Introduction to Psycholinguistics

Lecture 1

Linguistic and Biological Foundations

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Course structure

Date	Lecture	Topic	Staff
26-04	L1	INTRO - Linguistic and biological foundations	PK & MC
03-05	L2	INTRO - Human language processing	MC
10-05	L3	Psycholinguistic theories in sentence processing	MC
17-05	L4	Experimental methods I	PK
24-05	L5	Experimental methods II	PK
31-05	L6	Lexical Processing	PK
07-06	L7	Sentence processing: Testing linguistic theory	MC
14-06	L8	Language Production	AM
21-06	L9	Computational models	MC
28-06	L10	Situated spoken language processing	PK
05-07	L11	Language and embodiment	PK
12-07	L12	Review lecture	PK & MC
19-07		Klausur	

Course structure

Date	Lecture	Reading
26-04	L1	Chapter 1 In: V. Fromkin (2000). *Linguistics: an introduction to linguistic theory.* Oxford: Blackwell (Seminar folder in the coli library)
03-05	L2	Lewis, R.L. (1999). Cognitive modeling, symbolic. In Wilson, R. and Keil, F. (eds.), *The MIT Encyclopedia of the Cognitive Sciences.* Cambridge, MA: MIT Press.
10-05	L3	Edward Gibson and Neal Perlmutter. Constraints on Sentence Comprehension. *Trends in Cognitive Sciences,* 2(7), 1988.
17-05	L4	tba
24-05	L5	tba
31-05	L6	Lively, S., Pisoni, D., & Goldinger, S. (1994). Spoken word recognition: Research and theory. In M.A. Gernsbacher (Ed.), *Handbook of Psycholinguistics.* Chapter 8, pp. 265-301.San Diego: Academic Press. Miller, J. & Eimas, P. (1995). Speech perception: from signal to word. *Annual Rev. Psychol., 46,* 467-492.
07-06	L7	tba
14-06	L8	tba
21-06	L9	Matthew Crocker (1999). Mechanisms for Sentence Processing. In: Garrod & Pickering (eds), *Language Processing,* Psychology Press, London, UK.
28-06	L10	Tanenhaus, M. K., Spivey-Knowlton, M. J., Eberhard, K. M., & Sedivy, J. C. (1995). Integration of visual and linguistic information in spoken language comprehension. *Science,* 268, 1632-1634. Knoeferle, P. & Crocker, M.W. (in press). The coordinated interplay of scene, linguistic, and world knowledge: evidence from eye tracking. *Cognitive Science.*
05-07	L11	Barsalou, L. W. (1999). Language comprehension: archival memory or preparation for situated action? *Discourse processes, 28,* 61-80.

Today: Linguistic and biological foundations

❐ Linguistics

❐ Evolutionary/Developmental

❐ Biological/neuroscience foundations

Language ...

❐ Philosophy of language/Linguistics
  ⇨ What is language and linguistic knowledge?
  ⇨ How do we represent meaning and structure in language?
  ⇨ Ambiguity

❐ Evolution and development of language
  ⇨ Is language uniquely human?
  ⇨ How do children acquire language?

❐ Biology/Neuroscience
  ⇨ Where is linguistic knowledge stored? In which form is it stored?

What is language?

❐ Linguistic knowledge (*competence*)
  ⇨ Includes phonological, syntactic, and semantic knowledge
    ❐ Phonology: sound patterns
    ❐ Lexicon: vocabulary
    ❐ Syntax: constituent order
    ❐ Semantics: meaning

    ❐ How about world knowledge?

