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Grounded cognition

Symbol Interdependency Hypothesis

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Key terms and questions

- Terms:
  - *amodal*, *symbolic* and *linguistic* as antonyms for *modal*, *embodied*, and *perceptual* (De Vega et al., 2008)
  - usage: *symbolic = amodal linguistic*, *embodied = perceptual*

- Questions: Can computational algorithms
  1. extract meaning from language?
  2. advance theories of human cognition?

M. Louwerse: Symbol Interdependency in Symbolic and Embodied Cognition. *Topics in Cognitive Science,* 2010.

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Claims of the paper

1. Symbolic cognition account tends to place more emphasis on the algorithm than on linguistic regularities.
2. Embodied cognition account underestimates the importance of linguistics in general (meaning is modal in nature).
3. Embodied representations are directly mapped onto language *because* language encodes embodied relations.
4. Central claim: reminiscent of Deacon (1997): „The support for language comprehension and language production is vested neither in the brain of the language user, its computational processes, nor in embodied representations, but outside the user, the process, and the representation, in language itself."

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Symbolic cognition - LSA

- LSA goes beyond the simple word–context frequency matrix
- first-order (the same) vs higher-order (similar) co-occurrences
- many successful applications (better than keyword-based methods)
- Similarity estimates derived by LSA depend on a powerful mathematical analysis that is capable of correctly inferring much deeper relations.
- How is meaning extracted?
  - Landauer: via computational algorithm
  - Louwerse: from the language itself
  - these two options are not mutually exclusive

Arguments for embodied cognition

- Simple covariation of amodal symbolic patterns basically is not much more than a symbolic merry-go-round (Harnad, 1990).

- A wealth of experimental evidence exists that comprehension must go beyond symbol manipulation (e.g. Pulvermueller).

- Nonlinguistic representations are tightly coupled to language (Zwaan, Spivey,...)

- Amodal linguistic symbols must always activate embodied representations whose meshing only constitutes meaning (Glenberg, 1997).

Symbol interdependency hypothesis

- Proposal: language comprehension is both embodied and symbolic

- SIH emphasizes the importance of the language structures, without discarding the notion of symbol grounding.

- Prediction: language encodes perceptual information

- SIH has implications for both accounts:
  - Symbolic: LSA results can be obtained from language surface structure as well
  - Embodied: results attributed to perceptual simulations can be traced back to language itself.

- shallow (underspecified and incomplete, typical) and deep (opposite) language processing (Louwerse & Jeuniaux, 2010)

SIH relations

- based on hierarchy of signs (Deacon, 1997) ← semiotic theories (Peirce, 1923)

- humans as symbolic species, can make link b/w symbols (Deacon, 1997)

- SIH is related to Construction Integration model (Kintsch, 1998), but it does not emphasize propositional (but surface) structure

- Similar to Dual Coding theory (Paivio, 1971, 1986)
  - Levels of meaning: representational, referential, associative

- Similar to perceptual symbols theory (Barsalou, 1999)

- SIH assumption: (1) language encodes perceptual information and (2) language users make use of these linguistic cues.

- Evidence?

Evidence for SIH

- Language might in fact not be as arbitrary as the embodied cognition account suggests (Christiansen & Chater, 2008):

- Short words tend to describe objects and events that are frequent (Zipf, 1935).

- Cross-linguistically, phonological features alone can determine grammatical category (Monaghan, Chater, and Christiansen, 2005).

- Human ability to detect the difference between real and unreal language – different activation in Broca's area (Musso et al., 2003)

- shift from syntagmatic to paradigmatic relations (in development)

- incidental statistical learning (Saffran, Newport, ...)

- Even when there are no statistical regularities in incoming information, humans try to find a pattern.

Semantic regularities in language

- LSA vs first-order methods

- Strength of LSA lies in extracting meaning from small texts, whereas first-order co-occurrences fail because of data sparsity.

- LSA analysis is covert, whereas a word co-occurrence analysis is overt

- If humans are exposed to a large amount of language, then statistical learning humans can rely, in theory, on the surface structure of language.

- Example might indicate that language (exposure 200–500 mil. word tokens) overtly encodes some of the relations that LSA reveals in a latent analysis.

Semantic regularities in language (ctd)

- Categorization of semantic knowledge

- computational model that simulates (the emergence of) human categorization of concepts (Rogers and McClelland, 2004, 2008)

- Similar to LSA – if origin of features is irrelevant

- LSA categorization analysis: two findings

  1. First-order co-occurrence analyses yielded very similar results as the LSA analyses.
  2. Perceptual features assigned to verbal descriptors yielded a grouping of concept categories.

- That is, language encodes categorization information that first-order co-occurrence techniques can visualize as well as LSA.

Perceptual information in language

- Argument: Embodied cognition results obtained using linguistic stimuli should also be considered from a symbolic cognition perspective.

- Modality switching

- Affordances

- Iconic relations

- Geographical information

- Motor resonance (cues for motor affordances)

- … all encoded in language

Discussion

- According to SIH, meaning can be induced by symbol grounding, as well as by bootstrapping meaning through relations between the symbols themselves.

- Bootstrapping process is facilitated by language having encoded embodied information.

- Proposal for an alternative to SGP: „you know some basics of the language, then symbolic cognition helps to bootstrap meaning that is obtained through embodied cognition (because humans are skilled at picking up linguistic regularities that encode embodied relations)."

- An embodied component should not be abandoned altogether, but neither should a symbolic component. The two are mutually reinforcing.