

Multi-modal representation and communication

Lecture 3:

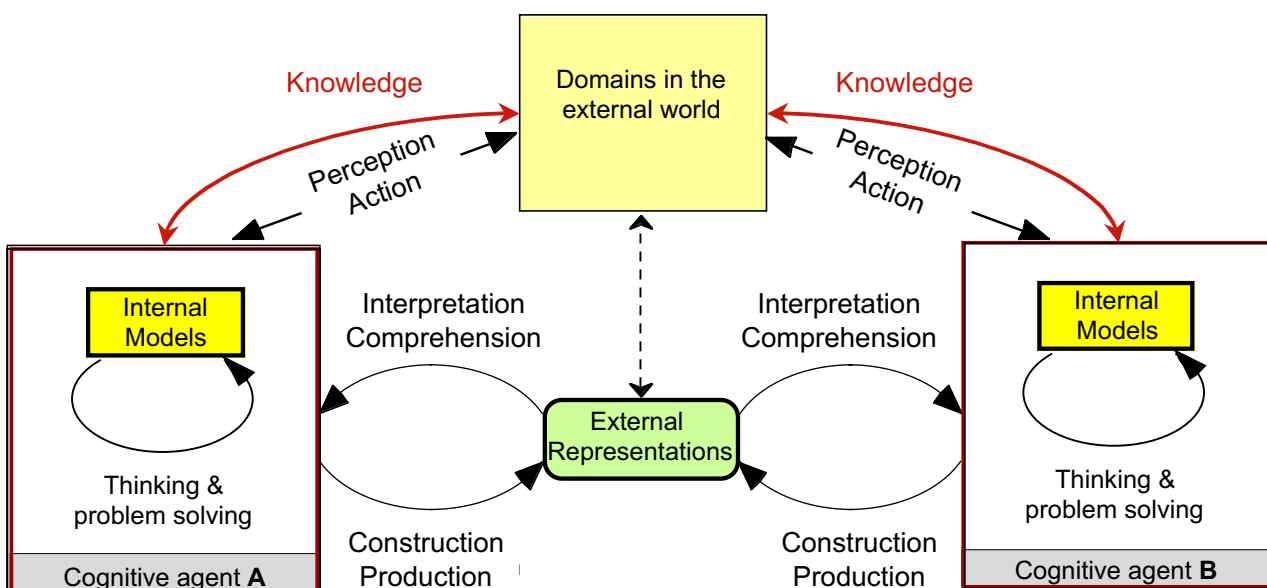
Towards a unified view on
representation and communication

Signs and symbols

Syntax – Semantics – Pragmatics

Linguistic and pictorial symbol systems

Perception, cognition & communication: Internal models and their relation to the external world



The core problems of content determination

Given an **external representation**:

- What is its meaning / content?
 - Relations to internal representations
 - Relations to the external world
- What are the processes to compute the meaning from the representation?
- Which prior knowledge is necessary / is used to compute the meaning?

Given an **internal representation**:

- What external representations exist to represent this content?
 - What are the processes to compute corresponding external representations?
 - How to decide between different external representations corresponding to one internal representation?
- How is the internal representation connected to the external world?

Grounding problem

Semiotics: An early “theory of representations”

Orientation towards **logics, philosophy and psychology**

- Charles Sanders Peirce (1839–1914)
- Charles W. Morris (1901-1979)

Orientation towards **language / linguistics**

- Ferdinand de Saussure (1857–1913)
- Charles Kay Ogden (1889–1957)
- Ivor Armstrong Richards (1893–1979)

Orientation towards **literature and arts**

- Umberto Eco (*1932)

