Slide 1

Grounded cognition

Language and simulation in conceptual processing

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Theories of knowledge representation

- Linguistically-motivated – amodal
  - Propositional structure via predicates, e.g. *sing*(*Maria,song*) (Newell & Simon 1972, Fodor 1975, Pylyshyn 1984)
  - Statistical distributions of linguistic forms (Landauer & Dumais 1997, Burgess & Lund 1997)
- Conceptually-motivated – (multi)modal
  - LASS (Barsalou et al., 2008),
  - Event-indexing model (Zwaan et al., 1995)

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Linguistic and conceptual systems

tokens (instances)

(Peirce, 1867)
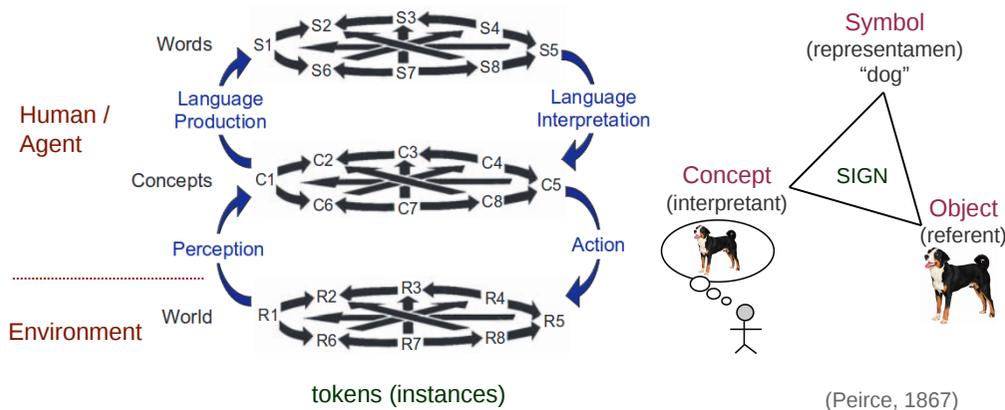
Abstract concepts do not have direct referents in the world.

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LASS theory of conceptual processing

What is a concept (in contemporary philosophy)? (wiki)
- abstract object (in Fregean sense),
- ability peculiar to a cognitive agent (mental state),
- mental representation (cognitive semantics)

→ Representation and processing of concepts relies on both language and situated simulation (focus on two representational systems).

→ LASS framework:
  1. linguistic processing
  2. situated simulation
  3. mixtures and interaction of language and situated simulation
  4. statistical underpinnings of language and situated simulation

Barsalou et al (2008). In *Symbols and Embodiment: Debates on Meaning and Cognition*. OUP.

LASS theory – sensitivity to statistics

Both systems are exquisitely sensitive to the statistical structure of their respective domains:

Simulation system (SS): simulators capture the statistical frequency of properties and the relation between them in experience.

Linguistic system (LS): frequency of words, associations between them and their relations to syntactic structures are coded statistically.

Statistical structures in the two systems roughly mirror each other.

Neural architecture naturally stores extensive amounts of statistical information.

Linguistic and conceptual processing in LASS

- Assumption: When a word is perceived, LS and SS become active initially, but representations of linguistic forms peak first.
- After the word is recognized, associated linguistic forms are generated as inferences and as pointers to associated conceptual information.
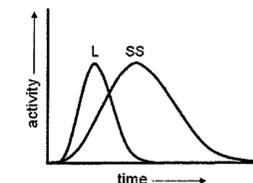

- Linguistic strategies are relatively superficial: may be sufficient for some tasks, when no retrieval of deeper conceptual information is necessary (e.g. lexical decision task).
- Meaning is largely represented in the simulation system.
- The two systems interact
- they are not modular systems

Mixtures of two systems – word association

Task: Receiving a word and generating associated words
- Linguistically related response
- Taxonomically related response
- Object–situation response
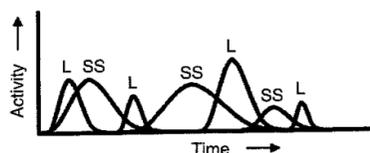
LASS predictions: (Santos et al, 2008)
- → Linguistically related responses are produced earlier than object-situation response.
- → Responses that are more likely to originate in LS occur earlier than responses that are more likely to originate in SS.
- → Taxonomic response falls halfway in between.

Mixtures of two systems – property generation

Task: Receiving a word and generating properties verbally (15 sec.)
- production of less linguistic response and more object-situation response
- linguistic response precedes object-situation response

Property generation with fMRI: (Simmons et al, 2008)

- → Word association localizer: activation in Broca's area, left inferior temporal gyrus and right cerebellum
- → Situation localizer: activation in the precuneus (part of superior parietal lobule) and right middle temporal gyrus
- → SS appears responsible for responses produced during the late phase of property generation.

Mixtures of two systems – property verification

Task: Receiving an object name and then verifying whether a subsequently presented property was *part* of the respective object.

- Linguistic strategy: assess whether the object and property word are associated: fast linguistic strategy
- Simulation strategy: part relation linking the object and property concepts must be found: slow simulation strategy

fMRI:

Related false trials force using simulation strategy: activation of left fusiform gyrus

Mixtures of two systems – Abstract concepts

Task: given an abstract word for 5 seconds and then verifying whether the concept applies to a subsequent picture (Wilson et al, 2008).
- e.g.: 'convince' – picture of a politician speaking to a crowd

Result:

'convince': activation of brain areas involved in representing mental states and social interaction (e.g. medial prefrontal cortex)

'arithmetic': activates brain areas involved in performing arithmetic operations (e.g. intraparietal sulcus)

- In both cases, SS involved, LS not more active than for concrete words.
- → When task condition requires deeper conceptual processing, participants rely on SS.

Representation of abstract concepts can differently recruit LS and SS.

Relation of LASS to earlier theories

- Paivio (1971) – dual-coding theory (of cognition)
  - assumes analogue (images) & symbolic (words) codes
  - partially consistent with LASS, since DCT
    - assumes deep processing in both systems
    - postulates LS as central
- Glaser (1992) – lexical hypothesis
  - LS can perform superficial processing independently of the conceptual system (i.e. LH)
  - Concetual system may not contain modal representations

Summary

- Conceptual system already evolved in nonhuman species
- Added value of (complex) linguistic processing in
  - producing compositional structures of simulations
  - communicating non-present situations
  - coordinated simulations (social organization)
- linguistic system = control system (?)
- nonlinguistic stimuli vs verbal cues
- Importance of statistical sensitivity
- None of the systems alone sufficient for symbolic behavior