

# **Multi-modal representation and communication**

Lecture 3

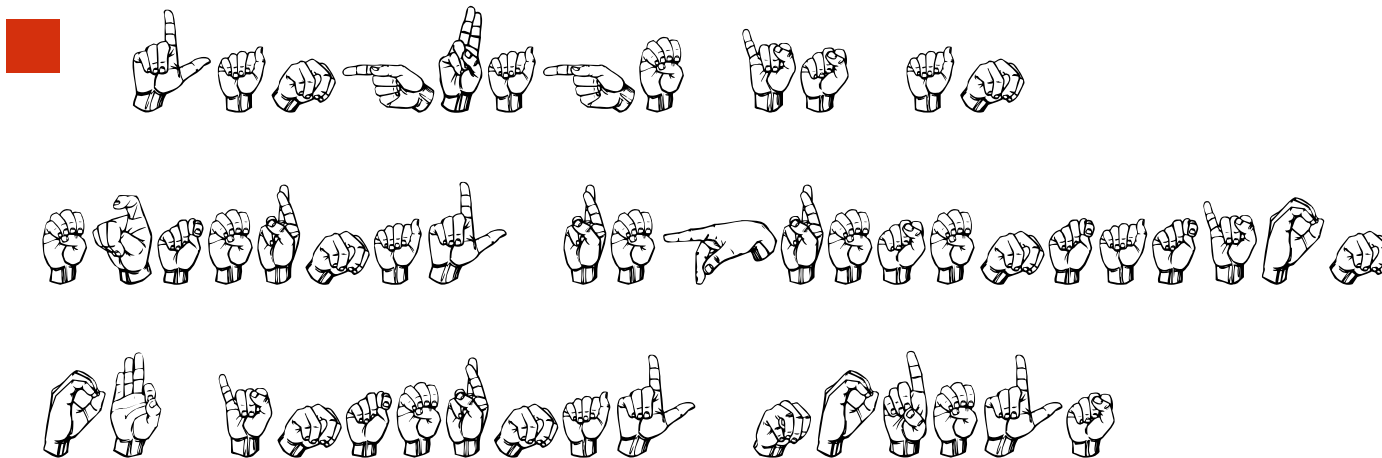
Communicative modalities: language

## Topics of the 3<sup>th</sup> & 4<sup>th</sup> lecture

- **Communicative modalities**
  - Language and sub-modalities
  - Linguistics: some basic definitions
  - The form and meaning of language
  
- **Representing language, gesture and mimics**
  - Meaning representation
  - Syntax-Semantics interface
  - Representation of gesture and mimics

# Introduction

- What is language?
  - Language is an external representation of internal models.
  - speech.rtf



## Overview

- What is language?
- What does a linguist study?
- What is represented by language?

## What is language?

- Language
  - is very complex.
  - is systematic and hence can be modelled via explicit rules.
  - deploys information of different kinds.
  - is highly ambiguous.
- Language is understood and produced by (almost) every human.
- Language is defined as a symbol system.

## More features

- Language is used as an external representation of objects, events, emotions and abstract entities.
- Language is temporally anchored: past, present and future tense.
- Language is productive: a limited number of sounds and symbols can be used to produce an unlimited number of messages

## Types of language

- Spoken language (=speech) is the primary and oldest form of language.
- Written language is a graphical-visual form of language, derived from speech.
- Sign language is a gesture-visual form of language.

## Speech vs. written language

<b>speech</b>	<b>written language</b>
continuously produced	discontinuously produced
Real-time production and perception	Time- and location-independent storage of information
Prosody and intonation	Emphasis via fonts
Perceived without visual input	Visually perceived
Dialogue; turn taking	Text; highly structured

## Modern linguistics

- Language can be described historically, sociologically or by the study of the literature.
- A new paradigm in Linguistics was introduced by Saussure (Structuralism):
  - **Langage**: ability to learn and use language
  - **Langue**: language as a normative system of symbols defined by rules and conventions
  - **Parole**: actual realisation
- Difference between performance and competence (Chomsky):
  - **Performance**: actual realisation of language by a speaker
  - **Competence**: (idealised) ability of the speaker to produce language with a limited number of elements and rules

## Focus on written language

- Linguistic research mainly concentrated on written language (langue):
- Linguistic data was based on intuition und grammaticality judgements (competence)
- The linguistic analysis of speech and naturally-occurring text has been neglected by the Structuralism approach to Linguistics.
- Hence
  - Data-driven linguistics (corpora) and
  - Dialogue and discourse analysis (intonation, coherence)
  - have gained increasing interest in recent years.
- However, a multi-modal approach to language is still in its infancy.