  ⇨ Linguistic theory describes these components

Phonological knowledge

❐ Phonetics
  ⇨ Range of sounds that articulatory system can produce

❐ Phonology: study of the sound system
  ⇨ Minimal meaningful sounds: *Phonemes*, e.g., voiced vs. unvoiced, (e.g., /b/ vs. /p/ for plosives)
    ❐ *Minimal pairs*, e.g., *beer* vs. *peer; thin* vs. *this*
  ⇨ Two similar sounds that are not separate phonemes: *allophones*
    ❐ Voiceless stops (e.g., /p/, /t/) can be aspirated in English
      ⇨ At the beginning of a word they are aspirated
      ⇨ But not after /s/; *pain* vs. *Spain*
    ❐ Used in *complementary distribution:* [p] and [pʰ] are allophones of /p/ because they occur in complementary distribution
  ⇨ When two sound forms occur in the same environment without change in meaning/being considered incorrect
    ❐ *Free variation*, e.g., glottal stop in word-final position (*butter*)

The lexicon

- ❑ Vocabulary of a language (*lexicon*)
  - ⇨ Average person knows between 45.000 and 60.000 words
  - ⇨ Unit of vocabulary: *lexeme*/lexical unit
  - ⇨ *Grammatical/function* (signal grammatical relationships, e.g., *of, by*) *vs. lexical/content* words (that have a meaning/lexical content)
  - ⇨ Open vs. closed class (e.g., *of, by, with, the*) distinction
  - ⇨ Organization of lexicon: lexical fields (e.g., colour, cooking)
  - ⇨ Structure of words: *morphology*
    - ❑ Root, prefix *(dis-enchant, be-zahlen)*, suffix *(bewilder-ment)*
  - ⇨ Some operations
    - ❑ *Conversion*: changes of word classes, e.g., noun -> verb
    - ❑ *Derivation*: *prefixation, suffixation;*
      - ⇨ *Independent* through prefixation from *dependent*
    - ❑ *Compounding:* e.g., *dog catcher, life saver*
    - ❑ *Blending:* e.g., *breakfast + lunch -> brunch*; *smog*; *sneet*
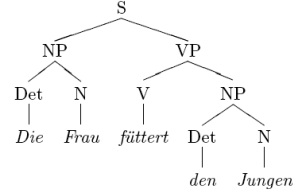
Syntactic knowledge

- ❑ Rules that govern how words in a language are combined
  - ⇨ Often also referred to as *grammar*
    - ❑ Internal representation of grammar rules in a person's head
    - ❑ Model of that representation
- ❑ Grammaticality judgments
  - ⇨ Grammatical sentence: *Die Frau füttert den Jungen.*
  - ⇨ Ungrammatical sentences: **Die Frau füttert in Jungen.*
  - ⇨ *Non-canonical* sentences: *Die Frau füttert der Junge.*
- ❑ Syntactic analysis: sentence constituents
  - ⇨ *Phrases* (e.g., noun phrase, verb phrase) are clausal constituents
  - ⇨ *Clauses* can also be constituents
    - ❑ *Susan realized that he was drunk.*
    - ❑ *That he was drunk* is embedded in the main clause and is a direct object

Syntactic analysis

- ❑ Constituent tests
  - ⇨ Substitution (e.g., *it* can replace the clause *that he was drunk*)
    - ❑ *Susan realized it.*
  - ⇨ Movement
    - ❑ *Fronting*
      - ⇨ *He ate the cheese with great gusto. -> With great gusto, he ate the cheese.*
    - ❑ *Clefting*
      - ⇨ *She bought a bottle of juice. -> It was a bottle of juice that she bought.*
  - ⇨ Passivization
    - ❑ *The car hit the man. -> The man was hit by the car.*

Syntactic analysis

- ❑ Syntactic analysis
  - ⇨ Syntactic categories/classes established on basis of the syntactic relationships between linguistic items in a construction
- ❑ *Die Frau füttert den Jungen.*
  - ⇨ *Bracket notation*   [S [NP[Det N]] [VP [V [NP[Det N]]]]
  - ⇨ Grammatical function   Subject   V   dir. Object

  - ⇨ *Tree diagrams*

- ❑ *Example*
  - ⇨ *Die Frau füttert den Jungen mit dem Löffel.*

Syntactic operations

- Infinite set of sentences in any language
  - Recursive embedding: Suzy who loves Peter hates cats.
  - A procedure is recursive if one of the steps that makes up the procedure calls for a new running of the procedure