Semiotics: References and further readings

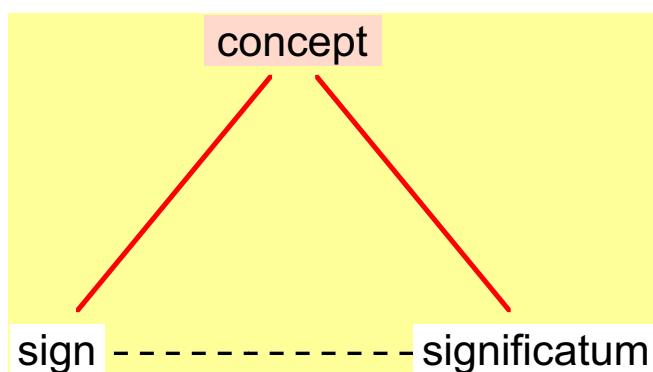
- Peirce, C. S. (1931–58). *Collected Papers*. Cambridge, MA: Harvard University Press.
- Saussure, F. de (1916). *Cours de linguistique générale*. Lausanne-Paris: Payot.
- Ogden, C.K. & Richards, I.A. (1923). *The Meaning of Meaning*. Routledge & Kegan Paul: London.
- Morris, C. (1938). *Foundations of the Theory of Signs*. University of Chicago Press: Chicago.
- Eco, U. (1976). *A Theory of Semiotics*. Bloomington, IN: Indiana University Press.
- Von Eckhardt, Barbara (1993). *What is Cognitive Science*. Cambridge, MA: MIT Press.
- Chandler, Daniel (1994): *Semiotics for Beginners* [WWW document] **URL**
<http://www.aber.ac.uk/media/Documents/S4B>

Classical texts

Semiotics & Cognitive Science

An introduction in the WWW

Signs and symbols: The semiotic triangle (1)

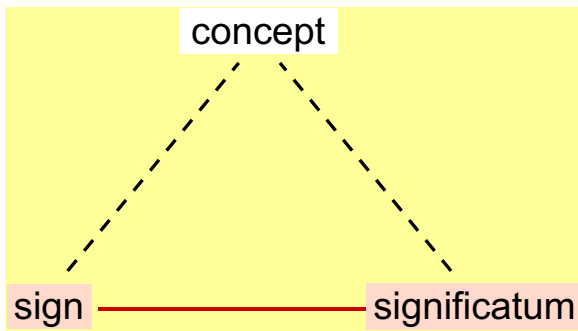


Tripartite structure of signs

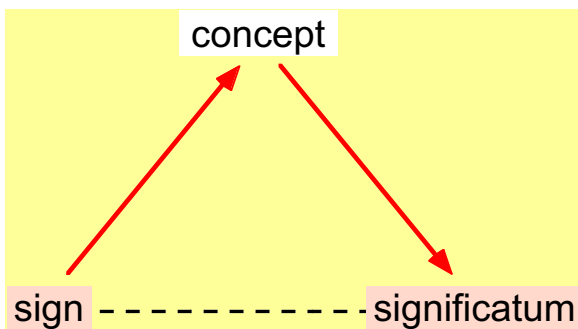
- Peirce
- Ogden & Richards
- Morris

- Scholastic Philosophy:
 - „vox significat [rem] mediantibus conceptibus“
 - „The word signifies [the thing] via mediating concepts.“
- significatum entities in the real / external world
- symbols / signs external representations
- concepts mental entities

Signs and symbols: The semiotic triangle (2)



- Reference: sign – significatum
 - (partially) arbitrary, but constrained by conventions
 - *Hund – dog*



- Symbols in a successful communication
 - Sender produces symbols
 - Receiver interprets symbols (induces concepts with relation to the significatum)

Peirce' theory of signs

Sign

- a *stimulus pattern* that has a *meaning*
- three types
 - **Icon** physically resembles what it 'stands for'.
 - **Index** is defined by some sensory feature, A, that correlates with and thus implies or 'points to' B, something of interest to an agent.
 - **Symbol** is an arbitrary pattern (usually a sound pattern in a language) that gets its meaning primarily from its mental association with other symbols.

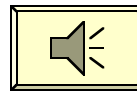
❖ Peirce' terms are often used today, but mostly not following his characterization.