## What is studied in Linguistics?

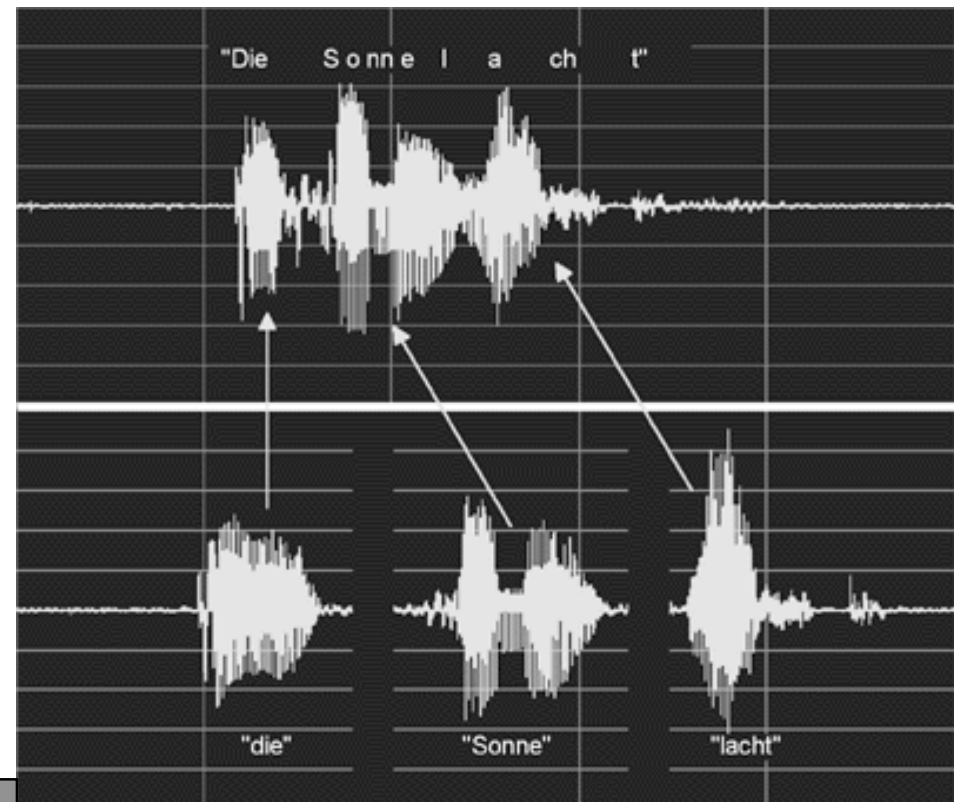
- Well-formedness of language (\*- ungrammatical ??-marked):
  - Syntax:
    - \*Peter Maria book gives a.
    - Peter gives Maria a book.
  - Semantics:
    - ??Peter eats a book.
    - Peter reads a book.
  - Discourse:
    - ??Peter gives Maria a book. She likes Spinach.
    - Peter gives Maria a book. She likes it.
  - Dialogue:
    - ??Can you tell me what time it is? Yes!
- There are other sub-areas in Linguistics: phonology, morphology, language acquisition etc.

# Speech processing

- Speech processing is concerned with
  - the study of speech signals and
  - the processing methods of these signals.
- Speech recognition deals with the identification of the words, hesitations (e.g. *ehm* ) etc. in a speech signal.
- Speech generation offers techniques for the artificial synthesis of speech.

Is not a focus of this lecture!