- Other operations
  - Conjoining sentences, negation, question formation, binding

- Difference between structural operations in morphology vs. syntax
  - E.g., recursion

Semantic/conceptual knowledge

- Meaning of words and concepts
  - Arbitrary relationship between form and meaning

  Begriff/Concept

  Signifikant/Form (*das Bezeichnende;* Wort)   Signifikat/Referent (*das Bezeichnete*)

  - Speakers/listeners know the meaning of words and concepts
    - E.g., a *chair, an armchair, a stool* are all object you can sit upon, and part of the concept CHAIR
  - Types of concepts: e.g., event, state, object, agent, action
    - *Walk, run, & throw,* are part of the concept type ACTION
  - The nature of conceptual representations: *Modal* or *amodal*?
    - *Amodal:* symbolic representations, abstracted from their modality-specific perceptual origin
    - *Modal:* common representational format for conceptual and sensory-motor processing

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Semantic/conceptual knowledge

- Analysis of word meaning
  - Semantic features: a man is [+animate][+human]; a 'cat' is [+animate][-human]

- Study of sense relationships such as e.g.:
  - Hyponymy
    - Hyponym: a parrot is a hyponym ('included in') of bird
    - Hypernym: an animal is a hypernym of cat

- Semantics and vagueness

- Interpretation of sentences
  - Semantic representation, e.g.:
    - *The old car is beside the store.*

    $[_{Situation}PRES [_{State}BE ([_{Object} [TYPE:CAR]]_{DEF} , [_{Place}BESIDE [_{Object}[TYPE:STORE]]_{DEF}])]]$
    $[_{Prop}OLD]$

The architecture of the language faculty

Interface Prozessor zu Gehör

Phonologisch integrativer Prozessor   Syntaktisch integrativer Prozessor   Konzeptuell integrativer Prozessor

Phonologische Strukturen   **Syntaktische Strukturen**   **Konzeptuelle Strukturen**   Interface Prozessor zu Sehvermögen und Handeln

Arbeitsgedächtnis

Schnittstellen Prozessor(en)   Schnittstellen Prozessor(en)

Interface Prozessor zu Vokalisierung

Schnittstellen Prozessor(en)

Jackendoff (2002)

Summary

- ❏ Linguistic knowledge
  - ⇨ Phonological

  - ⇨ Lexical

  - ⇨ Syntactic

 - ⇨ Semantic/conceptual

Ambiguity

- ❏ Lexical (at word level)
  - ⇨ Word category
    - ❏ E.g., verb/noun: *walk, praise, call, phone*
  - ⇨ Meaning
    - ❏ *Homographs*: same written form but different meaning
      - ⇨ *E.g., Lauf* (Klavier, Joggen), *Geschirr* (Pferd, Porzellan)
      - ⇨ *Peter remembered the ball which he had lost yesterday.*
      - ⇨ *Peter remembered the ball which he had gone to last week.*
    - ❏ *Homophones:* same pronunciation, different in meaning
      - ⇨ *Tale/tail; bear/bare;*

Ambiguity

- ❏ Structural ambiguity
  - ⇨ Word order: subject-object (SO) vs. object subject (OS)
    - ❏ *Die Mutter grüßt die Tante.*
      - ⇨ Word order variation: Subject-object and object-subject are grammatical
      - ⇨ Case ambiguity: for feminine nouns NOM and ACC case are identical
  - ⇨ Thematic role ambiguity
    - ❏ *The princess called by the king was talking to her nurse.*
    - ❏ The first noun phrase is both
      - ⇨ Agent (main clause *The princess was talking to her* nurse)
      - ⇨ Patient (reduced relative clause *called by the king*)

Ambiguity
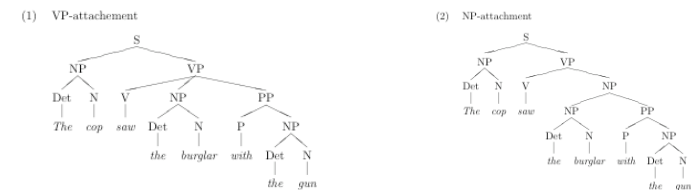
- ❏ Structural ambiguity
  - ⇨ Attachment ambiguity
    - ❏ PP-attachment