Icons, indexes and symbols

- Words and sentences are **symbols**, e.g. 'open'
- Pictograms can be **iconic** or **symbolic**, or combinations



- EARCONs
 - are **indexes** not icons



open

Internal structure of symbols – complex symbols (1)

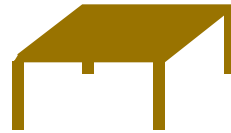
- **Syntax**
of systems of symbols / system of signs / languages
 - is based on an inventory / vocabulary / alphabet
 - determines the set of well-formed expressions
 - corresponds to semantics

➔ A **productive syntax** is the precondition for flexible communication:

- Large, possibly infinite, amount of information has to be communicated via a finite means of external representation.

Internal structure of symbols – complex symbols (2)

- Sentences of natural languages:
 - *Die Katze liegt auf dem Tisch.*
 - *Die Katze sitzt auf dem Tisch.*
 - *Die Katze sass auf dem Tisch.*
 - *Die Katze sitzt unter dem Couchtisch.*
 - *Die Siamkatze sitzt unter dem Bild.*
 - *Das Kind sitzt unter dem Bild.*
 - *Zwei Kinder sitzen unter dem Mondrian-Bild.*
- Noun phrase
 - Determiner
 - Numeral
- Verb
 - Tense
- Prepositional phrase
 - Preposition



Components of the language system

- Grammar = Knowledge of language consists of the following subsystems
 - Phonology: sound patterns
 - Morphology: internal structure of words
 - Syntax: structure of sentences / utterances
 - Semantics: meaning
- Lexicon
 - The basic inventory of language: *Lexems*
- Pragmatics
 - Meaning in context

Compositionality: Syntax – Semantics Correspondence (1)

- Language systems:
The meaning of a linguistic expression is determined by the meaning of its parts.

- Der 24. Dezember ist 2004 ein Freitag.



- day_of_the_week(24.12., Friday, 2004)
- IS_A (24.12.2004, Friday)

- $\lim_{n \rightarrow \infty} 1/n = 0$

Semantics and Pragmatics in Linguistics: Meaning & Content

Meaning of a sentence

- Context invariant
- Determined by the linguistic form
- Fundamental for the computation of the content

Content of an utterance

- Context dependent
- Processed by producer or recipient in a situation
- Depends on knowledge about linguistic meaning

➤ The construction of meaning is computation of complex representations.

Internal structure of symbols – complex symbols (3)

- Syntax of road signs (icons, pictograms):
 - color
 - shape
 - basic symbols
 constitute the meaning
- The meaning inventory:
 - Permission
blue (DE), green (US)
 - Regulation
circular (DE)
 - Prohibition
diagonal marking (DE), red (US)



Permission



Prohibition

Compositionality: Syntax – Semantics Correspondence (2)

- Pictograms: Road Signs
 - The ingredients:

P	parking
red	regulations
green	permission
↘	prohibition
← →	range

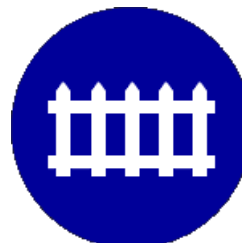


Components of the ~~language~~ ^{road sign} system

- Grammar = Knowledge of language consists of the following subsystems
 - ~~Phonology: sound path~~ *morphemes* \approx *iconic elements*
 - Morphology: internal structure of ~~words~~ pictograms
 - Syntax: structure of ~~sentences / utterances~~ combinations of road signs
 - Semantics: meaning
- Lexicon
 - The basic inventory of language: ~~Lexeme~~ *road signs*
- Pragmatics
 - Meaning in context

Exercise 5.a: Interpretation of road signs Germany before 1934

Characterize the syntax & semantics of the road sign system.



Exercise 5.b: Interpretation of road signs To be discussed in Lecture 4

Characterize the syntax & semantics of the US road sign system.



Topics of the 4th lecture

- Spatial-visual representations (cont'd): Maps
- Meaning and reference
 - Reference in communication
 - language
 - pictorial representations
 - Reference and perception