Die Sonne lacht

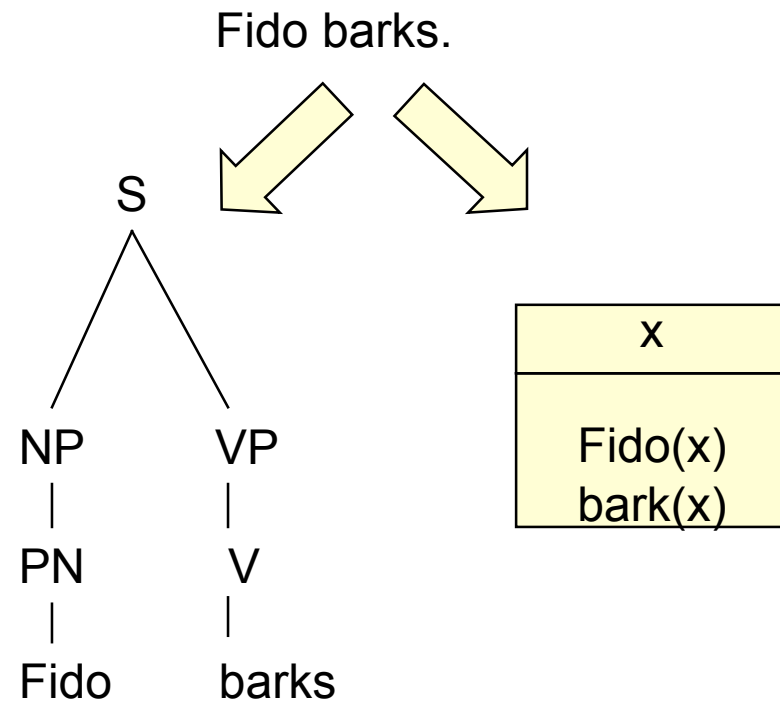


## The structure of language

- Dialogue
  - is less structured.
  - can contain ungrammatical sentences.
  - Contains many elliptical constructions (e.g. *Peter left...Mary, too.*).
- Text
  - is highly structured.
  - has to be coherent.
  - is created without an explicit reader in mind.

# Representation

- Language is analysed with respect to
  - The construction of sentences:
    - Via syntactic rules defined by a formal grammar
  - The meaning of words/sentences/texts/dialogues
    - Via truth conditions defined wrt. a model



# Model

- A model  $M = (D, F)$  consist of two parts:
  - A set of entities wrt. to the model (the domain  $D$ ).
  - A relation that defines how the symbols of the formal representation language should be interpreted (the interpretation function  $F$  ).
- Example:
- $D = \{d_1, d_2, d_3\}$
- The interpretation function may look like follows:
  - $F(\text{fido}) = d_1, F(\text{prinz})=d_2, F(\text{peter})=d_3$
  - $F(\text{dog})=\{d_1, d_2\}$ ,
  - $F(\text{human})=\{d_3\}$ ,
  - $F(\text{bark})=\{d_1\}$ ,
  - $F(\text{chase})=\{(d_1, d_3), (d_2, d_3)\}$ .

## Truth and models

- Having a model allows us to evaluate a sentence regarding its truth values.
- The sentence *Fido barks* may be true for one given model, but *Prinz barks* may not be true.
- *Truth-conditional semantics* provides a mechanism in order to say something about the truth conditions of sentence:
  - Fido barks. Fido and Prinz are dogs. Peter is a human. Fido and Prinz chase Peter.
  - *dog(Fido)* is true, but *dog(Peter)* is not.

## Modalities sub-modalities

- Language can be found with different sub-modalities:
  - Speech and listening is a vocal-auditive symbol system
  - Writing and reading is a graphical-visual symbol system
  - Gestures and seeing is a gesture-visual symbol system
- Well-formedness?
- Truth conditions?
- Combinations of these three systems?

# Ambiguity

- Language is highly ambiguous:

Written language:

- *Peter **read** a story.*
- *Mary wants to **read** a story.*

Speech:

- *Mary's bike is **red**.*

Syntactic Knowledge can help, but...

Ollie Octopus bumps into Sidney Squid one day,

"Hi Sidney, how are you?"

"Ab not too good really I hab a bit of a cold."

"That's just awful. Tell you what Sid, follow me."

And Sid does. They arrive at Wille Whales place where Ollie announces:

"Willie, here's the six quid I owe you".

Sick squid = six quid (=pound)

- Resolving references can be tricky:

- *Peter and Fido are in the park. He likes chasing sticks.*

- Who's he?

- World knowledge helps!

- Pointing gestures, gaze helps, too:

- *Martin knows the answer.*

## Sub-modalities and information structure

He's gone!  
He's gone?

Q: Who ate the cake?

A: **Peter** ate the cake!

A: \*Peter ate the **cake**!

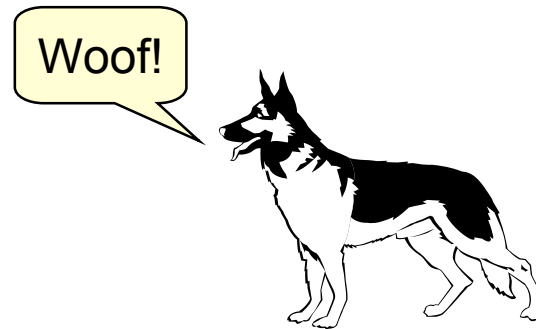
- Written language:
  - Statements and questions are marked by punctuation signs.
- Speech:
  - Intonation marks question or statement
- Prosody in particular interacts with information structure (given-new distinction)

## Conclusions

- Language can be analysed according to its form and meaning.
- Meaning can be represented via truth-conditional semantics based on a model.
- Written language and speech differ wrt. to the way they are produced and perceived.
- World knowledge, intonation, prosody can help to disambiguate ambiguous expressions.

## Exercise 3

- Are there other ways of representing meaning? What about pictorial representations?



Fido barks.

- Can you think of other combinations of modalities that help to disambiguate language?