Psycholinguistics

Outline

I What is Psycholinguistics?

II The *Computational Psycholinguistics* Group at Saarland University
Individual Presentations by the group members

What is Psycholinguistics?

Psycholinguistics is the study of the mental representations and processes that are involved human language processing

- Which psychological and neurological factors underlie language acquisition, language production and language comprehension?
- What are the architectures and mechanisms of language processing?

Human Language Processing

Human language processing is incredibly efficient

very fast, seemingly effortless, mostly correct, excellent coverage

Compare with Computational Language Processing Systems

~~very fast, seemingly effortless, mostly correct, excellent coverage~~

Language Processing: Complex

- huge number of words
- polysemic and homonymic words
- infinite number of sentences
- syntactic ambiguity
- role of general world knowledge
- context dependencies
- …

→ It is not surprising that computational language processing systems are not better than they are

→ It is surprising that human language processing is that good as it is

Human Language Processing: Areas

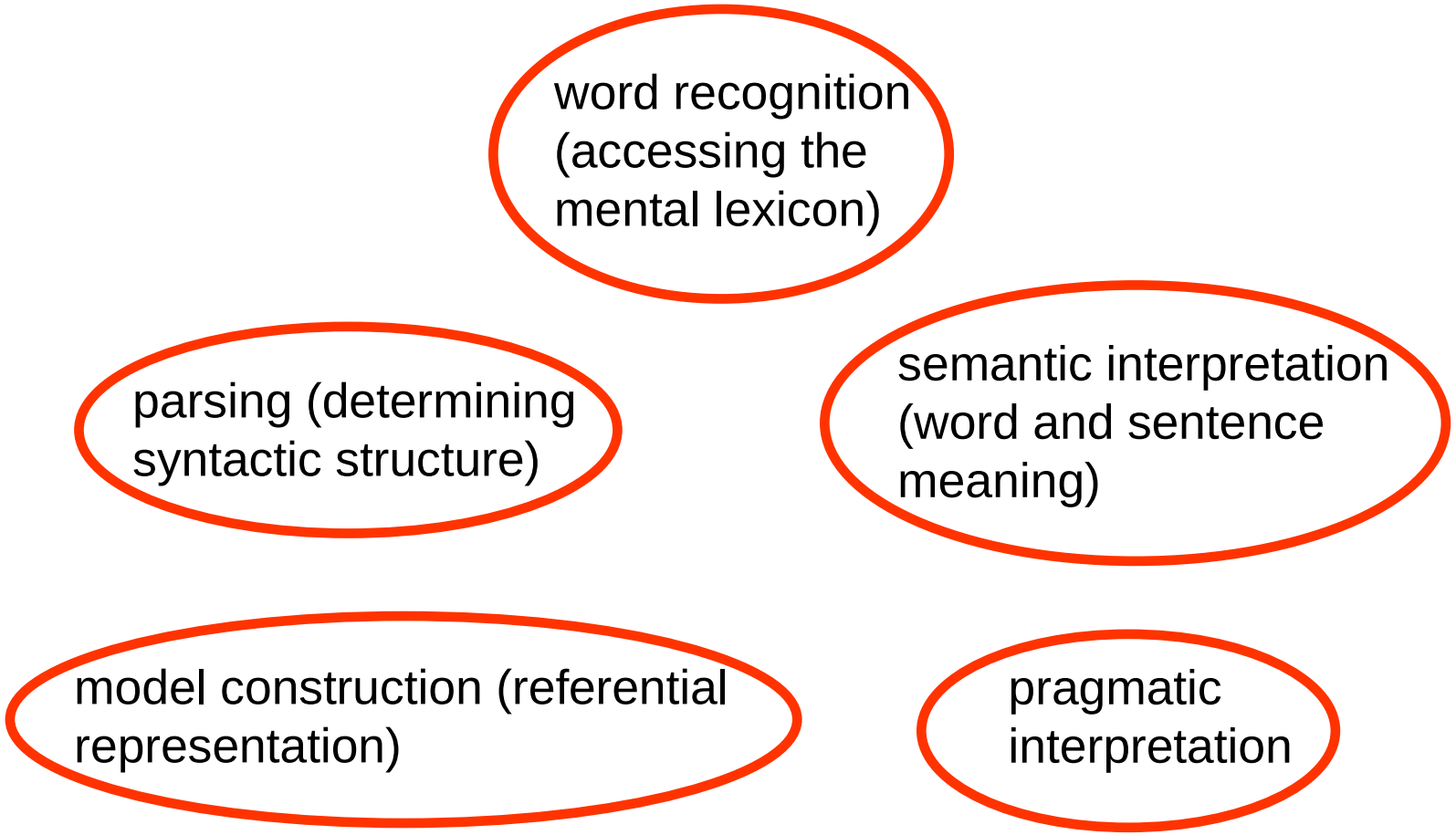
Language Comprehension

Language Production

Language Acquisition

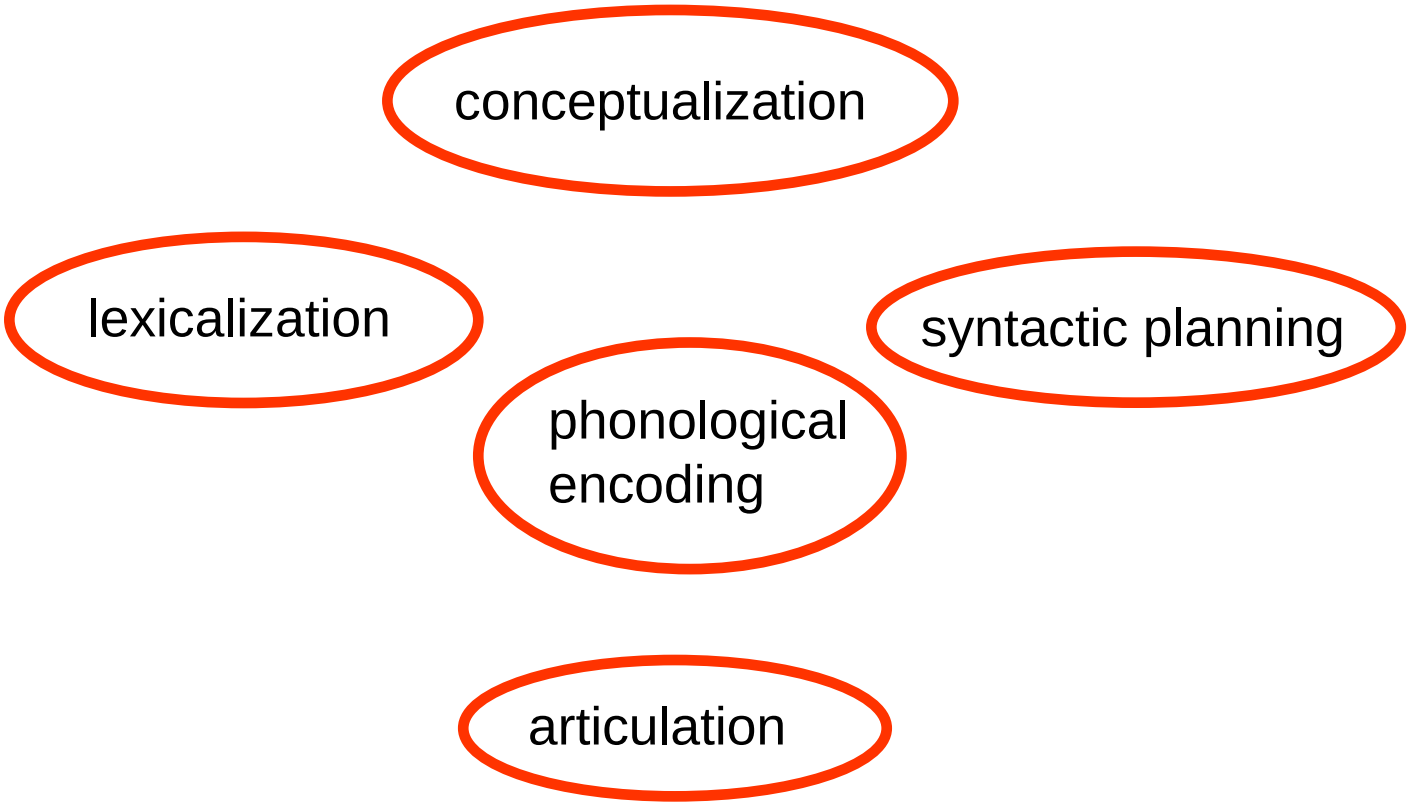
Language Comprehension

Subprocesses of language comprehension?



Language Production

Subprocesses of language production?



Language Acquisition

Language Acquisition: Domains

- conceptual knowledge
- lexical knowledge
- syntactic knowledge
- semantic knowledge
- pragmatic knowledge

- first language (L1)
- second language (L2)

Psycholinguistics: Meth. Approaches