Ambiguity

- Referential ambiguity
  - *The horse was beautiful.*

  - *The horse next to the tree was beautiful.*

Ambiguity

- *Local* versus *global* ambiguity
  - Disambiguating information
    - Information that resolves a local ambiguity
      - *Die Frau grüßt den Mann* (local)
      - *Die Frau grüßt die Tante* (global)

- Multiple ambiguity (more than two structural analyses)
  - *The girl hit the boy with the book on the hill.*
    - The book was an instrument for hitting the boy or the boy had the book
    - The hill was either the location of the book or of the hitting

Summary

- Lexical ambiguity

- Structural ambiguity
  - Word order and grammatical function
  - Thematic role ambiguity
  - Attachment ambiguity

- Referential ambiguity

- Local/global ambiguity

- Multiple ambiguity

Language evolution and development

- The *logical problem of language acquisition* (Chomsky, 1955)
  - We know more than is present in the input "on the surface"
    1. *Peter is easy to please.*
    2. *Peter is eager to please.*
       - In 1. Peter is the one being pleased; in 2. he is the agent of pleasing
       - Re 1: 'It is easy to please Peter', Re 2: *'It is eager to please Peter'
    - *Mary likes cooking apples.*
      - NP analysis ('Bratäpfel') vs. V-N analysis ('to cook apples')
  - No negative evidence

- Two proposals in the literature
  - Innate position (*Universal Grammar*)
    - Richness and complexity of the grammar, uniformity of language acquisition on the basis of limited and noisy evidence
  - Learned (*tabula rasa*)
    - Language is one of many puzzles in cognition; children's intelligence enables them to solve it

Language evolution and development

- ❏ Is language uniquely human?

- ❏ Do animals have a true language?
  - ⇨ Continuity theory
    - ❏ Language grew out of a primate call system (e.g., *Danger!*)
    - ❏ Step from alarm call warning of an animal to using the same sound as a 'word' that symbolizes that animal
    - ❏ Gradually refined until it evolved into language
  - ⇨ Discontinuity theory
    - ❏ Animal cries are only partly symbolic (e.g., can be a mix between fear and a warning)
    - ❏ Big difference between animal calls and real language

Language evolution and development

- ❏ Ten features that have been suggested capture the nature of human language (Hockett, 1963)
  - ⇨ Use of vocal organs & auditory system
  - ⇨ Semanticity: use of symbols to refer to objects and actions
  - ⇨ Arbitrariness: use of neutral symbols
  - ⇨ Cultural transmission: many bird songs are innate; humans reared in isolation do not develop language
  - ⇨ Spontaneous usage
  - ⇨ Turn-taking
  - ⇨ Duality: language is organized hierarchically
  - ⇨ Displacement: ability to refer to things remote in time/place
  - ⇨ Structure-dependence
  - ⇨ Creativity

Aitchison, 1989. *Chap. 2*

Language evolution and development

- ❏ Teaching sign language to apes
  - ⇨ Chimp named Washoe
    - ❏ Taught modified American sign language
    - ❏ Early on language development similar to children
      - ⇨ Acquired up to 100 simple words
      - ⇨ Semanticity present: Use of a sign to name an object; generalized use of signs such as for 'more' across situations)
      - ⇨ Creative: 2- and 3-word sequences of her own invention
      - ⇨ Tried to teach infant chimp some signs
      - ⇨ But: did not preserve a fixed subject-first word order - apparent failure to grasp structure-dependent operations

Language evolution and development

- ❏ Child language acquisition
  - ⇨ The biological foundations of language (Lenneberg, 1967)
  - ⇨ Biologically triggered behaviour
    - ❏ Emerges before it is needed
    - ❏ Appears not based on conscious decision/external events; little effect of direct teaching
    - ❏ Fixed sequence of acquisition stages
    - ❏ Critical period for acquisition

