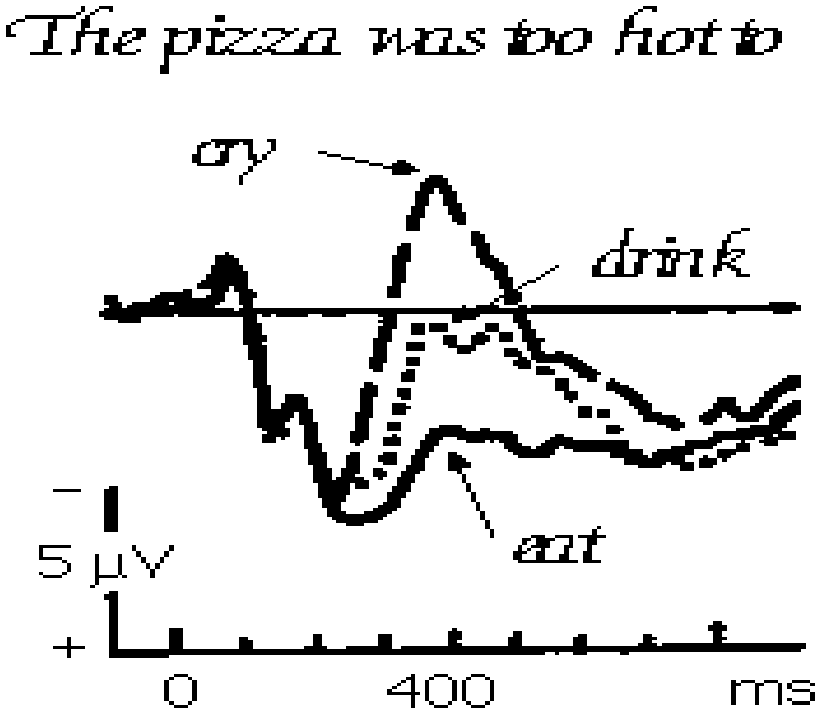
N400 peek appears when a word doesn't fit with the sentence

:

- The pizza was too hot to eat.
- The pizza was too hot to drink.
- The pizza was too hot to cry.

N400

N400-effect



Difference between different types of research

Observation	or	Experiment
Invasive	or	Non-invasive
Brain structure	or	Brain activity
Healthy subjects	or	Pathological cases
High temporal resolution	or	Low temporal resolution
High spatial resolution	or	Low spatial resolution

Language processing

- Processing works bottom-up:
  - On the basis of the sounds that we hear, from the beginning to the end of the word or sentence
- But also top-down:
  - We interpret things on the basis of what we expect

Parser

- The number of assumed movements in a sentence is not a good predictor of the time it will take to process the sentence.
- Perhaps the difference between the rules that native speakers use and the rules that syntacticians create are different
- Solution in generative syntax:
  - distinction between grammar - parser

Characteristics of the parser

- The parser (processing model) uses grammatical knowledge
- At the same time, the parser has its own principles and procedures for languge processing (cf. Frazier):
  - Minimal Attachment Principle
  - Late Closure
- The result of this distinction: experiment tell you nothing about the grammar, only about the parser.

Next time…

- “Responsiecollege”