Psycholinguistics studies the different subprocesses of language comprehension, language production and domains of language acquisition

Methodological approaches in Psycholinguistics

Experiment (central approach)

Computational Modeling

Case Studies (e.g., patients, feral children)

Experiment / Computational Modeling

Experiment

testing a prediction that is derived from a theory

goal: providing empirical support for the theory

Computational Modeling

modeling of cognitive processes (psycholinguistics: language processes)

implementation of theoretical assumptions

requires a precise formulation of the assumptions

goals: simulating of empirical data

derivation of novel predictions (that are to be tested in experiments)

More on Experiments

Experiment

- allows for a systematic observation of a particular behaviour under controlled circumstances
- manipulation of conditions → effect on behaviour
- testing of prediction: behavioural differences between conditions
- observed differences are attributed to manipulation of conditions → conditions should only differ with regard to manipulation
- manipulated variable: *independent variable* / *factor*
- observed behaviour: *dependent variable*
- statistical tests: testing whether an observed difference is *significant* (roughly speaking: whether it is not due to chance)

Experiment: Example

Prediction: Complex temporal sentences are more difficult to process when the order of mention of the two events mentioned in the main and subordinate clause does not match the order of occurrence compared to when there is a match between order of mention and order of occurrence.

e.g., *Anna baked some cookies, after she baked a cake. / After Anna baked a cake, she baked some cookies*.