Language evolution and development

❐ Fixed sequence of acquisition stages

➩ Birth - 8 mths   Crying, babbling, intonation patterns

➩ 1 year   1-word utterances

➩ 18 months   2-word utterances

➩ 18 months   Vocabulary spurt

➩ ca. 2 years   Inflections, questions, negatives

    ❐ E.g., Progressive -*ing*, and plurual -*s* occured before past tense, the third person singular -*s*, and the copula *am, is, are*

    ❐ E.g., *where*

      ➩ *Where you go? -> Where you **will** go? -> Where **will you** go?*

➩ 5 years   Complex constructions

➩ 10 years   Mature speech

Language evolution and development

❐ Critical period

➩ *Lateralization* (specialization of language to one side of the brain) happens during the first few months

➩ Huge language growth around the age of two years

    ❐ Vocabulary spurt

➩ Socially isolated children

    ❐ Isabelle, found at the age of 6.5 years; passed through usual stages at accelerated rate, and had caught up with normal development by the age of 8.5 years

    ❐ Genie, found at the age of 14 years; acquired the rudiments of language, but slower progress than normal children (e.g., the 2-word stage that normally lasts weeks, lasted 4-5 months)
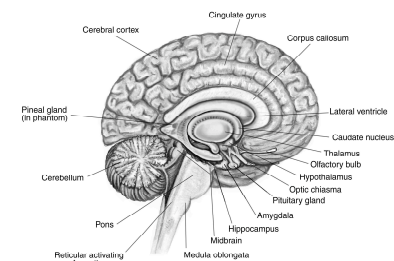

Anatomy of the brain

Back   Front
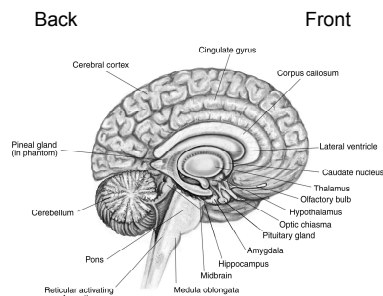
❐ *Cerebrum* ('Großhirn ')

➩ Separated into two hemispheres ('Halbkugeln')

➩ Link between the two hemispheres: *corpus callosum* ('Balken')

➩ Surface of the cerebrum: *cerebral cortex* ('Großhirnrinde')

➩ In the *cerebral cortex* you can localize the cortex ('Rindenfelder'), where sensory impressions are processed

➩ The cortex is divided into *lobes* ('Lappen')

    ❐ *Frontal, temporal, parietal, occipital* lobes

http://www.lumrix.de/icd/med/cerebral.html
http://www.headinjury.com/brainmapx.htm

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Anatomy of the brain

❐ *Cerebellum* ('Kleinhirn')

➩ Also separated in two hemispheres

➩ Responsible for equilibrium, sense of orientation, movements and their coordination

❐ *Diencephalon* ('Zwischenhirn')

➩ Consists of *thalamus*('Sehhügel') and *hypothalamus* ('Hirnanhangdrüse')

    ❐ Thalamus: mediates sensory and motor signals

    ❐ Hypothalamus: controls bodily and mental processes

➩ Between cerebrum und the brain stem ('Hirnstamm')

➩ Responsible for controlling sleep; temperature regulation

Anatomy of the brain
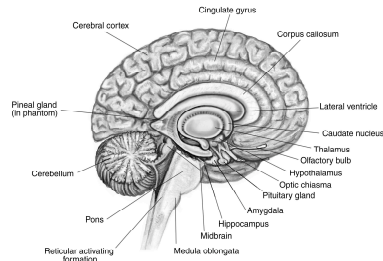
- ❐ Brain stem ('Hirnstamm')
  - ⇨ Consists of midbrain ('Mittelhirn'), pons ('Brücke'), and the medulla oblongata ('Nachhirn')
  - ⇨ Processes incoming sensory impressions and outgoing motor information
  - ⇨ Responsible for reflex-like control mechanisms