Independent Variable: order of mention → 2 conditions: non-chronological vs. chronological

Dependent Variable: Reading time

Material: 16 experimental sentences, each in 2 versions (non-chronological and chronological); 20 filler sentences (to conceal the experiment's purpose)

Procedure: Participants read the sentences (8 non-chronological, 8 chronological and the fillers) from a computer screen, self-paced (key press → next sentence)

Recording of reading times

Experiment: Extended Example

Prediction: Non-chronological complex temporal sentences are more difficult to process than chronological sentences, but the difference is larger with the connective *after* than with the connective *before*

e.g., *Anna baked some cookies, after she baked a cake. / After Anna baked a cake, she baked some cookies*. / *Before Anna baked a cake, she baked some cookies*. / *Anna baked some cookies, after she baked a cake.*

Independent Variables:
(1) order of mention: non-chronological vs. chronological

(2) type of connective: after vs. before

→ 2 x2 = 4 conditions

Dependent Variable: Reading time

Material: 32 experimental sentences, each in 2 x 2 versions (non-chronological with *after*, chronological with *after*, non-chronological with *before*, chronological with *before*);
40 filler sentences

Methods / Independent Variables

Measuring of time

Reading times, Reaction times, Response times, Naming times

Eye-movement data

- in written language comprehension
- in language production (eye movements on to be described pictures)
- in spoken language comprehension
  → visual-world paradigm: participants listen to words or sentences and simultaneously view pictures (eye movements on pictures)

Neuroscientific measures – measuring brain activation

event-related potentials (ERP), functional magnetic resonance imaging (fMRI)

Simulating an Experiment

Say the name of the word on the next slide

BLUE

Simulating an Experiment

Say the name of the word on the next slide

GREEN

Simulating an Experiment

Say the name of the colour on the next slide

BLUE

Simulating an Experiment

Say the name of the colour on the next slide

GREEN

Stroop-Effect

What was more difficult / what was easier:
word naming or colour naming?

Stroop-Effect

Colour naming: interference, when colour and word content mismatch

Word naming: no interference

Does the Stroop-Effect tell us something about word recognition?

→ Stroop-Effect suggests that word recognition is automatic

Read the following text beginning

John was on his way to school. He was terribly worried about the maths lesson. He thought he might not be able to control the class again today.

Did you encounter difficulties when reading the last sentence?

Why – what's the problem?

What does this tell us about text comprehension?

Comprehension can be constrained by inferences

Suppose, you wanted to test the inference-effect in an experiment

→ How would you do this?

Why to bother about Psycholing.?

- insights from psycholinguistic research may sometimes be helpful with regard to computational linguistics

- there is a trend towards experimental research in linguistics → knowledge about psycholinguistics/experimental methods provides a background to evaluate this work

- **local reason**: the M.Sc. in *Language Science and Technology* includes the possibility to specialize in *Computational Psycholinguistics*

Computational Psycholinguistics Group

http://www.coli.uni-saarland.de/groups/MC/index.html

Academic and Research Staff

Prof. Dr. Matthew Crocker (head of the group)

Dr. Afra Alishahi

Dr. Berry Claus

PhD Students

Emilia Ellsiepen

Judith Köhne

Garance Paris

Maria Staudte

Juliane Steinberg

Research in the Group

Computational modeling

- probabilistic and connectionist models
- topics
  - lexical processing (bilingual)
  - syntactic processing
  - situated language processing (i.e., within a visual environment)
  - language acquisition

Experimental

- behavioural experiments
- topics
  - lexical processing (situated, bilingual)
  - sentence processing (syntactic, semantic)
  - text comprehension
  - human-robot interaction

Central Method: Eye Tracking

Most of the experiments conducted in the Computational Psycholinguistics group are **eye tracking** studies within the **visual world paradigm** (presentation of visual scenes + spoken linguistic stimuli and monitoring of eye movements which are elicited by the linguistic stimuli)

Some eye-tracking facilities in our labs

- *Eye Link*: head-mounted eye tracker
- *Tobii*: remote eye tracker (eye-tracking hardware is embedded in a monitor)
- *faceLab*: remote eye-trackers (which can be cascaded to track head orientation and eye gaze in up to 270°)

Eye Link

lab tour

Tobii
faceLab

In what follows

Individual presentations by the group members

Juliane Steinberg: *lab tour* incl. a presentation on *speech mediated attention in virtual environments*

Garance Paris: *bilingualism and lexical competition*

Emilia Ellsiepen: *interplay of language processing and visual working memory in situated language comprehension*

10:30 - 11:00 coffee break

Maria Staudte: *utility of gaze in human-robot interaction*

Judith Köhne: *syntactic priming in language production*

Afra Alishahi: *computational modeling of child language acquisition*

Berry Claus: *embodied language comprehension and sentence mood*