Cortex: lobes

http://www.tbts.org/itemDetail.asp?categoryID=295&itemID=16377
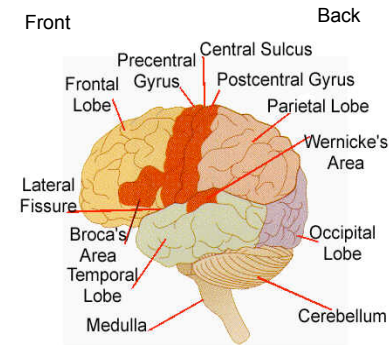
- ❐ Frontal lobe
  - ⇨ Separated from parietal lobe by central sulcus/rolandic fissure
  - ⇨ Contains Broca's Area
  - ⇨ Damage can result in impaired language production
- ❐ Parietal lobe
- ❐ Temporal lobe
  - ⇨ Separated of frontal and parietal lobes by the lateral/sylvian fissure
  - ⇨ Wernicke's area
  - ⇨ Damage can result in problems processing auditory language
- ❐ Occipital lobe
  - ⇨ Visual processing
  - ⇨ Damage can impair processing of written language

Organization of language in the brain

- ❐ A brief history (see Saffran, 2003)
  - ⇨ In Greece & Rome, capacity for language was ascribed to the tongue
- ❐ Empiricism of the 18th/19th century
  - ⇨ Study of *aphasia* (partial or total loss of the ability to articulate ideas or comprehend spoken or written language) following brain damage
- ❐ *Phrenology* (Gall, ca. 1800):
  - ⇨ Bumps on the skull taken to reflect areas of enlargement in the brain
  - ⇨ Located language at the protrusion of the eye socket below the eye
- ❐ Paul Broca (physician, ca. 1860)
  - ⇨ Localization of functions in the cerebral cortex
    - ❐ M. Leborgne, suffered a stroke, only uttered one monosyllable
    - ❐ Autopsy: area of damage in left inferior frontal lobe (Broca's area)
    - ❐ Broca's area lies anterior to area of the motor cortex that transmits commands to face muscles, tongue, and larynx

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Organization of language in the brain

- ❐ Broca's aphasia
  - ⇨ Sparse speech, nonfluent
  - ⇨ Intonation and stress patterns are deficient
  - ⇨ Lack of grammatical structure
    - ❐ Sentence construction is poor
    - ❐ Disjointed words
    - ❐ Omitting function words and inflections
      - ⇨ E.g., *Son ... University ... Smart ... Boy ... Good ... Good ...*

Organization of language in the brain

- ❑ Carl Wernicke (German physician)
  - ➩ Damage to an area of the left superior temporal lobe (part of auditory association cortex, and next to primary auditory cortex)
  - ➩ Result: Loss of language comprehension
    - ❑ Wernicke's aphasia
      - ➩ Deficits in comprehension and repetition
      - ➩ Speak fluently but content is often incorrect
      - ➩ Difficulty in word retrieval, generation of neologisms
  - ➩ Superior temporal area: where auditory word images are stored
  - ➩ Proposed a connection between Wernicke and Broca
  - ➩ Example (Saffran, 2003, Appendix 1)
    - ➩ [...] I can't recall the word that I can't *thay*. With the French, you know, uh, what is the name of the word, God, public *serpinz* they talk about, uh, but I have had that, it was *ryediss*, just before the *storage* you know, seven weeks, I had personal friends that, that, I would cook an' *food* the food and serve *fer* four or six *mean* for an evening.

Summary

- ❑ Linguistics
  - ➩ Linguistic knowledge
  - ➩ Ambiguity

- ❑ Language evolution/development
  - ➩ Logical problem of acquisition
  - ➩ Innateness vs. learning
  - ➩ Language acquisition in apes and children

- ❑ Anatomy of & organization of language in the brain
  - ➩ Four lobes of the cortex
  - ➩ Broca's and Wernicke's aphasia